COURSE CONTENTS 2021-22

FACULTY OF SCIENCE

UNIVERSITY OF PERADENIYA

COURSE CONTENTS

2021/2022

Faculty of Science

University of Peradeniya

FACULTY OF SCIENCE
UNIVERSITY OF PERADENIYA

Historical Background

The University of Peradeniya is the legacy of the University of Ceylon first established in Sri Lanka in 1942. The Faculty of Science, comprising the Departments of Botany, Chemistry, Mathematics, Physics and Zoology were initially located in Colombo along with other Faculties of the University of Ceylon. It had been decided to have the permanent home of the University in Peradeniya and accordingly, the Faculty of Arts, Oriental Studies, Law, Agriculture, Veterinary and Dental Sciences were established at Peradeniya by the early part of the 1951-60 decade.

In 1961, the buildings of the Faculty of Science were made available at Peradeniya and the admission of the first batch of students took place in the 1961 –62 academic year. In order to accommodate the increasing demand for science education in the country the Faculty of Science in Colombo was allowed to form a second Faculty in Peradeniya and a part of the staff from the Colombo Faculty moved to Peradeniya Faculty at the early stages, while the latter gradually built up the staff by direct recruitment. Both branches of the Faculty functioned under common administration at each of the levels of department and faculty, with common curricula and examinations. In 1967 those segments of the University of Ceylon which were situated in Colombo were constituted as a separate and independent University. Thus, the second Faculty of Science at Peradeniya comes into being on its own, as the Faulty of Science, University of Ceylon, Peradeniya.

Faculty Vision

To become a globally recognized faculty for excellence in education and research contributing towards the development of a scientifically literate community while adhering to moral and ethical principles

Faculty Mission

To inculcate scientific literacy, quantitative proficiency, as well as moral and ethical values in students through outcome-based learning within a conducive environment to promote excellence in innovative research and outreach activities that inspire solutions to societal and environmental challenges

Content

		Page No.
1.	Department of Botany	
	1.1 Botany Course Modules	1
	1.2 Microbiology Course Modules	23
2.	Department of Chemistry	
	2.1 Chemistry Course Modules	39
3.	Department of Environmental & Industrial Sciences	
	3.1 Environmental Science Course Modules	65
	3.2 Applied Sciences Course Modules	82
4.	Department of Geology	
	4.1 Geology Course Modules	97
5.	Department of Mathematics	
	5.1 Mathematics Course Modules	118
6.	Department of Molecular Biology & Biotechnology	
	6.1 Molecular Biology & Biotechnology Course Modules	141
7.	Department of Physics	
	7.1 Physics Course Modules	156
8.	Department of Statistics & Computer Science	
	8.1 Computer Science Course Modules	193
	8.2 Data Science Course Modules	212
	8.3 Statistics Course Modules	227
9.	Department of Zoology	
	9.1 Zoology Course Modules	243
	9.2 Biomedical Science Course Modules	261
10.	Supplementary Course Modules	276
11.	Statistics & Operations Research Course Modules	281
12.	Non-GPA Courses	
	12.1 English Courses	310
	12.2 Other Non-GPA Courses	312
13.	Inter-faculty Courses	315

PRINCIPAL SUBJECT AREA

Each department will use a three-letter prefix together with a four-digit number to identify the course units offered by that department. The first three letters will indicate the subject area while the first digit and the last digit of the four-digit number will indicate the level and the credit number, respectively.

Course Code	Department/s Offering the Course
BIO	Botany, Zoology, Molecular Biology & Biotechnology
BMS	Zoology
BOT	Botany
CHE	Chemistry
CSC	Statistics & Computer Science
DSC	Statistics & Computer Science
ENS	Environmental & Industrial Sciences
GEO	Geology
MAT	Mathematics
MIC	Botany
MBB	Molecular Biology & Biotechnology
PHY	Physics
STA	Statistics & Computer Science
ZOO	Zoology

1. DEPARTMENT OF BOTANY

1.1 Botany Course Modules

1000 LEVEL – BIOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Bio.*	**Bio.****
BIO1012	Cell Biology and Genetics	2		√	√
BIO1072	Introductory Microbiology	2		√	√
BIO1152	Biomolecules and their Applications	2			√
BIO1192	Tropical Ecosystems	2			√
Total		**08**		**04**	**08**

2000 LEVEL – BOTANY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
BOT2012	Algae and Fungi	2		√	√
BOT2022	Evolution and Diversity of Land Plants	2	BOT2012	√	√
BOT2032	Angiosperm Morphology and Anatomy	2			
BOT2042	Plant Water Relations and Nutrition	2		√	√
BOT2052	Photosynthesis and Respiration	2			
BOT2062	Microbial Ecology and Functions	2		√	√
BOT2072	Microbial Genetics	2			
BOT2082	Biodiversity Conservation and Management	2			
BOT2092	Food Chemistry and Technology	2			
Total		**18**		**08**	**08**

3000 LEVEL – BOTANY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
BOT3012	Bioinstrumentation	2			
BOT3022	Plant Metabolites	2		√	
BOT3032	Plant Systematics	2		√	√
BOT3042	Plant Pathology	2		√	√
BOT3052	Quantitative Plant Ecology	2			
BOT3062	Enzymes: Concepts to Applications	2	BIO1012		
BOT3072	Plant Quantitative and Applied Genetics	2		√	
BOT3082	Biostatistics	2		√	
BOT3092	Soil Fertility and Management	2			
BOT3102	Developmental Physiology and Postharvest Technology	2			
BOT3112	Microbiological Applications	2		.	

BOT3122	Biotic Interactions and Applications	2			
BOT3132	Plants, Life and Skills	2			
BOT3142	Effective Scientific Communication	2		√	√
BOT3152	Food Engineering and Nutrition	2			
Total		**30**		**12**	**06**

4000 LEVEL - BOTANY				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Comments**
				Hons.
BOT4012	Plant Systematics and Phylogenetics	2	BOT3032	
BOT4022	Plant Stress Physiology	2		
BOT4032	Phytogeography	2		
BOT4042	Advanced Plant Pathology	2	BOT3042	
BOT4053	Dynamic Plant Ecology	3	BOT3052	
BOT4062	Cryptogamic Botany	2		
BOT4072	Advanced Topics in Biochemistry	2		
BOT4082	Forest Management	2		
BOT4092	Diazotrophs and Sustainable Soils	2		
BOT4102	Physiology and Management of Ornamental Plants	2		
BOT4112	Toxicology	2		
BOT4122	Seed Biology and Technology	2		
BOT4132	Ecological Restoration	2		
BOT4142	Molecular Genetics: Genes to Function	2	BOT3072	
BOT4151	Herbarium Techniques	1		√
BOT4998	Research Project	8		√
SCI4003	Industrial Training	3		
Total		**41**		**09**

1000 Level Courses

Course Code	**BIO1012**
Course Title	**Cell Biology and Genetics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Cell Biology–Chemical and Physical Background: Microscopic techniques, Chemical nature of life, Biophysical principles, Prokaryotic and eukaryotic cells, Cellular organization, Animal and plant cell and tissue types; Structure and function of cell membranes; Cellular organelles and membrane trafficking; Cytoskeleton and cellular motility; Protein synthesis and folding; Cell cycle; Programmed cell death. Scientific method.
Genetics–Genome organization in virus, prokaryotes and eukaryotes. Central dogma (from gene to protein); Flow of genetic information. Mendelian genetics and deviations. Vertical vs. horizontal gene transfer. Genetic recombination. Linkage analysis and genetic maps. Polygenic inheritance. Sources of variation. Natural selection and genetics of speciation. GMOs and national biosafety framework.
Laboratory exercises based on above topics.

Recommended Texts

- Klug, W.S.C., Palladino, M.R., Spencer, M.A., & Klug, C.A.W.S. (2016). *Essentials of Genetics* (9^{th} Edition or later). Boston, MA: Pearson.
- Klug, W.S., Cummings, M.R., Spencer, C.A., & Palladino, M.A. (2015) *Concepts of Genetics* (11^{th} Edition or later). Boston, MA: Pearson.
- Pierce, B.A. (2013) *Genetics: A Conceptual Approach* (5^{th} Edition or later). Freeman.
- Pollard, T.D., Earnshaw, W.C., Lippincott-Schwartz, J. & Johnson, G.T. (2016). *Cell Biology* (3^{rd} Edition or later). Philadelphia, PA: Elsevier.
- Raven, P.H., Singer, S., Mason, K.A., Johnson, G.B. & Losos, J. (2016). *Biology* (11^{th} Edition or later). New York, NY:McGraw-Hill Education.
- Urry, L.A., Reece, J., Cain, M.L., Minorsky, P.V. & Wasserman S.A. (2016). *Campbell Biology* (11^{th} Edition or later). Boston, MA: Pearson.

Course Code	**BIO1072**
Course Title	**Introductory Microbiology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to microorganisms: history, discovery and diversity. Classification and major groups of microorganisms. Microbial cell structure and function. Growth cycle of microorganisms. Distribution and involvement of microorganisms in different environments: Applications of microbes. Microorganisms in biotechnology. Microbial techniques: Microbiological equipment and safety procedures; Sterile techniques - culturing, isolation and purification; characterization and identification of microorganisms. Laboratory exercises based on the above topics.

Recommended Texts

- Madigan, M.T., Martinko, J.M., Bender, K.S., Buckley, D.H. and Stahl, D. (2014). *Brock Biology of Microorganisms* (14^{th} Edition or later). Benjamin Cummings.
- Cappuccino, J.G. and Sherman, N. (2010). *Microbiology: A Laboratory Manual* (9th Edition or later). Benjamin Cummings.
- Willey, J.L., Sherwood. L. and Woolverton, C.J. (2017). *Prescott's Microbiology* (10^{th} Edition or later). McGraw-Hill.

• Tortora, G.J., Funke, B.R. and Case, C.L. (2008). *Microbiology An Introduction* (5th Edition or later) Benjamin Cummings Publishing Company.

Course Code	**BIO1192**
Course Title	**Tropical Ecosystems**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Tropical environment and climate: Geographic distribution, structure and function of tropical ecosystems, Types of tropical ecosystems: Aquatic (Fresh water, Maritime, Marine) and Terrestrial (Forests and Grasslands) ecosystems, Species adaptations to different environments, Role of biotic interactions in maintaining a sustainable ecosystems Ecosystem services, Challenges for conservation, Conservation outlook for the tropics. Field excursions and laboratory exercises based on above topics.	
Recommended Texts	
• Osborne, P.L. (2010). *Tropical Ecosystems and Ecological Concepts* (2nd Edition or later). Cambridge University Press, UK, Pp. 536. • Aguirre, A.A. and Sukumar, R. (2016). *Tropical Conservation: Perspectives on Local and Global Priorities* (1st Edition or later). Oxford University Press, UK, Pp. 520. • Spadling, M., Kainuma, M. and Collins, L. (2010). *World atlas of mangroves.* Earthscan, UK, Pp. 304.	

Course Code	**BIO1152**
Course Title	**Biomolecules and their Applications**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Essential classes of biomolecules- nucleic acids, proteins, fatty acids & lipids and carbohydrates; structure and functions; chemistry, properties and interactions of biomolecules; applications of biomolecules – industrial, agricultural and medicinal applications, biotechnological applications; biomolecules and health. Laboratory exercises on identification of biomolecules, presence of biomolecules in nature and industrial products, basic techniques of biotechnology.	
Recommended Texts	
● Buchanan, B.B., Guissem, W. and Jones, R.L. (2015). *Biochemistry and Molecular Biology of Plants* (2nd Edition or later). American Society of plant Physiologists. ● Stick, R.V. and Williams, S.J. (2009). *Carbohydrates,the Essential Molecules of Life* (2nd Edition or later). Elsevier Ltd. ● Nelson, D.L. and Cox, M.M. (2017). *Lehninger Principals of Biochemistry* (7th Edition or later). H.W. Freeman and Company. ● Berg, J., Tymoczko, J.L. and Stryer, L. (2002). *Biochemistry* (5th Edition or later). H.W. Freeman and Company. ● Wilson, K. and Walker, J. (2005). *Principals and Techniques of Biochemistry and Molecular Biology* (6th Edition or later). Cambridge University Press.	

2000 Level Courses

Course Code	BOT2012
Course Title	Algae and Fungi
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Diversity of fungi and algae and their evolutionary position. Nomenclature and modern classification systems, range of form, reproduction and life cycles with reference to type examples. Importance of fungi and algae in nature, conservation and sustainable utilization; bio-deterioration, medicine, agriculture and industry. Laboratory exercises based on above topics.

Recommended Texts

- David M.J. (2002). *The Freshwater Algal Flora of the British Isles: An Identification Guide to Freshwater and Terrestrial Algae, Volume 1*. David M.J., Brian A.W, Alan J.B. Cambridge University Press.
- Edward G. B. andDavid C.S. (2010). *Freshwater Algae: Identification and Use as Bioindicators.* John Wiley & Sons, Ltd.
- Leonel P. and Joao M.N. (2014).*Marine Algae: Biodiversity, Taxonomy, Environmental Assessment, and Biotechnology*. CRC Press.
- Dugan, F.M. (2006). *The identification of fungi: an illustrated introduction with keys, glossary & guide to literature.* American Phytopathological Society.
- Petersen, J.H. (2013). *The kingdom of fungi*.Princeton University Press, USA.

Course Code	BOT2022
Course Title	Evolution and Diversity of Land Plants
Credit Value	2
Pre-requisites	BOT2012
Compulsory/Optional	Compulsory

Course Content

Origin of land plants. Morphological diversity, molecular based classification systems and evolution of the major groups of land plants; bryophytes: bryophytes, pteridophytes, gymnosperms and angiosperms. Ecological and economic importance of major groups of land plants.
Laboratory exercises based on above topics.

Recommended Texts

- Vanderpoorten, A. and Goffinet, B. (2009). *Introduction to Bryophytes*. Cambridge University Press.
- Mehltreter, K., Walker, L. R. and Sharpe, J. M. (2010). *Fern Ecology*. Cambridge University Press.
- Sharma, O. P. (2012). *Pteridophyta*. Tata McGraw-Hill Education
- Graham, L. E. and Wilcox, L. W. (2009). *Algae* (2^{nd} Edition or later). Benjamin Cummings (Pearson), San Francisco, CA.
- Anderson, J. M., Anderson, H.M. and Cleal, C. J. (2007). *Brief history of the gymnosperms: classification, biodiversity, phytogeography and ecology*. Strelitzia 20. South African National Biodiversity Institute, Pretoria

Course Code	**BOT2032**
Course Title	**Angiosperm Morphology and Anatomy**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Morphology of roots stems and leaves of angiosperms. Reproductive morphology. Embryogenesis, apical meristems and their derivatives, morphogenesis and differentiation. Classification and organization of plant tissues and tissue systems; ground, vascular and dermal tissue systems. Structure and development of root and shoot, leaf anatomy; trichomes, secretory structures; secondary growth, anamolous growth, periderm and wood anatomy. Applications of plant anatomy in different disciplines.
Laboratory exercises based on above topics.

Recommended Texts

- Beck, C.B. (2011). *An introduction to plant structure and development. Plant anatomy for the Twenthy-first Century* (2nd Edition or later). Cambridge: Cambridge University Press
- Evert, R.F. (2006). *Esau's Plant Anatomy. Meristems, Cells and Tissues of the plant body: their structure, function and development* (3rd Edition or later). New Jersey: John Wiley & Sons, Inc.
- Panday, S.N., and Chadha, A. (1993). *A text book of botany (Plant anatomy and economic botany).* VIKAS ® Publishing House (Pvt Ltd.).

Course Code	**BOT2042**
Course Title	**Plant Water Relations and Nutrition**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Plant water relations: concept of water potential and its measurements; active and passive absorption of water; overview of soil-plant-atmospheric continuum; water regulation in seed dormancy; aquaporins. Stomatal physiology and morphology. Plant nutrition: transport of solutes across membrane barriers; essential nutrients in plants; nutrient solutions and diagnosis of deficiency symptoms.
Laboratory exercises based on above topics.

Recommended Texts

- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2014). *Plant Physiology and Development*(6th Edition or later).Sinaur Associate Inc, Sunderland, USA.
- Hopkins, W.G. and Huner, N.P.A. (2008). *Introduction to Plant Physiology*. John Wiley and Sons, New York.
- Salisbury, F.B. and Ross, C.W. (1996). *Plant Physiology*. Wadsworth Publishers, London.
- Kirkham, M.B. (2014). *Principals of Soil and Plant Water Relations*. Academic Press, London.
- Marschner, H. (2011). *Marschner's Mineral Nutrition of Higher Plants*. Academic Press, London.

Course Code	**BOT2052**
Course Title	**Photosynthesis and Respiration**
Credit Value	**2**
Pre-requisites	**None**

Compulsory/Optional	Compulsory
Course Content	
Photosynthesis as the energy conversion process in plants, photosynthetic electron transport, mechanism of photophosphorylation. Fixation of carbon dioxide, C3 PCR cycle, C2 photo respiratory carbon oxidation cycle, CO_2 concentrating mechanisms, C4 photosynthetic carbon assimilation cycle, CAM. Gluconeogenesis, Synthesis of sucrose and starch, Plant respiration, glycolytic pathway, tricarboxylic acid cycle, electron transport and ATP synthesis. Cyanide-resistant pathway of respiration. Regulation of energy metabolism Laboratory exercises based on above topics.	
Recommended Texts	
• Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2014). *Plant Physiology and Development* (6^{th} Edition or later). Sinaur Associate Inc, Sunderland, USA. • Hopkins, W.G. and Huner, N.P.A. (2008). *Introduction to Plant Physiology*. John Wiley and Sons, New York. • Öpik, H., Rolfe, S.A. and Willis, A.J. (2005). *The Physiology of Flowering Plants*. Cambridge University Press. • Hans Walter Heldt and Birgit Piechulla (2011). Plant Biochemistry (4^{th} edition or later). Elsevier.	

Course Code	BOT2062
Course Title	**Microbial Ecology and Functions**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Microbes in their habitats and functions: microbes in food and water: food spoilage, food preservation, probiotics and food-borne diseases; water pollution, water-borne disease, coliform bacteria (molecular techniques in identification), sanitary water analysis, and water purification; microbes in air: distribution and disease transmission; microbes in soil: estimation, distribution, role in nutrient cycling; rock inhabiting and endolithic microbial communities, biogeochemistry, applied biogeochemistry: bioremediation. Techniques to study microbial communities and functions in their habitats: metagenomics, index of *microbial air* contamination (IMA); SAS PCR. Laboratory exercises and industrial visits based on above topics.	
Recommended Texts	
• Paul, E. (2014). Soil Microbiology, Ecology and Biochemistry (4th Edition). Academic Press. • Coleman, D., Callaham, M. and Crossely D. Jr. (2017). Fundamentals of Soil Ecology (3rd Edition). London: Academic Press. • Van Elsas, J.D., Trevors, J.T., Rosado, A.S. and Nannipieri, P. (2019). Modern Soil Microbiology (3rd Edition). CRC Press.	

Course Code	BOT2072
Course Title	**Microbial Genetics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Microbial genomes: structure; organization; stability and evolution. Gene expression and regulation. Extra chromosomal inheritance. Horizontal gene transfer. Genetic recombination and gene mapping. Phage growth &	

genetics. DNA mutagenesis and repair. Antibiotics. Vaccines. Genetic analysis of bacteria and fungi. Microbial applications in Biotechnology. Laboratory sessions based on above topics.
Recommended Texts
• Lehninger, L., Nelson, D. L. and Cox, M. M. (2017), Principles of Biochemistry, 7th edition, W.H. Freeman. • Stryer, L. (2015), Biochemistry, 8th edition, W.H. Freeman. • Voet, D. and Voet, L. G. (2011), Biochemistry, 4th edition, John Wiley.

Course Code	**BOT2082**
Course Title	**Biodiversity Conservation and Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to biodiversity; Global and national biodiversity estimates; Importance of biodiversity: tangible benefits, ecosystem services including carbon sequestration and hydrological facets, ethical and aesthetic aspects; Cultural diversity and indigenous knowledge; Ecosystem valuation; Measuring biodiversity; Loss of biodiversity; Threats to biodiversity; Biodiversity conservation: Setting conservation priorities; *In situ* and *Ex situ* conservation, Sustainable management, Environmental education, Conservation through legislation; Sustainable development: Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA), Management plan, Strategic Environmental Assessment (SEA), and Environment audits, Ecotourism; International conventions on biodiversity; National legislation related to biodiversity conservation; Laboratory and field exercises/field visits related to above topics.	
Recommended Texts	
Wood, A., Stedman-Edwards, P. and Mang, J. (Eds.). (2000). *The root causes of Biodiversity loss*. Earthscan Publications Ltd., U.K. Ghazoul, J. and Sheil, D. (2010). *Tropical Rain Forest Ecology, Diversity, and Conservation.* Oxford University Press. Bolen, E.G. and Robinson, W. (2002). *Wildlife Ecology and Management*. Benjamin Cummings. Ann E. Maugurran. 1987. Ecological Diversity and its Measurement Chapman and Hall, UK. Sutherland, W.J. (2000). *The Conservation Handbook*. Blackwell Science. P 1-273.	

Course Code	**BOT2092**
Course Title	**Food Chemistry and Technology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Chemistry of Food: Introduction to Food Science and the food Industry; Basic food chemistry: definitions for food components, carbohydrates proteins, lipids, vitamins and minerals; food additives; Properties and significance of constituents of food; Analytical techniques in food biochemistry: sampling techniques, biochemical tests, Gas chromatography (GC), high performance liquid chromatography (HPLC), spectroscopic methods, and proximate analysis of food. Food Technology: Fruit and vegetable technology: physical, chemical and biological methods used in preservation, common unit operations; Functional properties of food; Post harvest handling of fruits and vegetables; Grain technology: Cereals and pulses-composition, structure, effect of processing; Microbes and enzymes in food industry; Food of animal origin: problems associated with keeping quality of meat, fish, eggs and milk; Genetically modified crops; Laboratory work based on above topics.	

Recommended Texts
• Nollet, L.M., Toldrá, F., Benjakul, S., Paliyath, G. and Hui, Y.H. (2012). *Food biochemistry and food processing.* John Wiley & Sons. • Finley, J.W., Hurst, W.J. and Lee, C.Y. (2018). *Principles of Food Chemistry* (4^{th} Edition or later). Cham, Switzerland: Springer. • Nielsen, S.S. (2017). *Food analysis laboratory manual* (3^{rd} Edition or later). Cham, Switzerland: Springer. • Nielsen, S.S. (2017). *Food analysis* (4^{th} Edition or later). Cham, Switzerland: Springer. • Fellows, P.J. (2018). *Food processing technology: principles and practice*. (4^{th} Edition or later). Elsevier.

3000 Level Courses

Course Code	**BOT3012**
Course Title	**Bioinstrumentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Visual Techniques: Microscopic techniques, X-Ray Diffraction (XRD); Soil and Plant Analytical Techniques: Kjeldahl, UV-VIS Spectrophotometer, Atomic Absorption Spectrophotometer (AAS), FTIR, Atomic Emission Spectrophotometer (AES), Mass Spectroscopy; Chromatographic Techniques: Paper, Flash and Column Chromatography, TLC, HPLC and GC; Use of isotopes in Plant Research; Molecular Techniques: Molecular markers, PCR, AFLP, RAPDs, RFLP, SSR, DNA Sequencing and related software and techniques; Other instruments: pH meter, Electrical Conductivity Meter, Porometer, Hypsometer, Pulse Amplitude Modulated (PAM) Fluorometer. Precision, calibration and trouble-shooting. Laboratory exercises based on the above topics.	
Recommended Texts	
● Heftmann, E. (Ed.) (2004). *Chromatography: Fundamentals and applications of chromatography and related differential migration methods - Part A: Fundamentals and techniques* (6^{th} Edition or later). Elsevier Science ● Hollas, J.M. (Ed.) (2004). *Modern Spectroscopy* (4^{th} Edition or later). John Wiley & Sons Ltd. Stefan, S. (2000). *Basic techniques in molecular biology*. Springer Publications.	

Course Code	**BOT3022**
Course Title	**Plant Metabolites**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Metabolism of carbohydrates, lipids and proteins; their role in plants, human nutrition and industry. Biosynthesis of secondary metabolites and their interrelationship with primary metabolism. The role of secondary metabolites in plants, human health and industry. Plant metabolic engineering and pathway discovery. Laboratory exercises based on above topics.	
Recommended Texts	

• Lehninger, L., Nelson, D.L. and Cox, M.M. (2017). *Principles of Biochemistry* (7th Edition or later). W.H. Freeman. • Stryer, L. (2015). *Biochemistry* (8th Edition or later). W.H. Freeman. • Taiz, L. and Zeiger, E. (2010). *Plant Physiology* (5th Edition or later). Sinauer Associates, Inc., Massachusetts.

Course Code	**BOT3032**
Course Title	**Plant Systematics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to plant systematics, taxonomic hierarchy, plant identification, plant nomenclature, systems of classification, phenetics and cladistics, Molecular-based Angiosperm Phylogeny Group classification system/s (APG), origin & evolution of Angiosperms, characters; plant collection, herbarium techniques and management; taxonomic keys; Characters of selected families. Laboratory exercises based on above topics	
Recommended Texts	
• Stace, C.A. (1993). *Plant taxonomy and biosystematics*. Cambridge University Press, U.K. • Judd W. S., Campbell C.S., Kellogg E.A., Stevens, P.A. and Donoghue, M.J. (2016). *Plant Systematics: A Phylogenetic Approach.* Sinauer Associates Inc. • Simpson, M. (2010). *Plant Systematics*. Academic Press.	

Course Code	**BOT3042**
Course Title	**Plant Pathology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Plant Pathology. Causes of plant diseases. Infection process. Mechanism of symptom development, fungal pathogenesis. Plant-pathogen interactions. Plant defence responses: constitutive and inducible defences, Systemic Acquired Resistance (SAR). Diseases in economically important crops. Diagnosis of plant diseases and control. Plant quarantine. Molecular techniques in Plant Pathology. Laboratory exercises based on above topics.	
Recommended Texts	
• R.S. Singh (2018). *Plant Diseases* Oxford & Ibh Publishing Company Pvt Ltd., India • *Diagnostic manual for plant diseases in Vietnam* (2008). ACIAR, Canberra • Agrios, G.N. (2005). *Plant Pathology* (5th Edition or later). UK: Elsevier Academic Press	

Course Code	**BOT3052**
Course Title	**Quantitative Plant Ecology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content
Plant communities; Importance of vegetation measurements; physiognomic/structural data (Raunkiaer classification for plant habits, leaf size classes, Species abundance, vegetation structure, vegetation cover); Floristic data: Community sampling methods, Determining the sample number and size of quadrat; Measures of species abundance: Frequency, Density, Cover, Basal Area, Biomass, Relative measures; Advantages and disadvantages of using aforementioned different methods in vegetation studies; Introduction to Ordination; Field and laboratory exercises based on the above topics.
Recommended Texts
● Martin, K. (2011). *Vegetation Description and Data Analysis: A Practical Approach* (2nd Edition or later). New York: John Wiley & Sons. ● Kershaw, K..A. (1973). *Quantitative and Dynamic Plant Ecology* (2nd Edition or later). Edward Arnold. ● McCune, B. and Grace, J. (2002) *Analysis of Ecological Communities*. MjM Software Design.

Course Code	**BOT3062**
Course Title	**Enzymes, Concepts to Applications**
Credit Value	**2**
Pre-requisites	**BIO1012**
Compulsory/Optional	**Optional**
Course Content	
Historical perspective of enzymes; enzymes as highly specific and efficient catalysts, thermodynamics, enzyme kinetics and determining kinetic parameters; factors affecting enzyme activity; enzyme assays, quantitative analysis of time-courses; enzyme inhibition; catalytic strategies; regulation of enzymatic activity, zymogens, isozymes and ribozymes; enzyme action of plant hormone regulation, enzyme dynamics in plant nutrition, worldwide enzyme market, food enzymes, microbial enzymes, PETase; enzyme engineering, rational drug design and other applications of enzymes/inhibitors in agriculture and biomedical sciences.	
Recommended Texts	
● Lehninger, L., Nelson, D.L. and Cox, M.M. (2017). *Principles of Biochemistry* (7th Edition or later). W.H. Freeman. ● Stryer, L. (2015). *Biochemistry* (8th Edition or later). W.H. Freeman.	

Course Code	**BOT3072**
Course Title	**Plant Quantitative and Applied Genetics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Reproductive systems in plants. Inheritance of qualitative vs. quantitative traits. Fundamentals of quantitative genetics: Biometrical genetics; variance components; heritability; environmental interactions; artificial selection; selection differential; response to selection. Principles of plant breeding: Germplasm and plant breeding. Locating genes/loci that affect quantitative traits and molecular breeding. Principles of population genetics: Allele frequencies; genetic diversity and measures of genetic distance; Wright-Fisher model; Population inbreeding; Linkage disequilibrium; Population structure and selection; Habitat fragmentation and conservation genetics. Molecular basis of genes. Basic molecular techniques. Field visits to Plant Genetic Resource Centre and selected crop research institutes	
Recommended Texts	
● Pierce, B.A. (2013) *Genetics: A Conceptual Approach* (5th Edition or later). Freeman, W.H. and Company. ● Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. (2015). *Introduction to genetic*	

analysis. New York, NY :W.H. Freeman & Company, ● Acquaah, G. (2009). *Principles of plant genetics and breeding*. John Wiley & Sons.

Course Code	**BOT3082**
Course Title	**Biostatistics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Biological data types, determination of appropriate statistical test, parametric statistical tests (two sample tests, Analysis of Variance (ANOVA), complex ANOVA designs, multivariate analysis), Non-parametric tests (χ^2, Mann-Whitney, Kruskal-Wallis, Mood's median and Friedman tests), regression analysis, curve fitting, introduction to mathematical modelling Use of statistical packages in data analysis; MINITAB, SigmaPlot, R	
Recommended Texts	
• Sokal, R.R. and Rohlf, F.J. (2011). *Biometry* (2nd Edition or later). W.H. Freeman and Company, USA. • Norman, G.R. and Streiner, D.L. (2008). *Biostatistics, the Bare Essentials*. BC Deckers Inc. Hamilton, Ontario, Canada. • Rosner, B. (2010). *Fundamentals of Biostatistics* (7th Edition or later). Cole Books, Boston, MA, USA.	

Course Code	**BOT3092**
Course Title	**Soil Fertility and Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Chemical, physical and biological properties of soil and their influence on availability of nutrients; sources, forms, and transformations of soil nutrients; soil organic matter and dynamics; soil microbes and their significance on plant growth: rhizosphere microbes, Plant growth promoting rhizobacteria (PGPR), and applications of biofertilizers; soil-related problems and their management; evaluating soil microflora and fertility status: sampling techniques, standard methods and interpretation of data. Laboratory exercises based on the above topics.	
Recommended Texts	
• Sanchez, P.A. (2019). Properties and Management of soils in the tropics (2nd Edition). Cambridge University Press. • Havlin, J., Tidsale, S.L., Werner, N.L. and Beaton, J.D. (2013). *Soil fertility and fertilizer* (8th edition or later), Pearsons. • Paul, E. (2014). Soil Microbiology, Ecology and Biochemistry (4th Edition or later). Academic Press.	

Course Code	**BOT3102**
Course Title	**Developmental Physiology and Postharvest Technology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content
Plant growth regulators: hormonal regulation of developmental and physiological processes in plants. Photoreceptors. Signal transduction. Mechanism of photoperiodism and control of flowering, vernalization. ABC model in floral development. Commercial applications of plant growth regulators. Postharvest technology of horticultural produce: pre-harvest management for postharvest quality of fresh produce; causes for deterioration of fruit, vegetable, cut flower and foliage; maturity indices; harvesting systems; packing house operations; transportation; storage; temperature management, modified atmosphere. Ethylene in postharvest technology. Technology at village and industrial level. Laboratory exercises based on the above.
Recommended Texts
● Wills, R.(2016). *Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables* (6th Edition or later) UK:CABI Publishing ● Florkowski, W.J. (2014). *Postharvest Handling: A Systems Approach* (3rd Edition or later). USA: Academic Press.

Course Code	BOT3112
Course Title	**Microbiological Applications**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Microorganisms with industrial and environmental applications. Role of microbes in small and large scale industrial processes: food, alcoholic beverages, single cell proteins, antibiotics, probiotics, prebiotics, synbiotics. Sustainable use of microbes: sewage and waste management by biosorption, bioaccumulation; pollution control with biofilters, biomining and biomonitoring; biofuel and biofertilizer; buffering climate change. Microbial biotechnology: microbes as a model in research. Designing a microbiological laboratory. Designing a microbiological laboratory. Community outreach programmes: microbiological surveys, social awareness. Laboratory exercises and industrial visits based on above topics.	
Recommended Texts	
● Glazer, A.N. and Nikaido, H. (1995). *Microbial biotechnology. Fundamentals of Applied Microbiology*. W.H. Freeman & Company, New York, USA. ● Saxena, S. (2015). *Applied Microbiology*. Springer India. ISBN: 978813223482-1. ● Laskin, A., Sariaslani, S. and Gadd, G. (2006). *Advances in Applied Microbiology*, Vol 60, 1st edition. Academic Press, USA. ISBN: 9780120026623. ● Verma, D.K. (2018). *Microbiology for Sustainable Agriculture, Soil Health, and Environmental Protection*. Apple Academic Press. ISBN: 9781771886697. ● Madigan, M.T., Martinko, J.M., Bender, K.S., Buckley, D.H. and Stahl, D (2014). *Brock Biology of Microorganisms*. 14th edition. Benjamin Cummings.	

Course Code	BOT3122
Course Title	**Biotic Interactions and Applications**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Neutralism verses interactions among plants, animals and microbes; Kinds of biotic interactions with examples: intra-species and inter-species interactions. Role of trophic interactions in community initiation, maintenance and degradation; biotic interactions affecting the sizes of species populations and diversity. Community	

consequences of biotic interactions, co-evolutionary dynamics, and trade-off and species coexistence. Molecular mechanisms of biotic interactions. Biotic interactions in human dominated landscapes; in the face of climate change and in mitigating environmental issues. Commercial applications of biotic interactions. Laboratory and field exercises based on above topics.
Recommended Texts
● Campbell, N.A. and Reece, J.B. (2002). *Biology* (6th Edition or later). Pearson Higher Education. ● Burslem, D. F. R. P., Pinard, M. A. and Hartley, S.E. (Eds.) (2005). *Biotic interactions in the tropics: their role in the maintenance of species diversity*. Cambridge University Press, U.K. ● Schoonhoven, L.M., van Loon, J.J.A. and Dicke, M. (2005). *Insect-Plant Biology*. Oxford University Press, U.K. ● Thompson, J.N. (2005). *The Geographic Mosaic of Coevolution*. University of Chicago Press

Course Code	**BOT3132**
Course Title	**Plants, Life and Skills**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Applications of Plant Science in urban infrastructure and architecture. Plants in aesthetics and cultural contexts. Bioprospecting and biopiracy. Social responsibility: Green consumerism; sustainable use of resources. Circular economy. Financial, social and economic issues in plant based industries. Intellectual property rights. Personal developmental aspects and positive self-reflection. Laboratory practicals, field visits and activities related to above topics.	
Recommended Texts	
● Preece, J.E. & Read, P.E. (2005). *The Biology of Horticulture: An Introductory Text Book*. John Wiley and Sons, Inc., USA. ● Singh, R. & Kumar, S. (2017). *Green Technologies and Environmental Sustainability*.Springer International Publishing. ● Sivasubramanian, V. (2016). *Environmental Sustainability Using Green Technologies.*CRC Press. ● Snodgrass, E.C. & Snodgrass, L.L. (2006). *Green Roof Plants: A Resource and Planting Guide.* Timber Press, Inc.	

Course Code	**BOT3142**
Course Title	**Effective Scientific Communication**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Ethical and legal standards in scientific research; Introduction to types of scientific communication; Effective use of online literature search engines; Manuscript structure and content; Scientific writing: plagiarism, organization and writing styles, effective use of language, presenting numerical data, constructing scientific figures: Reference citation: referencing styles, in-text citations and reference list, reference management software; Reviewing scientific manuscripts and presentations; Software skills required for scientific writing and oral presentations; Poster and oral presentations: planning, design, structure, effective use of visual, textual and audible elements; delivery, handling questions.	
Recommended Texts	
• American Psychological Association. (2010). *Publication manual of the American Psychological Association*, (6th Edition or later). Washington DC: American Psychological Association.	

- Carter, M. (2012). *Designing science presentations: a visual guide to figures, papers, slides, posters, and more*. Waltham, MA: Academic Press.
- Katz, M.J. (2009). *From research to manuscript: a guide to scientific writing*. Hackensack, NY: Springer Science & Business Media.
- Schimel, J. (2012). *Writing science: how to write papers that get cited and proposals that get funded*. New York, NY: Oxford University Press

Course Code	**BOT3152**
Course Title	**Food Engineering and Nutrition**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Concepts in Food Engineering: Physical concepts in food engineering: Properties of liquids and solids, measuring sensory characteristics, Physical and chemical properties of food products. Heat transfer systems for heating and cooling food products, Evaporation and drying, grinding and size reduction, Psychrometrics and dehydration. Nutrition and Quality of Food: Biochemistry and Nutrition: Digestion and absorption; Anthropometry; Food nutrients, their role in human nutrition, sources and availability; Food safety, hygiene and quality control: Natural and artificial toxicants in foods, Importance of hygienic handling, principles of quality control; Hazard Analysis Critical Control Point (HACCP) and Good Manufacturing Practise (GMP), Use of sensory evaluations, Food laws and standards, Role of International Bodies, i.e. World Health Organization and Food and Agriculture Organization of the United Nations (WHO/FAO), International Standards Organization (ISO), Biosafety Regulations, Food control infrastructure in Sri Lanka. Laboratory work Based on above topics.	
Recommended Texts	
● Gould, G.W. (2012). *New methods of food preservation*. Cham, Switzerland: Springer. ● Lawless, H.T. and Heyman, H. (1998). Sensory Evaluation of Food. (2nd Edition or later) New York, NY: Springer. ● Medeiros, D.M. and Wildman, R.E.C. (2018). Advanced human nutrition 4th edition. Burlington, MA: Jones and Bartlett. ● Rao, M.A., Rizvi, S.S., Datta, A.K. and Ahmed, J. (2014). *Engineering properties of foods*. CRC press. ● Toledo, R.T. (2007). *Fundamentals of food process engineering* (3rd Edition or later). Cham, Switzerland: Springer.	

4000 Level Courses

Course Code	**BOT4012**
Course Title	**Plant Systematics and Phylogenetics**
Credit Value	**2**
Pre-requisites	**Plant Systematics (BT3032)**
Compulsory/Optional	**Optional**
Course Content	
Types of data: morphological, anatomical, phytochemical, palynological and molecular; Phylogenetic systematics (Cladistics), Different tree building techniques (Neighbour joining, Parsimony and Model based) and constructing classification systems and tree statistics; Angiosperm classifications based on molecular data (APG); Application of molecular data in Plant Systematics and, biodiversity conservation and management. Laboratory exercises based on above topics	

Recommended Texts
• Stace, C.A. (1993). *Plant taxonomy and biosystematics.* Cambridge University Press, U.K. • Judd W. S., Campbell C.S., Kellog E.A., Stevens, P.A. and Donoghue, M.J. (2016). *Plant Systematics: A Phylogenetic Approach.* Sinauer Associates Inc. • Simpson, M. (2010). *Plant Systematics*. Academic Press

Course Code	**BOT4022**
Course Title	**Plant Stress Physiology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Fundamentals of Stress Physiology in plants: Structural attributes, architecture of plant cell walls and hydraulic architecture; Mechanisms of stress resistance (avoidance, tolerance and acclimation), stress signals; Ecophysiological responses of plants to major abiotic and biotic stresses: extremes of temperature, water, radiation, heavy metals, competition, herbivory and salinity; phenotypic plasticity/acclimatization and adaptation to climate change. Laboratory exercises based on above topics.	
Recommended Texts	
• Shabala, S. (Ed.) (2017). *Plant Stress Physiology*. University of Tasmania, Australia. • Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). *Biochemistry & Molecular Biology of Plants*. American Society of Plant Physiologists. • Taiz, L, and Zeizer, E, (2014). *Plant Physiology* (6th Edition or later) Sinauer Associates, Inc. • Berg, J.M., Tymoczko, J.L., and Stryer, L. (2006). *Biochemistry.* W. H. Freeman.	

Course Code	**BOT4032**
Course Title	**Phytogeography**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to phytogeography, history and theories. Geographic template; geodispersal; speciation and isolation barriers. Theory of continental drift, plate tectonics and palaeobotany. Vicariance biogeography. Island biogeography. Tertiary relict flora. Phylogeography. Laboratory exercises based on the above topics.	
Recommended Texts	
● Lomolino, M.V., Riddle, B.R., Whittaker, R. J. and Brown, J.H. (2010). *Biogeography* (4th Edition or later). Sinauer Associates Inc. Sunderland, Massachusetts. ● McLoughlin. (2001). *The breakup history of Gondwana and its impact on pre-Cenozoic floristic* provincialism. Aust. J. Bot. 49: 271–300. ● Zachos, J., Pagani, M., Sloan, L., Thomas, E. and Billups, K. (2001). *Trends, Rhythms, and Aberrations in Global Climate 65 Ma to Present*. Science 292: 686-693.	

Course Code	**BOT4042**
Course Title	**Advanced Plant Pathology**
Credit Value	**2**
Pre-requisites	**Plant Pathology (BOT3042)**
Compulsory/Optional	**Optional**

Course Content

Molecular basis of plant-pathogen interactions: genes and disease, variability in pathogens, pathogenicity factors and virulence factors of fungi and bacteria, signal transduction pathways, priming of plant defences; Bacterial infections and patho-systems; Plant disease epidemiology: contributing factors, measurement of plant disease and yield loss, novel techniques in disease forecast and diagnosis; Sustainable disease control: organic agro-ecological pest management, transgenic techniques; Field and laboratory exercises based on the above topics.

Recommended Texts

- Wilson, C.R. (2014). *Molecular methods in Plant Disease Diagnostic Principles and Protocols*. UK: CABI Publishing.
- Vadivel, K. and Ganesan, S. (2015). *Sustainable Crop Disease Management using Natural Products*. UK: CABI Publishing.
- Punja, Z.K., DeBoer, S.H. and Sanfacon, H. (2007). *Biotechnology and Plant Disease Management*. UK: CABI Publishing.
- Agrios, G.N. (2005). *Plant Pathology* (5^{th} Edition or later). UK: Elsevier Academic Press.

Course Code	**BOT4053**
Course Title	**Dynamic Plant Ecology**
Credit Value	**3**
Pre-requisites	**Quantitative Plant Ecology (BOT3052)**
Compulsory/Optional	**Optional**

Course Content

Natural ecosystems of Sri Lanka and their spatial heterogeneity (extension lectures). Ecosystem dynamics: fire ecology; phenology; population dynamics; Disturbances in natural ecosystems and their impacts on natural regeneration and vegetation succession. Restoration of habitats. Valuation of ecosystem services. Laboratory and field exercises related to above topics, Field visits related to above topics and to collect herbarium specimens by students as a requirement of the course 'Herbariums - BT 413'.

Recommended Texts

- Richard, P.W. (1996). *Tropical Rain forests with contributions by R.P.D. Walsh, I.C. Baillie, and P. Greig-Smith*. Cambridge, Cambridge University Press.
- Whitmore, T.C. (1998). *An introduction to tropical rain forests* (2^{nd} Edition or later). Oxford:Oxford University Press.
- Palmer, M.A., Zedler, J.B. and Falk, D.A. (Eds.) (2011). *Foundations of Restoration Ecology*. New York: Island Press.
- National Research Council (2005). *Valuing Ecosystem Services: Towards Better Environmental Decision-Making*. Washington, DC: The National Academies Press.

Course Code	**BOT4062**
Course Title	**Cryptogamic Botany**
Credit Value	**2**
Pre-requisites	**None**

Compulsory/Optional	**Optional**
Course Content	
Introduction to Cryptogamic plants. Origins, diversification and phylogenetic relationships among the major lineages of Cryptogamic plants. Evolutionary trends and structural diversity of embryophytes. Biology, ecology and the role of Cryptogams in different ecosystems. Cryptogams as bio-indicators. Uses and applications of Cryptogamic plants in different disciplines. Cryptogams and biodiversity; threats and conservation of Cryptogamic plants. Laboratory exercises based on above topics.	
Recommended Texts	
• Vanderpoorten, A. and Goffinet, B. (2009). *Introduction to Bryophytes*. Cambridge University Press. • Graham, L.E. and Wilcox, L.W. (2009). *Algae* (2nd Edition or later). Benjamin Cummings (Pearson), San Francisco, CA. • Nash, T.H. (2008). *Lichen Biology*. Cambridge University Press. • Kenrick, P. and Crane, P.R. (1997). *The origin and early diversification of land plants. A cladistic study*. Smithsonian Institution Press, Washington & London. Washington: Smithsonian Inst. Press. • Becker, B. and Marin, B. (2009). *Streptophyte algae and origin of embryophytes*. Annals of Botany 103: 999 – 1004.	

Course Code	**BOT4072**
Course Title	**Advanced Topics in Biochemistry**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Biochemistry as an evolving science; DNA damage and repair: damages induced by endogenous and exogenous factors; repair mechanisms: photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, double strand break (DSB) repair (homologous recombination and non-homologous end joining); site-specific DSB induction as a tool for targeted mutagenesis, CRISPR and its applications in crop improvement; photoprotective medicinal plants. DNA methylation and demethylation: DNA methylation and restriction modification systems in prokaryotes; DNA (de) methylation in epigenetic reprogramming of plant development. 'Omics' revolution in plant sciences and biomedical research; antioxidant, antimicrobial and antiproliferative effects of medicinal plants, lead phytochemicals for anticancer therapy; the ethical and societal implications of modern biochemistry; emerging topics of biochemistry. Laboratory exercises based on the above topics.	
Recommended Texts	
• Lehninger, L., Nelson, D.L. and Cox, M.M. (2017). *Principles of Biochemistry* (7th Edition or later). W.H. Freeman. • Stryer, L. (2015). *Biochemistry* (8th Edition or later). W.H. Freeman. • Voet, D. and Voet, L.G. (2011). *Biochemistry* (4th Edition or later). John Wiley.	

Course Code	**BOT4082**
Course Title	**Forest Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	

Introduction to forest Management: Protection forestry; Industrial forestry, Social forestry, Urban forestry; Local and global demands for forest products; Forest landscape management to reap multiple benefits; Forests and forest policy of Sri Lanka; Forest mensuration; Silvicultural systems; Forest genetics; Species selection and nursery practices; Site preparation before planting; Weeding; Fertilizing; Pruning; Thinning; protection from diseases, pests and fire; Harvesting; Sustainable forest management; Field exercises and field visits based on above topics.
Recommended Texts
● Young, R.A. and Giese, R.L. (1990). *Introduction to forest science* (2nd Edition or later). New York: John Wiley and Sons. ● Savill, P.S. and Julian, E. (1986). *Plantation silviculture in temperate regions with special references to the British Isles*. Oxford: Clarendan press. ● Philip, M.S. (1994). *Measuring trees and forests*. (2nd Edition or later). Wallingford: CAB International.

Course Code	**BT4092**
Course Title	**Diazotrophs and Sustainable Soils**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Diazotrophs**:** taxonomy and biology; symbiotic and non-symbiotc N_2 fixation; physiological and biochemical processes. Genetic and molecular fundamentals. Role of biological nitrogen fixation in sustainable soils. Quantitative aspects of biological N_2 fixation. Field and research based experimental systems. Economic and ecological advantages of diazotrophs. Recent research advancements in the field. Field visits and laboratory exercises based on above topics.	
Recommended Texts	
• Klipp, W., Masepohl, B., Gallon, J.R. and Newton, W.E. (2004). *Genetics and regulation of nitrogen fixation in free-living bacteria*. Kluwer Academic Publishers. • Kulasooriya, S.A. 2008. *Biological Nitrogen Fixation.* Peradeniya Science Publication No 17. Science Education Unit, faculty of Science, University of Peradeniya. • de Bruijn, F.J. (2015). *Biological Nitrogen Fixation*. John Wiley & Sons, Inc.	

Course Code	**BOT4102**
Course Title	**Physiology and Management of Ornamental Plants**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to floriculture. Principles of plant propagation techniques (via seeds, tissue culture, cuttings, layering, grafting and budding) and management of stock plants. Pre- and postharvest physiology: ultra-structural and biochemical changes related to growth; maturation; senescence; respiration and water relations. Improving the postharvest longevity of ornamental plants. Pests, diseases and their control. Value addition in consumer usage. Flower and foliage supply chain. Legal aspects and intellectual property rights. Market and economic issues and regulatory problems. Laboratory exercises, community outreach activities and industrial visits related to above topics.	
Recommended Texts	
• Florkowski W.J. (2014). *Postharvest Handling: A Systems Approach.* (3rd Edition or later), Academic Press.	

- Davies, F.T., Geneve, R.L., Wilson, S.E., Hartmann, H.T. and Kester, D.E., (2017) Hartmann & Kester's Plant Propagation: Principles and Practices (9th Edition or later). Upper Saddle River, NJ, USA: Pearson Education Inc.
- Öpik, H., Rolfe, S.A. and Willis, A.J. (2005). *The Physiology of Flowering Plants* (4th Edition or later). Cambridge University Press.
- Wills, R., McGlasson, B., Graham, D. and Joyce, D. (2007). *Postharvest: An Introduction to the Physiology & Handling of Fruit, Vegetables & Ornamentals*. (5th Edition or later), University of New South Wales Press

Course Code	**BOT4112**
Course Title	**Toxicology**
Credit Value	**2**
Pre-requisites	**Photosynthesis and Respiration (BOT2152)**
Compulsory/Optional	**Optional**

Course Content

Introduction to toxicology; bioaccumulation, types of lethal dose measures of toxicity (LD_{50}, ED_{50}, LC_{50}); biodegradability; the toxicological paradigm, toxicokinetics, toxicodynamics; dose – response relationships, microbial toxins – of bacteria, cyanobacteria and fungi (mushroom toxins and mycotoxins), their nature and effects, factors contributing to their formation in food and methods of prevention of contamination and decontamination; case studies, toxins of higher plants, their nature and effects, analytical techniques of toxins, toxicogenomics, legislature in different countries, uses of toxins.
Practical exercises based on above topics.

Recommended Texts

- Curtis D. Klaassen (2019). Casarett and Doull's Toxicology-The basic science of poisons (9th edition). Mc Graw Hill Education.
- Ernest Hodgson (2010). A text book of modern toxicology. (4th Edition or later). Wiley & Sons, Inc.
- Miller, J.D. and Trenholm, H. L. (1994). *Mycotoxins in grain – compounds other than aflatoxins*. Eagon Press.
- Vries, D.J. (1997). *Food Safety and Toxicology*. CRC Press, USA.
- The Comparative Toxicogenomics Database (CTD; http://ctdbase.org/)

Course Code	**BOT4122**
Course Title	**Seed Biology and Technology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction to seed science; development of fruits and seeds; desiccation tolerance of seeds, seed quiescence, dormancy and non-dormancy; seed longevity and natural seed banks; seed germination; molecular genetic advances in seed biology; production; harvesting; purity; handling techniques; post production improvement; vigour; health; deterioration and storage; preservation; somatic embryogenesis and artificial seed production; certification and seed act.
Laboratory exercises based on above topics.

Recommended Texts

- Adkins, S.W., Ashmore, S. and Navie, S.C. (2007). S*eeds: Biology, Development and Ecology.* Wallingford, OX, UK: CABI Publishers.
- Baskin, C.C. and Baskin, J.M. (2014). *Seeds: Ecology, biogeography, and evolution of dormancy and germination* (2nd Edition or later). San Diego, USA, Academic Press.

• Copeland, L.O. and McDonald, M.B. (2001). *Principles of Seed Science and Technology, 4th ed.* Kluwer Boston, USA, Academic Publications. • Davies, F.T., Geneve, R.L., Wilson, S.E., Hartmann, H.T. and Kester, D.E. (2017) *Hartmann & Kester's Plant Propagation: Principles and Practices* (9th Edition or later). Upper Saddle River, NJ, USA: Pearson Education Inc.

Course Code	**BOT4132**
Course Title	**Ecological Restoration**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Principles and theories in Restoration Ecology: Drivers and consequences of tropical deforestation, forest disturbance and regeneration, benefits of restoration, future outlook for restoration. **Current practices and challenges:** Assisted natural regeneration, Framework species method, Maximum diversity method, Site amelioration and nurse plantations, Nursery establishment and management, Seed collection and germination, transplantation of seedlings, maintenance and monitoring, Effect of biological invasions and climate change on restoration. **Implementation and evaluation: S**takeholder identification, decision making in restoration initiatives, project plan, above- and below-ground indicators, social indicators. **Economies of restoration:** Basic financial concepts and project planning, major types of funding sources, assessment and combining funding types. Field excursions to observe case studies, laboratory exercises and designing a project based on the above topics.	
Recommended Texts	
• van Andel, J. and Aronson, J. (2012). *Restoration Ecology: The New Frontier*. Wiley-Blackwell. Pp.400. • Stanturf, J., Lamb, D. and Palle, M. (2012). *Forest Landscape Restoration: Integrating Natural and Social Sciences* (World Forests Book 15). Pp. 338	

Course Code	**BOT4142**
Course Title	**Molecular Genetics: Genes to Function**
Credit Value	**2**
Pre-requisites	**Plant Quantitative and Applied Genetics**
Compulsory/Optional	**Optional**
Course Content	
The organization of plant genomes. Molecular basis of the regulatory pathways associated with development and adaptation. Trait manipulation for crop improvement. Biometrical genetics and statistical methods for analyzing quantitative traits. Methods of plant breeding and selection. Genetic mapping. GWAS. Gene mining. Bioinformatics: genomics and comparative genomics. Intellectual property rights and biosafety framework: GMOs, Cartagena protocol and national biosafety framework. Case studies on basic and selected advanced techniques used in plant molecular genetics.	
Recommended Texts	
• Acquaah, G. (2009). *Principles of Plant Genetics and Breeding*. John Wiley & Sons. • Allard, R.W. (1999). *Principles of Plant Breeding*. John Wiley & Sons. • Falconer, D.S. (1960). *Introduction to quantitative genetics*. Oliver and Boyd; Edinburgh; London. • Bernardo, R. (2014). *Essentials of plant breeding*. Stemma Press. • Fehr, W.R. (1987). Principles of cultivar development. Vol. 1. Theory and technique. Macmillan, New York. *Principles of cultivar development. Vol. 1. Theory and technique. Macmillan, New York.*	

Course Code	**BOT4151**
Course Title	**Herbarium Techniques**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Field collection, preservation, mounting, identification and preparation of plant specimens from Algae, Fungi, Bryophytes, Tracheophytes, Gymnosperms and Angiosperms. Different Herbarium practices. Digitizing Herbaria. Field visits to collect a recommended number of specimens representing above groups of plants.	
Recommended Texts	
● Bridson, D. and Forman, L. (2000). *The Herbarium Hand book*. Kew Publishing, London 2000 ● Coppejans E., Leliaert F., Dargent O., Gunasekara R. and Clerck O.D. (2009). Sri Lankan Seaweeds Methodologies and field guide to the dominant species. Acadamic press. ● Schofield, W.B. (1985). *Introduction to Bryology*. The Blackburn Press. Caldwell, New Jersey 07006 USA.	

Course Code	**BOT4998**
Course Title	**Research Project**
Credit Value	**8**
Pre-requisites	**BOT3082**
Compulsory/Optional	**Compulsory**
Course Content	
Each student will carry out a research project during the final year under the supervision of a staff member(s). The student is required to deliver two seminars, (a) pre-project seminar, based on preparatory work and research plan and (b) end of the project seminar, based on the outcome of research and prepare a comprehensive report containing Title page, Abstract, Introduction and Literature Review, Objectives, Materials & Methods, Results, Discussion and References.	
Recommended Texts	
Relevant literature related to the given research topic.	

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Each student will undergo full time training in the industry for the period prescribed, on projects assigned to them. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the projects assigned to them.	
Recommended Texts	
Reading material relevant to their industrial training	

1.2 Microbiology Course Modules

3000 LEVEL – MICROBIOLOGY				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory Hons.**
MIC3012	Microbial Systematics and Evolution	2		√
MIC3022	Microbial Biochemistry and Physiology	2	BOT3062	√
MIC3032	Gene regulation in Microbes	2	BOT2072	
MIC3042	Plant Pathology	2	MIC3042	√
MIC3052	Plant Virology	2		√
MIC3062	Environmental Microbiology	2	BOT2012	√
MIC3072	Symbiosis	2	BOT2012	
MIC3082	Introduction to Bioinformatics	2	BOT2012, BOT2072	
MIC3092	Microbial agents for Plant disease management	2	MIC3042	
MIC3102	Bio fertilizers and Bio pesticides	2		
MIC3112	Fermentation Technology and Probiotic Microorganisms	2	BOT2062	
MIC3122	Wastewater and Solid Waste Microbiology	2		
MIC3132	Bacteria of Medical Importance	2		
MIC3142	Vector borne Diseases	2	ZOO2212	
MIC3152	Viral diseases - past, present and future	2		
MIC3162	Microbes for Sustainability	2		√
MIC3172	Bioethics	2		√
MIC3182	Effective Scientific Communication	2		√
Total		**36**		**16**

4000 LEVEL - MICROBIOLOGY				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Comments Hons.**
MIC4012	Applied Microbial Genetics: Case studies	2	BOT2072	
MIC4022	Diazotrophs and sustainable soil management	2	BOT2062	
MIC4032	Lichen Biology	2	BOT2012	
MIC4042	Advanced Plant Pathology	2	MIC3042	
MIC4052	Toxicology	2	BOT2052	
MIC4062	Biosecurity	2	MIC3042	
MIC4072	Microbiological Applications	2	BOT2062	
MIC4082	Wetland and Aquatic Microbiology	2	BOT1192	
MIC4092	Bio-fermentation	2		
MIC4103	Applied Parasitology	3	ZOO3232	
MIC4112	Animal Pathogens and Public Health	2	MIC3132	

MIC4123	Immunobiology	3		
MIC4132	Laboratory Management and Quality Assurance	2		√
SCI4003	Industrial Training	3		
MIC4998	Research Project	8		√
Total		**39**		**10**

3000 Level Courses

Course Code	**MIC3012**
Course Title	**Microbial Systematics and Evolution**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Microbial taxonomy and classification, taxonomic hierarchy, classical and modern approaches to microbial classification and identification, molecular based classification, dendrograms and similarity matrices, origin of life and microbial evolution. Laboratory exercises based on above topics.	
Recommended Texts	
• Madigan, M.T., Martinko, J.M., Stahl, D. and Clark, D.P. (2018). *Brock Biology of Microorganisms*. 15th Ed. Benjamin Cummings Publishing Company. • Tortora, G.J., Funke, B.R. and Case, C.L. (2008). *Microbiology- An Introduction*, 5th Ed., Benjamin Cummings Publishing Company. • Garrity, G.M., Krieg, N.R. and Brenner, D.J. (2006). *Bergey's Manual of Systematic Bacteriology: The Proteobacteria (Vol. 2).* Williams and Wilkins Co, Baltimore.	

Course Code	**MIC3022**
Course Title	**Microbial Biochemistry and Physiology**
Credit Value	**2**
Pre-requisites	**Enzymes: Concepts to Applications (BOT3062)**
Compulsory/Optional	**Compulsory**
Course Content	
Physical requirements of microbial growth: temperature, pH, gaseous requirement, osmotic pressure and other conditions. Nutritional requirement for microbial growth: chemical elements such as nutrients, organic growth factors, nutritional classification of microorganisms, nutrient uptake process. Chemical composition and biosynthesis of macromolecules in microbial cells, molecular structure and function, molecular assembly, cell bioenergetics (energy production and ATP generation by different processes), biochemical diversity, metabolic pathways (aerobic and anaerobic) and microbial adaptation of cells to extreme environments and stress conditions (e.g. salt, temperature and oxidative), regulation of gene expression under stress conditions, uptake and secretion of various molecules, quorum sensing, microbial photosynthesis, energy from oxidation of inorganic compounds and intra- and intercellular signaling pathways. Laboratory exercises based on above topics.	
Recommended Texts	

- Nelson, D.L. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*. 5th Ed. W.H. Freeman and Company, USA.
- Moat, A.G. and Foster, J.W. (2002). *Microbial Physiology.* 3rd Ed. John Wiley and Sons. England.
- White, D. (2006). The Physiology and Biochemistry of Prokaryotes. 3rd Ed, Oxford University Press, England.
- Madigan, M.T., Martinko, J.M., Stahl, D. and Clark, D.P. (2018). *Brock Biology of Microorganisms*. 15th Ed. Benjamin Cummings.

Course Code	**MIC3032**
Course Title	**Gene Regulation in Microbes**
Credit Value	**2**
Pre-requisites	**Microbial Genetics (BOT2072)**
Compulsory/Optional	**Optional**
Course Content	
Bacterial and fungal gene regulation; regulatory sequences, transcription initiation and termination, inducible and repressible operons, *in vitro* studies of gene regulation and reporter systems; regulatory RNAs and riboswitches; bioinformatics tools for studying gene regulation; system biology and proteomics. Field visits to relevant industries and laboratories based on basic techniques in molecular biology.	
Recommended Texts	
• Snyder, L., and Champness, W. (2007). *Molecular genetics of bacteria*. Washington, DC: ASM Press.	

Course Code	**MIC3042**
Course Title	**Plant Pathology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Plant Pathology. Causes of plant diseases. Infection process. Mechanism of symptom development, fungal pathogenesis. Plant-pathogen interactions. Plant defense responses: constitutive and inducible defenses, Systemic Acquired Resistance (SAR). Diseases in economically important crops. Diagnosis of plant diseases and control. Plant quarantine. Molecular techniques in Plant Pathology.Laboratory exercises based on above topics.	
Recommended Texts	
• Agrios, G.N. (2005). *Plant Pathology*, 5th Ed. UK: Elsevier Academic Press. • Ploetz, R.C. (2003). *Diseases of Tropical Fruit Crops*. UK: CABI Publishing. • Snowden, A.L. (1991). *A colour Atlas of Postharvest Diseases & Disorders of Fruits & Vegetables, Volume 1*: *General Introduction & Fruits*.UK: CABI Publishing.	

Course Code	**MIC3052**
Course Title	**Plant Virology**
Credit Value	**2**

Pre-requisites	Plant Pathology (MIC 3042)
Compulsory/Optional	Compulsory
Course Content	
Introduction: characteristics of viruses and virus-like entities, classification of plant viruses, architecture and assembly of virus particles, transmission, epidemiology, symptoms and host range; Virus-plant-vector molecular mechanisms and interactions: replication, origins and evolution of plant viruses, RNA silencing, movement within plants, plant-to-plant movement; Applied aspects: major viral diseases of economic importance, identification, purification, detection of plant viruses, disease management strategies. Laboratory and field exercises based on above topics.	
Recommended Texts	
• Agrios, G.N. (2005). *Plant Pathology*. Elsevier Academic Press, UK. • Dickinson, M. (2003). *Molecular Plant Pathology*. Bios Scientific Publishers, UK. • Hull, R. (2013). Plant Virology. Elsevier Academic Press, UK.	

Course Code	MIC3062
Course Title	Environmental Microbiology
Credit Value	2
Pre-requisites	Algae and Fungi (BOT 2012)
Compulsory/Optional	Compulsory
Course Content	
The diversity of microbial populations and their important roles in environmental processes in air, water, soils, and sediments; Microbial community ecology and interactions with plants and animals; Microbial activities that sustain natural ecosystems and contribute to environmental quality; the use of these functions to support and manage artificial systems; Techniques for investigating microbial processes. Laboratory exercises and field visits based on above topics.	
Recommended Texts	
• Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G., and Zuberer, D. A., D. (2005). *Principles and Applications of Soil Microbiology*, 2nd Ed. • Madigan, M.T., Martinko, J.M., Stahl, D. and Clark, D.P. (2018). *Brock Biology of Microorganisms*. 15th Ed. Benjamin Cummings Publishing Company.	

Course Code	MIC3072
Course Title	Symbiosis
Credit Value	2
Pre-requisites	Algae and Fungi (BOT 2012)
Compulsory/Optional	Optional
Course Content	
Plant symbioses: their structures, origin of symbioses and their role in the evolution of life on earth, co-evolution and symbiosis; morphology, physiology, biochemistry and molecular mechanisms of symbiosis; symbiosis in ecosystems, horticulture, agriculture, forestry and in the environment; nomenclature, systematics and phylogeny of symbiotic organisms; scientific approaches and techniques relevant to studying symbiotic systems. Laboratory exercises based on above topics.	
Recommended Texts	
• Nash III, T.H. (2010). *Lichen Biology*. Cambridge University Press, Cambridge • Weerakoon, G. (2015). *Fascinating Lichens of Sri Lanka*. Ceylon Tea Services PLC / Karunaratne&	

Sons (Pvt) Ltd. • Fortin, J.A., Plenchette C. and Piché, Y. (2009). *Mycorrhizas. The new green revolution.* Editons Multimondes, Quebec, Canada. • Thompson, J.N. (1982). *Interaction and coevolution*. Wiley, New York. • Kulasooriya, S.A. (2008). *Biological Nitrogen Fixation; fundamentals and utilization.*Peradeniya Science Publication. No. 27.

Course Code	**MIC3082**
Course Title	**Introduction to Bioinformatics**
Credit Value	**2**
Pre-requisites	**Algae and Fungi (BOT 2012), Microbial Genetics (BOT 2072)**
Compulsory/Optional	**Optional**
Course Content	
Introduction to whole genome sequencing, genome visualization, searching and accessing, alignment and comparison, functional annotation, comparative genomics, construction of phylogenies, transcriptomics, pathway analysis, system biology, proteomics, metabolomics, metagenomics, genome applications in industry. Practical exercises based on selected topics.	
Recommended Texts	
• Lesk, A.M. (2017). *Introduction to genomics*. Oxford University Press. • *Introduction to Bioinformatics in Microbiology*. (2018). Christensen**,** H. (Ed.). Springer. ISBN-13: 978-3319992792 • Ussery, D.W., Wassenaar, T.M., and Borini, S. (2009). *Computing for comparative microbial genomics: Bioinformatics for Microbiologists (Computational Biology)*. Springer. ISBN-13: 978-1848002548	

Course Code	**MIC3092**
Course Title	**Microbial agents for Plant disease management**
Credit Value	**2**
Pre-requisites	**Plant Pathology (MIC 3042)**
Compulsory/Optional	**Optional**
Course Content	
Introduction to major groups of microbial bio control agents; characteristics of bio control agents; microbial bio control agents used in research and commercialization: successful stories; morphological adaptions, biochemical and molecular mechanisms behind bio control of plant diseases such as antibiosis, siderophore production, quorum sensing, GacS/GacA regulatory system of bio control in bacteria; process of commercialization of bio control agents; legislations and legal background in commercialization of bio control agents in different countries and regions of the world. Laboratory exercises and field visits based on above topics.	
Recommended Texts	
• Narayanasamy, P. (2013). *Biological Management of Diseases of Crops. Volume 3, Mechanisms of Action of Fungal Biological Control Agents*. Springer Netherlands. • Alioscha, J., Parra, C. (2015). *Biological Control of Phytopathogenic Fungi.* OMICS Group eBooks, CA, USA.	

Course Code	MIC3102
Course Title	**Bio Fertilizers and Bio pesticides**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction to biofertilizers and biopesticides; biofertilizers include nitrogen fixing bacteria, phosphorus solubilizing, plant growth stimulating microorganism and mycorrhizae; application methods - to seeds, plant surface and soil; mode of action - colonize the rhizosphere or the interior of plants and promote growth by increasing supply or availability of primary nutrients to host plant. Use of Bio-fertilizers in reducing chemical fertilizers. Pesticides - derived from natural materials from animals, plants, bacteria, and certain minerals. Microbial pesticides consist of bacteria, fungi, virus or protozoan and control weeds, and fungal pathogens, insect pests. Commercial preparation of biofertilizers and biopesticides and their benefits. Laboratory exercises based on above topics.

Recommended Texts

- Rai, M. (2006). *Handbook of Microbial Biofertilizers*, CRC Press.
- Lakshman, H C and Channabasava A, (2014). *Biofertilizers and Biopesticides*, Bio-green books.
- Kulasooriya, S.A. (2008). *Biological Nitrogen Fixation; fundamentals and utilization*. Peradeniya Science Publication. No. 27

Course Code	MIC3112
Course Title	**Fermentation Technology and Probiotic Microorganisms**
Credit Value	**2**
Pre-requisites	**Microbial Ecology and Functions (BOT 2062)**
Compulsory/Optional	**Optional**

Course Content

Fermented food and beverage products: vegetables, seeds, meats, milk and dairy; beverages, microbes involved and identification of yeasts, lactic acid bacteria, and fungi; problems and dangers involved with misidentification of microbes involved; scope of probiotics in human health and animal-based products. Laboratory exercises based on above topics.

Recommended Texts

- Hutkins RW. (2006). *Microbiology and Technology of Fermented Foods* .Wiley Blackwell
- Latest review articles and research papers on relevant topics

Course Code	MIC3122
Course Title	**Wastewater and Solid Waste Microbiology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Principles and fundamentals of biological, chemical and separation methods of waste water and solid waste management. Microorganisms used in waste water treatment and solid waste disposal. Biofilm formation and their effects on environmental systems. Use of multi-disciplinary approaches in waste water and solid waste management. Different systems of handling wastewater and solid waste disposal. Visits to wastewater treatment and solid waste disposal plants. Discuss management of wastewater and solid waste systems based on experiences and trends from urban areas in different countries. Laboratory exercises based on above topics.

Recommended Texts
• Bitton, G. (2010). *Wastewater Microbiology*, 4th Ed. Wiley-Blackwell. • Rada, E.C. (2015). *Biological Treatment of Solid Waste: Enhancing Sustainability*. Apple Academic Press.

Course Code	**MIC3132**
Course Title	**Bacteria of Medical Importance**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Importance of bacteria in human health; normal flora and microbiome; proving causation of diseases, Koch's postulates and their limitations; classification of medically important bacteria; processes by which bacteria cause disease. Introduction to medically important bacteria, Gram positive cocci to include staphylococci, streptococci and enterococci; Gram negative bacilli to include enterobacteriaceae, pseudomonads and other non-lactose fermenters of medical importance; Gram negative cocci to include *Neisseria* and *Moraxella*; Gram positive bacilli to include *Bacillus*, *Nocardia*, *Listeria*, mycobacteria; anaerobes to include clostridia, actinomycetes and *Prevotella*; Gram negative coccobacilli to include *Haemophilus*, *Bordetella*, *Legionella* and *Pasteurella*; *Vibrio*, *Campylobacter* and *Helicobacter*; spirochaetes; *Chlamydia*, rickettsiae and *Mycoplasma*. Emerging and re-emerging bacterial infections and zoonotic bacterial infections. Antibiotics to include beta-lactams, aminoglycosides, macrolides, tetracyclines, glycopeptides, their mechanisms of actions, resistance mechanisms, emergence and spread of resistance. Overview of the defense system to include innate and adaptive immune responses. Methods employed in the laboratory diagnosis of bacterial infections to include culture, immunological methods and molecular diagnostics. Prevention of infections to include sterilization and disinfection. Laboratory exercises based on above topics.	
Recommended Texts	
• *Lippincott's illustrated reviews: Microbiology.* (2006). Lippincott Williams and Wilkins Health. Latest Edition • *Jawetz, Melnick, & Adelberg's Medical microbiology*. (2007). New York: McGraw Hill Medical. Latest Edition	

Course Code	**MIC3142**
Course Title	**Vector Borne Diseases**
Credit Value	**2**
Pre-requisites	**Invertebrate Diversity (ZOO2212)**
Compulsory/Optional	**Optional**
Course Content	
Taxonomy, morphology, distribution and life cycle of medically and veterinary important vector borne pathogens; Emergence and resurgence of vector borne diseases; Dynamics of transmission; Detection and control; Integrated strategies to address vector borne diseases; Environmental and ecological relations, Outbreaks and geographic spread of vectors and pathogens; Vectors of medically and veterinary importance, and their control; Case study on currently important vector borne disease in Sri Lanka. Laboratory exercises based on above topics.	
Recommended Texts	

- Marquardt, W. C., Demaree R.S., and Grieve, R.B. (2000). *Parasitology and Vector Biology* 2nd Ed. Harcourt/Academic Press.
- Bannister,B.A., BeggN.T., and Gillespie, S.A. (2000) *Infectious diseases*. 2nd Ed. Blackwell Science Ltd.
- Scott, M.E., and Smith, G. Eds. (1994). *Parasitic and Infectious Diseases: Epidemiology and Ecology.* Academic Press Ltd.

Course Code	**MIC3152**
Course Title	**Viral Diseases - Past, Present and Future**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Viruses in the context of their global impact on disease and history, beneficial uses of viruses. Understanding the diversity of viruses, their replication strategies and their interactions with the host in disease. General aspects of virology with reference to DNA viruses (Pox, Parvo, papova and adenoviruses; Herpes viruses and Hepatitis B virus); RNA viruses (Respiratory viruses – Influenza and corona viruses including SARS and MERS corona viruses; polio and diarrhoeal viruses; ARBO viruses (dengue, JE, chikungunya, Zika and others); zoonotic viruses including rabies; retroviruses (HIV/AIDS) and prions; maternal viral infection that affect the foetus and neonate including rubella; control of viral diseases. The relevance of viruses in society, historical accounts and contemporary news articles. Laboratory exercises based on above topics.

Recommended Texts

- White, D.O. and Fenner, F. (2010). *Medical Virology*. 5th Ed. Academic Press, San Diego
- Acheson, N.H. (2011) *Fundamentals of Molecular Virology*, 2nd Ed. McGill University.
- Flint, J., Racaniello, V., Rall, G., and Skalka, A.M. (2015*). Principles of Virology*. 4th Ed. American Society for Microbiology.
- Brooks, G.F., Butel, J.S. and Morse S.A. (2012).*Jawetz, Melnick and Adelberg's Medical Microbiology.* 26th Ed. McGraw Hill Press.
- Mims C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zukerman, M. (2005). *Medical Microbiology*. 3rd Ed. Elsevier Mosby Publishers.
- Flannery, T. (2005). *The Weather Makers. The History and Future Impact of Climate Change.* Text Publishing, Melbourne.
- Web links http://www.virology.net/garryfavweb10.html and http://virology-online.com

Course Code	**MIC3162**
Course Title	**Microbes for Sustainability**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to Economics of production. Comparative cost analysis between microbial and synthetic industrial processes. *viz;* bio fertilizer vs chemical fertilizer; biofuel vs fossil fuel; Bio mining vs physiochemical mining. plant based antibiotics vs synthetic antibiotics; microbial vs chemical waste water treatment; bio control vs pesticides for plant disease management. The contribution of the above microbial processes for national cost benefit and development. Industrial visits. Strategies for commercialization and popularization of developed products. Laboratory exercises based on above topics.

Recommended Texts

- Ahmad, I., Ahmad, F., and Pichtel, J (2011). *Microbes and Microbial Technology*. Springer-Verlag.

New York

- Castro-Sowinski, S. (Ed.) (2016). *Microbial Models: From Environmental to Industrial Sustainability*.Springer- Singapore
- Latest review articles and research papers on relevant topics

Course Code	**MIC3172**
Course Title	**Bioethics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Definitions of ethics, Introduction to the fundamentals of ethical decision-making; Ethical questions surrounding scientific research; Consent, privacy and confidentiality; Protection of the environment, the biosphere and biodiversity; Social responsibility and health; Bio-piracy; Biological warfare; Ethics of GMO, stem cells, antibiotic use, DNA fingerprinting and biobanking; method of application for ethical clearance in research; Discussions and writing assignments based on the above topics.

Recommended Texts

- Biricolti, S., Ammann, K., Jacot, Y., and Braun, R. (2004). *Methods for risk assessment of transgenic plants*. IV Biodiversity and Biotechnology.
- Gert, B., Culver, C. M., and Clouser, K. D. (2006). *Bioethics: a return to fundamentals*. Oxford University Press.
- Jecker, N. S., Jonsen, A. R., and Pearlman, R. A. (2011). *Bioethics*. Jones & Bartlett Publishers.
- Kuhse, H., Schüklenk, U., and Singer, P. (2015). *Bioethics: an anthology (Vol. 40).* John Wiley & Sons.
- Steinbock, B. (2007). *The Oxford handbook of bioethics*. Oxford University Press on Demand.

Course Code	**MIC3182**
Course Title	**Effective Scientific Communication**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Ethical and legal standards in scientific research; Introduction to types of scientific communication; Effective use of online literature search engines; Manuscript structure and content; Scientific writing: plagiarism, organization and writing styles, effective use of language, presenting numerical data, constructing scientific figures: Reference citation: referencing styles, in-text citations and reference list, reference management software; Reviewing scientific manuscripts and presentations; Software skills required for scientific writing and oral presentations; Poster and oral presentations: planning, design, structure, effective use of visual, textual and audible elements; delivery, handling questions.

Recommended Texts

- American Psychological Association. (2010). *Publication manual of the American Psychological Association*, 6th Ed. American Psychological Association.
- Carter, M. (2012). *Designing science presentations: a visual guide to figures, papers, slides, posters, and more*. Waltham, MA: Academic Press.
- Katz, M. J. (2009). *From research to manuscript: a guide to scientific writing*. Hackensack, NY: Springer Science & Business Media.
- Schimel, J. (2012). *Writing science: how to write papers that get cited and proposals that get funded*. New York, NY: Oxford University Press.

4000 Level Courses

Course Code	**MIC4012**
Course Title	**Applied Microbial Genetics: Case Studies**
Credit Value	**2**
Pre-requisites	**Microbial Genetics (BOT 2072)**
Compulsory/Optional	**Optional**
Course Content	
Applications in microbial genetics: medicine, agriculture, industry and the environment. The theory, practice, and the importance of microbial genetics in these areas are explored through a problem-based approach. The topics would change and updated to provide current and relevant review, bioengineering custom microbes, microbial application in phytoremediation, renewable resources, mode of action of antimicrobial agents, bio-based nanomaterial, CRISPR/Cas9, Metagenomics, Human microbiome project	
Recommended Texts	
• Snyder, L., and Champness, W. (2013). *Molecular genetics of bacteria*. Washington, DC: ASM Press. • Glasman-Deal,H. (2010). *Science Research Writing for Non-Native Speakers of English.* Imperial College press. London.	

Course Code	**MIC4022**
Course Title	**Diazotrophs and Sustainable Soil Management**
Credit Value	**2**
Pre-requisites	**Microbial Ecology and Functions (BOT 2062)**
Compulsory/Optional	**Optional**
Course Content	
Diazotrophs**:** taxonomy and biology; symbiotic and non-symbiotic N_2 fixation; physiological and biochemical processes. Genetic and molecular fundamentals. Role of biological nitrogen fixation in sustainable soils. Quantitative aspects of biological N_2 fixation. Field and research based experimental systems. Recent research advancements in the field. Laboratory exercises and field visits based on above topics.	
Recommended Texts	
• Klipp, W., Masepohl, B., Gallon, J.R. and Newton, W.E. (2004). *Genetics and regulation of nitrogen fixation in free-living bacteria*. Kluwer Academic Publishers. • Kulasooriya, S.A. (2008). *Biological Nitrogen Fixation*. Peradeniya Science Publication No 17. Science Education Unit, faculty of Science, University of Peradeniya. • deBruijn, F.J. (2015). *Biological Nitrogen Fixation*. John Wiley & Sons, Inc.	

Course Code	**MIC4032**
Course Title	**Lichen Biology**
Credit Value	**2**
Pre-requisites	**Algae and Fungi (BOT 2012)**
Compulsory/Optional	**Optional**
Course Content	
Introduction of lichen symbionts, mycobiont and photobiont; lichen thallus anatomy and morphology; lichen nomenclature; water relation, CO_2 and N_2 fixation, stress physiology of lichens; taxonomy and phylogeny of lichen fungi and algae; secondary metabolites of lichen; biochemistry and gene expression during lichen	

symbiont interaction; lichens as pioneer species; lichens and air pollution; isolation of lichen fungus and algae under laboratory conditions and *in vitro* re-synthesis of lichen thallus. Laboratory exercises and filed visits based on above topics.
Recommended Texts
• Nash III, T.H. (2010*). Lichen Biology*. Cambridge University Press, Cambridge • Weerakoon, G. (2015). *Fascinating Lichens of Sri Lanka*. Ceylon Tea Services PLC / Karunaratne& Sons (Pvt) Ltd

Course Code	**MIC4042**
Course Title	**Advanced Plant Pathology**
Credit Value	**2**
Pre-requisites	**Plant Pathology (MIC3042)**
Compulsory/Optional	**Optional**
Course Content	
Molecular basis of plant-pathogen interactions: genes and disease, variability in pathogens, pathogenicity factors and virulence factors of fungi and bacteria, signal transduction pathways, priming of plant defences; Bacterial infections and patho-systems; Plant disease epidemiology: contributing factors, measurement of plant disease and yield loss, novel techniques in disease forecast and diagnosis; Sustainable disease control: organic agro-ecological pest management, transgenic techniques; Field and laboratory exercises based on above topics.	
Recommended Texts	
• Agrios, G.N. (2005). *Plant Pathology*, 5th Ed. UK: Elsevier Academic Press. • Wilson, C.R. (2014). *Molecular methods in Plant Disease Diagnostic Principals and Protocols*. UK: CABI Publishing. • Punja, Z.K., DeBoer, S.H. and Sanfacon, H. (2007). *Biotechnology and Plant Disease Management*. UK: CABI Publishing. • Vadivel, K. and Ganesan, S. (2015). *Sustainable Crop Disease Management using Natural Products*. UK: CABI Publishing.	

Course Code	**MIC4052**
Course Title	**Toxicology**
Credit Value	**2**
Pre-requisites	**Photosynthesis and Respiration (BOT 2052)**
Compulsory/Optional	**Optional**
Course Content	
Introduction to toxicology; bioaccumulation, types of dose measures of toxicity (LD_{50}, ED_{50}, LC_{50}); biodegradability; the toxicological paradigm, toxicokinetics, toxicodynamics; dose – response relationships, microbial toxins – of bacteria, cyanobacteria and fungi (mushroom toxins and mycotoxins), their nature and effects, factors contributing to their formation in food and methods of prevention of contamination and decontamination; case studies, toxins of higher plants, their nature and effects, analytical techs of toxins, toxicogenomics, legislature in different countries, uses of toxins. Laboratory exercises based on above topics.	
Recommended Texts	
• Eaton, D.L. and Groopman, J. D. (1994). *The toxicology of aflatoxins*. Academic Press, U.K. • Friedman, M. (1990). *Nutritional and Toxicological consequences of food processing. Advances in Experimental Medicine and Biology*. Vol 289. Plenum Press. • Jones, J. M. (1993). *Food Safety*. Eagon Press. • Miller, J. D. and Trenholm, H. L. (1994). *Mycotoxins in grain – compounds other than aflatoxins*.	

Eagon Press. • Vries, D. J. (1997). *Food Safety and Toxicology*. CRC Press, USA. • The Comparative Toxicogenomics Database (CTD; http://ctdbase.org/)

Course Code	**MIC4062**
Course Title	**Biosecurity**
Credit Value	**2**
Pre-requisites	**Plant Pathology (MIC 3042)**
Compulsory/Optional	**Optional**
Course Content	
Introduction to biosecurity; Biological threats to human health: communicable diseases and agents; epidemic and pandemic potential of diseasesand bioterrorism; Biological threats to agriculture and ecosystems: animal and plant diseases, agroterrorism and invasive organisms; Impact of biosecurity and geopolitics; Legal aspects of biosecurity; International approaches of FAO. Border security and quarantine: roles of border personnel, permits, inspections, certifications, commodity treatments and quarantine strategies; Biosecurity management: Animal and plant diseases, and pest management, outbreak management, invasive organism detection, management and eradication. Case studies, field visits and online assignments based on above topics.	
Recommended Texts	
Persson, K. (2013). *Agricultural Quarantine Inspection Program: Select Analyses.* Nova Science Publishers Inc, New York. Ryan, J. (2016). Biosecurity and bioterrorism: containing and preventing biological threats. Butterworth-Heinemann. Dobson, A., Barker, K., & Taylor, S. L. (Eds.). (2013). Biosecurity: the socio-politics of invasive species and infectious diseases. Routledge.	

Course Code	**MIC4072**
Course Title	**Microbiological Applications**
Credit Value	**2**
Pre-requisites	**Microbial Ecology and Functions (BOT 2062)**
Compulsory/Optional	**Optional**
Course Content	
Field based exposure to microorganisms with industrial and environmental applications. Microbial biotechnology: microbes as a model in research. Community outreach programmes: microbiological surveys, social awareness. Industrial visits.	
Recommended Texts	
• Glazer, A.N. and Nikaido, H. (1995). *Microbial biotechnology. Fundamentals of Applied Microbiology*. W.H. Freeman & Company, New York, USA. • Saxena, S. (2015). *Applied Microbiology*. Springer India. • Laskin, A., Sariaslani, S. and Gadd, G. (2006). *Advances in Applied Microbiology*, Vol 60. Academic Press, USA. • Verma, D.K. (2018). *Microbiology for Sustainable Agriculture, Soil Health, and Environmental Protection*. Apple Academic Press. • Madigan, M.T., Martinko, J.M., Bender, K.S., Buckley, D.H. and Stahl, D (2018). *Brock Biology of Microorganisms*. 15th Ed. Benjamin Cummings.	

Course Code	MIC4082
Course Title	Wetland and Aquatic Microbiology
Credit Value	2
Pre-requisites	Tropical Ecosystems (BOT1192)
Compulsory/Optional	Optional
Course Content	
Introduction to wetland and aquatic ecosystems and their overall functioning; characterization and ecology of wetland, fresh water and marine microorganisms; Patterns in wetland and aquatic microbial community composition; role of microbes in organic and inorganic cycling processes and food web dynamics, in the biogeochemical cycles of nitrogen, sulfur and methane; role of marine microbes in geomicrobiology, antibiosis and productivity in the sea; microbial activities in corrosion, foul, and seafood-related spoilage and contamination; eutrophication; algal toxins, grazing impact; impacts on marine life and human health; methane emission from wetlands; Indicator species; identification, enumeration of harmful microbes in water bodies and toxin detection techniques; exploitation of mixed microbial communities for biotechnology and bioremediation. Laboratory exercises and filed visits based on above topics.	
Recommended Texts	
• Bodelier, P. (2013*). Microbiology of wetlands.* Frontiers E-books • Munn, C. (2011). *Marine Microbiology: Ecology & Applications.* 2nd Ed. Garland Science. • Sigee, D.C. (2004). *Freshwater Microbiology: Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment*. John Wiley and Sons.	

Course Code	MIC4092
Course Title	Bio fermentation
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Optional
Course Content	
The use of microorganisms or their enzymes for production of compounds that find applications in energy, chemical, material and pharmaceutical and the food sector. Development of cell factories for biofuels (bioethanol, biobutanol and biodiesel) and biochemicals, biopharmaceuticals and nutraceuticals, enzyme technology (enzyme discovery, cloning, expression and characterization). Changes in society and technology, the growing need for efficiency and sustainability of the production systems, changing consumer perception and behaviour and changing agricultural systems and practices. Laboratory exercises based on above topics.	
Recommended Texts	
• Lens, P., Westerman, P, Haberbauer, M., Moreno A. (Eds.) (2005). *Biofuels for Fuel Cells: Renewable Energy from Biomass Fermentation.* IWA Publishing, Pittsburg. • Katz, S. E. (2012). *The Art of Fermentation: An In-Depth Exploration of Essential Concepts and Processes from around the World.*Chelsea Green Publishing.	

Course Code	MIC4102
Course Title	Applied Parasitology
Credit Value	3
Pre-requisites	Vector Borne Diseases (ZOO3232)
Compulsory/Optional	Optional
Course Content	

Epidemiology of parasitic diseases with special reference to Sri Lanka; Drug resistance of parasites; Zoonoses; Emerging and re-emerging infectious diseases; Epidemiology and control of helminthes in livestock; Parasite behaviours; Parasite-induced alterations in host behavior, reproduction and survival; Evolution of parasitism; Impact of parasites on wild animal health and population declines; Arthropods of medical and veterinary importance and vector borne diseases; Diagnostic techniques of parasitic diseases; Assignments and discussions on current research articles. Laboratory exercises based on above topics.
Recommended Texts
• Marquardt, W.C., R.S. Demaree, R.S., and Grieve, R.B.(2000). *Parasitology and Vector Biolog* Academic Press. • Ash, L.R. and Orihel,T.C. (1990) *Atlas of Human Parasitology*. American Society of Clinical Pathologists, Chicago. • Burton J. Bogitsh, B.J. and Cheng, T.C.(2005) *Human Parasitology*. 3rd Ed. Elsevier Academic Press • Mehlhorn, H. (1988). *Parasitology in Focus*. Springer-Verlag

Course Code	**MIC4112**
Course Title	**Animal Pathogens and Public Health**
Credit Value	**2**
Pre-requisites	**Bacteria of Medical Importance (MIC3132)**
Compulsory/Optional	**Optional**
Course Content	
Normal microbial population of different animal species: birds, farm animals, aquatic animal and wild animals. Animal pathogens in livestock, poultry, fish and wild animals: Entry of pathogens into the host, types of bacterial, viral and fungal pathogens, Mechanism of pathogenicity, colonization and growth, virulence, virulence factors – exotoxins, enterotoxins, endotoxins, neurotoxins. Microbiological examination of various samples collected from diseased animals, poultry and fish. General Account of Epidemiology (including molecular epidemiology) in investigating microbial diseases in animals. Measures to prevent epidemics - biosecurity and vaccination. Microbes in food of animal origin. Laboratory exercises based on above topics.	
Recommended Texts	
• Quinn, P. J., Markey, B. K., Leonard, F. C., Hartigan, P., Fanning, S., and FitzPatrick, E. S. (2011). *Veterinary microbiology and microbial disease*. John Wiley & Sons. • Radostits, O. M., Gay, C. C., Hinchcliff, K. W., and Constable, P. D. (Eds.). (2006). *Veterinary Medicine: A textbook of the diseases of cattle, horses, sheep, pigs and goats*. Elsevier Health Sciences. • Carter, G. R., Chengappa, M. M., Roberts, A. W., Claus, G. W., and Rikihisa, Y. (1995). *Essentials of veterinary microbiology*. Willians& Wilkins. • Swayne, D. E., and Glisson, J. R. (2013). *Diseases of poultry*. Wiley- Blackwell. • Wolf, K. (1988). *Fish viruses and fish viral diseases*. Comstock Publishing Associates, Cornell University Press. • Post, G. W. (1983). *Textbook of fish health*. TFH Publications Inc. • Soulsby, E. J. L., Torgerson, P. R., and Brown, D. W. (2011). *Oxford Textbook of Zoonoses: Biology, clinical practice, and public health control*. S. R. Palmer (Ed.). Oxford University Press.	

Course Code	**MIC4123**
Course Title	**Immunobiology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Adaptive and innate immunity; cells and soluble mediators of immune system; Antigens and antigen presentation; inflammation; Antibodies; T-cell receptors; Major histocompatibility complex; Cytokines and	

cytokine receptors; Evolution of immunity; Vaccination; Tumor immunology; Immunodeficiency; Transplantation and rejection; Autoimmunity and autoimmune diseases; Hypersensitivity; immunological techniques. Practical exercises and discussions based on above.
Recommended Texts
• Male,D., Brostoff, J., Roth, D and Roitt, I. (2006). *Immunology* 7th Ed. Elsevier • Roitt I., Brostoff J., Male D., *Immunology*. 6th Ed. Elsevier Health Sciences

Course Code	**MIC4132**
Course Title	**Laboratory Management and Quality Assurance**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Microbiology laboratory quality management systems; Starting up a laboratory; Laboratory design; Equipment; Organization; Purchasing and inventory; Process control; Documentation; standardization of pre-analytical, analytical, post-analytical and reporting procedures, forms and logs, laboratory quality manuals, implementation of a laboratory handbook for customers; Sample Management; Laboratory quality control; Laboratory assessment; Audits; Customer service; Occurrence management; Information management: Laboratory information systems (LIS). Industrial visits based on the above topics.	
Recommended Texts	
• *Laboratory quality management system: Handbook*. World Health Organization. • *Clinical and Laboratory Standards Institute. Protocols to Validate Laboratory Information Systems; Proposed Guideline*. CLSI document AUTO8. Clinical and Laboratory Standards Institute, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898 USA, 2005. • *Clinical and Laboratory Standards Institute. Laboratory Design: Approved Guideline* – 2nd Ed. CLSI document GP18-A2. Clinical and Laboratory Standards Institute, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898 USA, 2007. • Harmening, D.M. (2013). *Laboratory Management: Principles and Processes.* D.H. Pub. & Consulting	

Course Code	**MIC4142**
Course Title	**Industrial Training**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained ‘Daily Diary’ which should be submitted to the Head of the Department within two weeks after completion of the training. The students are expected to write a report and make a presentation on the projects assigned to them.	
Recommended Texts	
Guidelines for Industrial Training and Preparation of Report. Students’ Handbook. Department of Botany, Faculty of Science, University of Peradeniya	

Course Code	**MIC4158**
Course Title	**Research in Microbiology**
Credit Value	**8**
Pre-requisites	**Biostatistics (BOT3082), Bioethics (MIC3172), Effective Scientific Communication(MIC3182)**
Compulsory/Optional	
Course Content	
The students will conduct sufficient amount of laboratory/field work on a chosen research topic under the guidance provided by an assigned supervisor/s, make a presentation of research findings at a Department / University / national/international conference, and write a complete report.	
Recommended Texts	
• Backwell, J., Martin, J. (2011). *A Scientific Approach to Scientific Writing*, Springer. • Guidelines provided by the Department of Botany.	

2. DEPARTMENT OF CHEMISTRY

2.1 Chemistry Course Modules

1000 LEVEL - CHEMISTRY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
CHE1013	Principles of Chemistry I	3		√	√
CHE1023	Principles of Chemistry II	3	CHE1013	√	√
CHE1081	Elementary Chemistry Laboratory I	1		√	√
CHE1091	Elementary Chemistry Laboratory II	1		√	√
Total		**08**		**08**	**08**

2000 LEVEL – CHEMISTRY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
CHE2112	Inorganic Chemistry I	2	CHE1023	√	√
CHE2122	Inorganic Chemistry II	2	CHE2112		
CHE2181	Inorganic Chemistry Laboratory I	1	CHE1091	√	√
CHE2212	Organic Chemistry	2	CHE1023	√	√
CHE2282	Techniques in Organic Chemistry I	2	CHE1081	√	√
CHE2313	Physical Chemistry I	3	CHE1023	√	√
CHE2332	Chemical Calculations	2	CHE1023		
CHE2381	Physical Chemistry Laboratory I	1	CHE1091	√	√
Total		**15**		**11**	**11**

3000 LEVEL – CHEMISTRY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
CHE3112	Structural Inorganic Chemistry	2	CHE2112	√	
CHE3122	Advanced Inorganic Chemistry I	2	CHE2112	√	
CHE3192	Advanced Inorganic Chemistry Laboratory	2	CHE2181	√	
CHE3212	Organic Chemistry II	2	CHE2212	√	
CHE3222	Organic Chemistry III	2	CHE 2212	√	
CHE3232	Biomolecules and Heterocycles	2	CHE 2212	√	
CHE3282	Techniques in Organic Chemistry II	2	CHE 2282		√
CHE3292	Advanced Organic Chemistry Laboratory	2	CHE2282	√	
CHE3303	Advanced Physical Chemistry I	3	CHE2313	√	
CHE3313	Physical Chemistry II	3	CHE2313	√	√

CHE3381	Physical and Industrial Chemistry Laboratory	1	CHE2381		√
CHE3392	Advanced Physical Chemistry Laboratory	2	CHE2381	√	
CHE3413	Analytical Chemistry	3	CHE2313	√	
CHE3491	Analytical/Instrumental Chemistry Laboratory	1	CHE3413	√	
CHE3481	Analytical and Inorganic Chemistry Laboratory	1	CHE2181, CHE2381		√
CHE3512	Biological Chemistry I	2	CHE2212	√	
CHE3712	Industrial Chemistry	2	CHE2212, CHE2313		
CHE3723	Nanoscience and Nanosynthesis	3	CHE2313		
CHE3812	Computer Applications and Instrumentation	2	CHE2313		
Total		**39**		**28**	**07**

4000 LEVEL – CHEMISTRY				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
				Hons.
CHE4112	Advanced Inorganic Chemistry II	2	CHE2122, CHE3122	√
CHE4122	Advanced Inorganic Chemistry III	2	CHE3112, CHE3122	√
CHE4132	Solid State Chemistry	2	CHE2112, CHE4112	
CHE4213	Advanced Organic Chemistry II	3	CHE2212, CHE3212	√
CHE4222	Natural Product Chemistry	2	CHE3512	√*
CHE4312	Advanced Physical Chemistry II	2	CHE3313	√
CHE4322	Advanced Physical Chemistry III	2	CHE3313	√
CHE4332	Molecular modeling	2	CHE3812	
CHE4342	Special topics in Physical Chemistry	2	CHE3302, CHE3313	
CHE4352	Applications of Nanoscience in Chemistry	2	CHE3723	
CHE4412	Advanced Analytical Chemistry	3	CHE3413	√
CHE4512	Biological Chemistry II	2	CHE2212, CHE3512	√*
SCI4003	Industrial Training	3		√
CHE4911	Seminar	1		√
CHE4921	General Aspects and Recent Developments in Chemistry	1		√
CHE4998	Research Project	8		√
Total		**39**		**29**

1000 Level Courses

Course Code	CHE1013
Course Title	Principles of Chemistry I
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

General Chemistry I (15 L): Modern view of the atomic structure and the development of the atomic theory of matter; atomic spectrum of hydrogen, Bohr model, wave-particle duality, electrons as waves, de Bröglie relationship, the quantum mechanical description of the atom, Heisenberg‘s uncertainty principle; electron spin and the Pauli exclusion principle, Hund‘s rule, Aufbau principle, electron configurations of elements and development of the periodic table; Bonding: types of chemical bonds, covalent bonds, ionic bond, coordinate (dative) bonds, organometallic bonds, metallic bonds, non-valence cohesive forces, ion-dipole interactions, dipole-dipole interactions, hydrogen bonding; Lewis theory, octet rule, Sidgwick-Powell theory, effect of electronegativity on molecular shape, partial ionic character of a covalent bond, electronegativity, polarity and dipole moment, ionic lattices, partial covalent character of an ionic bond, lattice energies, solubility

Structure and Reactivity (15 L): Types of intermolecular interactions in organic compounds; factors affecting electron availability in bonds and at individual atoms; Acidity and basicity; Functional groups responsible for reactivity of different classes of organic compounds; Relationships between the main classes of organic molecules; Introduction to reaction mechanisms: bond cleavage processes, types of reagents and reaction intermediates; Energy diagrams; Mechanisms of substitution, addition and elimination reactions; Reactions in functional group analysis and their mechanisms; IUPAC nomenclature; Aromaticity and Hückel’s Rule

Chemical Thermodynamics (15 L): Thermodynamic systems, thermodynamic processes; Zeroth law and First law of thermodynamics, work, heat, internal energy, extent of reaction, enthalpy; Second law of thermodynamics, entropy, Gibbs free energy, Helmholtz free energy, extent of reaction, reaction quotient; Exogenic and endogenic reactions, reactions at equilibrium, thermodynamic equilibrium constant; effects of concentration, pressure, volume and temperature on the position of equilibrium

Recommended Texts

- Ebbing, D. D. and Gammon, S. D. (2018). General Chemistry. 9th Edition
- Lee, J. D. (2012). Concise Inorganic Chemistry. 5th Edition
- Cotton, F. A. and Wilkinson, G. (1994). Basic Inorganic Chemistry. 3rd Edition
- McMurry, J.E (2012). Organic Chemistry. 8th Edition, Brooks/Cole Publishing Co.
- Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry.7th Edition, Prentice Hall
- Atkins, P. W. and de Paula, J. (2019). Physical Chemistry.). 9th Edition, Freeman and Co.
- Atkins, P. W. and de Paula, J. (2014). Physical Chemistry: Thermodynamics, Structure and Change. 10th Edition

Course Code	CHE1023
Course Title	Principles of Chemistry II
Credit Value	3
Pre-requisites	CHE1013
Compulsory/Optional	Compulsory

Course Content
General Chemistry II (15 L): Molecular structure: VSEPR model, three- center bonds, resonance, hybridization of atomic orbitals, molecular orbital theory, bonding in homonuclear and heteronuclear diatomic models; Size and energy factors in chemistry, magnetic properties; electrode potentials and Nernst equation; Basic concepts in chemical analysis: titrations, buffers, indicators, solubility equilibria and applications [del] **Kinetic Molecular Theory (KMT) and Chemical Kinetics** (15 L): KMT as a model for microscopic theories, experimental evidence, properties of gases, the perfect gas, state of gases, individual gas laws, combined gas laws, kinetic model for gases, imperfect gases; Molecular collisions; Basic concepts of chemical kinetics and reaction mechanisms; Rate laws: rate constant, order of chemical reaction, factors affecting the reaction rates; Elementary reactions, molecularity of a reaction, integrated rate laws, half-life of a reaction, Arrhenius equation and activation energy **Stereochemistry** (15 L): Configurational isomers, E,Z-nomenclature, symmetry, chirality; R,S-nomenclature, meso-compounds, diastereomers; Conformations in acyclic and cyclic compounds, cis-trans and optical isomerism in cyclic compounds; Biphenyls, allenes, stereochemical pathway of organic reactions (SN1, SN2, E1, E2) and effect of solvents on substitution reactions
Recommended Texts
• Ebbing, D. D. and Gammon, S. D. (2018). General Chemistry 9th Edition • Lee, J. D. (2012). Concise Inorganic Chemistry. 5th Edition • Chang, R. (2014). Chemistry. 9th Edition, McGraw-Hill • Cotton, F. A. and Wilkinson, G. (1994). Basic Inorganic Chemistry. 3rd Edition • McMurry, J.E (2012). Organic Chemistry. 8th Edition, Brooks/Cole Publishing Co. • Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry. 7th Edition, Prentice Hall • Atkins, P. W. and de Paula, J. (2019). Physical Chemistry. 9th Edition, Freeman and Co. • Atkins, P. W. and de Paula, J. (2014). Physical Chemistry: Thermodynamics, Structure and Change. 10th Edition

Course Code	CHE1081
Course Title	**Elementary Chemistry Laboratory I**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Laboratory Orientation (3 L + 2 P): Laboratory safety; Familiarizing equipment and glassware used in chemistry laboratory; Materials safety data sheets, waste disposal protocols, significant figures, measurements and error analysis. **Qualitative organic analysis** (10 P): Elementary laboratory techniques: testing acidity, heating solutions (direct/indirect), testing evolved gases, transferring, filtering; Simple elemental analysis; Testing solubility of compounds; Analysis of unsaturation, carboxylic acids, esters, amides, amines, nitro, alcohol functional groups.	
Recommended Texts	
• Vogel, A.I. (1989). Qualitative Organic Analysis. 5th Edition, Longman Scientific	

Course Code	CHE1091
Course Title	**Elementary Chemistry Laboratory II**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Quantitative Analysis (5 P): Volumetric titrations: acid-base, oxidation-reduction and precipitation titrations **Qualitative analysis** (10 P): Analysis of inorganic salts in semi-micro scale	
Recommended Texts	
• Vogel, A.I. (1978). Qualitative Inorganic Analysis. 5th Edition, Longman Scientific	

2000 Level Courses

Course Code	CHE2112
Course Title	**Inorganic Chemistry I**
Credit Value	**2**
Pre-requisites	**CHE1023**
Compulsory/Optional	**Compulsory**
Course Content	
Trends in the periodic table (8L):Electronic structures and oxidation states, general properties; Trends in reduction potentials; electropositive character, inert pair effect and its consequences, catenation; Properties of hydrides, halides and oxides (acid-base properties, structural variability); Ability to form double bonds; Hydrolyzing ability of the simple compounds; Oxidizing power and reactivity; Complex forming ability of the elements in group 18; Solubility and thermal stability of the simple salts of group 1 and 2. **Coordination chemistry** (10 L): Coordination complexes; structures, stability constants, nomenclature, coordination numbers; Introduction to reaction mechanism; Valence bond theory; Crystal field theory; Introduction to magnetochemistry; Spectra of coordination complexes. **Solid state chemistry** (12 L): Crystalline state, unit cell systems, Bravais lattices, crystal planes, Miller indices, crystal structures of binary ionic compounds; Generation and diffraction of X-rays, Bragg Equation, Powder X-ray diffraction method and applications, crystallographic databases, radius ratio, calculation of lattice energies; Molecular Symmetry: point symmetry elements and operations; Classification of molecules/ions according to their symmetry.	
Recommended Texts	
• Hammond, C. (2012). The Basics of Crystallography and Diffraction. 4th Edition • Lee, J. D. (2012). Concise Inorganic Chemistry. 5th Edition • Kettle, S. F. A. (1999). Coordination Chemistry. 2nd Edition, Appleton Century • Liprot, G. F. (1977). Modern inorganic chemistry. ELBS series with Collins Educational • Greenwood, N. N. (1984). Chemistry of the Elements. 2nd Edition • Shriver, D. F., Atkins, P. W. and Langford, C. H. (1994). Inorganic Chemistry. 2nd Edition	

Course Code	**CHE2122**
Course Title	**Inorganic Chemistry II**
Credit Value	**2**
Pre-requisites	**CHE2112**
Compulsory/Optional	**Compulsory**

Course Content

Organometallic chemistry (8 L): Stability, 18-electron rule, effective atomic number rule, nature of bonding, Synergism: donation and back donation; metal-carbonyl, metal-dinitrogen, metal- nitric oxide, metal-olefin; metal-metal bonding; Experimental evidence for the nature of bonding (IR, NMR); Isolobal Analogy; Enemark-Feltham notation to describe the nature of metal nitrosyl bonding, synthesis and reactions; Complexes of π-acceptor ligands: CO, RNC, PR3, AsR3, SbR3, NO, 1,10-phenanthrolene; Metal carbonyls: Bonding in metal carbonyls

Basic radiochemistry (7 L): Introduction of radiochemistry: structure of the nucleus, radioactivity; Kinetics of radioactive decay, Nuclear transmutation and artificial radioactivity; Detection of radiation and radioactivity; Basic structure of nuclear reactors, hydrogen bomb; Uses of isotopes and radiation as traces; Effects of radiation.

Chemistry of Transition Metals (15 L): Chemistry of the transition elements; Lanthanides; Actinides; Transuranium compounds; d-block contraction and its consequences: colours and magnetic properties of the complexes; Lanthanide/Actinide contraction and its consequences; Extraction and separation

Recommended Texts

- Cotton, F. A. and Wilkinson, G. (1999). A Textbook of Inorganic Chemistry. 6th Edition, Wiley Inter-science
- Liprot, G. F. (1977). Modern inorganic chemistry. ELBS series with Collins Educational
- Huheey, J. E. (1983). Inorganic chemistry principles of structure and reactivity. 4th Edition
- Dougles, B., Danial, D. H. M. S. and Alexender, J. J. Concepts and models of Inorganic Chemistry.
- Choppin, G., Liljenzin, J. O. and Rydberg, J. (2001). Radiochemistry and Nuclear Chemistry. 3rd Edition
- Spinks, J. W. T. and Woods, R. J. (1991). An Introduction to Radiation Chemistry. 3rd Edition
- Glasstone, S. (1970). Sourcebook on Atomic Energy
- Frisch, D. and Thorndike, A. (1964). Elementary Particles.
- Zumdahl, S. S. (2017). Chemical Principles. 8th Edition
- Carswell, D. J. (1967). Introduction to Nuclear Chemistry.
- Cotton, F.A. (1990). Chemical applications of group theory. 3rd Edition
- Atkins, Overton, Rourke, Weller, Armstrong. (2011). Inorganic Chemistry. 7th Edition, Oxford University Press
- Greenwood, N. N. and Earnshaw, A. (1994). Chemistry of the Elements. 2nd Edition, Pergamon

Course Code	**CHE2181**
Course Title	**Inorganic Chemistry Laboratory I**
Credit Value	**1**
Pre-requisites	**CHE1091**
Compulsory/Optional	**Compulsory**

Course Content

Quantitative analyses of Inorganic compounds: Determination of simple inorganic anions and cations by gravimetric and redox titrations (with Br2, K2Cr2O7 and KMnO4, and iodometric titrations), complexometric titrations involving EDTA; Synthesis of inorganic complexes; Qualitative analysis of simple inorganic mixtures in

semi-micro scale and phosphate separation.
Recommended Texts
• Vogel, A.I. (1978). Qualitative Inorganic Analysis. 5th Edition, Longman Scientific

Course Code	**CHE2212**
Course Title	**Organic Chemistry**
Credit Value	**2**
Pre-requisites	**CHE1023**
Compulsory/Optional	**Compulsory**
Course Content	
Organic Reaction Mechanisms I (15 L): Energetics – thermodynamics and kinetics of organic reactions; Concerted reactions, multi-step reactions; Electrophilic and nucleophilic addition to double bonds; Reactions of carboxylic acids and derivatives; Reactions of carbonyl compounds – carbanions, enols, enolates; Rearrangements reactions. **Introduction to Organic Synthesis** (15 L): Oxidations - alcohols, alkenes; Sharpless asymmetric epoxidation; Reductions-carbonyl compounds using hydride reducing agents, catalytic hydrogenation; Reactions of carbonyl compounds-methods of generating enolates, C-alkylation, O-alkylation, nitrogen analogues of enols and enolates, organocuprates; Carbonyl condensation reactions-aldol reactions; Robinson annulation, Claisen ester condensation, Dieckmann condensation, Thorpe nitrile condensation, Knoevenagel condensation; C=C formation - Wittig reaction and its modifications; Diels Alder reaction; Cope rearrangement; Claisen rearrangement.	
Recommended Texts	
• Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry. 7th Edition, Prentice Hall • Fessenden, R. J. and Fessenden, J. S. (1998). Organic Chemistry. 6th Edition, Brooks/Cole Publishing Co. • Wannigama, G. P. (2000). Organic Reaction Mechanisms. SEU, University of Peradeniya. • Solomon, T. W. G. and Fryhle, C. B. (2002). Organic Chemistry. John Willey	

Course Code	**CHE2282**
Course Title	**Techniques in Organic Chemistry I**
Credit Value	**2**
Pre-requisites	**CHE1081**
Compulsory/Optional	**Compulsory**
Course Content	
Spectroscopy I (15 L): Electromagnetic spectrum and different types of molecular energy levels; UV-Vis spectroscopy: Beer-Lambert law, electronic transitions, effects of auxochromes, conjugation, and solvents on UV-Vis absorption, Woodward-Fieser rules; IR spectroscopy: sample preparation, characteristic IR absorption of different functional groups, types of vibrations, effects of conjugation, H-bonding and inter/intra-molecular interactions on IR absorption; NMR spectroscopy: instrumentation, principles of 1H-NMR, and 13C-NMR spectroscopy, double resonance and spin decoupling, proton broadband decoupled spectra, proton off-resonance decoupled spectra; 2D-NMR: COSY, HETCOR; Mass spectrometry: principles of MS, fragmentation rules, types of ionization techniques **Laboratory Techniques** (45 P): Separation and purification through solubility, phase distribution, distillation,	

steam-distillation, chromatography and recrystallization; Synthesis of simple derivatives of organic compounds with temperature control illustrating several different classes of reactions; Characterization of products using melting points, thin-layer chromatography
Recommended Texts
• Silverstein, R. M., Webster, F. X., and Kiemle, D. J. Spectrometric Identification of Organic Compounds. John Wiley • Ege, S. (1994). Organic Chemistry. DC Heath & Co. • Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry. 7th Edition, Prentice Hall • Fessenden, R. J. and Fessenden, J. S. (1998). Organic Laboratory Techniques. 6th Edition, Brooks/Cole Publishing Co. • Vogel, A. I. (1978). A Textbook of Practical Organic Chemistry. 4th Edition, Longman Scientific

Course Code	**CHE2313**
Course Title	**Physical Chemistry I**
Credit Value	**3**
Pre-requisites	**CHE1023**
Compulsory/Optional	**Optional**
Course Content	
Quantum Mechanics (10 L): Evidence for quantization, the Schrödinger equation, quantum mechanical principles, postulates in quantum mechanics, operators and observables, superposition and expectation values, the uncertainty principle, probability functions, solutions of Schrödinger equation for 1-, 2-, and 3-dimensional systems, and hydrogen atom. **Atomic Structure and Atomic Spectra** (8 L): Review of atomic models, quantum mechanical description of the atom, orbital shapes, radial distribution curves, probability plots; Polyelectronic atoms, electron shielding; Energy levels, and the filling up principle; Hydrogen atomic spectra, transitions and selection rules; Alkali metal spectra. **Molecular Properties, Molecular Spectroscopy and Spectroscopic Instrumentation** (17 L): Introduction to molecular properties; Electrical properties, dipole moment, polarizability, monopoles, polarization; Optical properties, refractive index; Magnetic properties, magnetic moment, magnetizability, magnetic susceptibility; experimental determination of molecular properties; Intermolecular forces; Introduction to molecular spectroscopy; Rotational spectra, vibrational spectra, electronic spectra; Basic components of spectroscopic instrumentation **Electrochemistry** (10 L): Conductometry, electronic and ionic conductors, conductivity and molar conductivity, strong and weak electrolyte solutions, determination of limiting molar conductivity, Kohlrausch's law of independent migration of ions, determination of ionic concentrations, equilibrium constants and rate constants; Conductometric titrations, electrodes, electrochemical cells, applications of potentiometry, factors affecting cell electromotive force (emf); Thermodynamic functions from emf measurements, potentiometric titrations	
Recommended Texts	
• Atkins, P. W. and de Paula, J. (2009). Physical Chemistry. 9th Edition, Freeman and Co. • Moore, W. J. (1998). Introduction to Molecular Spectroscopy. 2nd Edition, Pergamon Press • McQuarrie, D. A. (2001). Quantum Chemistry. 2nd Edition, University Science Books	

Course Code	**CHE2332**
Course Title	**Chemical Calculations**
Credit Value	**2**
Pre-requisites	**CHE1023**
Compulsory/Optional	**Optional**
Course Content	
Basic chemical calculations I (30 L): Problem solving: Identification of defining equation towards the goal in problem solving; Calculation in ionic equilibrium, applications of logarithmic and exponential functions (pH, pKa, pKb); Analytical chemistry calculations; Applications of complex numbers in physical chemistry; Linearization; Linear and non-linear graphical representations: Arrhenius equation, Clapeyron equation, isotherms, distribution functions (Maxwell, Boltzmann); Application of calculus: chemical kinetics; Chemical thermodynamics; Electrode equilibrium, Problems in thermodynamics and quantum chemistry; Matrices and Determinants: Addition and multiplication of matrices, transpose, inverse, diagonal and unit matrix, rules of determinants, minors and cofactors.	
Recommended Texts	

Course Code	**CHE2381**
Course Title	**Physical Chemistry Laboratory I**
Credit Value	**1**
Pre-requisites	**CHE1091**
Compulsory/Optional	**Compulsory**
Course Content	
Estimation of errors; Propagation of errors; Tabular and graphical presentation of data; Experiments in physical chemistry: equilibria, thermodynamics, colorimetry and conductometry; Mini-project	
Recommended Texts	
• Shoemaker, D. P., Garland, C. W. and Nibler, J. W. (1988). Experiments in Physical Chemistry. 5th Edition • Findlay, A. (1973). Practical Physical Chemistry. Oxford University Press • Mathews, P. (1986). Experimental Physical Chemistry. Oxford University Press	

3000 Level Courses

Course Code	**CHE3112**
Course Title	**Structural Inorganic Chemistry**
Credit Value	**2**
Pre-requisites	**CHE2112, CHE1023**

Compulsory/Optional	Compulsory
Course Content	
Structural Chemistry (15 L): Structures and nomenclature of boranes, carboranes and metalloboranes, Wade's rule, synthesis and reactions of boranes, carboranes and metalloboranes, Classification of silicates, introduction and structural chemistry of nesosilicates, sorosilicates, cyclosilicates, inosilicates, phyllosilicates and tectosilicates, classification and application of layer silicate clays, layered double hydroxide [LDHs], intercalates (graphite intercalation compound)and clathrates, Introduction, structural and geometry of metal clusters **Symmetry** (15 L): Symmetry elements, symmetry operations, classification of molecules/ions according to their symmetry; point groups; determination of point groups of molecules/ions, deduction of polarity and optical activity of molecules from their point groups, stereographic projections, group multiplication tables, basis, representative and matrix representation, character of an operation, reducible and irreducible representations and character tables and preparations.	
Recommended Texts	
• Shriver, D. F., Atkins, P. W. and Langford, C. H. (1991). Inorganic Chemistry. ELBS with Oxford university press • Huheey, J. E. (1993). Inorganic chemistry. 4th Edition • Cotton, F. A. and Wilkinson, G. (1999). Advanced Inorganic Chemistry. 6th Edition, Wiley Inter-science • Miessler, G. L. and Tarr, D. A. (2011). Inorganic Chemistry. 4th Edition • Cotton, F. A. (1990). Chemical applications of group theory	

Course Code	CHE3122
Course Title	**Advanced Inorganic Chemistry I**
Credit Value	**2**
Pre-requisites	**CHE2112**
Compulsory/Optional	**Compulsory**
Course Content	
Advanced coordination Chemistry (15 L): Ligand field theory; Van Velck theory Wave functions and Quantum numbers for a single electron; Angular momentum and coupling of angular momentum; Russell-Saunders or L-S coupling scheme; micro states; Construction of Energy level diagram; Development of ligand field Theory from group theory; electronic spectra of complexes; correlation diagrams: Orgel and Tanabe Sugano diagrams; effect of Jahn-teller distortion, nephelauxetic effect, estimation of crystal field stabilization energy from spectra, charge transfer spectra **Resonance Spectroscopic Methods** (15 L): Theory, selection rules, symmetry species, spectral transitions of 19F-NMR, 14/15N-NMR, 31P-NMR. Nuclear Quadrupole Resonance (NQR), Electron Spin Resonance (ESR), Mossbauer spectroscopic methods; and their inorganic applications	
Recommended Texts	
• Cotton, F. A. and Wilkinson, G. (1999). Advanced Inorganic Chemistry. 6th Edition, Wiley Inter-science • Sutton, D. (1968). Electronic spectra of Transition metal Complexes. • Kettle, S. A. (1997). Coordination Chemistry. • Orgel, L. E. (1962). An introduction to ligand field theory. • Alexender, J. J. (1998). Concepts and models in Inorganic Chemistry. 3rd Edition • Miessler, G. L. and Tarr, D. A. (2002). Inorganic Chemistry. 3rd Edition • Dragon, R. S. (1965). Physical Methods in Inorganic Chemistry. Oxford university Press, UK	

Course Code	**CHE3192**
Course Title	**Advanced Inorganic Chemistry Laboratory**
Credit Value	**2**
Pre-requisites	**CHE2181**
Compulsory/Optional	**Compulsory**

Course Content

Analysis of rare earth elements, fusion mixtures, synthesis of special inorganic compounds, determination of ligand field strength, nanoparticle synthesis and characterization, qualitative phase analysis and unit cell calculation using powder X-ray diffraction, XRF analysis of alloys and compound mixtures, UV-visible spectra of transition metal complexes, separation of inorganic ions.

Recommended Texts

- Vogel, A.I. (1978). Qualitative Inorganic Analysis. Longman Scientific

Course Code	**CHE3212**
Course Title	**Organic Chemistry II**
Credit Value	**2**
Pre-requisites	**CHE2212**
Compulsory/Optional	**Compulsory**

Course Content

Organic Reaction Mechanisms II (15 L): Reactive intermediates; Pericyclic reactions, Symmetry controlled reactions.

Organic Synthesis II (15 L); Retrosynthetic analysis; Chemoselectivity, regioselectivity, stereoselectivity and stereospecificity; Types of disconnections; Amine synthesis; Strategies and control in carbonyl condensation; Strategies in ring synthesis.

Recommended Texts

- Ege, S. (1981). Organic Chemistry. 2nd Edition, DC Heath & Co.
- Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry. 7th Edition, Prentice Hall
- Corey, E. J. and Cheng, X. M. (1995). The Logic of Chemical Synthesis. 1st Edition, John Wiley.
- Mackie, R. K. and Smith, D. M. (1990). Guidebook to Organic Synthesis. 3rd Edition, Addison, Wesley and Longman

Course Code	**CHE3222**
Course Title	**Organic Chemistry III**
Credit Value	**2**
Pre-requisites	**CHE2212, CHE2282**
Compulsory/Optional	**Compulsory**

Course Content

Conformational Analysis (15 L): Conformations of simple acyclic molecules, alkenes, carbocyclic systems (3-, 4-, 5-, 6- membered rings and large rings); Conformation and reactivity; Rules of ring closure; Stereo-electronic effects in reaction mechanisms. **Spectroscopy II** (15L): 2D NMR: DEPT, HSQC, HMBC, NOE; Application of advanced spectroscopic methods in structure determination of organic compounds.
Recommended Texts
• Eliel, E. L. and Wilen, S. H. (1994). Stereochemistry of Organic Compounds. John Wiley & Sons Inc. • Silverstein, R. M., Bassler, G. C. and Morrill, T. C. (2014). Spectrometric Identification of organic compounds. 8th Edition, John Wiley and Sons

Course Code	**CHE3232**
Course Title	**Biomolecules and Heterocycles**
Credit Value	**2**
Pre-requisites	**CHE2212**
Compulsory/Optional	**Compulsory**
Course Content	
Biomolecules (20 L): Reactions and properties of monosaccharides, structures of disaccharides and polysaccharides; Conformations of carbohydrates and conformational effects; Anomeric effect and mutarotation; Reactions at anomeric and non-anomeric centers; Structures of lipids; Properties and reactions of amino acids, structures of proteins **Heterocyclics** (10 L): Definition of heterocycles (five and six membered heterocycles, fused ring systems); Chemistry of Pyrrole, furan and thiophene; Six Membered Ring Aromatic Heterocycles: Structures, synthesis, and reactions; Synthesis and reactions of pyrylium salts, anthocyanins, α-pyrones; Polycyclic Aromatic Heterocycles: Structures, synthesis, and reactions; Heterocycles with more than one heteroatom.	
Recommended Texts	
• Fessenden, R. J. and Fessenden, J. S. (1998). Organic Chemistry. Brooks/Cole Publishing Co. • Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry. 7th Edition, Prentice Hall • Carey, F. A. and Sundberg, R. K. (2007). Advanced Organic Chemistry, Part A. Plenum Press • Lehninger, A., Nelson, D. L. and Cox, M. M. (2017). Principles of Biochemistry. 7th Edition, Worth Publishers Inc. • Stryer, L. (2019). Biochemistry. 9th Edition, WH Freeman and Co.	

Course Code	**CHE3282**
Course Title	**Techniques in organic Chemistry II**
Credit Value	**2**
Pre-requisites	**CHE2212, CHE2282**
Compulsory/Optional	**Compulsory***
Course Content	
Organic reactions (15 L): Reactions of free radicals and carbenes ; Mechanisms of simple organic reactions/Rearrangements; Reactions of carbocyclic and heterocyclic aromatic compounds; Basic structural units,	

precursors and common reactions in biosynthesis; Acetate, shikimate and mevalonate pathways **Applied Laboratory** (45 P): Synthesis of simple organic compounds; Isolation and characterization of natural products and synthesis and characterization of industrially important products; Elementary biochemistry tests for carbohydrates and proteins; Applications of spectroscopy for structure determination
Recommended Texts
• Vogel, A.I. (1978). Elementary Practical Organic Chemistry, Part A. 4th Edition, Longman Scientific • Silverstein, R. M., Bassler, G. C. and Morrill, T. C. (1999). Spectrometric Identification of organic compounds. 5th Edition, John Wiley and Sons

Course Code	**CHE3292**
Course Title	**Advanced Organic Chemistry Laboratory**
Credit Value	**2**
Pre-requisites	**CHE2282**
Compulsory/Optional	**Compulsory**
Course Content	
Multi-step synthesis of organic compounds involving advanced reaction mechanisms; Separation, purification and characterization techniques; Extraction and identification of natural products	
Recommended Texts	
• Silverstein, R. M., Bassler, G. C. and Morrill, T. C. (1999). Spectrometric Identification of organic compounds. 5th Edition, John Wiley and Sons • Vogel, A.I. (1978). A Textbook for Practical Organic Chemistry. 4th Edition, Longman Scientific	

Course Code	**CHE3303**
Course Title	**Advanced Physical Chemistry I**
Credit Value	**3**
Pre-requisites	**CHE2313, CH3313**
Compulsory/Optional	**Compulsory***
Course Content	
Quantum Mechanics (15 L): Quantum mechanical models: review of the particle-in-a-box model, simple harmonic oscillator model, rigid rotator model and its extension to the H-atom, detailed quantum mechanical treatment for the H-atom, eigen value relationships for observables; Approximate methods: variation and perturbation theories, the He-atom; electron spin and the Pauli exclusion principle, Slater determinants, spin magnetic moment; Many electron atoms: atomic units, Hartree-Fock equations and the self-consistent field method, antisymmetric wave functions, Slater determinants, quantum mechanical treatment of molecules: Born-Oppenheimer approximation, molecular orbital and valence bond theories, Huckel molecular orbital theory. **Advanced Molecular Spectroscopy** (15 L): Spectral line widths and intensities, microwave spectroscopy; rigid and non-rigid rotor systems; symmetric-top molecules; spectra of isotopes; vibrational spectroscopy; harmonic and anharmonic oscillators, fundamentals, overtones, combination bands, hot bands; vibrational-rotational spectroscopy: diatomic and polyatomic molecules; Raman spectroscopy; determination of molecular structure; electronic spectroscopy; vibrational and rotational fine structure, Franck – Condon principle.	

Statistical Thermodynamics (15 L): Boltzmann factor and statistical entropy, ensembles, molecular partition functions, canonical partition function, translational, rotational, vibrational and electronic partition functions, molar entropy and Sackoor-Tetrode equation, calculation of thermodynamic functions from partition function data, equipartition principle and mean energy, calculation of heat capacity, residual entropy, applications of partition functions to ideal gas and diatomic molecules, calculating equilibrium constant for selected examples: dissociation reactions, isotope exchange reactions, thermal ionization equilibria
Recommended Texts
• Atkins, P. W. and de Paula, J. (2009). Physical Chemistry. 9th Edition, Freeman and Co. • Moore, W. J. (1998). Introduction to Molecular Spectroscopy. 2nd Edition, Pergamon Press • McQuarrie, D. A. (2001). Quantum Chemistry. 2nd Edition, University Science Books

Course Code	**CHE3313**
Course Title	**Physical Chemistry II**
Credit Value	**3**
Pre-requisites	**CHE2313**
Compulsory/Optional	**Compulsory**
Course Content	
Advanced Thermodynamics (10L): Specific applications of the first law and second law of thermodynamics, Carnot cycle, free energy functions, criteria for spontaneity, fundamental equations of thermodynamics, open systems; temperature dependence of internal energy and enthalpy, Maxwell equations, general relationships between Cp and Cv. third law, third law entropies, reaction entropies; temperature dependence of Gibb's function, Gibbs-Helmhlotz equation; pressure dependence of Gibb's function, chemical potential of gases, real gases and fugacity, standard state of gas; real solutions, activities, solvent and solute activities; equilibrium constants for real gases, response of equilibrium constants to catalysts. **Phase Equilibria** (10 L): The phase rule, one component systems and their phase diagrams; Two-component systems, liquid-liquid phase diagrams, distillation of partially miscible liquids, liquid-solid phase diagrams; phase diagrams for reactive systems; ultra purity and controlled purity; three component systems; triangular phase diagrams, industrial applications of phase equilibria **Surface and Colloid Chemistry** (10 L): Interfaces and surfaces; Kelvin equation and its applications; adsorption and absorption, surface excess; physisorption and chemisorption, adsorption at liquid/gas, solid/gas interfaces, measurement of amount of adsorption, Gibbs and Langmuir adsorption isotherms; enthalpy of adsorption; introduction to colloidal systems: dispersion systems; foams and emulsions; surfactants, and their uses. **Kinetics** (7 L): Experimental determination of rate, rate constant, order of reaction, activation energy (initial rate method and isolation method); Steady-state approximation, pre-equilibrium, enzyme catalyzed reactions, complex reactions **Polymer Chemistry** (8 L): Introduction to polymers, polymerization process: Carother's equation for linear step growth polymerization, mechanism and kinetics of step growth polymerization, mechanism and kinetics of addition polymerization systems, polymer characterization.	
Recommended Texts	
• Atkins, P. W. and de Paula, J. (2009). Physical Chemistry. 9th Edition, Freeman and Co. • Campbell, M. (1988). Catalysis at Surfaces	

Course Code	**CHE3381**
Course Title	**Physical and Industrial Chemistry Laboratory**
Credit Value	**1**
Pre-requisites	**CHE2381**
Compulsory/Optional	**Compulsory***
Course Content	
Experiments in physical chemistry: Potentiometry, chemical kinetics, spectroscopy, surface chemistry, **Mini Project –** (Learner centered) Short research work by the students on identified scientific concept/ phenomena on applications	
Recommended Texts	
• DP Shoemaker, CW Garland, JW Nibler, Experiments in Physical Chemistry; • A Findlay, Findlay's Practical Physical Chemistry; Revised Edition, Oxford University Press. • P Mathews, Experimental Physical Chemistry; Oxford University Press	

Course Code	**CHE3392**
Course Title	**Advanced Physical Chemistry Laboratory**
Credit Value	**2**
Pre-requisites	**CHE2381**
Compulsory/Optional	**Compulsory**
Course Content	
Experiments in advanced physical chemistry: electrochemistry, colourimetry, kinetics, spectroscopy, surface chemistry	
Recommended Texts	
• Shoemaker, D. P., Garland, C. W. and Nibler, J. W. (1989). Experiments in Physical Chemistry. 5th Edition • Findlay, A. (1973). Findlay's Practical Physical Chemistry. Oxford University Press • Mathews, P. (1986). Experimental Physical Chemistry. Oxford University Press	

Course Code	**CHE3413**
Course Title	**Analytical Chemistry**
Credit Value	**3**
Pre-requisites	**CHE2313**
Compulsory/Optional	**Compulsory**
Course Content	
Analytical Calculations (12 L): Review of statistics in chemical analysis: test of significance, paired t-test, F-test, etc.; Statistics of linear chemical relationships; Uncertainties associated with solution preparations; Performance characteristics of analytical methods; Interlaboratory testing; Sensor characteristics; Advanced calculations as applied to chemical analysis: derivation and error calculations associated with acid-base, redox and complexometric	

titrations; Iteration methods; metal-complex equilibria; Solubility equilibria. **Analytical Aspects of Spectrophotometry** (9 L): Atomic absorption and emission methods, molecular UV and visible absorption spectroscopy; Analytical characteristics, detection limits, interferences, applications and basic instrumental aspects of the above methods. **Separation Methods** (12 L): Solvent Extraction, partition coefficient, distribution ratio, multiple extractions, extraction of metals, introduction to chromatographic techniques and classifications, gas chromatography, van-Deemter equation, ion-exchange chromatography, thin layer and paper chromatography, introduction to liquid-liquid chromatography, Troubleshooting in Gas Chromatographic separations; Role of organic solvents in liquid chromatographic separations. **Electroanalytical Chemistry** (10 L): Activity and activity coefficients, ionic strength effects; Potentiometric applications; Voltammetry including polarography, pulsed polarographic techniques, linear sweep voltammetry and cyclic voltammetry; steady-state and flow injection amperometric methods; bulk electrolysis methods; microelectrodes in chemical analysis; electrochemical sensors **Non-aqueous solvents** (2 L): Polar aprotic and polar protic solvents, Leveling effects of liquid ammonia, Non-aqueous titrations.
Recommended Texts
• Skoog, D. A,. West, D. M. and Holler, F. J. (2010). Analytical Chemistry. 5th Edition, Marcel Dekker • Kissinger, P. and Heineman, W. R. (1996). Laboratory Techniques in Electroanalytical Chemistry. 2nd Edition, Freeman, Marcel Dekker • Bard, J. and Faulkner, L. (2001). Electrochemical Methods. 2nd Edition

Course Code	**CHE3481**
Course Title	**Analytical and Inorganic Chemistry Laboratory**
Credit Value	**1**
Pre-requisites	**CHE2181, CHE2381**
Compulsory/Optional	**Compulsory***
Course Content	
Inorganic preparations, spectrometry, PXRD, XRF applications of physical methods to study inorganic reactions, quantitative analytical methods.	
Recommended Texts	
• Jolly W.L, Inorganic preparations	

Course Code	**CHE3491**
Course Title	**Analytical/Instrumental Chemistry Laboratory**
Credit Value	**1**
Pre-requisites	**CHE3413**
Compulsory/Optional	**Compulsory**
Course Content	
Experiments in advanced analytical chemistry; Error Analysis as applied to instrumental techniques; Elementary electronics, Analytical atomic and molecular spectrometric methods; Advanced electrochemical methods: cyclic	

voltammetry and amperometry; Gas liquid chromatographic and High-Performance Liquid Chromatographic techniques in analysis; NMR, FT-IR, Particle size analyzer
Recommended Texts
• Skoog D.A., Instrumental Analysis Chemistry, Saunders College Publishing Co.

Course Code	**CHE3512**
Course Title	**Biological Chemistry I**
Credit Value	**2**
Pre-requisites	**CHE2212**
Compulsory/Optional	**Compulsory**
Course Content	
Enzymology (15 L): Enzymes as catalysts in biological systems, structure, classification and nomenclature of enzymes; Mode of enzyme action; Enzyme kinetics; Regulatory enzymes; Applications of enzyme technology in industry; Enzyme systems and human health; Introduction to enzyme engineering **Metabolic pathways and control** (15 L): Glycolysis; Pentose phosphate pathway; Gluconeogenesis; Glycogenesis; Glycogenolysis; Beta oxidation of even and odd numbered carbon containing fatty acids and fatty acid biosynthesis and their regulation; Citric acid cycle and energy production from the respiratory chain; Nitrogen metabolism	
Recommended Texts	
• Fessenden, R. J. and Fessenden, J. S. (1998). Organic Chemistry. 6th Edition, Brooks/Cole Publishing Co. • Morrison, R. T. and Boyd, R. N. (2010). Organic Chemistry. 7th Edition, Prentice Hall • Carey, F. A. and Sundberg, R. K. (2007). Advanced Organic Chemistry, Part A. Plenum Press • Lehninger, A., Nelson, D. L. and Cox, M. M. (2008). Principles of Biochemistry. 5th Edition, Worth Publishers Inc.	

Course Code	**CHE3712**
Course Title	**Industrial Chemistry**
Credit Value	**2**
Pre-requisites	**CHE2212, CHE2313**
Compulsory/Optional	**Optional**
Course Content	
Industrial inorganic chemistry (10L): Metallurgy, Ellingham diagram, iron-carbon phase diagram, steel and cast iron and their applications, Industries based on minerals **Industrial organic chemistry** (10 L): Coal, petroleum, essential oils, polymers, dyes, pharmaceuticals **Industrial physical chemistry** (10 L): Elementary chemical engineering, Mass transfer, Heat transfer, reactors. Preparation of solid materials for industrial processes, Classification of materials, reactor technology in Chlor-alkali industry, urea production, and vapor depositions.	
Recommended Texts	
• Cooray, P. G. (1984). Geology of Sri Lanka. 2nd Edition, Ceylon Museum • Karunaratne, V. Industrial organic Chemistry. SEU, Faculty of Science, University of Peradeniya	

Course Code	**CHE3723**
Course Title	**Nanoscience and Nanosynthesis**
Credit Value	**3**
Pre-requisites	**CHE2313**
Compulsory/Optional	**Optional**

Course Content

Introduction to nanoscience and nanotechnology: Materials, structure, and the Nano surface: Importance of surface, Engineering materials, Surface and volume, Geometrical surface to volume ratio, Specific surface area, Spherical cluster approximation, Particle orientation (optical responses, surface Plasmon resonance)

Nanotools: Electron probe methods, Scanning probe microscopy methods, Spectroscopic methods, Nonradiative and non-electron characterization methods.

Fabrication methods: Top-down methods (Mechanical methods,Thermal methods,High energy methods, Chemical fabrication methods, Lithographic methods); Bottom-up methods (Gaseous phase method, Liquid phase method, Template synthesis)

Energy at nanoscale: Liquid state: Cohesive forces, Adhesive forces; Solid state: Interaction pair potentials, Surface energy of low index crystals, Surface energy minimization methods

Quantum dots: Schrodinger‘s Equation for confined systems, Bandgap variation with size, Properties of quantum dots (electronic Conductivity, Thermal and Optical properties), Plasmon resonance in metallic dots, Fabrication methods, Applications

Carbon based nanostructures: Graphene, Fullerenes, Nanotubes

Nanoscience Laboratory: Experiments and virtual experiments relating to the synthesis and characterization of nanomaterials.

Recommended Texts

- Hornyak, G. L., Tibbals, H. F., Dutta, J. and Moore, J. J. (2008). Introduction to Nanoscience and Nanotechnology. 1st Edition
- Poole, C. and Owens, F. (2007). Introduction to Nanotechnology. Wiley
- Ramsden, J. (2011). Essentials of Nanotechnology. 1st Edition, Venus publishing

Course Code	**CHE3812**
Course Title	**Computer Applications in Chemistry**
Credit Value	**2**
Pre-requisites	**CHE2313**
Compulsory/Optional	**Optional**

Course Content

Digital Electronics and Interfacing (16 L + 12 P): Number systems, logic gates, Boolean logic, de Morgan’s theorems, combinational logic circuits, circuit minimization, flip flops, counters, shift registers; Computer memory organization, analog to digital conversion (ADC), data acquisition and instrument control; Interfacing and microcontrollers.

Computational Chemistry (14 L + 8 P): Data analysis and visualization. Representation of 2D and 3D chemical structures. In silico experiments, classical and modern methods. Introduction to Hatree-Fock self-consistent field method. Introduction to molecular mechanics and molecular dynamics.

Recommended Texts
• Horowitz, P. and Hill, W. (2015). The Art of Electronics. 3rd Edition, Cambridge University Press • Cramer, C. J. (2004). Essential of Computational Chemistry. 2nd Edition, Wiley

4000 Level Courses

Course Code	**CHE4112**
Course Title	**Advanced Inorganic Chemistry II**
Credit Value	**2**
Pre-requisites	**CHE2122, CHE3122**
Compulsory/Optional	**Compulsory**
Course Content	
Diffraction Methods (15L): General aspects of diffraction mechanism, reciprocal lattices, translational symmetry operation and elements, space groups, systematic absences and space group determination, atomic scattering factors, structure factors, Fourier and Patterson maps, structure determination and refinement using single crystal XRD data and applications; Neutron diffraction, introduction to protein crystallography **Advanced Radiochemistry** (15L): Radiation detectors, particle accelerators (linear accelerators, cyclotron, synchrocyclotron, betatron); Nuclear models (shell model and liquid drop model), stability of isobars; Radioanalytical techniques (isotope dilution analysis, neutron activation analysis, tracer analysis)	
Recommended Texts	
• Hammond, C. (2015). The Basics of Crystallography and Diffraction. 4th Edition • Stout, G. H. and Jensen, L. H. (1989). X-ray Structure Determination. 2nd Edition, Chapman and Hall Ltd. • Giacovazzo, C. (2002). Fundamentals of Crystallography. Edited by F. M. Henry, 2nd Edition • International Tables for Crystallography, Volume A; The Kynoch Press, Birmingham • Glasstone, S. (1958). Sourcebook on Atomic Energy. Chapman and Hall • Skoog, D. A., Holler, F. J. and Neiman, T. A. (2009). Principles of Instrumental Analysis. Saunders Golden Series. 5th Edition	

Course Code	**CHE4122**
Course Title	**Advanced Inorganic Chemistry III**
Credit Value	**2**
Pre-requisites	**CHE3112, CHE3122**
Compulsory/Optional	**Compulsory**
Course Content	
Advanced Organometallic Chemistry (15 L): IUPAC naming of organometallic compounds; Complexes of olefins, carbonyls, nitrosyls, arenes, and other organic ligands; spectroscopic characterization; Applications of organometallic complexes in various fields including catalysis. **Reaction Mechanisms in Inorganic Chemistry** (15 L): Substitution reactions of octahedral and square planar complexes, Electronic effects; Acid and base hydrolysis reactions; electron transfer reactions: outer and inner-sphere mechanisms; Marcus theory; Robin and Day classification of electron transfer systems, Experimental determination of electron transfer rates.	

Recommended Texts
• Coates, G. E., Green, M. L. H., Powell, P. and Wade, K. (1979). Organometallic Chemistry. 3rd Edition, Chapman and Hall • Basolo, F. and Pearson, R. G. (1967). Inorganic Reaction Mechanism. 2nd Edition • Miessler, G. L. and Spessard, G. O. (2010). Organometallic Chemistry. 3rd Edition

Course Code	**CHE4132**
Course Title	**Solid State Chemistry**
Credit Value	**2**
Pre-requisites	**CHE2112, CHE4112**
Compulsory/Optional	**Optional**
Course Content	
Advanced materials (30 L): Advanced ceramics, inorganic polymers, conducting polymers and their applications, solid state batteries, semiconductor catalysts, solid state electrolytes, photoelectrochemical solar cells, photovoltaics, liquid crystals, ionic solids, crystal defects, solid solutions, Chevural phases, sol-gel technology, synthesis of inorganic materials, thermal techniques	
Recommended Texts	
• Butler, I. S. and Harrod, J. F. (1989). Inorganic Chemistry. Benjamin/Cummings • Serpone, N. (1985). Photocatalysis and Photoreactors: NATO-SCI series • Kuran, W. (2001). Principles of Coordination Polymerisation • Nosaka, Y. and Nosaka, A. (2016). Introduction to Photocatalysis • Kalyanasundaram, K. (2010). Dye-sensitized Solar Cells. 1st Edition • Paranthaman, M. P., Wong-Ng, W. and Bhattacharya, R. (2016). Semiconductor materials for solar photovoltaic cells	

Course Code	**CHE4213**
Course Title	**Advanced Organic Chemistry II**
Credit Value	**3**
Pre-requisites	**CHE2212, CHE3212**
Compulsory/Optional	**Compulsory**
Course Content	
Physical Organic Chemistry (15 L): Analysis of factors that influence the rates and mechanisms of organic reactions: Kinetic and thermodynamic data analysis; Hammond postulate; Curtin Hammett Principle; Kinetic isotope effect; SAR studies with respect to the substituents using Hammett equation, Yukawa Tsuno Equation and Taft equation; Other experiments to understand the reaction mechanisms: Isotope labeling experiments, competitive experiments, crossover experiments, stereo-chemical analysis experiments and isolation of intermediates and products **Advanced Stereochemistry** (15 L): Stereochemical control in cyclic and acyclic systems; Chiral catalysis **Problem Solving** (15 L): Application of principles of stereochemistry, reaction mechanisms, organic synthesis and spectroscopy in solving problems in organic chemistry	

Recommended Texts
• Isaacs, N. S. (1995). Physical Organic Chemistry. Longman • Eliel, E. L. and Wilen, S. H. (1994). Stereochemistry of Organic Compounds. John Wiley & Sons Inc.

Course Code	**CHE4222**
Course Title	**Natural Product Chemistry**
Credit Value	**2**
Pre-requisites	**CHE3512**
Compulsory/Optional	**Compulsory****
Course Content	
Biosynthesis (15 L): Introduction to the chemistry of flavonoids, terpenoids, steroids and alkaloids; Basic structural units, precursors and common reactions in biosynthesis; Investigation of Acetate, shikimate and mevalonate pathways; Biosynthesis of alkaloids **Proteins and Nucleic acids** (15 L): Biosynthesis and chemical synthesis of proteins; Biological functions of some selected proteins and their 3D structures; Interactions of proteins with proteins, carbohydrates, lipids and nucleic acids; Membrane proteins and their functions in transport across membranes; Biological role of nucleic acids; Molecular structure of nucleic acids; Structural aspects of DNA; DNA damage	
Recommended Texts	
• Voet, D., Voet, J. G. and Pratt, C. W. (2016). Biochemistry. 5th Edition, John Wiley & Sons • Derwick, P. M. (2009). Medicinal Natural Products. 3rd Edition, John Wiley & Sons	

Course Code	**CHE4312**
Course Title	**Advanced Physical Chemistry II**
Credit Value	**2**
Pre-requisites	**CHE3313**
Compulsory/Optional	**Compulsory**
Course Content	
Advanced Electrochemistry (15 L): Solvents, electrolyte solutions, non-ideal nature of electrolyte solutions, ion-solvent interactions, ion-ion interactions; The Debye-Huckel theory, ideal polarized electrodes, electrocapillary curves, determination of surface charge density, surface excess concentrations of ionic and neutral species at electrode surfaces, AC methods, theories of electrode/solution interfaces, electrode kinetics, mass transfer, charge transfer and other processes, Tafel plots, mass transfer-controlled electrode kinetics. **Advanced Topics in Chemical Kinetics and Reaction Dynamics** (15 L): Review of fundamental laws of chemical kinetics, fast chemical reactions and experimental methods for studying rates of such reactions; Relaxation methods, collision theory, activated complex theory, Eyring equation, thermodynamic parameters; Potential energy diagrams and potential energy surfaces; Applications of activated complex theory in surface science and catalysis.	
Recommended Texts	
• Atkins, P. W. and de Paula, J. (2010). Physical Chemistry. 9th Edition, Freeman and Co. • Laidler, K. J. (1983). Chemical Kinetics. McGraw Hill, London, Inc. • Bard, A. J. (2001). Fundamentals of Electrochemistry. 2nd Edition	

Course Code	**CHE4322**
Course Title	**Advanced Physical Chemistry III**
Credit Value	**2**
Pre-requisites	**CHE3313**
Compulsory/Optional	**Compulsory**
Course Content	
Surface and Colloid Chemistry (15 L): Growth and structure of solid surfaces: surface defects; Adsorption isotherms: BET, Temkin and Freundlich; Rates of surface processes: mobility on surfaces; Catalytic activity of surfaces: adsorption and catalysis, Herkins Jura isotherms, equation of states Eley-Rideal mechanism, Langmuir-Hinshelwood mechanism, molecular beam studies, examples of catalysis; Colloidal systems: classification and purification, stability of colloids, zeta potential, isoelectric point; Use of AFM to study surfaces; Industrial applications. **Polymer Chemistry** (15 L): Physical and chemical properties of polymers, Step-growth polymerization systems and prediction of Gel point, Polymerization-depolymerization equilibria, Addition polymerization and living polymerization systems: Atom-transfer radical polymerization, Stable-free radical polymerization, Radical addition-fragmentation transfer polymerization, Living cationic polymerization, Living anionic polymerization, Stereoregular polymerization, Thermodynamics of polymer solutions: simple lattice model, Flory-Huggins theory, reactions of polymers, Applications of polymers	
Recommended Texts	
• Thomas, J. M. and Thomas, W. J. (2014). Principles and Practice of heterogeneous catalysis. 2nd Edition, John Wiley • Campbell, M. (1988). Catalysis at surfaces. Oxford University Press • Young, R. J. and Lovell, P. A. (1991). Introduction to polymers. 2nd Edition, John Wiley	

Course Code	**CHE4332**
Course Title	**Molecular Modeling**
Credit Value	**2**
Pre-requisites	**CHE3812**
Compulsory/Optional	**Optional**
Course Content	
Molecular Quantum Mechanics (8 L): Hartree-Fock treatment of polyelectronic systems: Electronic term symbols, SCF-MO method, basis functions; Semiempirical treatment of polyatomic molecules. Density functional theory **Electronic Structure Calculations** (4 L + 3 P): Single point calculations, geometry optimization calculations, predicating molecular properties and spectra **Classical Modeling Methods** (8 L + 6 P): Molecular mechanics, potential energy surfaces, force field models, conformational searches, geometry optimization, molecular dynamics and Monte-Carlo methods	
Recommended Texts	
• Leach, R. (1996). Molecular Modelling Principles and Applications. Longman • Frenkel, D. and Smit, B. (2002). Understanding Molecular Simulation, from Algorithms to Applications. 2nd Edition, Academic Press • Cramer, C. J. (2004). Essential of Computational Chemistry. Wiley	

Course Code	**CHE4342**
Course Title	**Special Topics in Physical Chemistry**
Credit Value	**2**
Pre-requisites	**CHE3302, CHE3313**
Compulsory/Optional	**Optional**

Course Content

Photochemistry (10 L): Electronic transitions of polyatomic molecules, selection rules and absorption strength, vibronic transitions, radiative lifetime. Fates of excited states: Jablonski diagram, fluorescence and phosphorescence, vibrational relaxation, intersystem crossing and internal conversion. Lifetimes of excited states: quantum yield, photochemical kinetics, quenching, Stern-Volmer plot, intramolecular energy transfer: application of Fermi's Golden Rule, rates of intersystem crossing and internal conversion, energy-gap law, isotope effects, conical intersections, delayed fluorescence. Intermolecular energy transfer, electronic energy transfer, long-range (dipolar, FRET) and short-range (exchange) mechanisms, spin correlation rules. Triplet annihilation. Triplet sensitization and delayed fluorescence. excimers and exciplexes. Photodissociation, and predissociation, ozone destruction, ultrafast photochemistry and photophysics, pulsed lasers, pump-probe spectroscopy

Atmospheric Chemistry (10 L): Introduction to the Earth's atmosphere: vertical structure of the atmosphere, pressure, composition, temperature; the hydrostatic equation; blackbody radiation, absorptivity and emissivity, scattering and absorption of solar radiation; radiative balance and the green-house effect; role of boundary layer processes and clouds; photolysis rates. Half-life, residence time and renewal time of chemicals in the atmosphere, the importance of trace species; sources, transformation, transport, and sinks of chemicals in the troposphere; tropospheric chemical cycles; air pollution. The stratospheric ozone layer, catalytic cycles, perturbations to the ozone layer; polar ozone loss. Heterogeneous chemistry; aerosol concentration and size distribution, sources of aerosols, transformations, chemical composition, atmospheric effects. Measurement methods for atmospheric sensing. Ground based methods for minor constituents, absorption, scattering, fluorescence.

Industrial Electrochemistry (10 L): Batteries and fuel cells; Applications of nanoelectrodes; Construction, characterization and industrial applications of chemically modified electrodes; Monitoring of corrosion: Linear polarization and electrochemical impedance spectroscopic methods, Nyquist plots, inhibition of corrosion.

Recommended Texts

- Atkins, P. W. and de Paula, J. (2010). Physical Chemistry. 9th Edition, Freeman and Co.
- Laidler, K. J. (1983). Chemical Kinetics. McGraw Hill, London, Inc.
- Bard, A. J. (2001). Fundamentals of Electrochemistry. 2nd Edition

Course Code	**CHE4352**
Course Title	**Applications of Nanoscience in Chemistry**
Credit Value	**2**
Pre-requisites	**CHE3723**
Compulsory/Optional	**Optional**

Course Content

Current Impact of Nanotechnology (1 L): The spread of nanotechnology into industry and consumer goods; Future prospective

Scaling Laws (4 L): Review on scaling of physical properties with size in the nanoscale: surface properties, thermal properties, electronic properties, quantum confinement, density of states

Nanometrology (1 L): Review of instrumental techniques used for the study of nanoscale material and interpreting their output.

Nanomaterials (22 L): Properties, synthesis, characterization of selected nanomaterials; Student presentations based on contemporary research, case studies. **Nanotoxicity** (2 L): Routes of exposure and incidence; factors affecting nanoparticle toxicity.
Recommended Texts
• Hornyak, G. L., Tibbals, H. F., Dutta, J. and Moore, J. J. (2008). Introduction to Nanoscience and Nanotechnology. 1st Edition • Poole, C. and Owens, F. (2007). Introduction to Nanotechnology. Wiley • Klabunde, K. J. and Richards, R. M. (2009). Nanoscale materials in chemistry. 2nd Edition, Wiley • Schaefer, H. (2010). Nanoscience. Springer

Course Code	**CHE4412**
Course Title	**Advanced Analytical Chemistry**
Credit Value	**3**
Pre-requisites	**CHE3413**
Compulsory/Optional	**Compulsory**
Course Content	
Spectroscopic Instrumentation and Spectrochemical Analysis (10 L): Optical components of spectrophotometers: sources, transducers, measurement systems, signal-to-noise ratio; Spectrochemical measurements: methodology and errors in spectrochemical analysis, sensitivity and detection limits, automated spectrochemical measurements; Advanced atomic spectral methods: plasma, arc and spark methods; Atomic fluorescence spectrometry; Infrared and luminescence molecular spectroscopic methods **Surface Analytical Techniques** (7 L): Theory, applications and instrumental aspects of X-ray and UV photoelectron spectroscopies, Auger spectroscopy, Low energy electron diffraction, Rutherford backscattering, X-ray microscopy, etc. **Advanced Electroanalytical Techniques** (6 L): Electrochemical pulse techniques, Gas sensors, Bio-sensors, Spectro-electrochemical methods, Applications of electroanalytical sensors **Advanced Separation Techniques** (7 L): Capacity factor and selectivity ratio as applied to gas chromatography and liquid chromatography, high performance liquid chromatography, size exclusion chromatography, supercritical fluid chromatography, affinity chromatography, capillary electrophoresis and electrochromatography, troubleshooting in chromatographic methods	
Recommended Texts	
• Skoog, D. A., Holler, F. J. and Neiman, T. A. (1998). Principles of Instrumental Analysis. Saunders Golden Series • Skoog, D. A. (1998). Instrumental Analysis Chemistry. Saunders College Publishing Co.	

Course Code	**CHE4512**
Course Title	**Biological Chemistry II**
Credit Value	**2**
Pre-requisites	**CHE2212, CHE3512**
Compulsory/Optional	**Compulsory****
Course Content	

Bioanalytical Chemistry (8 L): Biochemical techniques, centrifugation and chromatography; Topics in physical chemistry pertinent to biology - conformations of macromolecules, spectroscopy, thermodynamics, dynamics and transport processes, Donan equilibrium; Size exclusion chromatography, Capillary electrophoresis and electrochromatography, Micellar electro kinetic capillary chromatography (MEKC), Biosensors **Toxicology and Reactive species in biology** (10L): Natural toxins, environmental pollutants, drug abuse, fats and toxic effects of xenobiotics in biological systems; Reactive oxygen species, lipid peroxidation, free radicals and toxicology, free radical reactions in living systems, diseases associated with free radical damage **Bioinorganic Chemistry** (12 L): Role of metals in biological systems, electron transfer catalysts, cytochromes, iron sulfur proteins, molybdoenzymes, zinc and copper containing enzymes, oxygen carriers, nitrogen fixation, iron metabolism
Recommended Texts
• Fenton, D. E. (1996). Bio-coordination Chemistry. Oxford University Press • Lippard, S. J. and Berg, J. M. (1994). Principles of Bio-inorganic Chemistry. University Science Books, Mill Valley California • Cotton, F. A. and Wilkinson, G. (1999). Advanced Inorganic Chemistry. 6th Edition • Lehninger, A., Nelson, D. L. and Cox, M. M. (2017). Principles of Biochemistry. 7th Edition, Worth Publishers Inc. • Berg, J. M., Tymoczko, J. L. and Stryer, L. (2002). Biochemistry. WH Freeman and Co.

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
A six-week training programme at an industry/institution identified by the department. At the end of the training period students will compile a report and present the work to the place of training and to a common forum at the department.	

Course Code	**CHE4921**
Course Title	**General Aspects and Recent Developments in Chemistry**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Review of the previously taught concepts and theories in lectures, laboratory sessions, guest lectures, seminars, industrial exposure and research presentations.	
Recommended Texts	
• Textbooks used during the degree programme	

Course Code	**CHE4998**
Course Title	**Research Project**
Credit Value	**8**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Research Project: An individual project will be carried out under the supervision of a staff member(s). The student will be expected to review current literature, plan the project (with guidance), and perform procedures (experiments, analysis, synthesis, extractions, calculations, etc). The progress and development will be evaluated continuously. At the end of the project the student is required to submit a comprehensive report and present the findings of their research to an evaluation committee **Student Seminar**: Each student will be required to present a topic in chemistry to a public audience. A supervisor will guide the selection of topic and preparation of the presentation	

3. DEPARTMENT OF ENVIRONMENTAL & INDUSTRIAL SCIENCES

3.1 Environmental Science Course Modules

3000 LEVEL – ENVIRONMENTAL SCIENCE				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory Hons.**
ENS3013	Concepts in Environmental Science	3		√
ENS3022*	Advanced Mathematics for Biological Sciences	2		√
ENS3033	Statistics for Environmental Science	3		√
ENS3042#	Biology for Environmental Science	2		√
ENS3052	Environmental Law and Environmental Impact Assessment	2	ENS3013	√
ENS3112	Biological Indicators in Environmental Management	2		
ENS3122	Wetlands and Their Exploitation	2		
ENS3132	Marine Resources and Marine Pollution	2		
ENS3142 (Same as MIC3062)	Environmental Microbiology	2	BOT2012	
ENS3152	Quantitative Ecology	2	ENS3042	
ENS3162 (Same as BOT3122)	Biotic Interactions and Applications	2		
ENS3171	Plant and Animal Systematics	1	ENS3042	
ENS3213	Water and Soil Pollution	3	ENS3013	√
ENS3223 (same as CHE3413)	Analytical Chemistry	3	CHE2313	√
ENS 3232 (same as CHE3712)	Industrial Chemistry	2	CHE2212 CHE2313	
ENS3312 (same as GEO3072)	Remote Sensing and GIS	2		√
ENS3322 (same as GEO3012)	Hydrology	2		
ENS3332	Mining and the Environment	2		
ENS3342	Geological Environment and Earth Resources	2		
ENS3412	Environmental Modelling	2	ENS3022	
ENS3512	Energy, Weather and Environment	2	ENS3013 ENS3022	√
ENS3993	Industrial Training	3	ENS3022 ENS3052 ENS3223	√
Total		**48**		**23**

4000 LEVEL – ENVIRONMENTAL SCIENCE				
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory Hons.
ENS4012 (same as APS4322)	Cleaner Production in Industry	2		√
ENS4022	Sustainable Development and Green Technology	2	ENS3512	√
ENS4032	Environmental Economics	2	ENS3013	√
ENS4112	Ecotourism and Nature Conservation	2		
ENS4123	Biodiversity and Conservation Biology	3		
ENS4132 (same as MBB4162)	Environmental Biotechnology	2	MBB2263 MBB3222	
ENS4212	Air and Noise Pollution	2	ENS3213	√
ENS4222	Atmospheric Chemistry	2	ENS4212	
ENS4233	Waste and Waste Management	3	ENS3213	√
ENS4242	Nanotechnology and the Environment	2	ENS3223	
ENS4292	Environmental Analysis Laboratory	2	ENS3213 ENS3223	√
ENS4312	Oceanography	2		
ENS4322	Medical Geology and Environmental Toxicology	2		
ENS4412	Multivariable Calculus	2	ENS3022	
ENS4422	Basic Environmental Engineering	2	ENS4412	
ENS4912	Research Methodology & Scientific Writing	2		√
ENS4921	Seminar	1		√
ENS4998	Research Project	8	ENS3013	√
Total		**43**		**24**

* compulsory for Biological Science stream students only
[#] compulsory for Physical Science stream students only

3000 Level Courses

Course Code	**ENS3013**
Course Title	**Concepts in Environmental Science**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction of environmental science: Development of human civilizations, man's special place on earth, conflicts with nature, interaction between human society and the environment, environmental effects of developments in science and technology, environmental risks and their assessment, current environmental issues (local and global), natural disasters, anthropogenic activities, health problems due to environmental pollution, agriculture and its impact on man and the environment, compromise between industrial development and management of environmental pollution for quality life, environmental policies, effect of aqueous equilibrium on solubility of pollutants, mitigation of environmental problems. **Environmental safety:** Identification of workplace hazards, methods to prevent accidents and exposure to harmful situations and substances, response to accidents, emergency preparedness, use of protective clothing and equipment.	
Recommended Texts	
● Harpet, C.L. (2011). *Environment and Society: Human Perspectives on Environmental Issues*. 5th edition, Pearson. ● Swain, D.L., Charmley, E., Steel, J.W. and Coffey, S.G. (2007). *Redesigning Animal Agriculture. The Challenge of the 21st Century*. CABI. ● Baird, C. and Cann, M. (2012). *Environmental Chemistry*. 5th edition, Macmillan Learning. ● O'Reilly, J.T. and Hagan, P. (1996*). Environmental and Workplace Safety: A Guide for University, Hospital and School Managers (Industrial Health & Safety).* 1st edition, Wiley.	

Course Code	**ENS3022**
Course Title	**Advanced Mathematics for Biological Sciences**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for biological science students**
Course Content	
Calculus: Review of differentiation and integration. **Vectors:** Vector algebra, vector geometry, vector valued functions, calculus of vector valued functions. **Matrices:** Matrix algebra, transpose matrix, inverse matrix, determinants, solving systems of equations using matrices, geometric properties of matrix operations, programming with matrices and vectors. **Ordinary Differential Equations:** Introduction, types of differential equations, geometric interpretation, solving first order differential equations, system of linear differential equations, phase plane analysis. **Partial Differential Equations:** Introduction to partial derivatives, partial differential equations; Heat, diffusion and wave equations. **Complex numbers:** The complex plane, algebraic operations, exponential and logarithmic functions of complex variables, quadratic equations, oscillations. **Complex numbers:** The complex plane, algebraic operations, exponential and logarithmic functions of complex variables, quadratic equations, oscillations.	
Recommended Texts	
● Batschelet, E. (1979). *Introduction to Mathematics for Life Scientists*. Springer Study Edition, Springer-Verlag. ● Bodine, E.N., Lenhart, S. and Gross, L.J. (2014). *Mathematics for the Life Sciences.* Princeton University Press.	

Course Code	**ENS3033**
Course Title	**Statistics for Environmental Science**
Credit Value	**3 Credits**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Basic ideas in Statistics: Fundamental elements of statistics, sources of data, methods of collecting data, data types; Measures of location: Various means (AM, GM, HM, TM), median, mode, quantiles, deciles, percentiles; Measures of dispersion: Range, interquartile range, variance, standard deviation, Chebyshev's rule for sample, coefficient of variance, moments of higher order, skewness, kurtosis; Counting principles and probability theory: Basic principles of counting, combinations, permutations, fundamentals of probability, discrete and continuous probability distributions, special probability distributions (discrete uniform, Bernoulli, binomial, Poison, continuous uniform, exponential, normal); Hypothesis tests: One sample tests for mean, variance and proportions, two sample tests for mean, variance and proportion comparisons, ANOVA for comparing multiple samples; Correlation and regression: Scatter plots, correlation, simple linear regression;

Statistical process control: Fundamentals of process control, process capability and process measures, control charts for variables, control charts for attributes;

Recommended Texts

- Gould, R.N. and Ryan, C.N. (2015). *Introductory Statistics*. 2nd Edition, Pearson Publications.
- Agresti, A. and Franklin, C.A. (2006). *Statistics: The Art and Science of Learning from Data*. 3rd Edition, Pearson Publishers.

Course Code	**ENS3042**
Course Title	**Biology for Environmental Science**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for physical science students**

Course Content

Chemical nature of life, origin of life, prokaryotic and eukaryotic cells, function of genetic material, Internal structure of plants, photosynthesis and respiration, ecological levels, energy flow in ecosystems, biodiversity and ecosystem services, cycles of materials, classification of microorganisms, distribution of microorganisms in different environments.

Cells and metabolism: Cell structure and function, prokaryotic and eukaryotic cells, photosynthesis, respiration, enzymes, cell division and genetics; Evolution and ecology: evolutionary and ecological aspects of behaviour, populations, communities and ecosystems; Origin and classification of life: the animal kingdom, the plant kingdom; Physiological processes: reproduction, nutrition, etc.

Recommended Texts

- Enger, E.D., Ross, F.C. and Bailey, D.B. (2009). *Concepts in Biology*. 13th Edition, McGraw Hill.
- Mader, S.S. and Windelspecht, M. (2018). *Essentials of Biology*. 5th Edition, McGraw Hill.
- Mauseth, J.D. (2019). *An Introduction to Plant Biology*.7th Edition, Jones and Bartlett Publishers Inc.

Course Code	**ENS3052**
Course Title	**Environmental Law and Environmental Impact Assessment**
Credit Value	**2**
Pre-requisites	**ENS3013**
Compulsory/Optional	**Compulsory**

Course Content
Environmental Impact Assessment: Philosophy, history and methodology of the EIA process globally and in Sri Lanka; Types of EIA; Effectiveness of the EIA process as a planning tool, and its role in sustainable development; The key steps involved in the EIA process; Critical review of the EIA process in Sri Lanka; Field excursion to a project site. **Environmental Law**: Introduction to Environmental Law; Brief overview of the international legal framework and its evolution; Brief overview of the principles underlying environmental law; Domestic legal framework (relevant Acts and constitutional provisions) and its implementation in Sri Lanka; Domestic and foreign judicial decisions that impacted domestic environmental law.
Recommended Texts
• Glasson, J. and Thervel, R. (2019*). Introduction to Environmental Impact Assessment*. 5th Edition, Routledge. • Holder, J. and Lee, M. (2007*). Environmental Protection, Law and Policy*. 2nd Edition, Cambridge University Press. • Shelton, D. and Kiss, A. (2005). *Judicial Handbook on Environmental Law.* The United Nations Environmental Programme.

Course Code	**ENS3112**
Course Title	**Biological Indicators in Environmental Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Changes and challenges of environment of emerging Asia, Indicator organisms: background, principles and examples; The use of biota, sediments and water in environmental monitoring; Indicators of land and water quality and sustainable management; Systematic approach using indicator organisms to measuring and reporting environmental problems such as acidification, air pollution and climatic changes; Framework for the development of environmental health indicators; Biological indicators of environmental health; Rapid urban environmental assessment and case studies of urban development in the developing world; Developing a national set of environmental indicators.	
Recommended Texts	
• Wetzel, R.G. (2001). *Limnology - Lake and River Ecosystems*. 3rd Edition, Harcourt Brace College Publishers, San Diego. • Smol, J. (2008). *Pollution of Lakes and Rivers*. 2nd Edition, A Paleolimnological Perspective, Wiley-Blackwell. • Jongman, R.H.G., ter Braak, C.J.F. and Tongeren, O.F.R. (1999). *Data Analysis in Community and Landscape Ecology*. Cambridge University Press.	

Course Code	**ENS3122**
Course Title	**Wetlands and Their Exploitation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Wetland types; Wetlands and wildlife; Fauna and flora of wetlands; Threats to wetlands; Environmental problems associated with wetland exploitation; Salinization and desalinization of wetlands**;** Ancient and recent irrigation systems of Sri Lanka; Water-based tourism and its environmental effects; Wetland reclamation; Wetland and fisheries; Capture and culture fisheries; Effects of fisheries on the environment.	
Recommended Texts	

● Campbell, N.A., Reece, J.B. and Mitchel, L.G. (2009). *Biology*. 8th Edition, Cambridge University Press. ● Bronmakr, C. and Mamquist, B. (2005). *The Biology of Lakes and Ponds*. 2nd Edition, Oxford University. ● Gilter, P.S. and Hansso, L.A. (2004). *The Biology of Streams and Rivers*. 6th Edition, Oxford University.

Course Code	**ENS3132**
Course Title	**Marine Resources and Marine Pollution**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Marine resources; Marine habitats and biodiversity (fauna and flora): coastal zone, open water and deep sea; Coral and other reefs; Mangroves and salt marshes; Fishing and whaling; Over exploitation of marine resources; Marine and coastal pollution; Marine transportation and its effects on the sea; Desalination; Salt and chemical production.	
Recommended Texts	
● Clark, R.B. (2001). *Marine Pollution*. 5th Edition, Oxford University Press. ● Morrissey, J. and Sumich, J. L. (2018). *Introduction to the Biology of Marine Life*. 11th Edition, Jones & Bartlett Learning.	

Course Code	**ENS3152**
Course Title	**Quantitative Ecology**
Credit Value	**2**
Pre-requisites	**ENS3042**
Compulsory/Optional	**Optional**
Course Content	
Vegetation description (physiognomic, structural and floristic); Measures of species abundance for animals: line transects, quadrat counts, mark-recapture techniques; Measures of species abundance for plants: frequency, density, cover, basal area, biomass, gr owth; Population growth and carrying capacity; Population regulation; Age structure; Life history strategies; Survivorship curves and life tables; Experimental design, collection of field data, data processing methods and data analysis techniques in ecological studies using relevant software packages; Species diversity measures; Field visits and laboratory experiments/exercises based on above topics.	
Recommended Texts	
● Kent, M. (2011). *Vegetation Description and Data Analysis: A Practical Approach.* 2nd Edition, John Wiley & Sons. ● Kershaw, K.A. (1973). *Quantitative and Dynamic Plant Ecology.* 2nd Edition, Edward Arnold. ● Boitani, L. and Fuller, T.K. (2000). *Research Techniques in Animal Ecology.* Columbia University Press. ● Fowler, J., Cohen, L. and Jarvis, P. (1998). *Practical Statistics for Field Biology.* John Wiley & Sons. ● Krebs, C.J. (1999). *Ecological Methodology.* 2nd Edition, Benjamin/Cummings. ● Odum, E.P. and Barret, G.W. (2009). *Fundamentals of Ecology*. 5th Edition, Thomas Brooks/Cole.	

Course Code	**ENS3171**
Course Title	**Plant and Animal Systematics**
Credit Value	**1**
Pre-requisites	**ENS3042**
Compulsory/Optional	**Optional**

Course Content
Plant systematics: Introduction and components in systematics, objectives and principles, plant identification and nomenclature, current updated Angiosperm phylogeny, Herbarium techniques. **Animal systematics**: Need for classification, history of taxonomy, binomial nomenclature, Linnaean system of classification, domains and kingdoms of life, classification of selected animal groups.
Recommended Texts
• Urry, L.A., Cain, M.L., Wassermann, S.A., Minorsky, P.V. and Reece, J.B. (2017). *Biology.* 11th Edition, Pearson. • Simpson, M. (2010). *Plant Systematic.* 2nd Edition, Academic Press. • Judd, W.S., Campbell, C.S., Kellog, E.A., Stevens, P.A. and Donoghue, M.J. (2016). *Plant Systematics: A Phylogenetic Approach.* Sinauer Associates Inc.

Course Code	ENS3213
Course Title	**Water and Soil Pollution**
Credit Value	**3**
Pre-requisites	**ENS3013**
Compulsory/Optional	**Compulsory**
Course Content	
Surface water pollution: Aquatic environment and water resource; Properties of freshwater and seawater; Lotic and lentic waters; Man-made lakes and other aquatic facilities; Types and sources of pollutants; Eutrophication and algal toxins; Biological oxygen demand and chemical oxygen demand and opacity; Run-off from agricultural land and roads; Water quality guidelines and standards; Chemical and ecological water pollution control; Techniques of containment and dispersal; Water-borne diseases; Water quality monitoring methods for various applications. **Soil pollution**: Environmental chemistry of soil, Fundamentals of soil pollution, Classification of common pollutants in soils, soil functions, soil and sediment, soil pollutant load and soil quality parameters; Soil quality standards; Measurements of soil quality. **Groundwater pollution**: Groundwater geochemistry: Fundamentals; Aquifer geochemical system; Rain water and groundwater; Solute transport; Contaminant interactions and reactive transport; Vadose zone processes; Water/rock interactions; Solution, redox and gas exchange processes; Groundwater quality; Groundwater monitoring and remediation; Practical applications: Landfills, metals contamination, acid mine drainage, organic compound contamination; Introduction to geochemical models.	
Recommended Texts	
• Appelo, C.A.J. and Balkema, D.A.A. (2006). *Geochemistry, Groundwater and Pollution*. Rotterdam-Brookfield. • Manahan, S.E. (2009). *Environmental Chemistry*. 9th Edition, CRC Press. • Liu, D.H.F. and Liptark, B.G. (1999). *Groundwater and Surface Water Pollution*. 1st Edition, Lewis Publishes. • Essington, M.E. (2015). *Soil and Water Chemistry: An Integrative Approach*. 2nd Edition, CRC Press	

Course Code	ENS3332
Course Title	**Mining and the Environment**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Methods of exploration and mining geology, including mapping, geophysics, remote sensing, exploration geochemistry, inclusion studies and diamond drilling; Technical and economic aspects of exploration programme design and reserves evaluation procedures; Open cast mining, underground mining, mining in the soft ground, underwater and deep sea**;** Use	

of minerals, mineral distribution and formation, mining, processing and extraction; Environmental implications; Mineral conservation and recycling; Mining and its environmental problems in Sri Lanka (gems, dolomite, sand, clays, silica).
Recommended Texts
● Haldar, S.K. (2013). *Mineral Exploration: Principles and Applications*. Elsevier. ● Telford, W.M., Geldart, L.P. and Sheriff, R.E. (1990). *Applied Geophysics*. 2nd Edition, Cambridge University Press, New York, Port Chester, Melbourne, Sydney. ● Kearey, P. and Brooks, M. (1991). *An Introduction to Geophysical Exploration.* 2nd Edition, Blackwell Scientific Publications. ● Stevens, R. (2010). *Mineral Exploration and Mining Essentials*. Pakawau Geo Management.

Course Code	**ENS3342**
Course Title	**Geological Environment and Earth Resources**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Foundations of environmental geology (minerals and rocks, rock cycle, weathering, tectonics, volcanoes, surface processes – rivers, groundwater, oceans, deserts, and glaciers); Earth processes and natural hazards (earthquakes, volcanic activity, landslides and subsidence); Earth Resources and utilization (extraction of water, mineral, and energy resources, mineral resources in Sri Lanka, problems relevant to resource utilization; specific examples relevant to Sri Lanka).	
Recommended Texts	
● Keller, E.A. (1998). *Environmental Geology*. 8th Edition, Prentice Hall. ● Montgomery, C.W. (2014). *Environmental Geology*. 10th Edition, McGraw-Hill. ● Murck, B.W. (1996). *Environmental Geology*. John Wiley & Sons. ● Pitawala, H.M.T.G.A. and Fernando, G.W.A.R. (2010). *Mineral Resources of Sri Lanka, National Science Foundation, Colombo*.	

Course Code	**ENS3412**
Course Title	**Environmental Modelling**
Credit Value	**2**
Pre-requisites	**ENS3022**
Compulsory/Optional	**Optional**
Course Content	
Linear Algebra: Solving simultaneous linear equations by Gaussian elimination, finding the inverse of a matrix, determinants, eigenvalues and eigenvectors, numerical methods. **Recurrence equations:** Introduction to recurrence equations, first order recurrence equations, fixed points and stability, linear recurrence equations with constant coefficients, systems of recurrence relations. **Mathematical modelling:** Compartmental analysis; Mathematical modelling through recurrence equations (Discrete dynamical systems, The Cobweb Model, A model for annual plants, The Logistic Model, Predator-prey Model); Mathematical modelling through ordinary differential equations (Continuous models, Exponential differential equations, logistic differential equation, Allee effect model, Harvesting models, The classical predator-prey model, Competition models, Mutualism models); Numerical methods for solving mathematical models. **Applications in Environmental Chemistry:** Analysis of linearized forms of various adsorption isotherm models, such as Langmuir, Freundlich, Redlich–Peterson, Sips, Temkin and Dubinin–Radushkevich; Error calculation of the above isotherms; evaluation of thermodynamic properties of adsorption systems; kinetics of environmental systems, pseudo order kinetics models as applied to heterogeneous environmental systems; Diffusion models of pollutants in solution; Calculations of the above models.	

Recommended Texts
● Lay, D.C., Lay, S.R., and McDonald, J.J. (2016). *Linear Algebra and Its Applications.* 5th Edition, Pearson Publishing. ● Zill, D.G. (2012). *A First Course in Differential Equations with Modeling Applications.* 10th Edition, Brooks/Cole Cengage Learning. ● Kapur, J.N. (1998). *Mathematical Modelling*. John Wiley &Sons. ● Mooney, D. and Swift, R. (1999). *A Course in Mathematical Modelling.* Mathematical Association of America. ● Choy, B. and Reible D.D. (2017). *Diffusion Models of Environmental Transport*. Lewis Publishers. ● Butt, H.J., Graf, K. and Kappl, M. (2003). *Physics and Chemistry of Interfaces*. John Wiley & Sons.

Course Code	**ENS3512**
Course Title	**Energy, Weather and Environment**
Credit Value	**2**
Pre-requisites	**ENS3013, ENS3022**
Compulsory/Optional	**Compulsory**
Course Content	
Renewable and non-renewable energy sources; The World's energy problem; Exponential growth and energy usage; Fossil fuel production/Consumption; Nuclear structure and energy; How a reactor works; Nuclear waste management; Urbanization and environment; Energy conservations; an overview of alternative energy; Atmosphere, its composition and structure; Earth–sun geometry; Solar radiation; Energy balance; Temperature, moisture and stability of the atmosphere; Clouds and precipitation; Forces, winds and wind systems; Weather systems; Severe storms; Climate change.	
Recommended Texts	
● Kraushaar, J.J. and Ristine, R.A. (2002). *Energy and Problems of a Technical Society.* ● Moran, J.M. and Morgan, M.D. (2002). *Meteorology*. Prentice Hall. ● Haughton, J.T. (2001). *The Physics of Atmosphere.* 2nd Edition, Cambridge University Press. ● Everett, B. (2012). *Energy Systems and Sustainability: Power for a Sustainable Future*. 2nd Edition, Oxford University Press.	

Course Code	**ENS3993**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**ENS 3022, ENS 3052, ENS 3223**
Compulsory/Optional	**Compulsory**
Course Content	
Each student will be full time engaged on work assigned to them in any area of environmental science in a government/private industry/institution for a period of 3 months. Students are required to maintain 'Industrial training daily diary' which should be signed by the officer in-charge every two weeks and should be submitted to the Head of the Department on the day of presentation along with the report.	
Recommended Texts	
● Wentz, F.H. (2012). *Soft Skills Training: A Workbook to Develop Skills for Employment.* Lrg edition, CreateSpace Independent Publishing Platform. ● Tulgan, B. and Jossey-Bass, (2015). *Bridging the Soft Skills Gap: How to Teach the Missing Basics to Today's Young Talent.* 1st edition. ● *Skills for the Workplace*, Student textbook edition, Goodheart-Willcox, 2016.	

4000 Level Courses

Course Code	**ENS4012**
Course Title	**Cleaner Production in Industry**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to environmental issues related to industry and the importance of proper Environmental Management; Cleaner Production: The concept of cleaner production, cleaner production methodology and tools; Prerequisite for success of cleaner production, Advantage of cleaner production, Material and Energy balances, energy and material saving calculation, feasibility assessment; ISO 14001 Standards: Concept of environmental management, component of ISO 14001, application of ISO 14001 in industry, Life cycle perceptive and life cycle management; Case Studies and Group Exercises

Recommended Texts

- ISO14001 -2015 Standard
- Asian Productivity organization, 2002, Green Productivity Training Manual, http://www.apo tokyo.org /publications/ebooks/green-productivity-training-manual-pdf-2-8mb/.
- Asian Productivity organization, 2010, Training Manual on Energy Efficiency for Small and Medium Enterprises, http://www.apo-tokyo.org/publications/ebooks/training-manual-on-energy-efficiency-for-small-and-medium-enterprises-pdf-4mb.

Course Code	**ENS4022**
Course Title	**Sustainable Development and Green Technology**
Credit Value	**2**
Pre-requisites	**ENS3512**
Compulsory/Optional	**Compulsory**

Course Content

Sustainable development and biodiversity conservation; United Nation's sustainable development goals; Renewable and non-renewable resources; Ecological foot print; Climate adaptation and mitigation; Green procurement; Green technologies: Alternative fuels and energy efficiency; Sustainable energy generation technologies such as photovoltaics, wind turbines and bioreactors; Green buildings; Green chemistry; Green transportation and vehicles; Green nanotechnology; Environmentally friendly methods of farming; Eco-friendly architectural landscaping; Laboratory and field exercises based on above topics, and industrial visits.

Recommended Texts

- *World Commission on Environment and Development - Our common future.* Oxford, Oxford University Press, 1987.
- Singh, J., Sharma, D., Kumar, G. and Sharma, N.R. (2018). *Microbial Bioprospecting for Sustainable Development.* Springer Singapore.
- Singh, J.S. and Singh, D.P. (2019). *New and Future Developments in Microbial Biotechnology and Bioengineering. Microbial Biotechnology in Agro-environmental Sustainability.* 1st Edition, Elsevier.
- Belyakov, N. (2019). *Sustainable Power Generation: Current Status, Future Challenges, and Perspectives.* 1st Edition, Academic Press.
- Kutscher, C.F., Milford, J.B. and Kreith, F. (2018). *Principles of Sustainable Energy Systems*, 3rd Edition, CRC Press.

Course Code	**ENS4032**
Course Title	**Environmental Economics**
Credit Value	**2**
Pre-requisites	**ENS3013**
Compulsory/Optional	**Compulsory**
Course Content	
Concept of the externality, the Coase theorem and the importance of property rights as a determinant of market failure; Alternative revelation methods for determining the value of public goods; Pigouvian tax based solutions and other regulatory methods of pollution control including tradable permits, environmental subsidies; Implementation of these measures within the context of imperfect competition, imperfect mixing and with imperfect monitoring; Uncertainty and tax interaction effects; The monitoring and enforcement of environmental regulations; The ex-post regulation of environmental hazards using strict and negligence based liability versus ex-ante standards.	
Recommended Texts	
● Kolstad, C. (2000). *Environmental Economics*. Oxford University Press. ● Field, B.C. (2017). *Environmental Economics*. 7th Edition, R.D. Irwin Publishers. ● Tietenberg, T. and Lewis, L. (2019). *Environmental Economics: The Essential*. 1st Edition, Routledge Publishers.	

Course Code	**ENS4112**
Course Title	**Ecotourism and Nature Conservation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Types of tourism; Potential for ecotourism: landscapes (ecosystems), man-made ecosystems, cultural background, biological diversity, protected areas, coral reefs, elephant orphanage; Ecotourism services: sources of information, travel operators, transport facilities, hotel and other facilities; Potential for joint ecotourism with nearby countries; Constraints to tourism; Ancillary benefits of ecotourism; Negative impacts of tourism; Improvement of ecotourism facilities.	
Recommended Texts	
● Cebellos-Lascurdin, H. (2005). *Tourism, Ecotourism and Protected Areas: The State of Nature-Based Tourism around the World and Guidelines for Its Development. IUCN.* ● Fennell, D.A. (2006). *Ecotourism: An Introduction.* Routledge. ● Ashton, P.S., Jr Ashton, R.E. (2002). *Ecotourism: Sustainable Nature and Conservation Based Tourism.* Krieger Pub Co.	

Course Code	**ENS4123**
Course Title	**Biodiversity and Conservation Biology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Ecosystem and genetic diversity; Global patterns and values of biodiversity; Effective population size, Inbreeding and Gene flow; Overexploitation; Demography and extinction processes; Population viability analysis; Endangered species and their protection; Exotic introductions and invasive species; Ecosystem degradation, habitat fragmentation and edge	

effects; Habitat pollution; Modified ecosystems; Ecosystems management and restoring ecosystems; Protected areas; Captive breeding and reintroduction; Zoos and gardens; Human population growth; Human impact; Sustainable development; Law and politics; Social factors in conservation; Economics of conservation; Conservation politics.
Recommended Texts
● Meffe, G.K. and Carroll, C.R. (1997). *Principles of Conservation Biology*. Sinauer Associates, Inc. ● Primack, R.B. (1994). *A Primer of Conservation Biology.* Sinauer Associates, Inc. ● Heywood, V.H. (2002). *Global Biodiversity Assessment.* UNEP.

Course Code	**ENS4212**
Course Title	**Air and Noise Pollution**
Credit Value	**2**
Pre-requisites	**ENS3213**
Compulsory/Optional	**Compulsory**
Course Content	
Air pollution: Atmospheric composition and climate; Air pollution: classes of air pollutants, urban air pollution, global warming; Possible effects of greenhouse gasses; Ozone layer depletion and the Montreal protocol; Acid rain and its effects on biota; Air quality standards; Causes and consequences of photochemical smog; Kyoto protocol; Clean development mechanism; Carbon trading; Effect of air pollutants on health and ecosystem; Control strategies. **Noise pollution**: Introduction to noise pollution, sources of noise pollution, measurements, Decibel scale, adverse effects, legal aspects and regulations, noise prevention and reduction; experiments on noise pollution.	
Recommended Texts	
● Marshall, J. and Plump, R.A. (2007). *Atmosphere, Ocean and Climatic Dynamics: An introductory Text.* ● Manahan, S. (2017). *Environmental Chemistry*. 10th Edition, CRC Press. ● Vallero, D. (2014). *Fundamentals of Air Pollution.* 5th Edition, Academic Press. ● Murphy, E. and King, E. (2014). *Environmental Noise Pollution.* 1st Edition, Elsevier.	

Course Code	**ENS4222**
Course Title	**Atmospheric Chemistry**
Credit Value	**2**
Pre-requisites	**ENS4212**
Compulsory/Optional	**Optional**
Course Content	
Composition, structure and transport in the atmosphere; Chemistry of stratosphere: Solar radiation spectrum/ Properties of emr, good ozone/bad ozone, ultraviolet protection by ozone, Chapman mechanism, CFCs and their replacements, ODP, numbering system for CFCs and HCFCs, polar ozone depletion; Chemistry of troposphere: photochemical aspects, processes that affect the concentrations of chemical species in the atmosphere, one-box/three-box model, organic and inorganic pollutants, chemical and photochemical reactions in the troposphere; Indoor air pollution; Introduction to aerosol chemistry; Air pollution modeling, and basis of modeling; Air pollution meteorology; Atmospheric energy/mass balancing; atmospheric dispersion models; Emission inventories; dispersion of vehicle emissions and exposure modeling concepts; indoor air pollution models; Cardinal rules for model stability analysis; Recent advances/current topics in atmospheric chemistry: Presentations/discussions based on journal articles.	
Recommended Texts	
● Marshall, J. and Plump, R.A. (2007). *Atmosphere, Ocean and Climatic Dynamics: An introductory Text.* ● Seinfeld, J.H. and Pandis, S.N. (2016). *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change.* Wiley & Sons. ● Jakobson, M.Z. (2005). *Fundamentals of Atmospheric Modeling.* 2nd Edition, Cambridge.	

Course Code	**ENS4233**
Course Title	**Waste and Waste Management**
Credit Value	**3**
Pre-requisites	**ENS3213**
Compulsory/Optional	**Compulsory**
Course Content	
Treatment of waste water: Types of wastewater and types of industrial effluents; Industrial effluent treatment: Physical, chemical and biological methods; Hazardous liquid waste treatment; Filed trips. *Treatment of solid waste*: Types of solid waste; biological treatment methods; Incineration; Special treatment for hazardous solid waste; Field visits. *Management of waste*: Types of waste; Steps of waste management; Disposal methods of waste; Control of gaseous pollutants; Monitoring and regulation of waste management; 3R, 4R, 5R and 6R strategies of waste management; Challenges in waste management. *Waste as a resource*: Useful products from waste; Energy generation from waste; Value addition to industrial waste and industrial by-products.	
Recommended Texts	
● Wang, L.K., Lo, H.H. (2006). *Hazardous Industrial Waste Treatment*. CRC Press. ● Williams, P.T. (2005). *Solid waste Management.* 2nd Edition, John Wiley & Sons . ● Ram Chandra (2015). *Environmental Waste Management*. 1st Edition, CRC Press. ● Edwards, J.D. (2017). *Industrial Wastewater Treatment*. 1st Edition, CRC Press. ● Ranade, V. and Bhandari, V. (2014). *Industrial Wastewater Treatment, Recycling and Reuse*. 1st Edition, Butterworth-Heinemann Publishers.	

Course Code	**ENS4242**
Course Title	**Nanotechnology and the Environment**
Credit Value	**2**
Pre-requisites	**ENS3223**
Compulsory/Optional	**Optional**
Course Content	
Introduction to nanoparticles: Structure, aggregation and characterization of nanoparticles, thermodynamics and kinetics of nano particles; Fate of engineered nanoparticles; Environmental toxicology of nanoparticles; Nanotechnology for environmental remediation; Nanoparticle based water treatment systems; Nanoparticles in natural water systems.	
Recommended Texts	
● Bhushan, B. (2004). *Spinger Hand Book of Nanotechnology*. Springer. ● Fulekar, M.H. and Pathak, B. (2017). *Environmental Nanotechnology.* 1st Edition, CRC Press. ● Wiesner, M.R. and Bottero, J.Y. (2007). *Environmental Nanotechnology: Applications and Impacts of Nanomaterials.* McGraw-Hill.	

Course Code	**ENS4292**
Course Title	**Environmental Analysis Laboratory**
Credit Value	**2**
Pre-requisites	**ENS3213; ENS3223**

Compulsory/Optional	**Compulsory**
Course Content	
Instrumental methods in environmental analysis: Electroanalytical methods, ion selective electrodes, potentiometry and amperometry), molecular spectroscopic methods (UV/Vis and IR), atomic spectroscopic methods (absorption and emission techniques), chromatographic methods (Gas Liquid, Ion exchange and HPLC); Water quality analysis including both biological and chemical parameters; Selected experiments on air quality analysis.	
Recommended Texts	
● Skoog, D.A., Holler, F.J. and Crouch, S.R. (2006). *Principles of Instrumental Analysis*. 6th Edition, Cengage Learning. ● Kleiböhmer, W. (2001). *Environmental Analysis, Volume 3*. 1st Edition, Elsevier Science. ● Barbooti, M. (2015). *Environmental Applications of Instrumental Chemical Analysis.* 1st Edition, Apple Academic Press. ● Baird, R., Eaton, A.G. and Rice, E. (2017). *Standard Methods for the Examination of Water and Wastewater*. 23nd Edition, American Public Health Association.	

Course Code	**ENS4312**
Course Title	**Oceanography**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to chemical, geological, biological and physical oceanography; Sea floor spreading, marine sediments, sea floor morphology, waves, tides, currents, global thermostat, ocean-atmosphere-climate connection and marine life, biological productivity and ocean ecology, productivity and coastal processes; Global environmental changes due to rise and fall of sea-levels and related processes of sedimentation/ erosion.	
Recommended Texts	
● McCormick, M.J., and Thiruvathukal, J.V. (1981). *Elements of Oceanography*. Saunders College Publishing. ● Chester, C.K. (1990). *Marine Geochemistry*. Springer. ● Millcro, W. and Saha, M.L. (1992). *Chemical Oceanography.* John Wiley. ● Garrison, T. (2012). *Essentials of Oceanography*. Wadsworth Publishing Company.	

Course Code	**ENS4322**
Course Title	**Medical Geology and Environmental Toxicology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Medical Geology: Definitions and terminology of medical geology/geochemistry; Classification of elements; Major, minor and trace elements in geological and biological materials; Geochemical classifications; Elemental link between geosphere and biosphere; Essential and non-essential elements with reference to human health; Trace element speciation and human health; Tropical environmental geochemistry; Case studies on related health issues - fluoride, iodine, water hardness, arsenic, selenium etc.; Geophagy; Natural radioactivity; Toxicity of natural dust; Common analytical methods; Health benefits of rocks and minerals. **Environmental Toxicology**: Toxic chemicals in the environment; Persistent organic pollutants; Heavy metal toxicity; Carcinogenic and mutagenic effects of industrial chemicals/by-products; Pesticides and their problems; Improper use of	

pesticides and laws relating to use of pesticides; Integrated Pest Management (IPM); Good Agricultural practices (GAP); Alternatives to synthetic pesticides; Fate and transport of chemicals in the environment; Bioaccumulation and biomagnifications; Chronic toxicity; Mixture of poisons; Environmental factors affecting toxicity; Biochemical assays in environmental toxicology; Environmental risk assessment.
Recommended Texts
● Selinus, O.B.J., Alloway, J.A., Centeno, R.B., Finkelman, R., Lind, U.F. and Smedle, P. (2005). *Essentials of Medical Geology - Impacts of the Natural Environment on Public Health.* Elsevier Academic Press. ● Komatina, M. (2004). *Medical Geology - Effects of Geological Environments on Human Health.* Elsevier Science Publishing Co. ● Dissanayake, C.B. and Chandrajith, R. (2008). *Introduction to Medical Geology-Focus on Tropical Environment.* Springer, Heidelberg. ● Hemond, H.F. and Fechner Levy, E.J. (2000). *Chemical Fate and Transport in the Environment.* Academic Press. ● Wright, D.A. and Welbourn, P. (2002). *Environmental Toxicology, Cambridge Environmental Chemistry Series (No. 11).* Cambridge Press. ● Crosby, D.G. (1998). *Environmental Toxicology and Chemistry.* Oxford University Press.

Course Code	**ENS4412**
Course Title	**Multivariable Calculus**
Credit Value	**2**
Pre-requisites	**ENS3022**
Compulsory/Optional	**Optional**
Course Content	
Functions of Several Variables: Differential calculus of functions of several variables: Introduction to functions of two variables, limits and continuity, partial derivatives, directional derivatives and the gradient vector, the general chain rule, maxima and minima of functions of several variables, extrema for functions with side conditions - Lagrange multipliers. **Integral Calculus of Functions of Several Variables:** Double integrals, triple integrals, multiple integrals in general regions, change of variables in integrals. **Vector Calculus:** Vector fields, line integrals, the fundamental theorem of line integrals, Green's theorem, curl and divergence, parametric surfaces and their areas, surface integrals, Stokes' theorem, divergence theorem.	
Recommended Texts	
● Larson, R. and Edwards, B.H. (2017). *Multivariable Calculus.* 11th Edition, Cengae Learning Publishing. ● Edwards, C.H. and Penney, D.E. (2002). *Multivariable Calculus.* 6th Edition, Pearson Publishing.	

Course Code	**ENS4422**
Course Title	**Basic Environmental Engineering**
Credit Value	**2**
Pre-requisites	**ENS4412**
Compulsory/Optional	**Optional**
Course Content	
Unit operations and processes encountered in the environmental engineering, design and operation of advanced water, wastewater, and waste management treatment systems; Assessment of the scope of the solid waste problem and engineering management strategies: solid waste sources, characterization and generation rates, collection and transportation technologies and management options, sanitary landfill design and operation, recycling strategies and technologies; Hydraulic Engineering: Water distribution, sewage collections, pipe network models, piping materials,	

pumps and pumping stations, valves and tanks, design and operation; Risk assessment: Hazard identification, dose-response assessment, exposure assessment, risk characterization, comparative risk analysis.
Recommended Texts
● Holmes, G., Singh, B.R. and Theodore, L. (1993). *Handbook of Environmental Management and Technology.* John Wiley & Sons, Inc., New York. ● Schnoor, J. (1996). *Environmental Modelling*. John Wiley & Sons, Inc, New York. ● Mihelcic, J.R. and Zimmerman, J.B. (2009). *Environmental Engineering: Fundamentals, Sustainability, Design.* John Wiley & Sons, Inc, New York. ● Mihelcic, J.R. (1999). *Fundamentals of Environmental Engineering*. John Wiley & Sons, Inc, New York. ● Reible, D.D. (1999). *Fundamentals of Environmental Engineering*. CRC Press LLC.

Course Code	**ENS4912**
Course Title	**Research Methodology and Scientific Writing**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Finding a research problem, searching the literature and review writing research proposals, methods of obtaining funding for research, selecting research designs, ethical issues in research, collection of data and analysis, preparation of thesis, writing research papers for journals, improving the writing skills, citation and listing of references, preparation of visual materials, oral and poster presentation in conferences, introducing library and its various features, use of information technology in retrieving and managing information through various means; Evaluation of quality of research output: h-index, i10 index, impact factor, etc.	
Recommended Texts	
● Thomas, C.G. (2016). *Research Methodology and Scientific Writing*. Ane Books Pvt. Ltd. ● Alle, M. (2018). *The Craft of Scientific Writing*, 4th Edition, Springer.	

Course Code	**ENS4921**
Course Title	**Seminar**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Seminars on assigned topics in Environmental Science should be presented after due preparation and literature survey by the students.	
Recommended Texts	
● Alley, M. (2013). *The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors to Avoid.* 2nd Edition, Springer.	

Course Code	**ENS4998**
Course Title	**Research Project**
Credit Value	**8**
Pre-requisites	**ENS3013**

Compulsory/Optional	Compulsory
Course Content	
Each student will carry out a research project during the final year under the supervision of a staff member. The student is required to ● Deliver two seminars, (a) pre-project seminar, based on preparatory work and research plan and (b) end of the project seminar, based on the outcome of research; ● Face an oral examination at the beginning of the second semester; ● Prepare a comprehensive report containing Title page, Abstract, Introduction and Literature Review, Objectives, Materials & Methods, Results, Discussion and References.	
Recommended Texts	
● Thomas, C.G. (2016). *Research Methodology and Scientific writing*. Ane Books Pvt. Ltd.	

3.2 Applied Sciences Course Modules

Course Code	Course Title	No. of credits	Compulsory
APS4002	Industrial Management	2	√
APS4018	Industrial Placement	8	√
APS4022	Research Methodology & Scientific Writing	2	√
APS4031	Seminar	1	√
APS4042	Data Integrity Management & Data Analysis	2	√
APS4092	Industry and the Environment	2	√
APS4102	Industrial Applications Laboratory	2	√
Category I (Biology – based Courses)			
APS4142	Industrial Microbiology	2	
APS4152	Biodiversity Conservation and Sustainable Development	2	
APS4162	Fisheries and Aquaculture	2	
APS4172	Food and Fresh Produce Technology	2	
APS4182	Ecotourism	2	
APS4812	Enzymes in Industry	2	
APS4821	Biochemistry and Molecular Laboratory Instrumentation	1	
APS4832	Bioinformatics	2	
Category II (Chemistry - based Courses)			
APS4312	Chemical Technology	2	
APS4322	Cleaner Production in Industry	2	
APS4332	Industrial Waste Management	2	
APS4342	Industrial Organic Chemistry	2	
Category III (Geology - based Courses)			
APS4442	Industrial and Economic Minerals	2	
APS4452	Remote Sensing and Geographic Information Systems	2	
Category IV (Mathematics - based Courses)			
APS4512	Industrial Mathematics	2	
APS4522	Financial Mathematics	2	
Category V (Physics - based Courses)			
APS4612	Semiconductor Device Technology and Application	2	
APS4622	Science and Technology of Ceramic Materials	2	
APS4632	Energy; Sources, Use and Conservation	2	
APS4642	Workshop Practice	2	
APS4652	Industrial Applications (Electronics/Hardware) Laboratory	2	
Category VI (Statistics/Computer Science - based Courses)			
APS4712	Design and Development of Software Systems	2	
APS4722	Management of Computers and Computer Networks	2	
APS4732	Visualizing Statistical Concepts using Java and Software Development	2	
APS4742	Statistical Applications in Industry and Project Presentation	2	
	Total	**68**	**19**

4000 Level Courses

Course Code	**APS4002**
Course Title	**Industrial Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Approaches to Management: Introduction to Management; Organizations and importance towards effective work; The scientific, the human relation, the quantitative and the systems approach. **Group Dynamics**: Formal and informal organizations, teamwork & team-building; self-managing teams; Motivation; motivational drives, models of motivation, behaviour modification, contemporary motivational approaches; Productivity and worker satisfaction. **Communication in Organizations**: The Two-Way communication process, communication barriers, upward, downward and lateral communication. public speaking. **Managing Conflicts Stress and Counseling**: Nature and level of conflict, sources of conflict, effects of conflict, conflict resolution, change management; Work change, resistance to change, implementing change successfully; Stress and job performance, approaches to stress management, employee counseling; Effect of culture on organizational behavior and its impact on management.	
Recommended Texts	
● Jain, K. C and Aggraval, S. (1990). *Production Planning and Control, and Industrial Management*, Khanna Publishers, Delhi. ● Karunarathne, K. M.R.T. (1995). *Quantitative Methods for Management: with applications in planning and decision making*, author published, Moratuwa.	

Course Code	**APS4018**
Course Title	**Industrial Placement**
Credit Value	**8**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Train students with work experience in an industrial environment and to produce a model science graduate to be competent to work in the industrial sector through variety of activities as specified by Sri Lankan industries. Students will specifically gain knowledge in the following areas during this period: Type of raw materials; Industrial process; Problems associated with the process; Quality control; Research & Development aspects; Management aspects. This course will be graded based on evaluation by industries, report.	
Recommended Texts	

Course Code	**APS4022**
Course Title	**Research Methodology & Scientific Writing**
Credit Value	**2**

Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Methods of Research: To provide skills of survey and quantitative research methods. **Scientific Writing**: Literature review; Problem-solving through scientific research; Data collection, analysis, and presentation; Interpretation and communication of the data obtained from scientific research; Writing effective research proposals.	
Recommended Texts	
• Kumar, R. (2005). *Research Methodology: A Step-by-Step Guide for Beginners*. 2nd edition. • Yin, R. K. (2003). *Case Study Research: Design and Methods*. 3rd edition.	

Course Code	**APS4031**
Course Title	**Seminar**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Under this course undergraduate students will give oral presentations and listen to presentations by various people in Departments and by other speakers. Each student enrolled in the course will give one oral presentation which will be evaluated by a team of members of the Faculty. Learning from and with each other is one important aspect of this course. Participation includes punctual attendance, engagement with topics being discussed, answering the posed relevant questions etc. **20-minute Student Seminar**: Students are encouraged to choose a topic with the guidance of a faculty member assigned. After preparation of a 20-minute presentation based on material in the published literature (journal articles or websites), it should be then submitted to the lecturer assigned by the coordinator for approval. This will be then presented to a selected audience according to a roster. These seminars will be graded based on continuous attendance, performance/speaking ability, grasp of the material, use of appropriate visual aids, answers to questions, and an overall presentation.	
Recommended Texts	

Course Code	**APS4042**
Course Title	**Data Integrity Management & Data Analysis**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Data Integrity Management: Good laboratory practice (GLP); Facilities and equipment (including computer systems); Use of equipment; Managing test and reference items and reagents; Design of experiments to obtain variable data; Recordkeeping; Storage and retention of records and materials; Maintenance and calibration of equipment; Standard operation procedures; Multi-site and multi-laboratory studies. **Errors of Measurements**: Concept of significant figures; Uncertainty of measurements; Statistical averages and deviations such as mean, median, standard deviation, relative deviation; Statistical tests such as Q test, Z test, t	

test, F test, and confidence intervals; propagation of errors; Errors in instrumental methods; Linearization and graphical analysis; Method of least squares. **Data analysis**: Data preparation and applications of statistical techniques using statistical software.
Recommended Texts
● Priyantha, N. (1999). *Measurements and Errors in Chemical Analysis*. Printing Unit, Faculty of Science, University of Peradeniya. ● Myers, R. H. (1990). *Classical and Modern Regression with Applications*. Duxbury Press. ● Jobson, J. D. (1991). *Applied Multivariate Data Analysis, Vol I: Regression and Experimental Design*. Springer. ● MINI TAB Reference Manual.

Course Code	**APS4092**
Course Title	**Industry and the Environment**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Chemical Aspects: Effect of industrial activities on the environment; Guidelines for discharge of industrial effluents; Water quality and air quality: chemical aspects, classical and instrumental methods for determination of water quality and air quality parameters, analytical aspects; Treatment of water and wastewater: chemical and biological methods, low-cost and modern methods. **Sound Pollution**: Sound pollution due to various industrial activities in Sri Lanka; Pollution parameters of sound and measurements of sound pollution. Reduction of sound pollution **Air Pollution**: Air pollution and climate change; Bio-monitoring of environmental pollution: concepts, active and passive monitoring, bio-indicator parameters, control of air pollution by plants, green belt design. **Field Visits**: Industrial /Field visits to various industries.	
Recommended Texts	
● Manahan, S. E. (1994*). Environmental Chemistry*. Lewis Publishers. ● Ileperuma, O. A. (1995*). Environmental Pollution and the Future of Mankind*. Science Education Unit, Faculty of Science, University of Peradeniya. ● Alloway, B. J. and Ayres, D.C. (1993). *Chemical Principles of Environmental Pollution*. Blackie Academic Professional.	

Course Code	**APS4102**
Course Title	**Industrial Applications Laboratory**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Analysis of Industrial Effluents: Determination of parameters, such as DO, BOD, COD, TDS, SS, floatables, conductivity, hardness, anions, etc. **Analysis and quality control of industrial materials:** Operation of modern instrumentation used in the industrial sector such as X-ray fluorescence spectrometer, X-ray diffractometer, scanning electron microscope, atomic absorption spectrophotometer, gas chromatograph, thermogravimetric apparatus & differential thermal apparatus, etc; Selected experiments using above instruments as applied to quality control processes of industries;	

Analysis of industrial raw materials and products such as cement clinker, ceramics, clay, dolomite, apatite, mineral sands, etc.
Recommended Texts
● Shoemaker, D. P., Garland, C.W. and Nibler, J.W. (1996). *Experiments in. Physical Chemistry*, McGraw Hill. ● Skoog, D. A., Holler, F.A. and Crouch, S.R. (2007). *Principles of Instrumental Analysis*. Thomson.

Course Code	**APS4142**
Course Title	**Industrial Microbiology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Microorganisms with industrial and environmental use and their products; Growth and product formation in industrial processes; Large scale fermentation: proteins, antibiotics, organic acids, amino acids, enzymes, vitamins, food, alcoholic beverages, fuel and energy, microbial quality of water; Setting up a microbiological laboratory. [Selected titles from the above course content will be offered each year]	
Recommended Texts	
● Glazer, A. N. and Nikaido, H. (1995). *Microbial biotechnology. Fundamentals of Applied Microbiology*. New York: W.H. Freeman & Company. ● Madigan, M. T., Martinko, J.M. and Parker. J. (2000). *Brock Biology of Microorganisms*. 9th edition. Prentice Hall. ● Gastel, B. and Day, R. A. (2016). *How to write and publish a scientific paper*. 8th edition.	

Course Code	**APS4152**
Course Title	**Biodiversity Conservation and Sustainable Development**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Impart Knowledge and Develop Skills on Biodiversity Conservation and Management: Changes of biodiversity over space and time; Assessing and Monitoring biodiversity; Conservation of biodiversity; Managing species and habitats. **Sustainable Use of Biodiversity:** Timber and nontimber forest products; Medicinal plants and lesser-known timber species in Sri Lanka, Indigenous knowledge; Ecotourism **Production Forestry and Biodiversity Conservation:** Forest management; Impacts of forestry practices in the conservation of biodiversity, Sustainable forestry practices; Soil fertility management for the conservation of biodiversity; **Computer-Aided Data Analysis and Management of Biodiversity:** Identification and classification of vegetation types/habitats using the computer programmes PC ORD, XL stat, Estimates. **Laboratory and Field Work:** Assessing and monitoring biodiversity, Estimating the plant species diversity in a forest, data analyses and identifying different vegetation types.	
Recommended Texts	

- Meffe, G. K. and Carroll, C.R. (1997). *Principles of Conservation Biology*.
- Primack, R. B. (1995). *A Primer of Conservation Biology*.
- Kent, M. and Coker, P. (1992). *Vegetation description and analysis- a practical approach*. Jhon Wiley & Sons, New York.

Course Code	**APS4162**
Course Title	**Fisheries and Aquaculture**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Inland Fisheries in Sri Lanka: Brief history and the recent developments in the industry, species involved, and the gear used. Fishery regulation, sustainable utilization, and potential for future developments.

Aquaculture: General principles and economics of aquaculture, culturable fish and shellfish species, design and construction of aquafarms, fish nutrition and feeding, farm management, integration of aquaculture with crop and livestock farming, marketing of aquaculture products, and aquarium fish trade.

Laboratory studies: Identification of fish species, fish parasites, and diseases, preparation of aquarium tanks

Field visits: visits to brackish water prawn farm, cage culture facility, fish processing unit, freshwater aquarium fish farm, reservoir with well-organized fishery.

Recommended Texts

- Agarwal, A C. (1994). *A hand book of fish farming*. Narendra Publishing House, Delhi, India.
- Santhanan, R., Sukumaran, N. and Natarajan, P.A. (1990). *Manual of Freshwater Aquaculture*. 2nd edition, South Asia Books.
- Baluyut, E. A. (1989). *Aquaculture Systems and Practices: A Selected Review*.
- Satyanarayana, V. (1996). *A symposium on fish culture: a practical and comprehensive guide on inland fish farming*. Narendra Pub., New Delhi.

Course Code	**APS4172**
Course Title	**Food and Fresh Produce Technology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Research & development, and quality control aspects of fruits, vegetables, and ornamental plant product handling; food processing and safety; packaging and analysis; floriculture.

Recommended Texts

- Florkowski, W. J. (2014). *Postharvest Handling: A Systems Approach*. 3rd edition. Academic Press
- Ingels, J. (2010). *Ornamental Horticulture: Science, Operations & Management*. 4th edition. Delmer Cengage Learning.
- Karunaratne, A. M. (2019). *Plants in Human Nutrition: A botanical overview*. Peradeniya Science Publication No. 33, Science Education Unit, Faculty of Science, University of Peradeniya, Sri Lanka.
- Öpik, H., Rolfe, S. A., Willis, A. J. (2005). *The Physiology of Flowering Plants*. 4th edition. Cambridge University Press.
- Perera, N. and Hettiarachchi, K. (2018). *Food Preservation Technology*. Godage Publications, Sri Lanka.
- Wills, R., McGlasson, B., Graham, D. and Joyce, D. (2007). *Postharvest: An Introduction to the Physiology & Handling of Fruit, Vegetables & Ornamentals*. CABI Publishing, UK.

Course Code	**APS4182**
Course Title	**Ecotourism**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Impart knowledge and develop awareness on non-detrimental tourism; develop skills as ecotourism guides and operators.	
Recommended Texts	
● Fennell, D.A. (2004). *Ecotourism: An Introduction*. ● Ashton, P. S. and Ashton, R.E. Jr. (2000). *Ecotourism: Sustainable Nature and Conservation Based Tourism*.	

Course Code	**APS4312**
Course Title	**Chemical Technology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction: Chemical engineering stoichiometry; Chemical plant technology: safety, services, storage, etc; fluid flow; Industrial chemical engineering equipment: reactors (batch, flow, semi-batch); Chemical engineering economics and planticides: cost, investments, fixed charges etc. **Chemical Technology**: Raw materials, raw materials for the chemical industry; New development in chemical technology; Automation and some selected examples. **Chemical Kinetics**: Chemical kinetics in plant design for isothermal, constant volume batch reactions, isothermal variable volume batch reactions, plug flow reactions continuous stirred tank reactants (Industrial reactants). **Catalysis**: Homogenous, heterogeneous catalysis, pack bed reactors, fluid dye pack reactors; Electrochemical industries.	
Recommended Texts	
● Panel on the Applications of Biotechnology to Traditional Fermented Foods. (1992). *Applications of Biotechnology in Traditional Fermented Foods*. National Research Council, Washington. ● Fogler, H. Scott. (2016). *Elements of Chemical Reaction Engineering*. 5th edition. Prentice Hall. ● Himmelblau, D. M. (2012). *Basic Principles and Calculations in Chemical Engineering.* 8th edition. Prentice Hall. ● Simpson, R., Sastry, S. K. (2013). *Chemical and Bioprocess Engineering*. Springer, New York, Heidelberg Dordrecht, London.	

Course Code	**APS4322**
Course Title	**Cleaner Production in Industry**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	

Introduction: Introduction to cleaner production, cleaner production tools; Assessment and audits; Introduction of cleaner production in an enterprise and cleaner production methodology; Prerequisite for success of cleaner production. **Industrial Aspects**: Cleaner production assessment, cleaner production team, process mapping and process flow diagram, data sources, material balance, energy balance, costing of waste; alternating option generations; Better process control, equipment and product modification, technology change, onsite recovery/reuse; Implementation of cleaner production options and payback period. **ISO Standards**: ISO standards in industrial processes. **Case Studies and Group Exercises**:
Recommended Texts
● National Cleaner Production Centre. (2006). *Proceedings: Seminar on Introduction to Cleaner Production into University Curriculum*, Colombo. ● National Cleaner Production Centre. (2005). *Cleaner Production: A Way to Improve Your Enterprise*.

Course Code	**APS4332**
Course Title	**Industrial Waste Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Characterization of Industrial Waste: Types of waste; Toxic substances in different types of waste; Chemical and physical methods of determining pollution parameters of industrial waste. **Minimization of Waste and Management of Waste**: Traditional and modern concepts, advantages and disadvantages of different waste management strategies. **Development of Industries Using Waste as a Resource**: Value addition methods for waste for reuse.	
Recommended Texts	
● Pichtel, J. (2005). *Waste Management Practices.* CRC Press.	

Course Code	**APS4342**
Course Title	**Industrial Organic Chemistry**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Industries Which Use Organic Materials: To impart a theoretical and practical knowledge of industries in Sri Lanka which use fats & oils, phospholipids and waxes with emphasis on soap making and surface active compounds, manufacture of bio-diesel and the food industry. **Essential Oils in Sri Lanka**: Overview of the essential oil industry in Sri Lanka, including the methods of extraction, analysis and quality standards utilized. **Tea Industry in Sri Lanka**: Tea industry and the processing technology and the importance of tea flavours. **Pharmaceutical Industry:** Role of chemistry within pharmaceutical industry and production of drug-dosage forms	
Recommended Texts	

- Karunaratne, D.N. (2006). *Oils and Fats in Industry*. Science Education Unit Publication.
- Shukla, S.D. and Pandey G.N. *Textbook of chemical Technology Vol. II*. Vikas Publishing.
- Meyer, L. H. (2006). *Food Chemistry (Pb*). CBS Publishers & Distributors Pvt Ltd., India.
- Riegel, E. R. (1949). *Industrial Chemistry*. Reinhold Publishing.

Course Code	**APS4442**
Course Title	**Industrial and Economic Minerals**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction to Gemmology: Introduction to gems and gemstones, basic physical properties of gem minerals-crystallography, colour, hardness (durability), lustre, cleavage, general optical properties-reflection, refractive index, pleochroism, special properties-special optical properties, luminescence, fluorescence, dispersion, Introduction to fashioning.

Industrial Minerals: Mechanisms of formation and distribution of metallic and non-metallic ore deposits; Classification of industrial minerals and rocks; Geology and origin of industrial minerals and rocks; Deposits of industrial minerals and rocks (quartz, feldspar, carbonates, asbestos, clay, phosphates).

Exploration and Mining Techniques: Introduction to mine planning, mining methods, mine plant design and mineral processing

Recommended Texts

- Read, P. G. (1995). *Dictionary of Gemmology*. Butterworth-Heinemann.
- Huralburt, C.S. Jr. and Switer, G.S. (1979). *Gemology*.
- Maning, D.A.C. (1995). *Introduction to Industrial Minerals*. Chapman & Hall.

Course Code	**APS4452**
Course Title	**Remote Sensing and Geographic Information Systems**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Remote Sensing: Overview and concepts of Remote Sensing technology, basics of photogrammetry, practical uses of aerial photographs in various disciplines, fundamental characteristics of electromagnetic radiation, remote sensing platforms, satellite system and sensors, active and passive sensing systems, concepts of spatial, spectral, radiometric and temporal resolution, an overview of RS applications.

GIS (Geographic Information System): Introduction to GIS, definition, concepts of GIS, scope and application areas, purpose and benefits of GIS, functional elements of GIS, required hardware and software for GIS, installation of GIS, map projection, data structures [WINDOWS-1252?]– raster and vector data structures, input of geospatial data, sources of data and input devices, spatial database data acquisition and management techniques, data manipulation and analysis, map output generation.

Laboratory Sessions: Visual interpretation of aerial photographs for land use, land pattern analysis, hands-on practical sessions on GIS, data input, linking non-spatial and spatial database, database editing and updating, GPS data integration in GIS, data manipulation and pre-processing, spatial analysis, map generation, mini-project for GIS application.

Recommended Texts

- Thomas M. Lilles and Ralph W. Kiefer (1999). *Remote Sensing and Image Interpretation*, 4^{th} Edition
- Burrough, P.A. and McDonnell, R.A. (1998). *Principles of Geographical Information Systems*. Oxford University Press.

Course Code	**APS4512**
Course Title	**Industrial Mathematics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Mathematical Modelling: Linear programming, integer programming and non-linear programming models.

Network Modelling: The transshipment problem, the shortest path problem, the equipment replacement problem, transportation/assignment problems, generalized network flow problems, maximal flow problems, special modeling considerations and minimal spanning tree problems.

Project Management: Introduction, creating the project network, critical path method, project crashing, project evaluation and review technique, simulating project networks and Microsoft project.

Recommended Texts

- Ragsdale, C.T. (2006). *Spreadsheet Modelling and Decision Analysis.* 4^{th} edition, Thomson Press.
- Albright, S.C., Winston, W.L. and Zappe, C.J. (1998). *Data Analysis and Decision Making with Microsoft Excel*. Duxbury Press.
- Winston, W.L. (1998). *Simulation Modeling Using @RISK.* Duxbury Press.
- Hamdy A. Taha. (2003). *Operations Research: An Introduction.* 7th edition, Eastern Economy Edition.

Course Code	**APS4522**
Course Title	**Financial Mathematics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Linear models, physical assets, model of a market, time-value of money, discounting rates; Usage of software packages (Mathematica, e-view, r-studio); Cost-revenue analysis, profit maximization, marginal functions, partial payments, money market; Annuities and their usage, stock-market functions

Recommended Texts

- Karatzas, I. and Shreve, S. (2017). *Methods Of Mathematical Finance*. Springer-Verlag, Berlin.
- Elliott, R. J. and Kopp, P. E. (2019). *Mathematics Of Financial Markets*. Springer-Verlag, Newyork.

Course Code	**APS4612**
Course Title	**Semiconductor Device Technology and Application**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

To provide knowledge on the physics behind semiconductor devices and the fabrication of semiconductor devices and IC circuits.
Recommended Texts
● Sze, S.M. (1981). *Physics of Semiconductor Devices.* 2nd edition, John Wiley & sons. ● Neamen, D.A. (1992). *Semiconductor Physics and Devices*. Richard D. Irwin.

Course Code	**APS4622**
Course Title	**Science and Technology of Ceramic Materials**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to ceramic materials **Traditional Ceramics**: Ceramic Industry in Sri Lanka, Raw Materials, Compositions of Ceramic Bodies, Density, porosity, permeability, Colour of ceramics. **Technical Ceramics**: Different categories: Oxides, Nitrides and carbides, synthesis and applications, Piezoelectric ceramics, Bio-ceramics, Problems associated with ceramics. **Powder preparation**: Chemical and Mechanical methods, Miscellaneous methods, Particle Size Analysis, **Shape forming:** Uniaxial pressing, Cold isostatic pressing, Slip casting, Tape casting, Injection Moulding, Extrusion, Jiggering and jollying, Hot Pressing. Hot Isostatic Pressing, **Sintering of Ceramics Materials:** Sintering Process, Theory of Sintering, Stages of sintering, Types of Sintering, Factors affecting sintering, Binders/lubricants, kilns and furnaces, Current trend in Firing Techniques, Sintering Problems. **Introduction to Glass and Glass Ceramics:** Structure and Formation, applications. **Introduction to Ceramic Composites:** Processing and applications. **Ceramic Films:** Thick &Thin films, Glazing, Coatings and Enamels. **Introduction to Nano ceramics** **Quality Assurance in ceramic industry** **Environmental Issues related to Ceramic Industry** **Practical Classes or industrial visits**	
Recommended Texts	
● Gingery, W.D., Bowen, H.K. and Human, D.R. (1976). *Introduction to Ceramics*. John Wiley & sons. ● Richardson, D.W. (1992). *Modern Ceramic Engineering*. Marcel Dekker.	

Course Code	**APS4632**
Course Title	**Energy; Sources, Use and Conservation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Energy resources: a. Fossil Fuels; Coal (electricity generation from coal, coal for industry), petroleum (refining, different products and their usage) b. Alternative energy resources; nuclear energy (nuclear energy from fission, nuclear power plants, advantages and problems, nuclear energy from fusion), solar energy (direct use of solar energy; Solar collectors, solar chimneys)(indirect use of solar energy; PV cells; Efficiencies, limitations), wind	

energy (wind blow, power dependence, efficiency with wind speed), tidal energy (origin, tidal fences, tidal turbines/offshore turbines), geothermal energy (high temperature resources, moderate/low temperature resources), biomass energy (direct use, through conversion; bio-fuel; ethanol, bio-diesel), batteries (fuel cells) **Energy Picture of Sri Lanka**: Main sources available, Energy consumption pattern, Use of biomass, Petroleum requirement, Electricity generation, Alternative sources, New power projects **Conservation of Energy**: Different methods to conserve energy; Advantages and disadvantages of different methods
Recommended Texts
• Viswanathan and Balasubramanian. (2017). *Energy Sources; Fundamentals of chemical conversion processes and applications*. Elsevier. • Wengenmayr, R. and Buhrke, T. (2012). *Renewable Energy: Sustainable concepts for the energy change*. Wiley-VCH. • Quaschning, V. (2005). *Understanding Renewable Energy Systems*. Earthscan.

Course Code	**APS4642**
Course Title	**Workshop Practice**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction: Introduce technical drawing methods, measuring instruments, handling of basic hand tools and portable machines used in sheet metal works. Use of Machines: machines of lathe, milling and drilling machines, etc. **Wood and Plastic Machining**: Practice basic wood and plastic working methods in wood and plastic machines of portable bench types. **Glass Work**: Practice glass cutting methods and blowing methods.	
Recommended Texts	
● John, K.C. (2010). *Mechanical Workshop Practice*. 2nd edition. PHI Learning Pvt. Ltd., New Delhi. ● Jackson, A. and Day, D. (2005). *Collins Complete Woodworker's Manual*. 3rd edition. HarperCollins Publishers. ● Hall, H. (2004). *Milling: A Complete Course (Workshop Practice)*. Trans-Atlantic Publications, Inc. ● Burke, E. (2005). *Glass Blowing: A Technical Manual*. Crowood Press.	

Course Code	**APS4652**
Course Title	**Industrial Applications (Electronics/Hardware) Laboratory**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Digital Electronics: Logic gates, combinational and sequential logics, flip flops; counters, 7-segment display and driver circuits; Stepper motors, sensors, DAC and ADC, interfacing exercises. **Analogue Electronics**: Power supplies and amplifier circuits, opamps. **Repair of instruments**: Repair of simple instruments such as colorimeters, ph meters, uv-vis spectrophotometers, etc	

Recommended Texts
• Horowitz, P. and Hill, W. (1989). *The Art of Electronics*. Cambridge University Press. • Wilamowski, B. M., and Irwin, J. D. (2017). *Fundamentals of Industrial Electronics*. 1st edition. CRC Press. • Plonus, M. (2020). *Electronics and Communications for Scientists and Engineers.* 2nd edition

Course Code	**APS4712**
Course Title	**Design and Development of Software Systems**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Software process and advantages of software process; Feasibility study; Requirement analysis; Requirement specification; Software design; Implementation; Testing and maintenance.	
Recommended Texts	
• Pressman, R. S. and Ince, D. (2000). *Software Engineering: A practitioner's Approach*. McGraw-Hill. • Robert, C. M. (2008). *Clean Code: A Handbook of Agile Software Craftsmanship*. • Mark, C. L., (2020). Steven, J. O., and Dean, J. K. *Agile Project Management for Dummies.*	

Course Code	**APS4722**
Course Title	**Management of Computers and Computer Networks**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
PC management; PC troubleshooting; Computer networks; Network configuration; Device interfacing; Data acquisition and data processing; Microcontrollers; Instrument control.	
Recommended Texts	
• Tanenanbaum, A.S. (1996). *Computer Networks*. Prentice Hall. • Mir, N. F. (2006). *Computer and Communication Networks*. Prentice Hall. • On-line material : IEEE Standards Association (http://standards.ieee.org/) • On-line material : Internet Engineering Taskforce (IETF) (http://www.ietf.org/) • On-line material : 3GPP (http://www.3gpp.org/)	

Course Code	**APS4732**
Course Title	**Visualizing Statistical Concepts using Java and Software Development**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
To provide experience to undergraduates in development of statistical software.	

Recommended Texts
● Wesley, T. A. (1998). *Addition Data Structures in Java*. Standish. ● Ditel, H.M. and Hall, P. P.J. (1999). *Java How to Program*.

Course Code	APS4742
Course Title	**Statistical Applications in Industry and Project Presentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
To provide experience in handling statistical problems in the industry and to improve project presentation skills and report writing.	
Recommended Texts	
● Online PowerPoint Tutorials: http://www.actden.com/pp/ http://einstein.cs.uri.edu/tutorials/csc101/powerpoint/ppt.html http://presentationism.com/	

Course Code	APS4812
Course Title	**Enzymes in Industry**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Proteins and Protein Purification: Amino acids and proteins, protein structure and function, protein purification and characterization, chromatography and electrophoresis. **Enzyme; The Agents of Life**: Enzymes as catalysts in biological systems, enzyme classification, enzyme kinetics, enzyme assay methods, regulatory enzymes. **Application of Enzymes Technology in Industry**: Bakery industry, food and dairy industry, textile industry, enzymes as detergents, enzymes in biotechnology. **Laboratory work**: Laboratory experiments relevant to above aspects.	
Recommended Texts	
● Lehninger A.L., Nelson D.L and Cox M.M. (1993). *Principles of Biochemistry*. 2nd edition, Worth Publishers. ● Scope, R.K. (1993). *Protein Purification: Principles and Practice*. 3rd edition, Springer. ● Fersht, A. (1998). *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding*. 3rd edition, Freeman.	

Course Code	APS4821
Course Title	**Biochemistry and Molecular Laboratory Instrumentation**
Credit Value	**1**
Pre-requisites	**None**

Compulsory/Optional	**Optional**
Course Content	
Introduction, preparation of biochemical laboratory solutions, pH and buffers;Absorption spectroscopic methods in biochemical applications; Chromatography methods; Electrophoresis; DNA isolation and analysis; Immunochemical methods (immunoblotting and ELISA); DNA isolation and analysis; Polymerase chain reaction.	
Recommended Texts	
● Sanbrook, J., Fritsch, E.F. and Maniatis, T. (1989). *Molecular Cloning – A Laboratory Manual*. Cold Spring Harbor Laboratory Press. ● Wilson, K. and Walker, J. (2000). *Principles and Techniques of Practical Biochemistry*. Cambridge University Press. ● Ninfa, A.J., Ballou, D. and Benore, M. (1998). *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*. Fitzgerald Science Press, Inc.	

Course Code	**APS4832**
Course Title	**Bioinfomatics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Bioinformatics; Structure and function of DNA; Collecting and storing sequence data; Biological databases and retrieval of information; Sequence alignment; Database searching for similar sequences; Phylogenetic analysis; Prediction of genes and regulatory sequences; Protein structure prediction.	
Recommended Texts	
● Baxevanis, A. (1998). *Bioinformatics: A practical Guide to Analysis of Genes and Proteins*. John Wiley. ● Mount, D.W. (2004). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.	

4. DEPARTMENT OF GEOLOGY

4.1 Geology Course Modules

1000 LEVEL – GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
GEO1013	Earth Processes	3		√	√
GEO1021	Earth Processes Laboratory	1	GEO1013	√	√
GEO1033	Earth Materials	3	GEO1013	√	√
GEO1041	Earth Materials Laboratory	1	GEO1033	√	√
Total		**08**		**08**	**08**

2000 LEVEL – GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
GEO2013	Optical Mineralogy	3	GEO1021, GEO1041	√	√
GEO2023	Introductory Petrology	3	GEO1021, GEO1041	√	√
GEO2032	Geochemistry	2	GEO1021, GEO1041		
GEO2042	Geophysics	2	GEO1021, GEO1041		
GEO2052	Economic Geology	2	GEO1021, GEO1041	√	√
GEO2062	Plate Tectonics and Geomorphology	2	GEO1021, GEO1041		
GEO2072	Soil and Rock Mechanics	2	GEO1021, GEO1041		
GEO2082	Photogeology	2	GEO1021, GEO1041		
GEO2092	Introductory Structural and Field Geology	2	GEO1021, GEO1041	√	√
Total		**20**		**10**	**10**

3000 LEVEL – GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
GEO3012	Hydrology	2			
GEO3022	Geology of Sri Lanka	2		√	√
GEO3032	Metamorphic Petrology	2	GEO2013 GEO2023	√	√
GEO3042	Igneous Petrology	2	GEO2013 GEO2023	√	
GEO3052	Sedimentary Petrology	2	GEO2013 GEO2023	√	
GEO3062	Applied Geophysics	2	GEO2042		
GEO3072	Remote Sensing and Geographical Information Systems (GIS)	2			
GEO3083	Structural Geology and Tectonics	3	GEO2013 GEO2023	√	√

			GEO2092		
GEO3093	Analytical Techniques in Geology	3	GEO2032		
GEO3102	Hydrogeology	2			
GEO3112	Environmental Geology	2			
GEO3123	Engineering Geology	3	GEO2072		
GEO3132	Advanced Economic Geology	2	GEO2013 GEO2023 GEO2052		
GEO3142	Gemmology	2	GEO2013 GEO2023		
GEO3152	Field Geology	2	GEO2013 GEO2023 GEO2092	√	√
Total		**34**		**13**	**09**

4000 LEVEL - GEOLOGY				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Comments**
				Hons.
GEO4012	Applied Hydrogeology	2	GEO3102	
GEO4022	Isotope Geology	2		
GEO4032	Surveying and Leveling	2		
GEO4042	Scientific Writing and Seminar	2		√
GEO4052	Field Geology Assessment	2	GEO3152	√
GEO4062	Seismology	2		
GEO4073	Oceanography and Quaternary Geology	3		
GEO4082	Exploration and Mining Geology	2		
GEO4092	Petroleum Geology	2	GEO3052	
GEO4103	Advanced Metamorphic Petrology	3	GEO3032	√
GEO4113	Advanced Igneous Petrology	3	GEO3042	√
GEO4123	Advanced Sedimentary Petrology	3	GEO3052	√
GEO4132	Advanced Engineering Geology	2	GEO3123	
GEO4998	Research Project	8		√
SCI 4003	Industrial Training	3		√
Total		**41**		**24**

1000 Level Courses

Course Code	GEO1013
Course Title	Earth Processes
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory
Course Content	
Introduction to Geology. The universe, the solar system and the earth. Structure of the Earth. Earth's atmosphere, biosphere, hydrosphere and lithosphere, their origin and evolution. Processes shaping the earth: Exogenous processes (weathering, actions of rivers, oceans, glaciers and wind, soil formation, erosion, transportation, mass movement, deposition and landforms etc.). Study of the Earth's internal processes: Endogenous processes (plate tectonics, orogenesis, volcanism, plutonism, earthquakes, deformation, diagenesis and metamorphism). Geological Time Scale. Laws of Uniformitarianism and superposition of strata. Criteria to determine top and bottom of layered sequences. Unconformities. Relative and absolute dating. Geological History of Sri Lanka.	
Recommended Texts	
• Summerfield, M.A. (1991). Global Geomorphology. Routledge, OX. • Byatt, A., Fothergill, A., Holmes, M. and Sir David Attenborough (2001). The Blue Planet. BBC Books. • Grotzinger, J. and Jordan, T.H. (2010). Understanding Earth. 4th Edition, Freeman, W.H. Publishers, NY.	

Course Code	GEO1021
Course Title	Earth Processes Laboratory
Credit Value	1
Pre-requisites	GEO1013
Compulsory/Optional	Compulsory
Course Content	
Study and interpretation of topographic, orographic, geological, agricultural and land use maps. Preparation of cross sections and identification of landforms and drainage patterns. Introduction to geological maps; horizontal, inclined, folded and faulted sequences. Introduction to basic field methods and equipment.	
Recommended Texts	
• Lisle, R.J. (1995). Geological Structures and Maps: A Practical Guide. 2nd Revised Edition, Butterworth-Heinemann, OX. • Grotzinger, J. and Jordan, T.H. (2010). Understanding Earth. 4th Edition, Freeman, W.H. Publishers, NY.	

Course Code	GEO1033
Course Title	Earth Materials
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content
Common crystal forms, habits and twinning, point group symmetry of crystals and their classification into crystal systems and classes. Bravais lattices. Introduction to common rock-forming minerals, their composition, physico-chemical properties, classification and identification. Introduction to igneous, sedimentary and metamorphic rocks, their classification, mineralogy, texture and identification. Introduction to paleontology. Trace, index, micro and plant fossils and their preservation and interpretation. Rock-, bio-, soil- and time-stratigraphy. Introduction to rocks of Sri Lanka.
Recommended Texts
• Nield, E.W. and Tucker, V.C.T. (1985). Paleontology – An Introduction. Pergamon. • Klein, C. Jr. and Hurlbut, C.S. (1993). Manual of Mineralogy. Willey, NY. • Grotzinger, J. and Jordan, T.H. (2010). Understanding Earth. 4^{th} Edition, Freeman, W.H. Publishers, NY.

Course Code	GEO1041
Course Title	**Earth Materials Laboratory**
Credit Value	**1**
Pre-requisites	**GEO1112**
Compulsory/Optional	**Compulsory**
Course Content	
Identification of common crystal forms, habits and twinning. Study of point group symmetry of crystals and their classification into classes and systems. Identification of common rock forming minerals on the basis of physico-chemical properties. Study of mineralogy and texture of igneous, sedimentary and metamorphic rocks. Laboratory study of fossils, their taxonomy and identification. Introduction to geological field mapping (Road mapping).	
Recommended Texts	
• Nield, E.W. and Tucker, V.C.T. (1985). Paleontology – An Introduction. Pergamon. • Klein, C. Jr. Hurlbut, C.S., Dana, J.D. (1993). Manual of Mineralogy. Willey, NY. • Deer, W.A., Howie, R.A. and Zussman, J. (1993). An Introduction to Rock-Forming Minerals. 2nd Edition, John Wiley and Sons, NY.	

2000 Level Courses

Course Code	GEO2013
Course Title	**Optical Mineralogy**
Credit Value	**3**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Petrographic microscope and orthoscopic and conoscopic arrangements. Light and polarized light, reflection, refraction and Snell's Law. Double refraction, isotropy and anisotropy, uniaxial and biaxial minerals and their indicatrices. Minerals under polarized light; colour and pleochroism, relief, forms and habit, twining and zoning, cleavage. Interference colors and birefringence, extinction, interference figures. Systematic study of optical mineralogy of common rock forming minerals, essentially silicates and non-silicates. Descriptive mineralogy. Laboratory work and exercises on identification of common rock forming minerals using petrographic (polarizing) microscope.	

Recommended Texts
• Kerr, Paul F. (1959). Optical Mineralogy. McGraw-Hill, London. • Mackenzie, W.S., Donaldson, C.H. and Guilford, C. (1982). Atlas of Rock-Forming Minerals. John Wiley and Sons, NY. • Gribble, C.D. and Hall, A.J. (1985). A Practical Introduction to Optical Mineralogy. George Allen and Unwin, London. • Deer, W., Howie, R. and Zussman, J. (1993). An Introduction to Rock-Forming Minerals. 2nd Edition, John Wiley and Sons, NY.

Course Code	**GEO2023**
Course Title	**Introductory Petrology**
Credit Value	**3**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to igneous rocks, mode of occurrence, texture, mineralogy of igneous rocks, classification, field relations, petrogenesis of common igneous rocks. Study of common sedimentary rocks and their textures, structures and genesis. Introduction to metamorphism, classification, mineralogy and fabrics of common metamorphic rocks and their field associations. Factors controlling metamorphism. Introduction to sedimentary rocks, environments, processes and their products. Study of igneous, sedimentary and metamorphic rocks in hand-specimens and thin-sections.	
Recommended Texts	
• Selley, R.C. (1982). An Introduction to Sedimentology. John Wiley and Sons, NY. • Yardley, B.W.D. (1989). An Introduction to Metamorphic Petrology. Longmann Publishers. • Philpotts, A.R. (1990). Principals of Igneous and Metamorphic Rocks. Prentice Hall. • Blatt, H. and Tracy, R.J. (1996). Petrology- Igneous, Sedimentary, and Metamorphic Rocks. W.H. Freeman, NY.	

Course Code	**GEO2032**
Course Title	**Geochemistry**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Optional**
Course Content	
Introduction to geochemistry. Primary differentiation of the earth and solar system. Classification and distribution of elements and isotopes. Geochemistry of rocks and minerals. Energy, entropy and fundamental thermodynamic concepts and their application to natural systems. Aqueous solutions in geology. Cosmochemistry. Geochemistry of solid earth. Soil, stream and organic geochemistry. Oxidation-reduction.	
Recommended Texts	
• Gill, R. (1989). Chemical Fundamentals of Geology. Unwin Hymann, London. • Mason, B. (1966). Principles of Geochemistry. John Wiley and Sons, NY. • Krauskopf, K.B. (1994). Introduction to Geochemistry. John Wiley and Sons, NY.	

Course Code	**GEO2042**
Course Title	**Geophysics**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Optional**
Course Content	
Introduction to geophysics, structure of the Earth. Earth's gravity, magnetic and electric fields. Seismicity and earthquakes, plate tectonics, paleomagnetism. Earth's internal heat, geothermal energy, radiometric dating.	
Recommended Texts	
• Vogelsang, D. (1994). Environmental Geophysics. John Wiley and Sons, NY. • Dmowska, V. and Rena, H. (1996). Advances in Geophysics. John Wiley and Sons, NY. • Sleep, N. and Norman, S. (1997). Principles in Geophysics. Unwin Hymann, London.	

Course Code	**GEO2052**
Course Title	**Economic Geology**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to ore-forming processes. Physico-chemical characteristics of economic mineral deposits derived from igneous, sedimentary, metamorphic and hydrothermal environments. Overview and geological setting of metallic, non-metallic deposits. Placer deposits. Economic minerals and industrial minerals. Rocks and minerals as industrial raw materials. Identification of economic minerals in the laboratory and ore microscopy.	
Recommended Texts	
• Bateman, A.M. (1960). Economic Mineral Deposits. John Wiley and Sons, Indian Print 1962. • Edwards, R. and Atkinson, K. (1985). Ore Deposits Geology. Chapman & Hall, London. • Evans, A.M. (1993). Ore Geology and Industrial Minerals – An Introduction. 3rd Edi, Black-Well Scientific Pub.	

Course Code	**GEO2062**
Course Title	**Plate Tectonics and Geomorphology**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Optional**
Course Content	
Landform types, climate, climatic changes and landform development. Volcanic landforms, karst landforms, structural landforms, marine and coastal landforms. Methods of landform analysis. Introduction to geomorphology, Differences between process and landforms, Landforms and scale, Exogenic and endogenic processes, Constructive and destructive processes, Erosional and depositional landforms, Chemical weathering and soils, Hillslope processes, landslides and landform, Fluvial processes and landforms, Coastal processes and landforms, Wind processes and landforms, GEOacial processes and landforms, Tectonics and landforms, Interactions between humans and earth surface processes, Application of remote sensing in geomorphology, Advanced quantitative tools used in geomorphology, Geomorphological evolution of Sri	

Lanka. From Continental drift to Plate Tectonics, Theory of plate tectonics and assumptions, Heat flow within plates, Plate boundaries, Plate tectonic motion and plate driving forces, Wilson Cycle and Precambrian Plate Tectonics, Plate tectonics and magmatism, metamorphism, and sedimentation, Where Plate Tectonics Fail.
Recommended Texts
• Swan, B. (1983). An Introduction to the Coastal Geomorphology of Sri Lanka. National Museums of Sri Lanka. • Rice, R.J. (1988). Fundamentals of Geomorphology. 2nd Edition, Longman Scientific and Technical, London. • Gupta, A. (2011). Tropical Geomorphology. Cambridge University Press. • Geomorphological Mapping: Methods and Applications (Developments in Earth Surface Processes), by Mike J. Smith and Paolo Paron • Fundamentals of Geomorphology (Routledge Fundamentals of Physical Geography), by Richard John Huggett • Xavier La Pichon (1973) Plate Tectonics, Elsevier. • Fritsch, W., Meschede, M. and Blakey, R (2011). Plate Tectonics: Continental Drift and Mountain Building, Springer.

Course Code	**GEO2072**
Course Title	**Soil and Rock Mechanics**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Optional**
Course Content	
Physical properties of soil, Classification of soil, soil permeability and seepage, stress and effective stress, shear strength, compressibility, consolidation and settlement. Lateral earth pressures and retaining structures, slope stability analysis. Bearing capacity and foundations, ground improvement techniques. Introduction to physical and mechanical properties of rocks, defects in rock masses, rock testing, strength and failure of rocks, improvement of properties of rock masses.	
Recommended Texts	
• Dunn, I.S. (1995). Fundamentals of Geotechnical Analysis. John Wiley and Sons, NY. • Bell, F.G. (1996). Engineering Properties of Soils and Rocks. McGraw Hill, NY. • Goodman, R.E. (1996). Rock Mechanics. John Wiley and Sons, NY.	

Course Code	**GEO2082**
Course Title	**Photogeology**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Optional**
Course Content	
Basics of photogrammetry, practical uses of aerial photographs in structural geology, economic geology, geomorphology, engineering geology, hydrology, hydrogeology, agriculture and land-use. Geological mapping and geological and structural analysis of a selected area. Visual interpretation of aerial photographs, resource exploration, land-use, land pattern and drainage analysis.	
Recommended Texts	

- Saif, S.I. (2014). Aerial Photography, Photogeology, GIS, R.S. and Image Processing. Lap Lambert Academic Pub.
- Pandey, S.N. (2013). Principles and Applications of Photogeology. New Age International (P) Ltd.
- Allum, J.A.E. (1966). Photogeology and Regional Mapping. Pergamon.

Course Code	**GEO2092**
Course Title	**Introductory Field and Structural Geology**
Credit Value	**2**
Pre-requisites	**GEO1021, GEO1041**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to basic geological structures: foliation, lineation, folds, faults, shear zones, slickensides. Methods, techniques and instruments used in field and structural geology. Planning of traverses based on maps and aerial photographs. Use of geomorphology in geological mapping. Terrain mapping and production of geological maps and reports.

Recommended Texts

- Mosely, F. (1981). Methods in Field Geology. W.H. Freeman and Co., California.
- Compton, S. and Robert, R. (1985). Geology in the Field. John Wiley and Sons, NY.
- Angela, L. Coe Eds. (2010). Geological Field Techniques. Willey Blackwell Publishers.
- Hobbs, B.E., Means, W.D. and Williams, P.F. (1976). An Outline of Structural Geology. John Wiley and Sons, NY.

3000 Level Courses

Course Code	**GEO3012**
Course Title	**Hydrology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction to basic principles of hydrology including mathematical, physical and chemical concepts. Practical applicability of analytical techniques in understanding the different components of the hydrologic cycle – precipitation, runoff, infiltration and evapo-transpiration. Sources of stream flow, uniform and steady-state flow, hydrographs and hydrologic routing. Basin study and water balance, probability and statistical techniques. Computer applications in hydrology.

Recommended Texts

- Linsley, R.K., Kohler, M.A. and Paulhus, J.L.W. (1982). Hydrology for Engineers. 3rd Edition, Mc Graw-Hill.
- Ward, A.D. and Trimble, S.W. (2004). Environmental Hydrology. Lewis Publishers.
- Subramanya, K. (2013). Engineering Hydrology. 4th Edition, Mc Graw Hill Education, India Pvt. Ltd, New Delhi.

Course Code	GEO3022
Course Title	**Geology of Sri Lanka**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to lithology, structure, tectonics, petrology, geomorphology, economic geology and soils. Quaternary Geology of Sri Lanka. Subdivision of the Precambrian and Phanerozoic rocks of Sri Lanka. Sri Lanka in Gondwana. Metamorphic and structural history of Sri Lankan rocks. Genesis of Igneous and igneous looking rocks of Sri Lanka, Geochemistry of Sri Lankan rocks, soils and water. Hydrogeology of Sri Lanka. Slope stability and engineering geological aspects of Sri Lanka. Geomorphology of Sri Lanka.	
Recommended Texts	
• Cooray, P.G. (1984). An introduction to Geology of Sri Lanka. National Museum Publ. • Kröner, A. (Ed.). (1991). The Crystalline Crust of Sri Lanka. Part 1, summary of research of the German-Sri Lankan consortium, Geological Survey Department Professional Paper 5. • Herath, J.W. (1991). Economic Geology of Sri Lanka. Natural Resources Series - No. 1. Natural Resources, Energy and Science Authority, Colombo.	

Course Code	GEO3032
Course Title	**Metamorphic Petrology**
Credit Value	**2**
Pre-requisites	**GEO2013, GEO2023**
Compulsory/Optional	**Compulsory**
Course Content	
Phase rule and equilibrium in metamorphic rocks. Equilibrium mineral assemblages and their graphical representation using ACF, AKF, AFM diagrams. Disequilibrium and metamorphic reactions. Depth zones to facies concept. Facies series of metamorphism. Partial melting and migmatite formation. Laboratory study of hand-specimen and thin-section study of rocks of various facies and subfacies.	
Recommended Texts	
• Yardley, B.W.D. (1989). An Introduction to Metamorphic Petrology. Longman Publishers. • Philpotts, P.A.R. (1990). Principles of Igneous and Metamorphic Rocks. Prentice Hall Pub. • Bucher, K. and Frey, M. (1994). Petrogenesis of Metamorphic Rocks. Springer Verlag, Heidelberg.	

Course Code	GEO3042
Course Title	**Igneous Petrology**
Credit Value	**2**
Pre-requisites	**GEO2013, GEO2023**
Compulsory/Optional	**Compulsory**
Course Content	
Magma generation and migration, crystallization, intrusion and eruption. Partial melting and magmatic processes: crystal fractionation, magma mixing and assimilation. Kinetics of crystallization. Igneous rock associations. Hand-specimen and thin-section study of igneous rocks.	

Recommended Texts
• Best, M.G. (1982). Igneous and Metamorphic Petrology. Freeman and Sons. • Wilson, M. (1989). Igneous Petrogenesis. Unwin Hyman. • Philpotts, A.R. (1990). Principles of Igneous and Metamorphic Rocks. Prentice Hall Pub.

Course Code	**GEO3052**
Course Title	**Sedimentary Petrology**
Credit Value	**2**
Pre-requisites	**GEO2013, GEO2023**
Compulsory/Optional	**Compulsory**
Course Content	
Sedimentary Facies and their distribution. Sedimentary Cycles, associations and sequences. Deltaic, glacial, desert, coastal, and continental margin environments; their definition, classification, geomorphology, sedimentary processes, sediment characteristics and ancient and modern examples. Siliciclastic sediments, sandstones and sandstone diagenesis, Provenance and distribution. Conglomerates, breccia, mud rocks; chert, carbonate and siliceous sediments.	
Recommended Texts	
• Pettijohn, F.J. (1975). Sedimentary Rocks. Harper and Row, New York. • Reineck, H.E. and Singh, I.B. (1986). Depositional Sedimentary Environments. Springer • Verlag, NY. • Tucker, M.E. (1996). Sedimentary Petrology. Blackwell. • Mial, A.D. (1996). The Geology of Fluvial Deposits. Springer.	

Course Code	**GEO3062**
Course Title	**Applied Geophysics**
Credit Value	**2**
Pre-requisites	**GEO2042**
Compulsory/Optional	**Optional**
Course Content	
Principles of applied geophysics. Investigations of earth resources and geologic structures by geophysical methods, seismic surveying, gravity surveying, magnetic surveying, electrical surveying, electromagnetic surveying, bore-hole geophysics. Introduction to geothermal and nuclear energy and their applications.	
Recommended Texts	
• Keary, P. and Brooks, M. (1992). An Introduction to Geophysical Exploration. 2nd Edition, Black Well Scientific Pub. • Kelly, W.E. and Mares, S. (1993). Applied Geophysics in Hydrogeological and Engineering Practices. Mc Graw-Hill. • Parasnis, D.S. (1986). Principles of Applied Geophysics. 4th Edition, Chapman and Hall, USA.	

Course Code	GEO3072
Course Title	Remote Sensing and Geographical Information Systems (GIS)
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Optional

Course Content

Overview and basic concepts of Remote Sensing (RS), Aerial Photography, fundamental characteristics of electromagnetic radiation, concepts of resolution, Remote sensing platforms. Satellite systems and sensors, active and passive sensing systems, Applications of RS in various disciplines, Introduction to Global Navigation Satellite System (GNSS), application of GNSS technology in positioning, Introduction to GIS, overview and concepts of GIS, scope and application areas, purpose and benefits of GIS. Hardware and software for GIS, Functions of GIS software, Installation of GIS, Mapping Concepts, map elements, map scales and representations, map projection, Raster and Vector data structures, sources of data, input devices and input of geospatial data, Geo-referencing, concept of spatial databases, data acquisition and management techniques, data manipulation and analysis, Map output generation.

Recommended Texts

- Burrough, P.A. and McDonnell, R.A. (1998). Principles of Geographical Information Systems. Oxford University Press.
- Gupta, R.P. (2002). Remote Sensing Geology. 2nd Edition, Springer.
- Canada Centre for Mapping and Earth Observation (2014). Fundamentals of Remote Sensing. Natural Resources, Canada
- Saif, S.I. (2014). Aerial Photography, Photogeology, GIS, R.S. and Image Processing. Lap Lambert Academic Pub.

Course Code	GEO3083
Course Title	Structural Geology and Tectonics
Credit Value	3
Pre-requisites	GEO2013, GEO2023, GEO2092
Compulsory/Optional	Compulsory

Course Content

Concepts of force, stress, strain and deformation. Mechanisms and processes of formation of brittle and ductile structures. Strain ellipsoid. Classification of faults, folds and shear zones. Fault rocks. Principles of stereographic projection and graphical analysis of structural data. Crystal defects, recovery and dynamic recrystallization. Sea floor spreading and concept of formation and break-up of supercontinents. Geodynamic evolution of Sri Lanka. Study of microscopic to megascopic structures and related fabrics in the laboratory and in the field.

Recommended Texts

- Phillips, F.C. (1971). The Use of the Stereographic Projection in Structural Geology. 3rd Edition, Edward Arnold.
- Ramsay, J.G. and Huber, M.I. (1983). The Techniques of Modern Structural Geology. Vol 1, Strain Analysis, Academic Press, London.
- Ragan, D.M. (2009). Structural Geology: An Introduction to Geometrical Techniques. 4th Edition, Cabbridge University Press.
- Passchier, C.W. and Trouw, R.A.J. (1996). Microtectonics. Springer-Verlag.

Course Code	GEO3093
Course Title	**Analytical techniques in Geology**
Credit Value	**3**
Pre-requisites	**GEO2032**
Compulsory/Optional	**Optional**

Course Content

Basic principles of sampling, preservation, preparation, and method selection, quality control in sampling and analysis, laboratory safety, principles and applications of spectroscopic (AAS, ICP, UV-Vis), X-ray and IR (XRF, XRD, EPMA, SEM, FTIR etc.) methods. Interpretation of analytical results. Basic statistics, surface contouring and modeling, graphical data representation and simple computer modeling of geological processes. Hands on experience with wet chemistry lab techniques, sample dissolution and digestion, colorimetric methods, quality control. Use of analytical instruments such as AAS, ICP, XRD and SEM-EDS.

Recommended Texts

- Fletcher, W.K. (1981). Analytical Methods in Geochemical Prospecting. Handbook on exploration Geochemistry, Vol. 1, Govett, G.J.S. (ed.), Elsevier, The Netherlands.
- Davis, J.C. (1986). Statistics and Data Analysis in Geology. John Wiley and Sons.
- Jenkins, R. and Snyder, R.L. (1996). X-Ray Powder Diffractometry. Wiley and Sons, New York.
- Gill, R. (1997). Modern Analytical Geochemistry (Longman Geochemistry Series). Addison Wesley Longman.

Course Code	GEO3102
Course Title	**Hydrogeology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Surface and sub-surface distribution of water. Unsaturated and saturated zones, aquifers and their properties. Darcy’s law and groundwater flow. Draw-down discharge relationships. Aquifer types and groundwater environments. Chemical characteristics of groundwater. Field and Laboratory studies and hydrogeological properties of soils and rocks. Maps, airphoto and satellite imagery interpretations in groundwater studies. Laboratory and field exercises in hydrogeology.

Recommended Texts

- Todd, D.K. (1980). Groundwater Hydrology. John Wiley and Sons.
- Karnath, K.R. (1993). Groundwater Assessment Development and Management. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Fetter, C.W. (1994). Applied Hydrogeology. 3rd Edition, Macmillan College Publishing Company, New York., NY.

Course Code	GEO3112
Course Title	**Environmental Geology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content
Introduction to environment; environmental issues, resources and the environment. Pollution of the Earth's environments (atmosphere, water and soil). Environmental effects of geological resource extraction, conserving mineral resources, land-use planning. Environmental Impact Assessment (EIA), Biogeochemical cycles. Chemistry of ecosystems: Heavy metal pollution- sources and origins, mobility of heavy metals in the environment, bioaccumulation and bio magnification. Dose-response relationships and toxic elements. Medical geochemistry: Geochemical health problems pertaining to Sri Lanka.
Recommended Texts
• Andrews, J.E. (1996). An Introduction to Environmental Chemistry. Blackwell Sciences. • Dissanayake, C.B. and Chandrajith, R. (1999). Medical Geochemistry of Tropical Environments. Earth Science Reviews, Vol. 47. • Siegel, F.R. (2002). Environmental Geochemistry of Potentially Toxic Metals. Springer. • Schlesinger, W.H. and Bernhardt, E.S. (2013). Biogeochemistry: An Analysis of global Change. Academic Press Elsevier.

Course Code	**GEO3123**
Course Title	**Engineering Geology**
Credit Value	**3**
Pre-requisites	**GEO2072**
Compulsory/Optional	**Optional**
Course Content	
Responsibilities of an Engineering Geologist, during construction of dams, reservoirs, tunnels, highways and major structures. Engineering geological site investigations. Natural and man-made geologic hazards and their mitigation techniques. Laboratory tests for engineering properties of soils and rocks. Drilling methods in site investigation and in-situ soil testing. Standard Penetration Test, Cone Penetration Test. Rocks and soils as construction materials. Use of maps as a tool in engineering geological studies.	
Recommended Texts	
• Bell, F.G. (1983). Fundamentals of Engineering Geology. Mc Graw-Hill. • McCarthy, P.E. (1993). Essentials of Soil Mechanics and Foundations. Prentice Hall. • Goodman, R.E. (1993). Engineering Geology. Mc Graw-Hill. • Michael, D.G.de. (2009). Engineering Geology. Springer.	

Course Code	**GEO3132**
Course Title	**Advanced Economic Geology**
Credit Value	**2**
Pre-requisites	**GEO2013, GEO2023, GEO2052**
Compulsory/Optional	**Optional**
Course Content	
Classification of Ore and Mineral Deposits. Geological ore formation process systems; Magmatic, Supergene, Sedimentary, Diagenetic, Metamorphic and Metamorphosed, Metamorphogenic and Metallogeny; Fossil Energy Raw Materials – Coal, Oil and Gas; Examples of world's typical ore deposits and uses of ore minerals. Overview of ore genesis related to plate tectonics through geological time. Classification of ore deposits. Volcanogenic ore deposits Cu-Zn, Pb-Z and Cu-Mo etc. Magmatic, sedimentary and metamorphic deposits of precious metals and base metals. Sedimentary exhalative (Sedex) ore deposits, Hydrothermal processes, Porphyry copper deposits. Weathering and supergene deposits. Formation of coal, oil and gas resources.	

Examples of world's typical ore deposits and uses of ore minerals. Overview of ore genesis related to plate tectonics through geological time.
Recommended Texts
• Edwards, R. and Aitkinson, K. (1985). Ore deposits Geology. Chapmann and Hall, London. • Evans, A.M. (1993). Ore Geology and Industrial Minerals – An Introduction. 3rd Edition, Black-Well Scientific Pub. • Walter L. Pohl (2011). Economic Geology Principles and Practice-Metals, Minerals, Coal and Hydrocarbons – Introduction to Formation and Sustainable Exploitation of Mineral Deposits, Blackwell Publishing Ltd.

Course Code	**GEO3142**
Course Title	**Gemmology**
Credit Value	**2**
Pre-requisites	**GEO2013, GEO2023**
Compulsory/Optional	**Optional**
Course Content	
Introduction to gem minerals and their common occurrences. Organic and inorganic gem materials and their properties. Basic gem identification methods, dichroism, refractive index, specific gravity and their internal characteristics. Gem mining, cutting and polishing methods. Outline of gem enhancement including value addition techniques. Colour and causes of colour in gemstones. Special optical properties of gems (chatoyancy, asterism, luminescence play of colours, labradorescence). Study of inclusions of gems. Synthetic gemstones. Specific gravity of gems and methods of determinations. Emission and absorption spectroscopy. Management of gem industries, practice, procedures and legal aspects of local, national and international gem trade. Socio-economic aspects of gem industries in Sri Lanka. Practical exposure to basic gemmological instrument, hand lens, gemmological microscope, polarising microscope/polariscope, dichroscope and spectroscopes.	
Recommended Texts	
• Dissanayake C.B. and Rupasinghe, M.S. (1995). Introduction to gems and gem deposits of Sri Lanka. • Read, P.G. (1995). Gemmology. Butterworth and Heinemann.	

Course Code	**GEO3152**
Course Title	**Field Geology**
Credit Value	**2**
Pre-requisites	**GEO2013, GEO2023, GEO2092**
Compulsory/Optional	**Compulsory**
Course Content	
Geological and structural mapping of a selected area. Preparation of a geological map, cross-sections and block diagrams. Interpretation of geological and structural information and field data. Field camps/excursions. Geological report writing.	
Recommended Texts	
• Lahee, F.H. (1981). Field Geology. McGraw-Hill Co., NY. • Mosely, F. (1981). Methods in Field Geology. W.H. Freeman and Co. Publ., California. • Compton, R.R. (1985). Geology in the Field. John Wiley and Sons. • Passchier, C.W., Myer, J. and Kröner, A. (1990). Field Geology of High-grade Gneiss Terrains. Springer Verlag, Heidelberg.	

4000 Level Courses

Course Code	**GEO4012**
Course Title	**Applied Hydrogeology**
Credit Value	**2**
Pre-requisites	**GEO3102**
Compulsory/Optional	**Optional**
Course Content	
Groundwater exploration, well design and construction. Evaluation of aquifer properties, well hydraulics and pumping tests. Pumping equipment, quality of groundwater and water treatment, groundwater recharge and balance. Groundwater development and management.	
Recommended Texts	
• Todd, D.K. (1980). Groundwater Hydrogeology. John Wiley and Sons. • Kamath, K.R. (1993). Groundwater Assessment, Development and Management. Tata McGrew Hill Publishing Co., New Delhi. • Fetler, C.W. (1994). Applied Hydrogeology. 3rd Edition, Prentice Hall, Englewood Cliffs, NY.	

Course Code	**GEO4022**
Course Title	**Isotope Geology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Isotopes - stable and radioactive, stable isotope fractionation, stable isotopes in the lithosphere, hydrosphere, biosphere and in the mantle. Radioactive isotopes, their decay schemes. Isotopic dating of minerals and rocks and inference of geological history of earth materials. Isotopic signatures of mantle reservoirs and mantle isotope paradoxes. Applications of isotopes in geology and use of radiogenic isotopes in multi component mixing.	
Recommended Texts	
• Faure, G. (1976). Isotope Geology. John Wiley. • Hoefs, J. (1997). Stable Isotope Geochemistry. Springer. • Dickin, P. (1998). Radiogenic Isotope Geology. Camb. Univ. Press. • Allegre, C.J. (2008). Isotope Geology. Camb. Univ. Press.	

Course Code	**GEO4032**
Course Title	**Surveying and Levelling**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to surveying. Basic principles of surveying. Maps and plans. Chain surveying. Plotting and Checking. Principles and use of theodolite and levelling instruments, traversing, traverse computations, and	

plotting. Other methods of surveying-triangulation. Plane Table surveying and Tacheometry levelling-Plotting cross sections and longitudinal sections, contouring. Use of Total Station for Surveying.
Recommended Texts
• Kavanagh, B.F. and Bird, S.J.G. (1998). Surveying Principles and Applications. Reston Pub., USA • Bannister, A.S. and Raymond, S. (1999). Surveying. ELBS/Pitman. • Basak, N.N. (2000). Surveying and Levelling. Tata Mcgraw Hill Education.

Course Code	**GEO4042**
Course Title	**Scientific Writing and Seminar**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Overview of Scientific writing. Scientific thinking, problem definition and research methodology for problem solving. Introduction to journal-style scientific writing. Making sense from data- effective tables and figures. Writing an abstract dealing with proofs. Citations and references, submission of a manuscript, reviewing and role of editor. Ethics in scientific writing (plagiarism, authorship etc.), Project repots, research proposals and budget estimation. A structured program of reading and seminars leading to an in-depth understanding of a chosen topic in geology. Based on this extensive literature review, they should present their work under different themes at the seminars organized by the Department	
Recommended Texts	
• Cooray, P.G. (1992). Guides to Scientific and Technical Writing. Geological Society of Sri Lanka special publication. • Day, R.A. and Gastel, B. (2006). How to Write and Publish a Scientific paper. 6th Edition, Cambridge Univ. Press. • Cargill, M. and O'Connor, P. (2009). Writing Scientific Research Articles. Wiley-Blackwell. • Swales, J.M. and Fead, C.B. (2012). Academic Writing for Graduate Students. 3rd Edition, University of Michigan Press. • Steve, M. (1995). Effective Presentation Skills. Crisp Publications. • Andrew, B. (2006). Successful Presentation Skills. 3rd Edition, Kogan Publishers. • Seminars And Training Made Easy: Become A Polished Trainer, Presenter, and Leader of Seminars, by Randy Tigner.	

Course Code	**GEO4052**
Course Title	**Field Geology Assessment**
Credit Value	**2**
Pre-requisites	**GEO3152**
Compulsory/Optional	**Compulsory**
Course Content	
Each student is required to individually prepare a detailed geological and structural map of a given area and submit a report and make an oral presentation on his/her study. The report (and the presentation) shall consist of laboratory studies pertaining to the area in addition to field observations.	
Recommended Texts	
• Lahee, F.H. (1981). Field Geology. McGraw-Hill Co., NY. • Compton, R.R. (1985). Geology in the Field. John Wiley and Sons.	

• Passchier, C.W., Myer, C.W. and Kröner, A. (1990). Field Geology of High-grade Gneiss Terrains. Springer Verlag, Heidelberg.

Course Code	**GEO4062**
Course Title	**Seismology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Seismic waves and earth models, seismic sources and source parameters, seismic signals and noise, seismic sensors and recording systems, site selection, preparation and installation of seismic stations, seismic networks and arrays, seismic data formats archival and exchange, data analysis and interpretation. Seismic hazard assessment.	
Recommended Texts	
• Stein, S. and Wysession, M. (2003). An Introduction to Seismology, Earthquakes and Earth Structure. Blackwell. • Havskov, J. and Alguavil, G. (2004). Instrumentation in Earthquake Seismology. Springer. • Bormann, P. (Ed) (2013). New Manual on Seismic Observatory Practice (NMSOP). Geo-Forschungs Zentrum (GFZ) Potsdam.	

Course Code	**GEO4073**
Course Title	**Oceanography and Quaternary Geology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to chemical, geological, biological and physical oceanography. Sea floor spreading, marine sediments, sea floor morphology, waves, tides, currents, global thermostat, ocean-atmosphere-climate connection and marine life, biological productivity and ocean ecology, productivity and costal processes. GEOobal environmental changes due to rise and fall of sea-levels and related processes of sedimentation/erosion. Quaternary geological environment. Major events and the significance of the Quaternary Period. Red and brown earth deposits, laterite and bauxite, nodular ironstones, lagoonal and estuarine deposits and swamps, littoral sandstones, sand dunes.	
Recommended Texts	
• McCormick, M.J. and Thiruvathukal, J.V. (1981). Elements of Oceanography. Saunders College Publishing. • Chester, C.K. (1990). Marine Geochemistry. Springer. • Millcro, W. and Saha, M.L. (1992). Chemical Oceanography. John Wiley. • Garrison, T. (2012). Essentials of Oceanography. Wadsworth Publishing Company. • Cooray, P.G. (1984). The Geology of Sri Lanka. National Museums Pub. • Catt, J.A. (1995). Soils and Quaternary Geology: A Handbook for Field Scientists (Monographs on Soil Resources Survey). Oxford University Press, USA.	

Course Code	**GEO4082**
Course Title	**Exploration and Mining Geology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Methods of exploration and mining geology, mapping, geophysics, remote sensing, exploration geochemistry, inclusion studies and diamond drilling. Technical and economic aspects of exploration programme design and reserve evaluation and estimation procedures. Open cast mining, underground mining, mining in the soft ground, underwater and deep sea. Mine waste management.	
Recommended Texts	
• Hood, P.J. (Ed), (1977). Geophysics and Geochemistry in the Search for Metallic ores. Proceedings of Exploration 77, An International Symposium held in Ottawa, Canada, Economic Geology Report No. 31, Geological Survey of Canada. • Telford, W.M., Geldart, L.P. and Sheriff, R.E. (1990). Applied Geophysics. 2nd Edition, Cambridge Univ. Press, New York, Port Chester, Melbourne, Sydney. • Kearey, P. and Brooks, M. (1991) An Introduction to Geophysical Exploration. 2nd Edition, Blackwell Scientific Publications.	

Course Code	**GEO4092**
Course Title	**Petroleum Geology**
Credit Value	**2**
Pre-requisites	**GEO3052**
Compulsory/Optional	**Optional**
Course Content	
Nature, occurrence, distribution and origin of petroleum and gas. Mode of occurrences and petroleum genesis. Sequence stratigraphy. Organic matter in depositional environment, preservation and maturation, oil shale and petroleum. Petroleum source rocks, migration, traps, reservoirs of petroleum and their characteristics and formation. Porosity and permeability. Tectonic approach in petroleum exploration. Basin analysis and seismic interpretation. Well logging and geophysical techniques in petroleum exploration. Petroleum prospects of the Gulf of Mannar.	
Recommended Texts	
• Dandekar, A.Y. (1985). Petroleum Reservoir Rocks and Fluid Properties. Taylor and Francis, NY. • Richard, C. and Selly, H. (1995). Elements of Petroleum Geology. Academic Press.	

Course Code	**GEO4103**
Course Title	**Advanced Metamorphic Petrology**
Credit Value	**3**
Pre-requisites	**GEO3032**
Compulsory/Optional	**Compulsory**
Course Content	
Principles and application of the P-T-t path concept. Petrogenetic grids and reaction histories. P-T-t path	

determination using reaction histories and compositional zoning in minerals. P-T-t path case studies. Introduction to thermodynamics of mineral equilibrium in metamorphic rocks and use of geothermometry and geobarometry. Laboratory study of P-T-t history of a metamorphic terrain using mineral reactions and reaction textures in thin-sections, with emphasis on Sri Lanka.
Recommended Texts
• Wood, B.J. and Fraser, D.G. (1976). Elementary thermodynamics for Geologists. Oxford Univ. Press. • Spear, F.S. (1994). Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths Min. Soc. Am. • Bucher, K. and Frey, M. (1994). Petrogenesis of Metamorphic Rocks. Springer Verlag, Heidelberg.

Course Code	**GEO4113**
Course Title	**Advanced Igneous Petrology**
Credit Value	**3**
Pre-requisites	**GEO3042**
Compulsory/Optional	**Compulsory**
Course Content	
Application of phase diagrams, field and petrographic relationships to understand the origin of magmas. Layered intrusions, Ophiolite complexes, Igneous processes and Global tectonics. Planetary differentiation. Composition of the earth's core, mantle and crust. Geochemical modeling of Mantle melting and genesis of peridotites, pyroxenites and basalts. Examples of magmatic systems at mid-ocean ridges, volcanic arcs and mantle hotspots and their geochemical affinities. Mantle heterogeneity and phase transitions. Introduction to experimental petrology.	
Recommended Texts	
• Yoder, H.S. (1979). The Evolution of the Igneous Rocks. Princeton University Press. • Hall, A. (1985). Igneous Petrology. 2nd Edition, Unwin Hyman. • Wilson, M. (1989). Igneous Petrogenesis. Chapman and Hall. • Winter, J.D. (2007). Introduction to Igneous and Metamorphic Petrology. 1st Edition, Academic Internet Publishers.	

Course Code	**GEO4123**
Course Title	**Advanced Sedimentary Petrology**
Credit Value	**3**
Pre-requisites	**GEO3052**
Compulsory/Optional	**Compulsory**
Course Content	
Limestone- carbonate diagenesis and microfabrics; dolomitization and de-dolomitization. Evaporites and sequences. Sedimentary ironstones and iron formations (Phanerozoic and Precambrian). Sedimentary phosphate deposits, nodular and bedded phosphorite, bioclastic and pebble bed phosphorites, Guano phosphorites. Geology of fluvial deposits and volcaniclastic sediments. Origin and mineralogy of clays. Methods in palaeontology. Fossils and fossilization. Trace fossils, plant fossils, microfossils and their uses.	
Recommended Texts	
• Pettijohn, F.J. (1975). Sedimentary Rocks. Harper and Row, New York. • Reineck H.E. and Singh. I.B. (1986). Depositional Sedimentary Environments. Springer Verlag, NY. • Tucker, M.E. (1996). Sedimentary Petrology. Blackwell. • Nield, E.W. and Tucker, V.C.T. (1985). Paleontology – An Introduction. Pergamon.	

Course Code	**GEO4132**
Course Title	**Advanced Engineering Geology**
Credit Value	**2**
Pre-requisites	**GEO3123**
Compulsory/Optional	**Optional**
Course Content	
Ground improvement engineering. Soil compaction, dynamic stabilization, chemical stabilization, geotextiles. Foundation engineering. Bearing capacity, designing and construction. Foundations on weathered rock. Lateral earth pressures and retaining structures. Soil and rock slope stability analysis. Environmental geotechnical applications. Solid waste disposal, Environmental impact assessments and preparations of geotechnical reports. Ethics for Geologists.	
Recommended Texts	
• McCarthy, P.E. (1993). Essentials of Soil Mechanics and Foundations. Prentice Hall. • Bell, F.G. (1983). Fundamentals of Engineering Geology. Mc Graw-Hill. • Goodman, R.E. (1993). Engineering Geology. Mc Graw-Hill. • Michael, D.G.de. (2009). Engineering Geology. Springer.	

Course Code	**GEO4998**
Course Title	**Research Project**
Credit Value	**8**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
A supervised field/laboratory study on a problem of current geological interest. A dissertation has to be submitted necessarily incorporating abstract, objectives, methodology, results, interpretation, conclusions and bibliography. Oral examinations based on the project will be held as a part of this course. The candidates will have to make a summary presentation of the project at this oral examination conducted by a panel of Academic Staff Members of the Department of Geology.	
Recommended Texts	
• Comstock, G. (2011). Research Ethics: A Philosophical Guide to the Responsible Conduct of Research. Cambridge University Press. • Stewart, C.N. (Jr) (2011). Research Ethics for Scientists: A Companion for Students. Willey-Blackwell.	

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Each student will undergo full-time training in a geology-related industry for eight weeks, on a project assigned by the industry, approved by the Department of Geology. Students are required to maintain a ‘Daily Diary’,	

which should be certified by the Head of the relevant industry and submitted to the Head of the Department of Geology, within two weeks after completion of the training. Each student is also required to write a report and make a presentation on work carried out during the period of training.
Recommended Texts
• Whetten, D.A. and Cameron, K.S. (2010). Developing Management Skills. Prentice Hall.

5. DEPARTMENT OF MATHEMATICS

5.1 Mathematics Course Modules

1000 LEVEL – MATHEMATICS						
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**		
				Hons.	**	*
MAT1002	Mathematics for Biological Sciences	2	None	Foundation		
MAT1013	Abstract Algebra I	3		√	√	√
MAT1023	Real Analysis I	3		√	√	√
MAT1032	Differential Equations	2		√	√	
MAT1042	Vector Methods	2		√	√	
MAT1053	Classical Mechanics I	3	MAT1042	√	√	
MAT1063	Introduction to Probability Theory	3		√	√	
Total		**16**		**16**	**16**	**06**

2000 LEVEL – MATHEMATICS						
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**		
				Hons.	**	*
MAT2013	Abstract Algebra II	3	MAT1013	√	√	√
MAT2023	Real Analysis II	3	MAT1023	√	√	√
MAT2033	Ordinary Differential Equations	3	MAT1032			
MAT2043	Mathematical Methods	3	MAT1042	√	√	
MAT2052	Classical Mechanics II	2	MAT1053			
MAT2063	Mathematical Modelling I	3		√	√	
MAT2072	Numerical Analysis I	2		√	√	
MAT2082	Logic and Set Theory	2	MAT1023			
MAT2092	Graph Theory	2				
MAT2102	Computational Mathematics	2				
Total		**25**		**14**	**14**	**06**

3000 LEVEL – MATHEMATICS						
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**		
				Hons.	**	*
MAT3013	Group Theory	3	MAT2013, MAT2082	√		
MAT3023	Real Analysis III	3	MAT2023	√	√	√
MAT3032	Partial Differential Equations	2	MAT1032			
MAT3042	Differential Geometry	2	MAT2043			
MAT3053	Fluid Mechanics I	3	MAT2043	√	√	
MAT3062	Mathematical Modelling II	2	MAT2063			
MAT3073	Numerical Analysis II	3	MAT2072	√	√	
MAT3083	Number Theory	3	MAT2013	√		
MAT3092	Combinatorics	2	MAT2092			
MAT3103	Linear Algebra	3	MAT2013	√	√	√

MAT3113	Linear Programming	3		√		
MAT3122	Complex Analysis I	2	MAT2023	√		
MAT3133	General Topology	3	MAT1023	√		
Total		**34**		**26**	**12**	**06**

4000 LEVEL - MATHEMATICS				
Course Code	**Course Title**	**No. of Credits**	**Pre -requisites**	**Compulsory**
				Hons.
MAT4013	Galois Theory	3	MAT3013	√
MAT4023	Measure Theory	3	MAT3023	√
MAT4033	Functional Analysis	3	MAT3103, MAT3133, MAT4023	√
MAT4043	Complex Analysis II	3	MAT3122	√
MAT4053	Fluid Mechanics II	3	MAT3053	
MAT4063	Optimization Theory	3	MAT3113	√
MAT4073	Algebraic Topology	3	MAT3013 MAT3133	
MAT4083	Financial Mathematics	3		√
MAT4093	Industrial Mathematics	3		
MAT4996	Research Project	6		√
SCI4003	Industrial Training	3		
Total		**36**		**24**

1000 Level Courses

Course Code	**MAT1002**
Course Title	**Mathematics for Biological Sciences**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Foundation**
Course Content	
Equations, Inequalities and Functions, Limits of a Function, Rate of Change and the Derivative of a Function, Differentiation Techniques, Finding Extrema of Functions, Application of the Derivative, Areas and the Definite Integral, The Fundamental Theorem of Calculus.	
Recommended Texts	
• J. C. Arya and R. W. Lardner (1979), Mathematics for Biological Sciences, Prentice-Hall. • Erin N. Bodine, Suzanne Lenhart, Louis J. Gross (2014), Mathematics for the Life Sciences, Princeton University Press. http://mathematicsforthelifesciences.com	

Course Code	**MAT1013**
Course Title	**Abstract Algebra I**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Matrices and Determinants: Matrix algebra, singular and non-singular matrices, determinants, applications to matrices and determinants. **Elements of Number Theory:** Euclid's algorithm, greatest common divisor, least common multiple and their relationship, solution of linear Diophantine equations in two variables, linear congruences, systems of linear congruences having the same modulus, Chinese remainder theorem. **Relations, Functions, and Binary Operations:** Cartesian product of two sets, relations and functions, equivalence relations and equivalence classes, injective, surjective and bijective functions, inverse of a function, image and the pre-image of a function, composition of functions, binary operations. **Permutations:** Multiplication of permutations, representing a permutation as a product of disjoint cycles, transpositions, parity and signature of a permutation. **Introduction to Group theory**: Definition of a group, sub-groups, cyclic groups, Abelian groups, symmetric and alternating groups, group tables.	
Recommended Texts	
• H. Anton, C. Rorres (2013), *Elementary Linear Algebra – Applications Version*, 11th Edition. • S. Warner (2019), *Abstract Algebra for Beginners*, 1st edition, Get 800 publications. • D. J. S. C. Robinson (2003), *An Introduction to Abstract Algebra*, 2nd edition, de Gruyter publications. • D.M. Burton (2010), *Elementary Number Theory*, 7th Edition. • John B. Fraleigh, (2002), *A First Course in Abstract Algebra*, 7th Edition.	

Course Code	**MAT1023**
Course Title	**Real Analysis I**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Elements of logic and set theory: Sentential and quantificational logic, truth tables, deductive reasoning and logical connectives, proofs involving negation and conditionals/quantifiers/conjunction and biconditionals/disjunction, existence and uniqueness proofs, proof by mathematical induction, proof by the method of contradiction, finite and infinite sets, cardinality of a set.

The real number system: Real number system as a complete ordered field, neighborhoods.

Sequences and limits: Definition of convergence, limit theorems, monotonic sequences, monotone convergence theorem, algebra of limits.

Limits and continuity of real valued functions: Limit of a function, algebra of limits, continuity of a function, properties of continuous functions, sequential criterion for limits and continuity, intermediate value theorem and extreme value theorem.

Differentiability of real valued functions: The definition of the derivative, algebra of derivatives, product and quotient rules, Rolle's theorem, mean-value theorem and its applications, L'Hospital's rule, applications of the derivative.

Recommended Texts

- R. G. Bartle and D. R. Sherbert (2011), *Introduction to Real Analysis*, 4^{th} Edition.
- S. R. Lay (2013), *Analysis: With an Introduction to Proof*, 5^{th} Edition.

Course Code	**MAT1032**
Course Title	**Differential Equations**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction: Definitions and basic terminology, initial value problems, differential equations as models.

First Order Ordinary Differential Equations: Direction fields, separable variables, exact equations, Clairaut's equation, Ricarti's equation, solutions by substitution.

Higher Order Ordinary Differential Equations: Linear equations with constant coefficients, Wronskian differential operators, method of undetermined coefficients, variation of parameters, reduction of order technique.

Recommended Texts

- S. G. Krantz (2014), *Differential Equations: Theory, Technique and Practice*, 2^{nd} Edition.
- Dennis G. Zill (2017), *A First Course in Differential Equations with Modeling Applications*, 11^{th} Edition.

Course Code	**MAT1042**
Course Title	**Vector Methods**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Vector Algebra: Introduction to vectors, linear combinations, linear dependence and independence, bases and dimension, scalar product, vector product, triple scalar product, triple vector product, solutions of vector equations involving products.

Vector Geometry: Collinear Vectors, coplanar vectors, vector equation of a line, vector equation of a plane, tetrahedron, parallelepiped, pyramid and the prism, coplanar and skew lines, intersecting and parallel planes, cylindrical polar coordinates, spherical polar coordinates, simple surfaces: sphere-cone, cylinder, cosine and sine formulae in spherical trigonometry.

Vector Functions of a Single Scalar Variable: Vector-valued functions of a scalar variable and the analysis of curves in space, differentiation and integration of vector-valued functions, tangents, normals and curvature of curves.

Recommended Texts

- L. Brand (2006), *Vector Analysis*, Dover publications.
- B. Hague (2012), *An Introduction to Vector Analysis: For Physicists and Engineers*, 6th revised edition, Springer publications.
- J. G. Coffin (2015), *Vector Analysis: "An Introduction to Vector-Methods and Their Various Applications to Physics and Mathematics"*, 1st edition, CreateSpace Independent Publishing Platform.

Course Code	**MAT1053**
Course Title	**Classical Mechanics I**
Credit Value	**3**
Pre-requisites	**MAT1042**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to the methods of dynamics

Review of forces: Forces, Moments, Force couples, pure moments and Torques, Constraint and reaction forces and moments, Frictional forces

Analyzing motion of a particle: Equations of motion, Angular Momentum, Calculating forces required to cause prescribed motion of a particle

Constrained motion: Motion in a space curve. Use of intrinsic coordinates

Analyzing motion of a system of particles: Conservation Laws for Particles, Linear momentum and equation of the center of mass. Angular Momentum, Equations for impulsive motion.

Analyzing motion of rigid bodies: Instantaneous center of a lamina, motion of the center of mass, motion relative to the center of mass, Describing the motion of a rigid body: angular velocity and acceleration, Linear Momentum, Angular Momentum and Kinetic energy. Analyzing Motion in Connected Rigid Bodies: Mechanisms, rolling wheel, gears.

Recommended Texts

- D. Gross, W. Haugar, J. Schroer, W.A. Wall, and S. Govindjee (2014) Engineering Mechanics 3, 2nd

Edition, Springer. • R. Douglas Gregory (2006), Classical Mechanics, Cambridge University Press. • F. Chorlton (1985), Textbook of Dynamics, CBS Publishers & Distributors. • C. Plumpton, and P. S. W. MacIlwane (1980), Vol. 1 Part 2, New Tertiary Mathematics, 1st Edition, Pergamon Press Ltd.

Course Code	**MAT1063/STA1023**
Course Title	**Introduction to Probability Theory**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Counting Techniques: Combinations, permutations, set partitions. elements of probability: experiments, events, sample space, laws of probability, Bayes' theorem, independence of events. **Random variables**: Discrete and continuous random variables, probability mass function, probability density function, cumulative distribution function, functions of a random variable, expectation, moments, mean and variance, moment generating function. Probability inequalities: Chebyshev's and Markov's etc. **Distributions**: **Discrete**: Uniform, Bernoulli & Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Multinomial, **Continuous**: Uniform, Normal, Gamma, Exponential. Properties and applications of distributions, Probability Generating functions. Approximation to Binomial using Poisson, Binomial using Normal, and Poisson using Normal.	
Recommended Texts	
• Ross, S.M. (2013). *A First Course in Probability*.9th Ed. Pearson Education. • Hogg, R.V. (2013). *Introduction to Mathematical Statistics*.7th Ed.Pearson India.	

2000 Level Courses

Course Code	**MAT2013**
Course Title	**Abstract Algebra II**
Credit Value	**3**
Pre-requisites	**MAT1013**
Compulsory/Optional	**Compulsory**
Course Content	
Groups: Definitions and examples, dihedral, symmetric, alternating, icosahedral groups, generators and relations of a group, cosets and Lagrange's theorem, normal subgroups, quotient groups, group homomorphisms, isomorphism theorems, internal and external direct products of groups. **Rings:** Definitions and examples, commutative rings, rings with identity, integral domains, division rings and fields, subrings, ring homomorphisms, ideals and quotient rings, prime ideals, maximalideals, principal ideals, principal ideal domains and unique factorization domains, Euclidean domains, field of fractions of an integral domain. **Polynomials:** Polynomials with integer coefficients, polynomial rings, solutions of cubic and quartic polynomials, polynomials over a field, roots of a polynomial, existence of roots, factorization, irreducible	

polynomials, Gauss's lemma, Eisenstein's irreducibility criterion. **Fields:** Properties of a field, properties of a multiplicative group of a field, field extensions, finite fields.
Recommended Texts
• D. S. Dummitand, R. M. Foote (2003), *Abstract Algebra*, 3rd Edition. • J. B. Fraleigh (2002), *A First Course in Abstract Algebra*, 7th Edition. • S. Lang (2005), *Undergraduate Algebra*, 3rd Edition.

Course Code	**MAT2023**
Course Title	**Real Analysis II**
Credit Value	**3**
Pre-requisites	**MAT1023**
Compulsory/Optional	**Compulsory**
Course Content	
Cauchy sequences: Cauchy sequences and their properties, Bolzano-Weierstrass theorem, Cauchy convergence criterion. **Series:** Tests for convergence, absolute and conditional convergence. **Power series:** Radius and interval of convergence of a power series, integration and differentiation of power series, Taylor and Maclaurin series, power series representation of functions**.** **Uniform continuity:** Definition, comparison with continuity, conditions for uniform continuity. **Riemann Integrals:** Upper and lower Riemann integrals, Riemann integrable functions, basic properties of the Riemann integral, Fundamental Theorem of Calculus, improper integrals, Riemann-Stieltjes integral.	
Recommended Texts	
• T. M. Apostol (1974), *Mathematical Analysis,* 2nd Edition, Addison-Wesley. • S. R. Lay (2013), *Analysis an Introduction to Proof*, 5th Edition, Prentice-Hall. • R. G. Bartle and D. R. Sherbert (2011), *Introduction to Real Analysis*, 4th Edition. • W. Wade (2017), *An Introduction to Analysis*, 4th edition, Pearson publications.	

Course Code	**MAT2033**
Course Title	**Ordinary Differential Equations**
Credit Value	**3**
Pre-requisites	**MAT1032**
Compulsory/Optional	**Optional**
Course Content	

Series solutions of differential equations: Solutions near an ordinary point, regular singular points and the method of Frobenius, reduction of order technique, special functions defined as solutions of differential equations. **Existence and Uniqueness of Solutions:** Picard iterates, Picard existence and uniqueness theorem, integral equations. **Systems of Ordinary Differential Equations:** Eigenvector method for linear systems, Fundamental matrix solutions, Non-linear autonomous systems, Phase plane, Phase portraits of linear systems, stability, Lyapunov functions, Periodic solutions, introduction to bifurcation theory.
Recommended Texts
• M. Braun, (1992), *Differential Equations and Their Applications*, 4th Edition. • S. G. Krantz (2014), *Differential Equations: Theory, Technique and Practice*, 2ndEdition. • D. G. Zill (2017), *A First Course in Differential Equations with Modeling Applications*, 11th Edition.

Course Code	**MAT2043**
Course Title	**Mathematical Methods**
Credit Value	**3**
Pre-requisites	**MAT1042**
Compulsory/Optional	**Compulsory**
Course Content	
Differentiation and Integration of Vectors: Definitions and physical interpretations of div, grad, curl and Laplacian in cartesian coordinates, derivations of useful vector relations, line integrals and their evaluation using parametric representation, surface integrals, Green's theorem in the plane Stokes theorem, circulation and flux of a vector point function, volume integrals, divergence theorem, irrotational and solenoidal vector fields, orthogonal curvilinear coordinates (OCC), grad, div, curl in OCC, cylindrical polar and spherical coordinate systems, use of these coordinate systems in the evaluation of surface and volume integrals. **Fourier Series:** Role of Fourier series in the solution of wave problems, orthogonality properties of the sine and cosine functions, Fourier series representation of a periodic function, complex form of a Fourier series, convergence of Fourier series, representation of odd and even functions by Fourier sine and cosine series, Parseval's theorem, applications of Fourier series to the solution of forced vibration problems. **Integral Transforms:** Fourier transforms, Fourier sine and cosine transforms and their application to time-series analysis, convolution integrals and their role in finding inverse transforms, Dirac delta function, applications of integral transforms to impulse response systems, Laplace transforms and their use in ordinary and coupled ordinary linear differential equations, inverse transforms and their application to circuit and system analysis.	
Recommended Texts	
• K.F. Riley (2006), *Mathematical Methods for Physics and Engineering: A Comprehensive Guide, 3rd edition*, Cambridge University Press • M. L. Boas (2005), *Mathematical Methods for Physical Sciences*, 3rd edition, Wiley publications.	

Course Code	**MAT2052**
Course Title	**Classical Mechanics II**
Credit Value	**2**
Pre-requisites	**MAT1053**
Compulsory/Optional	**Optional**

Course Content
Statics **Catenary**: Equation of a catenary, Standard relations, Tension at a point, Examples on equilibrium of heavy strings, Tightly stretched catenary. **Strings on plane curves:** Heavy strings on smooth space, Heavy strings on rough space. **Thin rigid beams:** Shear force (SF) and its diagram, Bending Moment (BM) and its diagram, Relationship between SF, BM and Loading (continuous/ concentrated). **Deflection of beams:** Equilibrium of slightly elastic beams, Bending of slightly elastic beams, Equation of three moments. **Dynamics** **Central Orbits:** Particle motion under a central force, Use of polar and reciprocal polar coordinates, Use of pedal coordinates, Elliptic, Parabolic and Hyperbolic Orbits, Kepler's Laws of planetary motion, Distributed central orbits. **Small Oscillations:** Expressions for Kinetic/Potential Energies, Equations of motion and their solutions, Normal modes of oscillation, Normal coordinates and their determination.
Recommended Texts
• A.S. Hall, F. E. Archer, and R. I. Gilbert (1999), Engineering Statics, 2nd Edition, UNSW Press Ltd. • F. Chorlton (1985), Textbook of Dynamics, CBS Publishers & Distributors. • C. Plumpton, and P. S. W. MacIlwane (1981), Vol. 2 Part 2, New Tertiary Mathematics, 1st Edition, Pergamon Press Ltd. • S. L. Green, (1962) General Degree Applied Mathematics, University Tutorial Press Ltd.

Course Code	MAT2063
Course Title	**Mathematical Modelling I**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Mathematical Modelling Process: Construction of a mathematical model **Mathematical Modelling:** polynomial and rational models, exponential and logarithmic models, model fitting, interpolation, modelling with difference and differential equations,modelling with game theory. **Dimensions and Units**: scaling and approximation. **Economic Functions:** supply; demand; total cost (TC); total revenue (TR); average cost (AC); average revenue (AR); marginal cost (MC) and marginal revenue (MR). elasticity, consumer's surplus, producer's surplus, cobweb model, equilibrium in economic resources. **Single-Species Models:** Exponential and logistic growth; harvest models: bifurcation and breakpoints; discrete-time models; delay models; **Traffic flow models:** Microscopic and macroscopic models. **Optimization models:** Basic applications in optimization models**.**	
Recommended Texts	
• F. R. Giordano, W. P.Fox and S. B. Horton (2014), *A First Course in Mathematical Modeling*, 5th Edition, Brooks/Cole CengageLearning. • R. Haberman (1998), *Mathematical Models*, SIAM. • M. Kot (2003), *Elements of Mathematical Ecology*, Cambridge University Press.	

Course Code	**MAT2072**
Course Title	**Numerical Analysis I**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Solutions of equations in one variable: Bisection method, fixed-point iteration, Newton-Raphson method, Error analysis for iterative methods.

Interpolation and Polynomial Approximation: Taylor polynomials, interpolation and Lagrange polynomial, iterated interpolation, divided differences, Hermite interpolation, cubic spline interpolation.

Numerical Differentiation and Integration: Numerical differentiation, Richardson's extrapolation, elements of numerical integration, numerical integration and polynomial interpolation using computer programming language/software.

Recommended Texts

- S. S. Rao (2001), *Applied Numerical Methods for Engineers and Scientists*, Prentice Hall.
- Richard L. Burden, J. Douglas Faires (2011). *Numerical Analysis*, 9th Edition. Brooks/Cole.
- Kendall E. Atkinson (2008), *An Introduction to Numerical Analysis*, 2nd Edition. Wiley India Pvt. Limited.

Course Code	**MAT2082**
Course Title	**Logic and Set Theory**
Credit Value	**2**
Pre-requisites	**MAT1023**
Compulsory/Optional	**Optional**

Course Content

Logic: Review of informal statement calculus, rules for manipulation and substitution, normal forms, adequate set of connectives, informal predicate calculus.

Set Theory: Axioms of set theory, The axiom of choice, Relations and functions, Cardinality, Ordinal numbers, The Cantor-Schröder-Bernstein theorem, The principle of recursive definition, Well-ordered sets, Zorn's lemma, The maximum principle, transfinite induction.

Number systems: Peano's and Von Neumann's construction of natural numbers, construction of rational numbers, Defining real numbers using Dedekind cuts, Defining real numbers using equivalence classes of Cauchy sequences.

Recommended Texts

- A Hamilton (1998), *Logic for Mathematicians,* 2nd edition
- Daniel J. Velleman (2006), *How to prove it: A Structured Approach,* 2nd edition, 2006

Course Code	**MAT2092**
Course Title	**Graph Theory**
Credit Value	**2**
Pre-requisites	**None**

Compulsory/Optional	Optional

Course Content

Introduction to Graph Theory: Isomorphism of graphs, matrix representation of graphs, types of graphs.

Eulerian and Hamiltonian graphs: Shortest path problem, Chinese postman problem, travelling salesman problem.

Trees: Tree sorting, spanning trees, minimum weighted spanning tree.

Planar Graphs: Planar representations of graphs, dual graphs.

Graph Coloring: Vertex coloring, edge coloring, map coloring, time table scheduling, four- color Theorem.

Network Flows: Directed graphs, Hall's theorem, transversal theory, maximum and minimum cut theorem.

Recommended Texts

- F. Harary (1988), Graph *Theory*, Narosa Publishing House.
- R. J. Wilson (1996), *Introduction to Graph Theory*, Addison-Wesley Longman.

Course Code	MAT2102
Course Title	Computational Mathematics
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Optional

Course Content

Programming basics: Computational Mathematics and Symbolic Mathematics , Solving linear systems and solving polynomials, Fundamental programming techniques including scripts, loops, conditional statements, logical operators, inbuilt functions.

Computational Mathematics: Applications to sequences, recurrence relations, finite series and the approximation of infinite series, Simulations and visualizing results, numerical Integration and Differentiation. An introduction to quadrature and Euler's method, solving ordinary differential equations and nonlinear equations computationally, generating geometric shapes and fractals, 3d printing.

Recommended Texts

- S. C. Chapra, (2012), *Applied Numerical Methods with MATLAB for engineers and scientists, 3rd Edition.*
- A. Saha, (2015), Doing *Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More! 1st Edition.*
- S. J. Chapman, (2009), *Essentials of MATLAB Programming, Second Edition.*

3000 Level Courses

Course Code	MAT3013
Course Title	Group Theory
Credit Value	3
Pre-requisites	MAT2013, MAT2082
Compulsory/Optional	Compulsory

Course Content

Basic Group Theory: Cayley digraph of a group, lattice of subgroups of a group, the lattice isomorphism theorem, simple groups, presentation of symmetric and alternating groups.

Group Actions: Definitions and basic terminology, orbits and stabilizers, permutation representations, groups acting on themselves by left multiplication and conjugation, Cayley's theorem, class equation for finite groups, automorphisms, Cauchy's theorem for abelian groups, Sylow's theorem, Applications of Sylow's theorem, simplicity of A_n for $n > 4$, Cauchy's theorem.

Series of Groups: Subnormal and normal Series, Jordan-Hölder theorem, solvable and nilpotent groups, non-solvability of S_n for $n > 4$,, commutators and lower central series, p-groups.

Free Groups: Definition of a free group, generators and relations, free product of groups, projective and injective groups.

Finitely Generated Abelian Groups: Direct products, fundamental theorem of finitely generated abelian groups, semi-direct products.

Recommended Texts

- D. F. Dummit, R. M. Foote (2003), *Abstract Algebra*, 3rd Edition.
- J. Rottman (1999), *An Introduction to the Theory of Groups (Graduate Texts in Mathematics)* 4th Edition.

Course Code	MAT3023
Course Title	Real Analysis III
Credit Value	3
Pre-requisites	MAT2023
Compulsory/Optional	Compulsory

Course Content

***Functions of several variables*:** Limits and continuity, partial derivatives, directional derivatives, extrema of functions of several variables, Lagrange multipliers, Jacobian, multiple integrals, change of variables in multiple integrals.

Sequences and Series of functions: Pointwise convergence, uniform convergence of a sequence of functions, Cauchy condition for uniform convergence, properties of uniform convergence, series of functions, uniform convergence of a series of functions and properties.

***Special functions*:** Gamma, Beta, Bessel, Legendre, etc. Fourier series and their applications.

Recommended Texts

- T. M. Apostol (1974), *Mathematical Analysis,* 2nd Edition, Addison-Wesley Longman
- N. N. Lebedev (1965), *Special Functions and Their Applications,* Prentice-Hall
- G. P. Tolstov (1962), *Fourier Series,* Dover publications
- R. G. Bartle and D. R. Sherbert (2011), *Introduction to Real Analysis*, 4th Edition.
- W. Wade (2017), *An Introduction to Analysis*, 4th edition, Pearson publications

Course Code	**MAT3032**
Course Title	**Partial Differential Equations**
Credit Value	**2**
Pre-requisites	**MAT1032**
Compulsory/Optional	**Optional**

Course Content

First order partial differential equations: Linear equations, non-linear equations, method of characteristics

Second order partial differential equations: Equations with constant coefficients, equations with variable coefficients, Laplace equation, wave equation, diffusion equation, boundary value problems, use of Fourier series in solving partial differential equations

Numerical Methods for solving partial differential equations

Recommended Texts

- P.J. Olver (2014), Introduction to Partial Differential Equations, 1st Edition, Springer.
- Y. Pinchover, and J. Rubinstein (2006), An Introduction to Partial Differential Equations, 1stEddition, Cambridge Press.
- R. V. Churchill and J.W. Brown (1987), Fourier Series and Boundary Value Problems, McGraw-Hill.
- W. A. Strauss, Partial Differential Equations: An Introduction, 2nd Edition.
- E. C. Zachmanoglou and D. W. Thoe (1986), Introduction to Partial Differential Equations with Applications, Dover Publications, Inc., New York.

Course Code	**MAT3042**
Course Title	**Differential Geometry**
Credit Value	**2**
Pre-requisites	**MAT2043**
Compulsory/Optional	**Optional**

Course Content

Curves in space: Serret-Frenet formulas, osculating plane, osculating circle and osculating sphere, involutes and evolutes, helices.

Surfaces: Envelopes, developable surfaces, fundamental forms, lines of curvature and asymptotic curves, ruled surfaces, geodesics.

Manifolds: Definitions, tangent space, the chain rule, vector fields, Riemannian metric.

Recommended Texts

- W. Kuhnel (2015), *Differential Geometry: Curves - Surfaces - Manifolds* (Student Mathematical Library) 3rd Edition.
- B. O-Neil (2006), *Elementary Differential Geometry*, Revised 2nd Edition, Academic Press.

Course Code	**MAT3053**
Course Title	**Fluid Mechanics I**
Credit Value	**3**
Pre-requisites	**MAT2043**

Compulsory/Optional	**Compulsory**
Course Content	
Kinematics of Fluid Motion: Introduction to fluid mechanics, Real and Perfect Fluids, Effects of viscosity in flows, Velocity of a fluid at a point, Streamlines and their differential equations, Steady and unsteady motions, Vorticity and Circulation; Stokes's theorem, Irrotational flow and the velocity potential, Material derivatives, Equation of Continuity, **Perfect fluids:** Compressible and Incompressible fluids Conditions satisfied by a perfect fluid at a rigid boundary, Pressure at a point in a fluid (moving or at rest), Euler's Equation, Motion under conservative body force, Steady Rotation about a fixed vertical axis, Bernoulli's Equation in irrotational motion, Radial flow, Theorems on velocity potential, Kinetic energy, Kelvin's theorems. **Three-dimensional flow fields:** Source, sink and doublet, Flow past a fixed sphere, Moving sphere in a fluid, motion generated by impulses on boundaries of fluid, Concentric spherical boundaries of fluid **Two-dimensional flow fields:** Velocity and vorticity in terms of the stream function in an incompressible fluid, The complex potential and the complex velocity in irrotational motion, source, sink, doublet and vortex	
Recommended Texts	
• F. White (2016), Fluid Mechanics, 8th Edition, McGraw-Hill. • R. Fox, and A. McDonald (2015), Introduction to Fluid Mechanics, 9th Edition, Wiley. • R. Daugherty, J. Franzini and E. Finnmore (2002), Fluid Mechanics with Engineering Applications, 10th Edition, McGraw-Hill. • A. J. Chorin, and J. E. Marsden (1990), A Mathematical Introduction to Fluid Mechanics, 2nd Edition, Springer.	

Course Code	**MAT3062**
Course Title	**Mathematical Modelling II**
Credit Value	**2**
Pre-requisites	**MAT2063**
Compulsory/Optional	**Optional**
Course Content	
Mathematical Modelling: Modelling with systems of difference and differential equations, Simulation Modelling. **Population models:** A classical predator-prey model, global bifurcation in predator-prey models, discrete-time predator-prey models, competition models, mutualism models. **Epidemic models:** SI, SIR, SEIR models, Reproduction number. **Optimal Control:** basic optimal control problems, preliminaries, Pontryagin's Maximum Principle, Numerical methods for solving Optimal Control Problems.	
Recommended Texts	
• F. R. Giordano, W. P. Fox & S. B. Horton (2014), *A First Course in Mathematical Modeling*, 5thEd. • S.P. Sethi, G. L. Thompson (2019), *Optimal Control Theory Applications to Management Science &Economics*, 3rd Ed, Springer. • M. Kot (2003), *Elements of Mathematical Ecology*, CAMBRIDGE UNIVERSITY PRESS • S. Lenhart and J. T. Workman (2007), *Optimal Control Applied to Biological Models*, Chapman • M. J. Keeling and PejmanRohani (2008), *Modeling Infectious Diseases in Humans and Animals*, Princeton University Press.	

Course Code	MAT3073
Course Title	Numerical Analysis II
Credit Value	3
Pre-requisites	MAT2072
Compulsory/Optional	Compulsory

Course Content

Initial-value Problems for Ordinary Differential Equations: Euler's method, Higher-order Taylor methods, Runge-Kutta method.

Direct Methods for Solving Linear Systems: Linear system of equations, Gaussian elimination and backward substitution.

Numerical Solutions of Non-Linear System of Equations: Fixed points for functions of several variables, Newton's method, Quasi-Newton methods, Steepest descent techniques.

Boundary Value Problems for Ordinary Differential Equations: The linear shooting method, The shooting method for non-linear problems, Finite-difference methods for linear problems, Finite-difference methods for non-linear problems.

Recommended Texts

- Richard L. Burden and J. Douglas Faires, Numerical Analysis, Brooks Cole (2004), 8th Edition.
- Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, Pearson, (2003) 7th Edition.
- K. Atkinson and W. Han, Elementary Numerical Analysis, John Willey & Sons (2004), 3rd Edition.

Course Code	MAT3083
Course Title	Number Theory
Credit Value	3
Pre-requisites	MAT2013
Compulsory/Optional	Compulsory

Course Content

Continued Fractions: Finite, infinite, and periodic continued fractions and their properties; convergents, evaluation of convergents, approximation theorems; applications.

The Theory of Congruences: Solving linear congruences in one, two, and several variables; system of congruences, solutions via theory of matrices, solutions via the Chinese Remainder Theorem; Polynomial congruences and Hensel's lemma; applications.

The Euler-φFunction: Wilson's theorem, Fermat's little theorem, Euler's theorem; Euler φ-function and properties; applications.

Primitive Roots and the theory of Indices: The order of an integer, primitive roots, index arithmetic; applications.

Quadratic Residues and Quadratic Reciprocity: Quadratic residues and nonresidues, the law of quadratic reciprocity; applications.

Recommended Texts

- D. Burton (2010), *Elementary Number Theory,* 7th Edition, McGraw-Hill**.**
- K. H. Rosen (2010), *Elementary Number Theory and Its Application,* 6th Edition, Pearson.

Course Code	**MAT3092**
Course Title	**Combinatorics**
Credit Value	**2**
Pre-requisites	**MAT2092**
Compulsory/Optional	**Optional**

Course Content

Block Design: Symmetric design, difference sets, Hadamard matrices, Hadamard designs, finite projective planes.

Steiner Triple System: Direct constructions, recursive constructions, higher order constructions, tournaments and Kirkman's schoolgirl problem.

Recurrence Relation: Modelling with recurrence relation, solving linear recurrence relations, generating functions, solving non-linear recurrence relation.

Counting: Basics of counting, Pigeonhole principle, more complex counting problems.

Recommended Texts

- P. J. Cameron (1994), *Combinatorics: Topics, Techniques, Algorithms*, Cambridge University Press
- H.J. Straight (1993), *Combinatorics (An Invitation)*, State university of New York at Fredonia.

Course Code	**MAT3103**
Course Title	**Linear Algebra**
Credit Value	**3**
Pre-requisites	**MAT 2013**
Compulsory/Optional	**Compulsory**

Course Content

Elementary Matrices: Block matrices, elementary matrix operations and elementary matrices, Systems of Linear Equations in n-variables: augmented matrix, theoretical treatment of systems of linear equations, row reduction.

Determinants: Determinants of order n, properties of determinants, Cramer's rule**,** properties of the adjoint, diagonalisation of matrices, eigenvalues and eigenvectors, diagonalizability, matrix Polynomials and Cayley-Hamilton theorem, minimal polynomial.

Vector Spaces: Vectors in n-dimensional Euclidean space, abstract vector spaces, subspaces, basis and dimension, spanning sets and linear independence, isomorphism theorems.

Linear Transformations and Matrices: Kernel and range of a linear transformation, rank-nullity theorem, matrix representation of a linear transformation, composition of linear transformations, change of coordinate matrix, similar matrices, matrix of change of bases, symmetric, Hermitian and unitary matrices.

Inner Product Spaces: Inner product spaces, Cauchy -Schwarz inequality, The Gram-Schmidt Process.

Recommended Texts

- Ron Larson (2012), *Elementary Linear Algebra,* 7th Edition, Cengage Learning.
- David C. Lay, Steven R. Lay, Judi J. McDonald (2015), *Linear Algebra*, 5th Edition, Pearson.

Course Code	**MAT3113**
Course Title	**Linear Programming**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Convex Analysis: Convex combinations, Convex sets, Extreme points of a convex set, Convex polyhedron, Hyper planes, Half-spaces and polytopes, Convex functions.

Linear Programming (LP): Mathematical formulation of the LP problem, LP in two-dimensional space, Graphical solution method, General LP problem.

The Simplex Method: Simplex algorithm, Big-M method, Two-phase simplex algorithm, Revised simplex algorithm, LP problems with unrestricted variables, LP problems with bounded variables.

Duality in LP: Duality in LP problems, Duality theorems, Applications of duality, Dual simplex algorithm.

Special Types of LP Problems: Transportation problem, Assignment problem.

Recommended Texts

- G. B. Dantzig and M. N. Thapa (1997), *Linear Programming: Introduction*, Springer-Verlag New York.
- K. Kapoor (1998), *Operations Research*, Sultan Chand &Sons.
- M. N. Thapa. (1997),*Linear Programming*, Springer Publishing.
- L. A. Wolsey. (1998), *Integer Programming.*

Course Code	**MAT3122**
Course Title	**Complex Analysis I**
Credit Value	**2**
Pre-requisites	**MAT2023**
Compulsory/Optional	**Compulsory**

Course Content

Algebra of complex numbers: The complex field, properties of complex numbers, n-th root of unity.

Analytic functions: Cauchy-Riemann equations, harmonic functions, exponential and trigonometric functions, Taylor series.

Complex Integration: Line integrals, contour integrals, Cauchy’s Theorem, Cauchy’s integral formulae.

Singularities: Laurent series, classification of singularities, Residue Theorem, Evaluation of definite integrals using residues.

Recommended Texts

- J. Bak and D.J. Newman (2017), *Complex Analysis*, 3rd Edition, Springer.
- R. V. Churchill and J. W. Brown (2013), *Complex Variables and Applications*,9th Edition, McGraw-Hill.

Course Code	**MAT3133**
Course Title	**General Topology**
Credit Value	**3**
Pre-requisites	**MAT1023**
Compulsory/Optional	**Compulsory**
Course Content	
Metric Spaces: Basic examples, open and closed sets, continuous functions on metric spaces, sequences and convergence in metric spaces, complete metric spaces, normed linear spaces and inner product spaces, topology of $\mathbb{R}^n$. **Topological Spaces:** Examples, neighborhood axioms, bases and subbases, subspace topology, products and quotients of spaces, closed sets and limit points, continuous functions and homeomorphisms. **Topological Properties:** Compactness, connectedness, path connectedness, local connectedness and local compactness, countability axioms, separation axioms, local finiteness and paracompactness. **Homotopy and the Fundamental Group:** Homotopy of paths, the fundamental group of a space, covering spaces, computation of the fundamental group of the circle.	
Recommended Texts	
• J. R. Munkres, (2015), *Topology, 2nd Edition.* Pearson. • W. A Sutherland, (2009), *Introduction to Metric and Topological 2ndEdition*, Oxford University Press.	

4000 Level Courses

Course Code	**MAT4013**
Course Title	**Galois Theory**
Credit Value	**3**
Pre-requisites	**MAT3013**
Compulsory/Optional	**Compulsory**
Course Content	
Field extensions: Extension fields, ruler and compass constructions, three classical problems, Galois groups of field extensions **Automorphisms of a field:** Theorem of the primitive element, splitting fields, automorphisms of a field extension over a fixed field, Galois groups, separable and inseparable extensions, normal extensions and Galois extensions, subgroups of the Galois group and intermediate fields of the extension, Fundamental Theorem of Galois Theory. **Polynomials:** Solvability of polynomials, Galois group of a polynomial, radical Extensions, solvability by radicals, proof that a polynomial is irreducible if and only if its Galois group acts transitively on its roots, proof of the fundamental theorem of Algebra.	
Recommended Texts	
• S. C. Newman (2012), *A Classical Introduction to Galois Theory*, 1st Edition, Wiley publications • N. Stewart (2015), *Galois Theory*, 4th edition, Routledge publications • D. S. Dummit, R. M. Foote (2003),*Abstract Algebra*, 3rd Edition. • J. Rotman (2013), *Galois Theory*, 2nd Edition, Springer.	

Course Code	**MAT4023**
Course Title	**Measure Theory**
Credit Value	**3**
Pre-requisites	**MAT3023**
Compulsory/Optional	**Compulsory**

Course Content

Lebesgue measure: Introduction, Lebesgue outer measure, the σ –algebra of Lebesgue measurable sets, outer measures, complete measures, countable additivity, continuity, the Borel-Cantelli lemma, existence of non-measurable sets, the Cantor set and the Cantor-Lebesgue function

Lebesgue measurable functions: Sums, Products, and Compositions, Sequential Pointwise Limits and Simple Approximation, measure spaces.

Lebesgue integration: The Lebesgue integral of a bounded measurable function over a set of finite measure, the Lebesgue integral of a measurable nonnegative function, the general Lebesgue integral, Monotone Convergence Theorem, Fatou's Lemma, Dominated Convergence Theorem, characterizations of Riemann and Lebesgue integrability, Modes of Convergence.

Differentiation and Integration: Continuity of monotone functions, differentiability of monotone functions: Lebesgue's theorem, functions of bounded variation: Jordan's theorem.

Recommended Texts

- R. G. Bartle (1995), *The Elements of Integration and LebesgueMeasure*,WileyInterscience.
- G. B. Folland (2007), *Real Analysis Modern Techniques and Their Applications,* 2nd Edition, Wiley-Interscience.
- H. Roydenand P. Fitzpatrick (2010), *Real Analysis*,4th Edition, Pearson.
- W. Rudin (1976), *Principles of Mathematical Analysis,* 3rd Edition, McGraw-Hill.

Course Code	**MAT4033**
Course Title	**Functional Analysis**
Credit Value	**3**
Pre-requisites	**MAT3103, MAT3133, MAT4023**
Compulsory/Optional	**Compulsory**

Course Content

Banach spaces**:** Normed linear spaces, Linear maps between normed linear spaces, Functionals, Hahn-Banach Theorem, Dual spaces, Riesz-Markov Theorem for positive linear functionals.

Hilbert spaces**:** Inner product spaces, Orthogonality, Convex sets, projection,Riesz representation Theorem, Orthonormal bases.

Fundamental Theorems**:** Nowhere dense sets, Principle of Uniform boundedness, Open Mapping Theorem, Banach Isomorphism Theorem, Closed Graph Theorem.

Recommended Texts

- E. Kreyszig (1989), *Introductory Functional Analysis with Applications*, John Wiley.
- Barbara MacCluer (2009), *Elementary* Functional Analysis, Springer, Graduate Texts in Mathematics.

Course Code	MAT4043
Course Title	Complex Analysis II
Credit Value	3
Pre-requisites	MAT3122
Compulsory/Optional	Compulsory

Course Content

The Cauchy Theory: Cauchy's Theorem, The Cauchy-Goursat Theorem, The Fundamental Theorems of Integration, Integral Representations for Analytic Functions, Morera's theorem, Gauss's mean value Theorem, Maximum modulus principle, Cauchy's estimate, Liouville's Theorem, Fundamental Theorem of algebra.

Zeros of Analytic Functions: Identity Theorem, Maximum modulus principle, Minimum modulus principle, Schwarz's lemma, Argument principle, Rouche's Theorem, Open mapping Theorem, Conformal mappings, Fractional Linear Transformations, Riemann mapping Theorem.

The Maximum Modulus Theorem: The Maximum Principle, Minimum modulus principle, Schawarz's Lemma.

Residue Theory: Cauchy's Residue Theorem, Miscellaneous contour integrals.

Recommended Texts

- L. V. Ahlfors (1979), *Complex Analysis,* 3rd Edition, McGraw-Hill
- J. B. Conway (1978), *Functions of One Complex Variable I,* 2nd Edition, Springer.
- Liang-shin Hahn and Bernard Epstein (1996), *Classical Complex Analysis*, Jones and Bartlett Learning.

Course Code	MAT4053
Course Title	Fluid Mechanics II
Credit Value	3
Pre-requisites	MAT3053
Compulsory/Optional	Optional

Course Content

Perfect Fluid theory: Two-dimensional flow, Complex potential, Blasius Theorem, Conformal Mapping, Joukowski and Schwartz Christoffel transformations, Discontinuous motion, Vortex motion, Three-dimensional flow; Stokes' stream function in axi-symmetric flows, Image systems in 3-D viscous flow.

Viscous Flow: Navier-Stokes equation of motion and its exact solutions, Non-dimensionalisation, Reynold's number, Stoke's flow, Steady slow motion past a fixed sphere, Boundary Layer Theory

Mini Project: Fluid flow simulations using a computer software

Recommended Texts

- A. J. Chorin, and J. E. Marsden (1990), A Mathematical Introduction to Fluid Mechanics, 2nd Edition, Springer.
- F. Chorlton (1990), Fluid Dynamics, Oxford University Press.
- L. M. Mline-Thomson (1968), Theoretical Hydrodynamics, 5th Edition, McMillan.
- D. H. Wilson, and E. Arnold (1959), Hydrodynamics, Hodder and Stoughton Educ.
- Munson, Young, Okiishi, Huebsch (2009), Fundamentals of Fluid Mechanics, John wiley& Sons, Inc. 6th edition.
- R. Fox & A. McDonald (2011), Introduction to Fluid Mechanics, Wiley.

Course Code	**MAT4063**
Course Title	**Optimization Theory**
Credit Value	**3**
Pre-requisites	**MAT3113**
Compulsory/Optional	**Compulsory**
Course Content	
Advanced linear programming: Multidivisional linear program models, Dantzig-Wolf decomposition algorithm, goal programming. **Integer programming:** Integer program models, cutting plane algorithms and branch and bound algorithms. **Nonlinear programming:** Non-linear program models, Kuhn-Tucker conditions, Quadratic programming and Separable programming.	
Recommended Texts	
• Mokthar, S., Sherali, H. and Shetty, C. (2016). *Nonlinear Programming Theory and Algorithms*, 3rd Ed, John Wiley & Sons. D.A.Pierre • D.A.Pierre (2012), *Optimization Theory with Applications*, General Publishing Company. • H. A. Taha. (1998), *Integer programming Applications and Computations.*	

Course Code	**MAT4073**
Course Title	**Algebraic Topology**
Credit Value	**3**
Pre-requisites	**MAT3013, MAT3133**
Compulsory/Optional	**Optional**
Course Content	
Geometric constructions on Spaces: Cell complexes, operations on spaces, homotopy and homotopy type, the homotopy extension property. **The Fundamental Group:** Homotopy of paths, induced homomorphisms, Sierfriet-Van Kampen theorem, homotopy lifting properties, classification of covering spaces, applications to cell complexes. **Introduction to Homology:** Δ-complexes, simplicial homology, singular homology, exact sequences and excision, computations, cellular homology, Mayer-Vietoris sequences. **Applications:** Persistent homology, introduction to topological data analysis.	
Recommended Texts	
• A. Hatcher (2001), *Algebraic topology*, 1st Edition. • *Computational Topology: An Introduction, American Mathematical Society*; New ed. (December 8, 2009)	

Course Code	**MAT4083**
Course Title	**Financial Mathematics**
Credit Value	**3**
Pre-requisites	**None**

Compulsory/Optional	**Compulsory**
Course Content	
An introduction to options and markets, Interest and present value analysis, Geometric Brownian Motion, Pricing contract via arbitrage, Arbitage theorem, Black-Scholes option pricing formula, The binomial option pricing model, More results on options, Valuing by expected utility, Exotic options, an introduction to mathematical economics.	
Recommended Texts	
• J. C. Hull (1998), *Options, Futures, and Other Derivatives*, Prentice Hall. • S. M. Ross, (1987), *An Elementary Introduction to Mathematical Finance: Options and other Topics.* • P. Wilmott, S. Howisan, and J. Dewynne (2000), *The Mathematics of Financial Derivatives, A Student Introduction.*	

Course Code	**MAT4093**
Course Title	**Industrial Mathematics**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Mathematical Modelling: Mathematical modelling process, linear, integer and non-linear programming models, Modeling and solving problems using MS Excel and Solver add-in **Sensitivity Analysis** **Network Modelling**: The transshipment problem, the shortest path problem, the equipment replacement problem, transportation/assignment problems, generalized network flow problems, maximal flow problems, special modelling considerations and minimal spanning tree problems. **Project Management**: Introduction, constructing a project network, critical path method, project crashing, project evaluation and review technique, simulating project networks. **Decision theory**: Characteristics of decision problems, decision rules, decision trees.	
Recommended Texts	
• Cliff T. Ragsdale (2008), *Spreadsheet Modeling & Decision Analysis: A Practical Introduction to Management Science, (fifth edition)*, Thomson Press • S. Christian Albright, Wayne Winston and Christopher Zappe (2009), *Data Analysis and Decision Making with Microsoft Excel*, south-Western Cengage Learning, Fourth Edition • Hamdy A. Taha (2003), *Operations Research: An Introduction,* Pearson Education, Inc., Seventh Edition	

Course Code	**MAT4996**
Course Title	**Independent Study/Research Project**
Credit Value	**6**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Reading a research paper: Reading a research paper critically and creatively, highlighting crucial facts, taking	

notes and summarizing, comparing with other related work.

Learning to write a research paper (in Latex): Title, Abstract, Introduction, Results and discussion, Conclusions, Acknowledgement, References.

Preparing a presentation (in Microsoft Power Point/Latex): Outlines, Slide Structure, Fonts, Colour, Background, Graphs, Spelling and Grammar, Conclusions.

Developing presentation skills: Organizing, Time management, Confidence, Eye contact, Flow of delivery, Confronting questions.

Computational Skills: Programming using a computer language/software to solve mathematical models using numerical technique.

Independent study/Research project:

Students are expected to learn and familiarize with current research in mathematics through an independent study/research project under the supervision of a senior academic staff member in mathematics.

Students are required to write a report based on the independent study/research project and submit for evaluation at the completion.

Students are required to face a Viva based on the project conducted.

Recommended Texts

There are no recommended texts. The students are required to consult with their research supervisor for recommendations on relevant textbooks and research papers.

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Each student will undergo a full-time training in a mathematics-related industry for eight weeks, on a project assigned by the industry, approved by the Department of Mathematics. Students are required to maintain a portfolio, which should be certified by the Head of the relevant industry and submitted to the Department of Mathematics, within two weeks after completion of the training. Each student is also required to make a presentation based on work carried out during the period of training.

6. DEPARTMENT OF MOLECULAR BIOLOGY & BIOTECHNOLOGY

6.1 Molecular Biology & Biotechnology Courses

1000 LEVEL – BIOLOGY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Bio.*	Bio.**
BIO1202	Introduction to Biotechnology and its Application	2			
Total		**2**			

2000 LEVEL - MOLECULAR BIOLOGY & BIOTECHNOLOGY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
MBB2013	Biological Chemistry	3	BIO1012 CHE1013 CHE1023	√	√
MBB2063	Principles of Genetics	3	BIO1012		
MBB2112	Cell and Tissue Culture	2	BIO1012		
MBB2161†	General Microbiology	1	BIO1012	√	
MBB2212	Enzymology	2	BIO1012 CHE1013 CHE1023	√	√
MBB2263	Molecular Genetics	3	BIO1012 CHE1013 CHE1023	√	√

†Available to students who have not offered biology in GCE (A/L).

3000 LEVEL - MOLECULAR BIOLOGY & BIOTECHNOLOGY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
MBB3012	Biochemistry and Molecular Biology Laboratory	2	MBB2013 MBB2263	√	√
MBB3063	Recombinant DNA Technology	3	MBB2013 MBB2263	√	√
MBB3113	Molecular Cell Biology	3	MBB2013	√	
MBB3162	Molecular Immunology	2	BIO1012	√	
MBB3222	Molecular Biotechnology	2	MBB2263 MBB3063	√	√
MBB3263	Bioinformatics	3	MBB2263	√	
MBB3312	Fermentation Technology	2	CHE1013 CHE1023		
MBB3332	Molecular Phylogenetics	2	MBB2063 MBB2263	√	
MBB3353	Molecular Virology	3	MBB2263	√	
MBB3372	DNA and Forensic Medicine Laboratory	2	MBB2263	√	

4000 LEVEL - MOLECULAR BIOLOGY & BIOTECHNOLOGY				
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory
				Hons.
MBB4012	Molecular Biology of Plant and	2	MBB2013	√

	Animal Diseases		MBB2263	
MBB4122	Biotechnology Industry	2	MBB3222	√
MBB4162	Environmental Biotechnology	2	MBB2263 MBB3222	√
MBB4413	Special Topics in Cell and Molecular Biology	3	MBB3113	√
MBB4723	Scientific Writing and Research Methodology	3		√
MBB4882	Biosafety Issues in Biotechnology	2	MBB3222	
MBB4893	Quantitative Genomics and Molecular Breeding	3		
MBB4901	Independent Study	1		
MBB4913	Molecular Developmental Biology	3		√
MBB4923	Applications of Nanobiotechnology	3	MBB3222	
MBB4951	Seminar	1		√
MBB4998	Research Project	8		√
SCI4003	Industrial Training	2		

1000 Level Courses

Course Code	**BIO1202**
Course Title	**Introduction to Biotechnology and its Applications**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Molecular Biology and Biotechnology, historical development, landmark discoveries and pioneering scientists, diverse applications of Biotechnology in medicine, food production and environmental protection. World Wide Web Resources on Biotechnology and their reliability, the fraudulent nature of bioterrorism and how to circumvent it through proper and safe use of Biotechnology. In the contexts of humanitarian and environmental catastrophes, the use of Biotechnology as a developmental tool to face the challenges in the present and future.	
Recommended Texts	
• Thieman, W.J., and Palladino, M.A. (2012). *Introduction to Biotechnology*, 3rd Edition, Benjamin Cummings • Walker, S. (2006). *Biotechnology Demystified*, 5th Edition, The McGraw-Hill Companies • National Center for Biotechnology Information, U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, USA. Website: http://www.ncbi.nlm.nih.gov/ • International Service for the Acquisition of Agri-biotech Applications (ISAAA), Operated in USA, Kenya and Philippines. Website: http://www.isaaa.org/ • GMO Compass, the task of GMO Compass is to collect objective, science-based information on the use of genetic engineering in the agri-food industry and present it to the public in a way that is easy to understand and readily accessible. Maintained at Genius GmbH, Robert-Bosch-Str. 7, 64293 Darmstadt, Germany. Website: http://www.gmo-compass.org/eng/	

2000 Level Courses

Course Code	MBB2013
Course Title	Biological Chemistry
Credit Value	3
Pre-requisites	BIO1012, CHE1013, CH1023
Compulsory/Optional	Compulsory

Course Content

The cell as a basic unit of life; major intracellular organelles and their functions; structure and function of the biological membrane; membrane transport; energetics of biochemical reactions, structure, function and metabolism of biomolecules (carbohydrates, lipids, nucleic acids and proteins) in plant and animal cells; control of cellular metabolism.

Recommended Texts

- Nelson, D.L., Cox, M.M. (2012). *Lehninger Principles of Biochemistry*, 6^{th} Edition, Worth Publishers Inc.
- Berg, J.M., Tymoczko, J.L., Stryer, L. (2010). *Biochemistry*, 7^{th} Edition, Freeman, W.H. and Company
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., Scott, M.P. (2012). *Molecular Cell Biology*, 7^{th} Edition, Freeman, W.H. and Company

Course Code	MBB2063
Course Title	Principles of Genetics
Credit Value	3
Pre-requisites	BIO1012
Compulsory/Optional	Compulsory

Course Content

Mendelian genetics; alterations of Mendel laws; linkage; sex determination; cytoplasmic inheritance; cytogenetics; macro and micro mutations; polyploidy and aneuploidy; population genetics; quantitative genetics; heterosis and hybrid vigor; conservation and evolutionary genetics; applied genetics; medical genetics, principles and practical aspects of breeding and modern applications.

Recommended Texts

- Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. (2015). *Concepts of Genetics*, 11^{th} Edition, Pearson Education Inc.
- Brown, T.A. (2011). *Introduction to Genetics: A Molecular Approach*, Garland Science
- Pierce, B.A. (2013). *Genetics: A Conceptual Approach*, 5^{th} Edition, Freeman, W.H. and Company

Course Code	MBB2112
Course Title	Cell and Tissue Culture
Credit Value	2
Pre-requisites	BIO1012
Compulsory/Optional	Compulsory

Course Content
Introduction and general techniques in cell and tissue (plants and animals) culture; preparation of culture media; isolation and culture of animal cells and tissues for assays; cell counting techniques; embryo and meristem cultures; somatic embryogenesis; protoplast isolation and culture. Somatic hybridisation; applications of cell and tissue culture; cell and tissue culture as a tool in Genetic Engineering and Biotechnology, micro propagation as a business, establishment and management of a tissue culture laboratory.
Recommended Texts
• Jain, S.M., Haggman, H. (eds) (2007). *Protocols for Micropropagation of Woody Trees and Fruits*, Springer • Bhojwani, S.S., Dantu, P.K. (2013). *Plant Tissue Culture: An Introductory Text*, Springer • Smith, R.H. (2012). *Plant Tissue Culture, Techniques and experiments*, 3rd Edition, Elsevier Inc. • Mather, J.P., Roberts, P.E. (2013). *Introduction to Cell and Tissue Culture: Theory and Techniques (Introductory Cell and Molecular Biology Techniques)*, Plenum Press, New York

Course Code	**MBB2161**
Course Title	**General Microbiology**
Credit Value	**1**
Pre-requisites	**BIO1012**
Compulsory/Optional	**Available to students who have not offered biology in GCE (A/L). Compulsory for General and Special**
Course Content	
Introduction. Basic groups of microbes; prokaryotic microbes, viruses and eukaryotic microbes. Microbial reproduction. Microbial taxonomy. Typical microbial growth curve, and predict the effect of different environmental conditions. Role of microbes in global C, N, S, and P cycles, and list examples of microbes that contribute these cycles. Symbiotic interactions between microbes and other organisms. Microbial diseases, prevention and treatments. Other applications of Microbiology. Importance of microbes to the environment. Basic laboratory procedures in Microbiology.	
Recommended Texts	
• Willey, J., Sherwood, L., Woolverton, C.J. (2013). *Prescott's Microbiology*, 9th Edition, McGraw-Hill Education • Talaro, K., Chess, B. (2014). *Foundations in Microbiology: Basic Principles*, 9th Edition, McGraw-Hill Education • Glazer, A.N., Nikaido, H. (2007). *Microbial Biotechnology: Fundamentals of Applied Microbiology*, (2nd Edition, Cambridge University Press	

Course Code	**MBB2212**
Course Title	**Enzymology**
Credit Value	**2**
Pre-requisites	**BIO1012, CHE1013, CHE1023**
Compulsory/Optional	**Compulsory**
Course Content	
Enzymes as catalysts in biological systems; protein structure and folding; classification and nomenclature of enzymes; mechanism of enzyme action; kinetics of enzymatic reactions; quantitative and qualitative aspects of enzyme activity; effect of temperature, pH, substrate, enzyme concentration and inhibitors on enzyme activity; mode of enzyme regulation; qualitative tests for different types of enzymes; isozymes and isozyme analysis;	

enzyme assay methods; purification and characterization; application of enzyme technology in industry; protein engineering.
Recommended Texts
• Scope, R.K. (1993). *Protein Purification: Principles and Practice*, 3rd Edition, Springer • Fersht, A. (1999). *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding*, 3rd Edition, Freeman, W.H. and Company • Nelson, D.L., Cox, M.M. (2012). *Lehninger Principles of Biochemistry*, 6th Edition, Worth Publishers Inc.

Course Code	**MBB2263**
Course Title	**Molecular Genetics**
Credit Value	**3**
Pre-requisites	**BIO1012, CHE1013, CHE1023**
Compulsory/Optional	**Compulsory**
Course Content	
Organization of prokaryotic and eukaryotic genomes; genes and chromosomes; mitochondrial and chloroplast DNA; mobile genetic elements; genome replication; genetic recombination; DNA repair; RNA synthesis, processing and metabolism; the genetic code; protein synthesis; regulation of gene expression; DNA cloning and microarrays; genetic disorders and gene therapy; genomics and genome projects; overview of genome mapping.	
Recommended Texts	
• Strachan, T., Read, A. (2010). *Human Molecular Genetics*, 4th Edition, Garland Science • Watson, J.D., Baker, T.A., Bell A.P., Gann, A., Levine, M., Losiick, R. (2013). *Molecular Biology of the gene*, 7th Edition, Cold Spring Harbor Laboratory Press, Pearson • Nelson, D.L., Cox, M.M. (2012). *Lehninger Principles of Biochemistry*, 6th Edition, Worth Publishers Inc. • Weaver, R.F. (2011). *Molecular Biology*, 5th Edition, McGraw-Hill	

<u>3000 Level Courses</u>

Course Code	**MBB3012**
Course Title	**Biochemistry and Molecular Biology Laboratory**
Credit Value	**2**
Pre-requisites	**MBB2013, MBB2263**
Compulsory/Optional	**Compulsory**
Course Content	
UV-visible spectroscopy; chromatographic methods; electrophoresis; DNA and RNA purification and analysis; polymerase chain reaction (PCR); restriction fragment length polymorphism (RFLP); DNA sequencing; southern and northern transfer techniques; immunochemical methods; radioactive and non-radioactive detection methods.	
Recommended Texts	
• Green, M.R., Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*, 4th Edition, Cold Spring Harbor Laboratory	

• Ninfa, A.J., Ballou, D.P., Benore, M. (2009). *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*, 2nd Edition, John Wiley and Sons, Inc. • Greenfield, E.A. (2014). *Antibodies: A Laboratory Manual*, 2nd Edition, Cold Spring Harbor Laboratory

Course Code	**MBB3063**
Course Title	**Recombinant DNA Technology**
Credit Value	**3**
Pre-requisites	**MBB2013, MBB2263**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Recombinant DNA technology; purification and manipulation of DNA; cloning vectors; transformation; production of genomic and cDNA libraries; isolation, identification & characterization of cloned genes; gene expression; restriction mapping; generation of transgenic and cisgenic plants and animals.	
Recommended Texts	
• Green, M.R., Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*, 4th Edition, Cold Spring Harbor Laboratory • Brown, T.A. (2010). *Gene cloning and DNA analysis: An Introduction*, 6th Edition, Willey Blackwell • Watson, J.D., Meyes, R.M., Caudy, A.A., Witkowski, J.A.(2007). *Recombinant DNA: Genes and Genomes – A Short Course: Watson, Recombinant DNA*, 3rd Edition, Macmillan Higher Education	

Course Code	**MBB3113**
Course Title	**Molecular Cell Biology**
Credit Value	**3**
Pre-requisites	**MBB2013**
Compulsory/Optional	**Compulsory**
Course Content	
Structure of eukaryotic and prokaryotic cells; cell organelles and functions; cell membrane, function and transport cross membranes; protein trafficking; organelle biogenesis; cytoskeleton and cell motility; extracellular matrix and cell adhesion; cell-to cell signaling; signaling in the sensory system; cell cycle, regulation and apoptosis.	
Recommended Texts	
• Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretsher, A., Ploegh, H., Amon, A., Scott, M.P. (2012). *Molecular Cell Biology*, 7th Edition, Freeman, W.H. and Company • Alberts, B., Johnson, A., Lewis, J., Morgan D., Raff, M., Roberts, K., Walter, P. (2004). *Molecular Biology of the Cell*, 6th Edition, Garland Science • Craig, N., Green, R., Greider, C., Storz, G., Wolberger, C., Cohen-Fix, O. (2014). *Molecular Biology: Principles of Genome Function*, 2nd Edition, Oxford University Press	

Course Code	**MBB3162**
Course Title	**Molecular Immunology**
Credit Value	**2**
Pre-requisites	**BIO1012**
Compulsory/Optional	**Compulsory**
Course Content	
The immune system; structure and function of immunoglobulins; cells of lymphoid systems; response to antigenic stimulation; antigenic determinants; antigen processing and presentation; intercellular interactions; compliment system and its function; biology of the major histocompatibility complex; mechanisms of immunity and hypersensitivity; Immunmodulatory products of parasites; diagnostic assays using antibodies; polyclonal and monoclonal antibodies; phage antibody production; immunochemical methods.	
Recommended Texts	
• Murphy, K. (2011). *Janeway's Immunobiology*, 8th Edition, Garland Science • Delves, P.J., Martin, S.J., Burton, D.R., Roitt, I.M. (2011). *Roitt's Essential Immunology*, 12th Edition, Wiley-Blackwell • Abbas, A.K., Lichtman, A.H.H., Pillai, S. (2014). *Cellular and Molecular Immunology*, 8th Edition, Elsevier Saunders • Greenfield, E.A. (Ed) (2014). *Antibodies; A Laboratory Manual*, 2nd Edition, Cold Spring Harbor Laboratory Press	

Course Code	**MBB3222**
Course Title	**Molecular Biotechnology**
Credit Value	**2**
Pre-requisites	**MBB2263, MBB3063**
Compulsory/Optional	**Compulsory**
Course Content	
Genetically modified organisms, and their applications; Emergence of Molecular Biotechnology, microbial biotechnology, agricultural biotechnology, medical biotechnology, germplasm assessment and conservation, aquatic biotechnology, bioremediation, effective microorganisms, bioprospecting, regulation of Biotechnology, Biotechnology as a business, career prospects in Biotechnology.	
Recommended Texts	
• Brown, T.A. (2010). *Gene Cloning and DNA Analysis: An Introduction*, 6th Edition, Wiley- Blackwell • Glick, B.R., Pasternak, J.J., Pattern, C.L. (2009). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*, 4th Edition, American Society for Microbiology Press, Washington DC • Dehlinger, C.A. (2014). *Molecular Biotechnology*, Jones and Bartlett Learning	

Course Code	**MBB3263**
Course Title	**Bioinformatics**
Credit Value	**3**
Pre-requisites	**MBB2263**
Compulsory/Optional	**Compulsory**

Course Content
Molecular databases; bioinformatics and computational biology software; sequence alignment;; phylogenetic analysis; functional genomics; genome analysis; complete genome; DNA micro arrays; protein structure analysis, motif identification, evolutionary alignments and structure prediction; drug design; archives and information retrieval, introduction to Systems Biology.
Recommended Texts
• Baxevanis, A. D., Ouellette, B.F. (2004). *A Practical Guide to the Analysis of Genes and Proteins*, 3rd Edition, Wiley-Interscience • Pevsner, J., (2009). *Bioinformatics and Fundamental Genomics*, 2nd Edition, Willey Blackwell • Mount, D.W. (1910). *Bioinformatics: Sequence and Genome Analysis*, 2nd Edition, IDEA Group Publishing • Lesk, A.M. (2014). *Introduction to Bioinformatics*, 4th Edition, Oxford University Press

Course Code	MBB3312
Course Title	Fermentation Technology
Credit Value	2
Pre-requisites	CHE1013, CHE1023
Compulsory/Optional	Optional
Course Content	
Microorganisms used in industrial fermentation; isolation and preservation of pure cultures; mutants, factors influencing rate of mutation; bioreactor design and operation; fermentation kinetics; culture media; sterilisation; control of different parameters; process monitoring; isolation of products; current applications, synthesis of secondary metabolites, strain improvement applications of functional genomics in fermentation technology.	
Recommended Texts	
• El-Mansi, E.M.T., Bryce, C.F.A., Dahhou, B., Sanchez, S., Demain, A.L., Allman, A.R. (Ed). *Fermentation Microbiology and Biotechnology*, CRC Press, Taylor and Francis Group • Dehlinger, C.A. (2014). *Molecular Biotechnology*, Jones and Bartlett Learning	

Course Code	MBB3332
Course Title	Molecular Phylogenetics
Credit Value	2
Pre-requisites	MBB2063, MBB2263
Compulsory/Optional	Compulsory
Course Content	
Introduction to evolution and systematics; molecular basis of heredity and evolution; genetic maps; general principle of systematics; phylogenetic variations in plant and animal taxa (cladistics and phonetics etc.); molecular phylogenies; speciation and hybridization; applications of molecular methods in biodiversity assessment; in vitro germplasm conservation.	
Recommended Texts	
• Ridley, M. (2003). *Evolution*, Blackwell • Hall, B.K., Hallgrimsson, B. (2013). *Strickberger's Evolution*, 5th Edition, Jones and Bartlet Publishers • Yang, Z. (2014). *Molecular Evolution: A Statistical Approach*, 1st Edition, Oxford University Press	

Course Code	MBB3353
Course Title	Molecular Virology
Credit Value	3
Pre-requisites	MBB2263
Compulsory/Optional	Compulsory

Course Content

History of virology and general characteristics of viruses; virus classification; structure and genomes; virological methods; virus infection cycle; virus receptors and mechanism of virus entry; replication and transcription of RNA viruses; reverse transcription and integration of DNA viruses; replication and transcription of DNA viruses; viral protein synthesis; virus assembly and exit; virus pathogenesis; oncogenic transformation; host resistance to viral infection; antiviral treatment; HIV and AIDS; exploitation of viruses in gene therapy.

Recommended Texts

- Flint, S.J., Racaniello, V.R. (2015). *Principles of Virology, Vol. 1 and 2*, 4th Edition, ASM Press
- Shors, T. (2011). *Understanding Viruses*, 2nd Edition, Jones & Bartlett Learning
- Cann, A.J. (2015). *Principles of Molecular Virology*, 6th Edition, Elsevier

Course Code	MBB3372
Course Title	DNA and Forensic Medicine Laboratory
Credit Value	2
Pre-requisites	MBB2263
Compulsory/Optional	Compulsory

Course Content

Principles and methods of DNA profiling; recent examples; biological evidences and serology, distribution and spattering of blood and other useful biological samples, isolation of DNA from forensic samples, techniques in DNA analysis; forensic DNA databases; STR population data analysis, forensic genetics, challenges and case studies, accreditation and quality control, applications such as criminal investigations and paternity analysis, implications in law enforcements, future trends.

Recommended Texts

- Dehlinger, C.A. (2014). *Molecular Biotechnology*, Jones and Bartlett Learning
- Rudin, N., Inman, K. (2001). *An Introduction to Forensic DNA Analysis*, 2nd Edition, CRC Press
- Buttler, J.M. (2014). *Advance Topics in Forensic DNA Typing: Interpretation*, Elsevier

4000 Level Courses

Course Code	**MBB4012**
Course Title	**Molecular Biology of Plant and Animal Diseases**
Credit Value	**2**
Pre-requisites	**MBB2013, MBB2263**
Compulsory/Optional	**Compulsory**

Course Content

Genetic disorders; abiotic stresses; infectious diseases; host-parasite interactions; infectiousness of disease-causing agents; host response to disease causing agents; diagnosis of disease; treatment; molecular aspects to drug resistance; rational drug design.

Recommended Texts

- Agrios, G.N. (2002). *Plant Pathology*, 5th Edition, Elsevier Academic Press
- Fox, R.T.V. (1993). *Principals of Diagnostic Techniques in Plant Patholog*y, C & B Intl.
- Delves, P.J., Martin S.J., Burton, D.R., Roitt, I.M. (2011). *Roitt's Essential Immunology*, 12th Edition, Wiley-Blackwell
- Cheng, L., Zhang, D.Y., Eble, J.N. (Eds) (2013). *Molecular Genetic Pathology*, 2nd Edition, Springer Reference

Course Code	**MBB4122**
Course Title	**Biotechnology Industry**
Credit Value	**2**
Pre-requisites	**MBB3222**
Compulsory/Optional	**Compulsory**

Course Content

Pharmacogenomics for personalized medicine, concept of White Biotechnology, industrial production process according to Kyoto objective applications, economic potential and implications for the society, biopharmaceuticals, food and feed, paper and pulp, bio-energy and high-tech food production with GM , Bio-refineries.

Recommended Texts

- Soetaert, W., Vandamme, E.J. (2010). *Industrial Biotechnology: Sustainable Growth and Economic Success*, 1st Edition, Willey-UCH
- Kamm, B., Grubew, P.R., Kamm, M. (2010). *Biorefineries Industrial Processes and Products: Status Quo and Future Directions*, Wiley-UCH
- Da Silva, S.S., Chandel, A.K. (2014). *Bio Fuels in Brazil: Fundamental Aspects*, Recent Development and Future Perspectives. Springer

Course Code	**MBB4162**
Course Title	**Environmental Biotechnology**
Credit Value	**2**
Pre-requisites	**MBB2263, MBB3222**

Compulsory/Optional	Compulsory
Course Content	
Living organisms as pollution indicators; biodegradation; waste management; pollution treatment; bio-mining; biogas production; microbes in environmental management, phytotechnology and photosynthesis, biotechnology waste, genetic manipulation, integrated Environmental Biotechnology.	
Recommended Texts	
• King, R.B., Long, G.M., Sheldon, J.K., (1997). *Practical Environmental Bioremediation: The Field Guide*, 2nd Edition, CRC Press • Ergas, S.J., Daniel, P., Chang, Y., Schroeder, E.D., Eweis, J.B. (Eds) (1998). *Bioremediation Principles*, McGraw-Hill • Evans, G.M., Furlong, J.C. (2010). *Environmental Biotechnology: Theory and Application*, Willey-Blackwell	

Course Code	MBB4413
Course Title	**Special Topics in Cell and Molecular Biology**
Credit Value	**3**
Pre-requisites	**MBB3113**
Compulsory/Optional	**Compulsory**
Course Content	
Cancer as a micro-evolutionary process; the preventable causes of cancer, finding the cancer critical genes; the molecular basis of cancer cell behavior; cancer treatment: present and future. epidermis and its renewal by stem cells, renewal by multi-potent stem cells: blood cell formation; fibroblasts and their transformations, stem cell engineering. primordial germ cells and sex determination in mammals; eggs; sperm; fertilization.	
Recommended Texts	
• Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2004). *Molecular Biology of the cell*, 6th Edition, Garland Science • Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon A., Scott, M.P. (2012). *Molecular Cell Biology*, 7th Edition, Freeman, W. H. and company • Karp, G. (2013). *Cell and Molecular Biology Concepts and Experiments*, 7th Edition, Wiley PLU.	

Course Code	MBB4723
Course Title	**Scientific Writing and Research Methodology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Review of research area; introduction to project; types and purposes of project proposals; structure and components of proposal; covering letter and the recipients of the proposal; identifying, justifying and presenting a problem; literature review and development of proposal; time frame, resource identification and budgeting; research philosophy, responsible conduct of research, monitoring project progress, thesis writing, avoidance of plagiarism, indices to measure productivity of scientists and research organizations.	
Recommended Texts	

- Graustein, J.S. (2013). *How to Write an Exceptional Thesis or Dissertation: A Step–By–Step Guide from Proposal to Successful Defense*, Atlantic Publishing Group
- Schimel, J. (2011). *Writing Sciences: How to Write Papers that get Cites and Proposal that get Funded*, Oxford University press
- Locke, L.F., Spirduso, W.W., Silverman, S.J. (2013). *Proposals that work: A Guide for Planning Dissertations and Grant Proposals*, 6th Edition, SAGE publication

Course Code	**MBB4882**
Course Title	**Biosafety Issues in Biotechnology**
Credit Value	**2**
Pre-requisites	**MBB3222**
Compulsory/Optional	**Optional**

Course Content

Status of molecular biotechnology in the world, use of genetically modified organisms in food industry and medicine, international treaties on biosafety such as Cartagena protocol, potential risks and their assessment, transgene introgression from genetically modified crops to their wild relatives (gene flow issues), the international guidelines for research involving recombinant DNA molecules, the release of genetically modified crops into the environment, food safety, biosafety framework for a country, the role of science in making informed decisions through transparent dialogues, globalization and the international governance of modern biotechnology for safe use.

Recommended Texts

- Ludlow, K., Smyth, S.J., Falck-Zepeda J. (2014). *Socio-Economic Considerations in Biotechnology Regulation*, Springer
- Grumet, R., Hancock, J.F., Maredia, K.M., Weebadde, C. (2011). *Environmental Safety of Genetically Engineered Crops*, Michigan State University Press, USA
- Knechtges, P.L. (2011). *Food Safety: Theory and Practice*. Jones and Bartlett Learning

Course Code	**MBB4893**
Course Title	**Quantitative Genomics and Molecular Breeding**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Advanced quantitative genetics and genomics, parametrical and non-parametrical statistical methods and related software, genome mapping and molecular markers, QTL theory, haplotype analysis, marker assisted selection as the basis of molecular breeding, association mapping, SNP platforms and GBS data, assessment and estimation of genomic diversity in germplasm conservation and management, definition of core-collections.

Recommended Texts

- Xu, S. (2013). *Principles of Statistical Genomics*, Springer
- Khatib, H. (2015). *Molecular and Quantitative Animal Genetics*, Wiley Blackwell
- Xu, Y. (2010). *Molecular Plant Breeding*, CAB International

Course Code	MBB4901
Course Title	**Independent Study**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

The student will work on a selected Molecular Biology or Biotechnology topic of interest under the guidance of a faculty member who agrees to supervise such work, and write a comprehensive report according to the specifications provided by the Department. This could preferably be a library research.

Recommended Texts

- None

Course Code	MBB4913
Course Title	**Molecular Developmental Biology**
Credit Value	**3**
Pre-requisites	**MBB3113**
Compulsory/Optional	**Compulsory**

Course Content

Plant development; Arabidopsis as a model plant for plant molecular genetics, basic strategy and molecular mechanisms of sexual reproduction in flowering plants, germination, involvement of environmental and hormonal signals in coordinating developmental events of the seedlings, switch from meristematic growth to flower formation and cell signaling. Animal development; Basic anatomical features of animals, proteins mediating cell interactions and gene regulation, regulatory DNA, interactions between cells of embryo, inductive signals, asymmetric cell division, positive feedback, signaling pathways controlling developmental patterning, Caernorhabditis elegans as a model for the study of development, Drosophila and the molecular genetics of pattern formation, homeotic selector genes and the patterning of the anteroposterior axis, organogenesis and the patterning of appendages, cell movements and the shaping of the vertebrate body, mammalian development and neural development.

Recommended Texts

- Gilbert, S.F. (2013). *Developmental Biology*, 10^{th} Edition, Sinauer Associates, Inc.
- Moore, K.L., Cersaud, T.V.N., Torchia, M.G. (Eds) (2015). *The Developing Human: Clinical Oriented Embryology*, 10^{th} Edition, Elsevier
- Henning, L., Köhler, C. (Eds) (2010). *Plant Developmental Biology: Methods and Protocols* (*Methods in Molecular Biology*), Human Press
- Fornara, F. (Ed) (2014). *Advances in Botanical Research: The Molecular Genetics of Floral Transition and Floral Development*, Volume 72, Elsevier

Course Code	MBB4923
Course Title	Applications of Nanobiotechnology
Credit Value	3
Pre-requisites	MBB3222
Compulsory/Optional	Optional

Course Content

Nanobiotechnological applications in environment and food, applications in health and disease, lab on a chip concept, protein biomolecular motors, molecular nanosystems, nanobiosensors and their applications, nanoparticle based molecular labels, engineering gene circuits, nanopore methods for DNA detection and sequencing, nanodiamonds and its applications, nanomaterials for cell detection, nanomembranes, nanoparticles as non-viral transfection agents, nanoparticles for electrochemical bioassays, microbial nanoparticle production, Nanobiotechnologies in adult stem cell research, nanotechnology in tissue engineering, enzyme reactors based on nano-structured materials, nanotoxicity, recent advances in Nanobiotechnology research and development.

Recommended Texts

- Mirkin, C.A., Niemeyer, C.M. (2004). *Nanobiotechnology: Concepts, Applications and Perspectives*, 1st Edition, Wiley VCH
- Mirkin, C.A., Niemeyer, C.M. (2007). *Nanobiotechnology II: More Concepts and Applications*, 1st Edition, Wiley VCH
- Vo-Dinh, T. (2007). *Nanotechnology in Biology and Medicine: Methods, Devices and Applications*, 1st Edition, CRC Press
- Xie, Y. (2012).*The Nanobiotechnology Handbook*, 1st Edition, CRC Press
- Nicolini, C. (Ed.) (2015). *Nanobiotechnology in Energy, Environment and Electronics: Methods and Applications* (*Pan Stanford Series on Nanobiotechnology*), CRC Press

Course Code	MBB4951
Course Title	Seminar
Credit Value	1
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

The student will present a seminar on a topic based on the latest developments in an area of Molecular Biology, Biotechnology or a related field. Upon announcement of the commencement of the seminar course, the student should get the consent for the selected topic from the Department coordinator for the seminar course.

Recommended Texts

- Gallo, C. (2009). *The Presentation Secretes of Steve Jobs. How to be insanely great in front of any audience*, The McGraw-Hill Companies

Course Code	MBB4998
Course Title	Research Project
Credit Value	8
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content
The student will carry out a research project under the supervision of a faculty member. The student is required to give a seminar on the project, display a poster and submit a report according to the specification given by the Department. The selection and planning of the project should commence during the second semester of the third Academic year.

Recommended Texts
• Graustein, J.S. (2013). *How to Write an Exceptional Thesis or Dissertation: A Step-By-Step Guide from Proposal to Successful Defense*, Atlantic Publishing Group • Shamoo, A.E., Resnik, D.B. (2015). *Responsible Conduct of Research*, Oxford University Press • Schimel, J. (2011). *Writing Sciences: How to Write Papers that Get Cites and Proposal that Get Funded*, Oxford University Press

7. DEPARTMENT OF PHYSICS

7.1 Physics Courses

1000 LEVEL - PHYSICS					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
PHY1103	General Physics I	3		√	√
PHY1203	General Physics II	3		√	√
PHY1911	Elementary Physics Laboratory I	1		√	√
PHY1921	Elementary Physics Laboratory II	1		√	√
Total		**08**		**08**	**08**

2000 LEVEL - PHYSICS					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
PHY2102	Mechanics and Fluid Dynamics	2	PHY1103	√	√
PHY2112	Vibrations and Waves	2			
PHY2302	Introductory Quantum Mechanics and Atomic Physics	2	PHY1203	√	√
PHY2402	Statistical Physics & Thermodynamics	2	PHY1103	√	√
PHY2812	Introductory Astronomy	2			
PHY2822	Medical Physics	2			
PHY2842	Energy and the Environment	2			
PHY2852	Circuit Theory & Introductory Electronics	2		√	
PHY2911	General Physics Laboratory I	1	PHY1911, PHY1921	√	√
PHY2921	General Physics Laboratory II	1	PHY1911, PHY1921	√	√
PHY2931	Electronic Laboratory I	1	PHY2852	√	
Total		**19**		**11**	**08**

3000 LEVEL - PHYSICS					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
PHY3102	Classical Mechanics	2	PHY2102	√	
PHY3112	Special Relativity	2		√	
PHY3202	EM Waves and Communication	2	PHY1203	√	√
PHY3212	Physical Optics and Optical Instruments	2	PHY1103	√	√
PHY3302	Quantum Mechanics I	2	PHY2302	√	
PHY3502	Nuclear Physics I	2		√	√
PHY3512	Elementary Particle Physics	2			
PHY3602	Solid State Physics I	2		√	√
PHY3612	Semiconductor Physics and Devices	2			

PHY3622	Structures and Properties of Materials	2			
PHY3703	Mathematical Methods in Physics	3		√	
PHY3712	Computational Physics	2			
PHY3812	Astrophysics	2			
PHY3822	Biophysics	2			
PHY3832	Health Physics	2			
PHY3842	Physics of Atmosphere, Weather and Climate	2			
PHY3852	Advanced Electronics	2	PHY2852		
PHY3862	Experimental Techniques and Material Characterization	2			
PHY3872	Introductory Nanoscience	2			
PHY3911	General Physics Laboratory III	1	PHY1911, PHY1921	√	√
PHY3921	Applied Physics Laboratory	1	PHY3911		
PHY3932	Advanced Physics Laboratory I	2	PHY2911, PHY2921	√	
PHY3942	Advanced Physics Laboratory II	2	PHY2911, PHY2921	√	
PHY3951	Electronics Laboratory II	1	PHY2931		
PHY3992	Scientific Writing and Seminar	2		√	
Total		**48**		**24**	**09**

4000 LEVEL - PHYSICS					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	
PHY4112	General Relativity	2			
PHY4122	Introduction to Cosmology	2	PHY4112		
PHY4202	Electromagnetic Theory	2	PHY3202	√	
PHY4302	Quantum Mechanics II	2	PHY3302	√	
PHY4312	Quantum Mechanics III	2	PHY4302		
PHY4402	Statistical Physics	2	PHY2402	√	
PHY4502	Nuclear Physics II	2	PHY3502	*	
PHY4512	Nuclear Reactor Physics	2	PHY3502		
PHY4522	Radiation Detection and Measurement	2			
PHY4602	Solid State Physics II	2	PHY3602	*	
PHY4622	Magnetic Materials and Superconducting Phenomena	2	PHY2402		
PHY4632	Ion Conducting Materials and Devices	2			
PHY4642	Polymer Physics	2			
PHY4852	Data Acquisition and Signal Processing	2	PHY3852		
PHY4872	Nanophysics	2	PHY3872/ CHE3723		
PHY4912	Advanced Physics Laboratory III	2	PHY3942	√	
PHY4922	Investigatory Physics Laboratory	2		√	

PHY4996	Research Project	6		√	
SCI4003	Industrial Training	3			
Total		**43**		**18**	

1000 Level Courses

Course Code	**PHY1103**
Course Title	**General Physics I**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Mechanics: Newton’s Laws, Inertial and gravitational mass, Forces of nature, Friction, Inertial frames, Galilean Transformations, Accelerating frames, Inertial forces, Principle of equivalence, Work done by forces, Work-energy theorem, Conservative and Non-conservative forces, Potential energy, Conservation of mechanical energy, Generalized work energy theorem, Impulse, Momentum and Center of mass, Conservation of momentum, Elastic and Inelastic collisions, Rocket motion, Angular velocity and acceleration, Torque, Moment of inertia, Rotational kinetic energy, Angular momentum, Rolling bodies, Work, Power and energy in rotational motion, Precession, Newton's law of gravitation, Gauss law, Kepler’s laws and planetary motion, Artificial satellites, Reduced mass, Gravitational potential energy, Escape velocity, Fluid Mechanics: Stream line flow, Equation of continuity, Bernoulli's principle, Viscous flow.

Special Relativity: Einstein’s postulates: Lorentz transformation equations, Time dilation, Length contraction, Velocity transformations, Mass, Momentum, Kinetic energy and mass-energy relation, Relativistic Doppler effect.

Thermal Physics: Basic assumptions in Kinetic Theory, Ideal gas, Molecular interpretation of temperature, Equipartition theorem and Heat capacities, Maxwell-Boltzmann speed distribution, Van der Waals equation.

Thermodynamic systems: State of a system, State variables, State of equilibrium, zeroth law. Reversible and non-reversible transformations, Cyclic, Isothermal, Isochoric and Isobaric, Adiabatic processes.

First law of thermodynamics and its applications, Second law of thermodynamics, Heat engines, Efficiency of heat engines, Coefficient of performance of refrigerators, Carnot cycle, Otto cycle, Carnot theorem, Entropy of a thermodynamic systems, properties of entropy.

Waves: Simple Harmonic Motion (SHM): Equation of motion, General solution, Amplitude, Phase. Energy considerations of SHM, Applications of SHM: Simple pendulum, Torsional oscillator, Compound pendulum, Bottle resonator, Lissajous figures. Damped Harmonic Motion: Equation of motion and solution, Critical, heavy and under damping, Examples from different areas. Forced Oscillators: Equation and solution, Introduction to resonance.

Optics: EM waves, Wave equations, Interference of light, Huygen's principle, Double beam interference: Intensity distribution, Relationship between phase and path difference, Young's double slit experiment, Fresnel's biprism, Lloyd’s mirror. Interference by thin films: soap bubbles, oil patches, etc., Fringes of equal inclination and thickness, Newton’s rings. Diffraction: Fraunhofer diffraction, Fresnel diffraction, Intensity distribution due to single slit, Circular aperture, Double slit and diffraction grating.

Recommended Texts

- Serway, R.A. & Jewett, J. W. (2013). *Physics for Scientists and Engineers.* 9th Edition, Brooks Cole.
- Resnik, R., Halliday, D. and Walker, J. (2013). *Fundamentals of Physics.* 10th Edition, John Wiley & Sons. Inc.

Course Code	PHY1203
Course Title	General Physics II
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

ELECTRICAL AND MAGNETIC PHENOMENA

The Electrostatics: Coulomb's law, electrical field, electric field lines, effects of electric fields, point discharge, electric potential, technological applications of electrostatics: electrostatic precipitator, xerography, inkjet printer, laser printer, Gauss law, polar and non-polar dielectrics, molecular theory of polarization, polarization vector, electric displacement vector.

Electromagnetism: Biot-Savart law, Ampere's circuit law, definition of the magnetic field, force on a current wire, torque on a current loop, magnetic moment, magnetic dipole in a magnetic feild, motion of a charged particle in a magnetic field, Van Allen belts, velocity selector, mass spectrometer, cyclotron frequency.

Magnetism in Matter: Paramagnetism, Diamagnetism, Ferromagnetism, measurement of magnetic properties, magnetic susceptibility, magnetic hysteresis.

Electromagnetic Induction: Faraday's law of electromagnetic induction, Lenz's law, mutual inductance, self-inductance, energy stored in an inductor.

Transient Circuits: *R-C* circuit, *R-L* circuits, *L-C* circuit, series *R-L-C* circuit.

Alternating Current: Alternating current generation, RMS value for alternating current and voltage.

MODERN PHYSICS

Introductory Quantum and Atomic Physics:

Particle nature of electromagnetic radiation: Blackbody radiation, Planck's hypothesis and quantization of radiation, photoelectric effect, Compton effect, energy and momentum of a photon. **Wave nature of particles:** De Broglie hypothesis, electron and neutron diffraction, wave particle duality, Heisenberg's uncertainty principle. **Atomic Physics:** Rutherford's atomic model, Bohr theory of hydrogen atom, quantization of energy and momentum, excitation and ionization potentials, hydrogen line spectrum, Rydberg's formula, Hydrogen-like atoms, X-rays: production, spectrum, properties, Mosely's law.

Molecules and Matter: Molecular bonds; potential energy curve, ionic, covalent, Hydrogen, Van der Walls and metallic bonds, energy levels and spectra of molecules.

Nuclear and Particle Physics:

Basics of Nucleus: Properties of the nucleus: Atomic number, neutron number, mass number, isotopes, isotones, isobars, nuclear size and shape, nuclear stability, N vs Z plot, nuclear force, nuclear mass, nuclear binding energy. **Radioactivity:** Law of radioactivity, half-life, units, α, β and γ decay, radioactive series, radiation sources, Carbon dating. **Nuclear Reactions:** Nuclear fission, energy released in fission, nuclear fusion, nuclear power, nuclear reactors. **Radiation biology:** Radiation types (non-ionizing and ionizing), absorbed dose, quality factor, dose equivalent, biological effects of radiation, permissible limits. **Elementary particles:** Introduction: properties (charge, mass, spin, antiparticle, etc.) and conservation laws. types of elementary particles: Leptons, Hadrons, Mesons, Baryons, Fermion, Bosons, Quarks: up, down, strange, charm, top, bottom.

Recommended Texts

- Serway, R.A. and Jewett, J. W. (2013). *Physics for Scientists and Engineers*. 9th Edition, Brooks Cole.
- Resnik, R., Halliday, D. and Walker, J. (2000). *Fundamentals of Physics*. 6th Edition, John Wiley & Sons. Inc.
- Tipler, P.A. (2007). *Physics for Scientists and Engineers*. 6th Edition, W. H. Freeman
- Krane, K.S. (2012). *Modern Physics*. 3rd Edition, Wiley
- Tipler, P.A, and Llewellyn, R.A. (2011). *Modern Physics*. 6th Edition, W. H. Freeman

Course Code	PHY1911
Course Title	Elementary Physics Laboratory I
Credit Value	1
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Basic Measuring Instruments: Introduction to measuring instruments related to mechanics, optics and sound.

Experiments related to Mechanics: Determination of various physical quantities related to simple harmonic motion, mechanical properties of matter using basic methods, and uniform circular motion.

Experiments related to Optics: Determination of properties of lenses, refractive index of solids and liquids using spectrometer, experiments using Laser kits.

Experiments related to Sound: Determination of sound properties using resonance of air columns, Sonometer.

Computer aided experiments and demonstration of experiments

Recommended Texts

- Nichols, F.R. and Smith, C.H. (2010). *Manual of Experimental Physics.* Kessinger Publishing, LLC.
- Worsnop, B.L., Flint, H.T. (1951). *Advanced Practical Physics for Students.* 9th Edition, Littlehampton Book Services Ltd.

Course Code	PHY1921
Course Title	Elementary Physics Laboratory II
Credit Value	1
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Basic Measuring Instruments: Introduction to measuring instruments related to electricity, magnetism, properties of matter and heat.

Experiments related to Electricity: Determination of electrical properties of materials such as electrical resistivity, thermal coefficient of resistance and properties of electrical components such as e.m.f., internal resistance, capacitance, and inductance.

Experiments related to Magnetism: Determination of Earth's magnetic field and magnetic fields of solenoids and bar magnets.

Experiments related to Properties of Matter: Determination of mechanical properties such as viscosity, surface tension and Young's modulus.

Experiments related to Heat: Determination of thermal properties of solids and liquids such as specific heat capacity, latent heats, thermal expansion coefficient and verification of laws in heat such as Newton's cooling law.

Computer aided experiments and demonstration experiments

Recommended Texts

- Nichols, F.R. and Smith, C.H. (2010). *Manual of Experimental Physics.* Kessinger Publishing, LLC.
- Worsnop, B.L., Flint, H.T. (1951). *Advanced Practical Physics for Students.* 9th Edition, Littlehampton Book Services Ltd.

2000 Level Courses

Course Code	**PHY2102**
Course Title	**Mechanics and Fluid Dynamics**
Credit Value	**2**
Pre-requisites	**PHY1103**
Compulsory/Optional	**Compulsory**

Course Content

Introduction: Mechanics as kinematics, dynamics and equilibrium, the frame of reference, inertial frames and non-inertial frames.

Coordinate systems: Rectangular (Cartesian) coordinate system, spherical coordinate system, cylindrical coordinate system, polar coordinate system, conversion between different coordinate systems.

Central orbits: Motion using plane polar coordinates, velocity and acceleration of a particle in polar coordinates, central force, motion under the influence of central forces, conservation laws in polar coordinates, general differential equation of a central orbit, conic equation, circular, elliptical, parabolic and hyperbolic paths, conditions for stability of circular orbits.

Mechanics of a system of particles: Conservation of linear momentum, conservation of angular momentum, the law of conservation of energy in vector and integration forms, definition of centre of mass (CM), linear momentum of the system, angular momentum of the system, total angular momentum with respect to CM, energy of the system, the two-body problem.

Motion in rotating frames: General equation of motion in a rotating frame, centripetal and centrifugal forces, Coriolis force, Earth as a rotating frame, angle between plumb line and true vertical, deviation of a falling object due to Coriolis force, cyclones and anticyclones.

Motion of rigid bodies: Pure rotation, pure translation and general motion, Euler's theorem, moment of inertia, radius of gyration, parallel axis theorem, perpendicular axis theorem, rolling without slipping.

Fluid Dynamics: Newtonian and non-Newtonian fluids, variation of stress with rate of shear, equation of motion of fluid, flow between parallel plates, Poiseuille flow, motion of a liquid between two coaxial cylinders, viscosity of gases, Rankin's method.

Recommended Texts

- French, A. P. (1971). *Newtonian Mechanics.* W. W. Norton.
- Smith, P. and Smith, R. C. (1990). *Mechanics.* 2nd Edition, John Wiley & Sons, Inc.
- Spiegel, M. R. (1967). *Schaum's Outline of Theory and Problems of Theoretical Mechanics*. McGraw-Hill.
- Massey, B. S. (1998). *Mechanics of Fluids.* 7th Edition, Nelson Thornes
- Serway, R.A. and Jewett, J. W. (2013). *Physics for Scientists and Engineers.* 9th Edition, Brooks Cole.

Course Code	**PHY2112**
Course Title	**Vibrations and Waves**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Periodic Motion: Simple harmonic motion, rotating vectors and complex number representations, energy and equation of motion.

Damped harmonic motion: Equation of damped harmonic motion, over damped, critical damped and under damped conditions, lifetime, mechanical energy, quality factor and logarithmic decrement.

Forced vibrations and resonance: Oscillator under a harmonic force with no damping, damped oscillator with harmonic forcing, transient phenomena, power absorbed by a driven oscillator, resonance, mechanical impedance.

Coupled oscillators and normal modes: Two coupled oscillators and normal modes in longitudinal oscillations coupled pendulum, superposition of normal modes and beats, normal modes of transverse oscillations in two coupled oscillators, normal modes of transverse oscillations in many coupled oscillators, free vibrations and forced harmonic vibrations of a stretched string.

General principles of wave propagation: Wave equations, Transverse waves, Linearity, interference, superposition and the Huygens construction, Fourier series and transforms, and the convolution theorem, Wave packets, dispersion and, phase and group velocities, Wave mechanical operators; wavefunction averages; transform limits and uncertainty, Energy and momentum transport in wave motions, Continuity conditions and interfaces, Longitudinal waves, waves from moving sources, waves in various physical systems

Recommended Texts

- French, A.P. (1971). *Vibrations and Waves.* Chapman & Hall.
- Pain, H.J. (2001). *The Physics of Vibrations and Waves.* 5^{th} Edition, John Wiley & Sons, Inc.

Course Code	**PHY2302**
Course Title	**Introductory Quantum Mechanics and Atomic Physics**
Credit Value	**2**
Pre-requisites	**PHY1203**
Compulsory/Optional	**Compulsory**

Course Content

Failure of classical physics: Review on particle nature of electromagnetic radiation.

Wave nature of particles: Young's double slit experiment and Davisson-Germer experiment with electrons, wave particle duality, wave packets.

Introduction of Schrödinger formalism: 1-dimensional time dependent and time independent Schrödinger equation, Hamiltonian and its eigenfunctions and eigenvalues.

Wavefunction and its properties: Single-valuedness, continuity of wavefunction and its derivative, normalizability, probability density, expectation value, boundary conditions, bound and unbound states.

Application of 1D Schrödinger equation: Free particle, step potentials, barrier potentials and tunneling effect with examples, infinite potential well, qualitative solutions to the finite potential well and simple harmonic oscillator potential (introducing energy levels and wavefunctions).

Introduction to Atomic Physics: Line spectrum, continuous spectrum, absorption spectrum, hydrogen line spectrum.

Hydrogen atom: Introduction of 3D time independent Schrödinger equation, outline of the wave functions, radial wavefunction and spherical harmonics, energy levels, quantum numbers n, l and m, probability density, selection rules, comparison with Bohr theory, spectroscopic notation, hydrogen-like atoms, alkali atoms.

Orbital angular momentum: Quantization of L^2 and L_z, vector model, magnetic moment of atoms, effect of magnetic field, Larmor precession, splitting of energy levels.

Spin: Stern-Gerlach experiment, electron spin, spin magnetic moment, gyro magnetic ratio.

Total angular momentum: L-S coupling, quantum numbers j and m_j, spectroscopic notation, selection rules.

Fine structure of spectral lines: Spin-orbit coupling and energy shifts (without relativistic effect and Darwin term), splitting of energy levels of hydrogen atom, selection rule.

Effect of external magnetic fields: Normal and anomalous Zeeman effect, Landé g-factor, Zeeman pattern of

hydrogen, transitions and selection rules; stimulated emission.
Recommended Texts
• Resnik, R. and Halliday, D. (1992). *Basic Concepts in Relativity and Early Quantum Theory*. 2nd Edition, Macmillan Publishing Company, USA • Krane, K. (1996). *Modern Physics.* 2nd Edition, John Wiley & Sons, Inc. • Constantinescu, F. and Magyari, E. (1971). *Problems in Quantum Mechanics*. Pergamon Press • Fromhold, A. T. (1981). *Quantum Mechanics for Applied Physics and Engineering.* Dover Publications

Course Code	**PHY2402**
Course Title	**Statistical Physics and Thermodynamics**
Credit Value	**2**
Pre-requisites	**PHY1103**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Statistical Methods: Elementary statistical concepts and examples, random walk problem in one dimension, binomial probability distribution, Gaussian distribution, general discussion on mean values, application to random walk problem. **Application of Statistical Methods to a model system**: Magnetic dipoles in a magnetic field, degeneracy function *g(N,m)*, Gaussian approximation of *g(N,m)*, Sterling approximation, energy of the magnetic dipole system. **Classical Statistical Mechanics and Thermodynamics**: Statistical equilibrium of a system, Maxwell-Boltzmann distribution Law, partition function, thermal equilibrium, temperature and zeroth law of Thermodynamics, application to the ideal gas, conservation of energy of a system of particles, many particle systems, the first law of Thermodynamics, entropy of a system in statistical equilibrium, processes in terms of entropy. **Quantum Statistics**: Fermi-Dirac statistics, Fermi-Dirac gas, application of Fermi-Dirac statistics to electrons in a metal, Bose-Einstein statistics, the photon gas, Planck's radiation law, Stefan-Boltzmann law, quantum statistics in the classical limit. **First law of Thermodynamics**: Statement of the first law of Thermodynamics and applications. **Second law of Thermodynamics**: Statements of the second law of Thermodynamics, Carnot cycle, absolute thermodynamic temperature, thermal engines. **Entropy**: Properties of cycles, entropy and its properties, Clapeyron equation. Thermodynamic potentials: Enthalpy, Joule-Thomson expansion, Helmholtz free energy, Osmotic pressure, Gibb's free energy, extremum principle. **Maxwell relations**: Derivation of Maxwell relations, simple applications of Maxwell relations.	
Recommended Texts	
• Kittel, C. (1980). *Thermal Physics.* 2nd Edition, W. H. Freeman • Alonso, M. and Finn, E. J. (1967). *Fundamental University Physics (Vol III)*. Addision-Wersley • Reif, F. (1965). *Fundamentals of Statistical and Thermal Physics*. McGraw-Hill • Callen, H.B. (1985). *Thermodynamics and an Introduction to Thermostatistics.* 2nd Edition, John Wiley & Sons, Inc.	

Course Code	**PHY2812**
Course Title	**Introductory Astronomy**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

History of astronomy: From ancient astronomy to the modern era.

Telescopes: Types of telescopes and their uses.

Brief introduction to the universe: Contents and dimension of the observable universe.

Observational Astronomy: Concept of the celestial sphere, the motions of the objects in the solar system, and various celestial phenomena such as eclipses, seasons, etc.

Astronomical objects: Physical properties and the formation of the solar system, stars and their evolution, physical properties and structure of galaxies and their distribution in the universe.

Cosmology: Introduction to Cosmology.

Astrobiology: Introduction to Astrobiology.

Recommended Texts

- Palen, S. and Larson, A. M. (2015). *Learning Astronomy by Doing Astronomy: Collaborative Lecture Activities.* W.W Norton
- Green, S. F. and Jones, M. H. (2015). *An Introduction to the Sun and Stars*. 2nd Edition, Cambridge University Press
- Jones, M. H., Lambourne, R. J. A. and Serjeant, S. (2004). *An Introduction to Galaxies and Cosmology.* Cambridge University Press
- Schneider, S. E. and Arny, T. T. (2012). *Pathways to Astronomy.* 3rd Edition, McGraw-Hill

Course Code	**PHY2822**
Course Title	**Medical Physics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction: Diagnostic medical imaging and image characters.

Ultrasound imaging: Acoustic impedance, transducers, different modes of scanning, attenuation of ultrasound, Doppler effect.

X-ray related imaging techniques: X-ray production, interaction of X-rays with matter, image formation, contrast media, Computed Tomography (CT), image reconstruction in CT, CT dose, mammography, angiography, fluoroscopy.

Nuclear imaging: Nuclear radiation, images from radioactivity, planner imaging, Anger camera, SPECT imaging, PET imaging.

MRI imaging: Nuclear structure and MR active nuclei, precession and resonance, signal generation and relaxation processes, instrumentation.

Optical instrumentation in medicine: Optical fibers in medicine, endoscopes, laser applications in medicine.

Recommended Texts

- Smith, N. B. and Webb, A. R. (2011). *Introduction to Medical imaging: Physics, Engineering and clinical applications.* Cambridge University Press
- Kane, S. A. (2003). *Introduction to Physics in Modern Medicine*. Taylor & Francis, Inc.
- Davidovits, P. (2001). *Physics in Biology and Medicine*. Harcourt/Academic
- Hobbie, R. K. (1997). *Intermediate Physics for Medicine and Biology*. Springer
- Cameron, J.R., Skofronic, J.G. and Grant, R.M. (1999). *Physics of the Body.* Madison: Medical Physics Publishing

Course Code	**PHY2842**
Course Title	**Energy and the Environment**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Physics principles related to energy: Conservation, units, global energy consumption, consumption in Sri Lanka, socio-economic importance of energy.

Renewable and non-renewable energy: Sources, limitations, impact on environment, storage and conversion, green energy, energy efficiency.

Environmental pollution: Types of pollution (air, radiation, noise…etc.), impact of pollution on weather, climate and health, impact of weather on pollution, pollution control and monitoring, international standards and regulations.

Recommended Texts

- Kraushaar, J. J. and Ristinen, R. A. (2005). *Energy and Problems of a Technical Society*. 2^{nd} Edition, ACS Publications
- Boeker, E. and Van Grondelt, R. (2011). *Environmental Physics.* 3^{rd} Edition, John Wiley & Sons, Inc.
- Fowler, J. M. (1975). *Energy and the Environment.* McGraw-Hill
- Haughton, J. T. (2001). *The Physics of Atmospheres.* 2^{nd} Edition, Cambridge University Press
- Brinkman, A.W. (2008). *Physics of the Environment*. Imperial College Press

Course Code	**PHY2852**
Course Title	**Circuit Theory and Introductory Electronics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Circuit analysis: Thevenin's theorem and applications, internal resistance and loading, DC analysis of circuits with resistors, capacitors and inductors

AC generation: Variation of current and voltage with time, amplitude, frequency and period of an AC wave, phase and phase difference, peak values, RMS values, average values of currents, voltages and power.

Analysis of AC circuits using vector method: Introduction to vector method, phase diagrams and impedance of circuit elements, addition of impedances, series and parallel *RL*, *RC* and *LRC* circuits.

Analysis of AC circuits using complex number method: Introduction to complex number method, impedances and admittance of circuit elements, series and parallel *RL*, *RC* and *LRC* circuits.

Energy and power in AC systems: Energy and power of circuit elements, average power, power factor, power dissipation at resonance and quality factor, voltage magnification in *LRC* circuits.

Filter circuits and bridges: High pass filter, low pass filter and band pass filter, band width and AM radio receiver, introduction to AC bridges, Owen's bridge, Schering bridge and Robinson bridge.

Junction diode: I-V characteristics, forward diode drop, applications: half-wave and full-wave rectification, Diode applications

Transistor: Switch, common base amplifier, common emitter amplifier, emitter follower, biasing, design examples, current source, introduction to transistor models.

Digital Electronics: Digital versus analog, basic logic elements.

Combinational logic: Truth table, number systems, Boolean algebra, gates, De Morgan's theorem, number codes, logic circuit analysis, logic circuit design, Karnaugh maps, combinational functions available as ICs, chip expansion, implementation of arbitrary truth tables.

Sequential logic: Flip-flops, master-slave and edge-triggered, divide-by-n circuits, counters, registers, RAMs, digital communication basics, sequential ICs, state diagrams.

Recommended Texts

- Horowitz, P. and Hill, W. (2015). *The Art of Electronics.* 3rd Edition, Cambridge University Press
- Malvino, A. P. (2016). *Electronics Principles.* 8th Edition, McGraw-Hill
- Floyd, T. L. (2012). *Electronic Devices (Electron Flow Version).* 9th Edition, Prentice Hall

Course Code	**PHY2911**
Course Title	**General Physics Laboratory I**
Credit Value	**1**
Pre-requisites	**PHY1911, PHY1921**
Compulsory/Optional	**Compulsory**

Course Content

Determination of physical properties by experiments based on oscillatory systems such as Kater's pendulum, coupled pendulum, torsion pendulum etc.

Determination of moment of inertia of Discs and Rings using the concept of rigid body rotation.

Determination of properties of materials such as Young's modulus, Shear modulus, Poisson's ratio, Surface Tension, Viscosity etc.

Recommended Texts

- Nichols, F.R., and Smith, C.H. (2010). *Manual of Experimental Physics.* Kessinger Publishing, LLC
- Squires, G. L. (2001). *Practical Physics.* 4th Edition, Cambridge University Press

Course Code	**PHY2921**
Course Title	**General Physics Laboratory II**
Credit Value	**1**
Pre-requisites	**PHY1911, PHY1921**
Compulsory/Optional	**Compulsory**

Course Content

Determination of thermal and thermodynamical properties such as Expansion coefficients, Thermal conductivity, Enthalpy of vaporization etc. Determination of mechanical properties of materials using waves. Determination of speed, frequency and wavelength of sound waves using the concept of resonance.
Recommended Texts
• Nichols, F.R. and Smith, C.H. (2010). *Manual of Experimental Physics.* Kessinger Publishing, LLC

Course Code	**PHY2931**
Course Title	**Electronics Laboratory I**
Credit Value	**1**
Pre-requisites	**PHY2852**
Compulsory/Optional	**Compulsory**
Course Content	
Use of instruments: Component identification and use of oscilloscopes, signal generators and multi-meters. **Filter circuits:** High pass, low pass and band pass filters. **Diode circuits:** Diode characteristics and common diode circuits. **Transistor circuits:** Characteristics, transistor amplifiers, transistor switches. **Digital circuits:** Identification of functions of logic gates, implementation of logic functions with basic logic gates and basic circuits with sequential logic circuits, flip-flops.	
Recommended Texts	
• Horowitz, P. and Hill, W. (2015). *The Art of Electronics.* 3rd Edition, Cambridge University Press • Malvino, A. P. (2016). *Electronics Principles.* 8th Edition, McGraw-Hill • Floyd, T. L. (2012). *Electronic Devices (Electron Flow Version).* 9th Edition, Prentice Hall	

3000 Level Courses

Course Code	**PHY3102**
Course Title	**Classical Mechanics**
Credit Value	**2**
Pre-requisites	**PHY2102**
Compulsory/Optional	**Compulsory**
Course Content	
Mathematical formulations: Geometrical equations of a line, plane and sphere in 3-D, equipotential surfaces, review of coordinate systems, coordinate transformations, rotating coordinate systems. **Introduction to classical mechanics:** Conservative forces, constants of motion, virtual displacement and virtual work done, generalized forces and coordinates, holonomic and non–holonomic constraints, virial theorem. **Equations of motions:** Motion of rigid bodies, D'Alembert's principle, the principle of least action, Lagrange's equation, Hamiltonian, Hamilton's equations, cyclic coordinates, generalized potential, Lagrange's undetermined multipliers. **Transformations:** Point transformation, canonical transformations, generating functions of Hamiltonian,	

Hamiltonian–Jacobi theory, Poisson brackets, Ehrenfest theorem, adiabatic invariants and canonical variables.
Recommended Texts
• Benacquista Matthew J. and Romano Joseph D. (2018). *Classical Mechanics.* Springer • Taylor John R. (2002). *Classical Mechanics.* University Science Books • Desloge Edward A. (1982). *Classical Mechanics – vol 1, 2, 3.* John Wiley & Sons • Goldstein, H, Poole, C.P and Safko, J.L. (2001). *Classical Mechanics.* 3rd Edition, Addision-Wesley • Landau, L. and Lifshitz, E.M. (1976). *Mechanics.* 3rd Edition, Pergamon press Ltd.

Course Code	**PHY3112**
Course Title	**Special Relativity**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Background: Galilean transformation (GT), invariance of Newton's laws under GT, problems with GT and electromagnetism, Michelson-Morley experiment, postulates of special relativity, derivation of Lorentz transformation (LT) equations. **Consequences of LT Equations**: Time dilation, length contraction, Ultimate speed, relations for addition of velocities, aberration and Doppler effect. **Relativistic Dynamics**: Relativistic momentum, relativistic force law and the dynamics of a single particle, equivalence of mass and energy, transformation properties of momentum, energy, mass and force. **Relativistic Electromagnetism**: Electric and magnetic fields, transformation equations for electric and magnetic fields, field of a uniformly moving point charge, Forces and fields near a current carrying wire, force between moving charges, invariance of Maxwell's equations, possible limitation of special relativity. **Special Topics**: Geometric representation of space-time, solutions of twin paradox.	
Recommended Texts	
• Morin, D.J. (2017). *Special Relativity: For the Enthusiastic Beginner*. CreateSpace Independent Publishing • Resnick, R. (1968). *Introduction to special Relativity*. John Wiley & sons • French, A.P. (1990). *Special Relativity.* 2nd Edition, Chapman & Hall	

Course Code	**PHY3202**
Course Title	**Electromagnetic Waves and Communication**
Credit Value	**2**
Pre-requisites	**PHY1203**
Compulsory/Optional	**Compulsory**
Course Content	
Maxwell's equations: A review on vector algebra and vector calculus, Maxwell's equations in free space, dielectric media, conducting media, properties of plane EM waves in free space, polarization of EM waves, Poynting's theorem. **Transmission of EM waves:** In conducting media, in dielectric media, in ionized gases, propagation of EM	

waves in the ionosphere. **Communication:** Radio/TV wave transmission, dipole antennas, wireless communication, transmission line theory and concepts, antennas and equivalent principles.
Recommended Texts
• Griffiths, D.J. (2017). *Introduction to Electrodynamics.* 4th Edition, Pearson • Pollack, G.L. and Stump, D.R., *Electromagnetism.* Addison Wesley Co. • Jackson, J.D., *Classical Electrodynamics.* John Wesley & Sons Inc.

Course Code	**PHY3212**
Course Title	**Physical Optics and Optical Instruments**
Credit Value	**2**
Pre-requisites	**PHY1103**
Compulsory/Optional	**Compulsory**
Course Content	
Interference: Multiple beam interference, Michelson Interferometer, Fabry-Perot interferometer, use of thin films in optics. **Diffraction:** Diffraction gratings, resolving power of optical instruments, Fresnal diffraction, diffraction by circular objects and apertures, diffraction at straight edges. **Polarization:** Introduction, quarter wave and half wave plates, Babinet compensator, analysis of polarized light, interference of polarized light. **Lasers:** Production of lasers, types of lasers, applications of lasers. **Introduction to optical Instruments:** Holography, recording and reconstruction of an off- axis hologram, recording materials (thick and thin holograms), white light holograms, holographic interferometry. **Fiber optics:** Optical fibers and their importance, different types of optical fibers, inter model dispersion, fiber modes, signal attenuation, basics of optical fiber communications. **Display devices:** Neon displays, cathode ray tube, liquid crystals, electrocrhromic and photochromic devices, laser writing and reading.	
Recommended Texts	
• Jenkins, F.A. and White, H.E. (1975). *Fundamentals of Optics.* 3rd Edition, McGraw-Hill • Longhurst, R.S. (1967, 1973). *Geometrical and Physical Optics.* 3rd Edition, Longman • Fowles, G.R. (1989). *Modern Optics.* 2nd Edition, Dover publications, New York • Jenkin and White (1975). *Fundamentals of Optics.* 3rd Edition, McGraw-Hill	

Course Code	**PHY3302**
Course Title	**Quantum Mechanics I**
Credit Value	**2**
Pre-requisites	**PHY2302**
Compulsory/Optional	**Compulsory**
Course Content	
1D Schrodinger equation: Time dependent and time independent Schrödinger equations, time dependent wave function.	

Applications of 1D Schrodinger Equation: Review of infinite potential well**,** Finite potential well, Delta function potential, Linear harmonic oscillator potential (analytically).

Quantum mechanics in 3D: Schrödinger equations in Cartesian coordinates: introducing the method of separation of variables, application in free particle, particle in a box and harmonic oscillator potential.

Separation of variables in Cylindrical coordinates: Cylindrically symmetric potential, Bessel equation and Bessel functions, application in infinite cylindrical well.

Separation of variables in Spherical coordinates: Central potentials, angular equation and spherical harmonics, parity, associated Legendre polynomials, magnetic and orbital quantum numbers, the radial equation, infinite spherical well.

The Hydrogen atom: Radial equation and radial wave function, energy eigenvalues and principle quantum number, energy level diagrams, excitation and transitions (H-spectrum), angular momentum operators (L^2, L_Z) in spherical coordinates, angular equation and eigenvalue equation.

Recommended Texts

- Griffiths, D.J. (2004). *Introduction to Quantum Mechanics*. 2nd Edition, Pearson
- Resnik, R. and Iceburg (1985). *Quantum Mechanics.* 2nd Edition, John Wiley & son
- Liboff, R. L. (2002). *Introductory Quantum Mechanic*s, Addison Wesley
- Krane, K. (1996). *Modern Physics.* 2nd Edition, John Wiley & sons

Course Code	**PHY3502**
Course Title	**Nuclear Physics I**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Distribution of Nuclear matter: α-particle scattering, Rutherford's formula, differential cross-session, other experimental evidence for the nuclear structure, nuclear density variation, nuclear radius, skin thickness.

Nuclear Binding energy: Neutron and proton separation energies, features of binding energy curve, liquid drop model, semi empirical mass formula, nuclear stability of isobars.

Nuclear Reaction: Reaction energy, threshold energy, exothermic and endothermic reactions

Nuclear Decay: Conservation laws, α-decay, β-decay, electron capture, γ-decay, nuclear excited states, internal conversion, isometric states.

Nuclear Fission: Spontaneous fission, activation energy, explanation using semi empirical formula, induced fission, mass distribution of fragments, energy released, neutrons emitted, chain reaction, fission reactors.

Nuclear Fusion: Basic process, characteristics of fusion, thermonuclear fusion, possibility of fusion reactors.

Recommended Texts

- Krane, K.S. (1998). *Introductory Nuclear Physic*. John Wiley & Sons
- Burcham (1995). *Nuclear Physics.* Longman Group Limited
- Wong, S.S.M. (1998). *Introductory Nuclear Physics.* Wiley-VCH
- Lilley, J. (2001). *Nuclear Physics: Principles & Applications*. Wiley
- Kaplan, I. (2002). *Nuclear Physics.* Narosa

Course Code	PHY3512
Course Title	Elementary Particle Physics
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Optional

Course Content

Introduction to Elementary particles: Units and interactions in particle physics, Classification of particles: fermions and bosons

Introduction to the Standard model: quarks, leptons and fundamental forces

Quarks and Leptons: properties and quantum numbers of quarks and leptons

Space-time symmetries: Noether‘s theorem, conservation laws, CPT theorem

Kinematics: introduction to four vectors, kinematics of two-body interactions

Wave equations: Klein-Gordon equation, Dirac equation, interpretation of antiparticle, Feynman diagrams, Feynman rules

Quark Model: the eightfold way, classify hadrons in Y-I3 diagrams, quark model, hadron masses in quark model

QCD: introduction to QCD, degrees of freedom, colour and colour confinement, perturbation and non-perturbation regimes in QCD, perturbative expansions in QCD

Experimental techniques: particle accelerators and detectors.

Recommended Texts

- Martin, R. & Shaw, G. (1992). *Particle Physics.* John Wiley & Sons
- Griffiths, D. (2008). *Introduction to Elementary Particles.* Wiley-VCH
- Perkins, D.H. (2000). *Introduction to High Energy Physics.* Cambridge University Press
- Halzen, F. & Martin, A.D. (1994). *Quarks and Leptons.* John Wiley & Sons

Course Code	PHY3602
Course Title	Solid State Physics I
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Crystals: Crystalline and amorphous solids, basics of crystallography and crystal systems, Bravais lattices, unit cells and unit vectors, packing fractions, reciprocal lattices, Brillouin zone, Miller indices, crystal defects.

Crystal Structure Determination: X-ray, electron and neutron diffraction, Bragg's law, Atomic scattering factor, structure factor.

Lattice vibrations: Vibration of one dimensional monoatomic and diatomic chains, phonons.

Thermal properties: Lattice heat capacity, Dulong and Petit model, Einstein's theory and Debye theory.

Free Electrons in solids: Drude's model of metals, DC electrical conductivity, heat capacity, thermal conductivity, Wiedemann–Franz law, introduction to quantum mechanical free electron theory, density of states, Fermi wave vector, Fermi energy and Fermi temperature.

Energy bands in solids; Effective mass of electrons; conductors, semi-conductors, insulators, motion of

charged carriers in solids, drift velocity, mobility.
Recommended Texts
• Kittel, C. (2005). *Introduction to Solid State Physics.* 8th Edition, John Wiley & Sons, Inc. • Ashcroft, N. and Mermin, D. (1976). *Solid State Physics.* Saunders College Publishing • Srivastava, J.P. (2015). *Elements of Solid State Physics.* 4th Edition, PHI Learning • Omar, M. A. (1975). *Elementary Solid State Physics.* Addision-Wesley Publishing

Course Code	**PHY3612**
Course Title	**Semiconductor Physics and Devices**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to semiconductors: Conductors, insulators and Semiconductors, elemental and compound Semiconductor materials, qualitative analysis of band theory of solids, E-k diagrams and electron effective mass, E-k diagrams for Semiconductors and the concept of holes. **Semiconductors in equilibrium and Semiconductor Statistics:** Density of State function and extension to Semiconductors, Fermi-Dirac probability function, Fermi energy and Boltzmann approximation, equilibrium and carrier concentrations at equilibrium, intrinsic Semiconductors and intrinsic Fermi level, doping and extrinsic (n-type and p-type) Semiconductors, equilibrium electron and hole concentrations, degenerate and non-degenerate Semiconductors, compensated Semiconductors, charge neutrality and dopant ionization, position of Fermi level in extrinsic Semiconductors and temperature dependence. **Carrier Transport properties:** Carrier drift current, Charge carriers, carrier lifetimes, mobility and conductivity, Diffusion and diffusion currents, Einstein relation, Hall effect. **Non-equilibrium excess carriers in Semiconductors:** Excess carrier generation and recombination, excitation mechanisms and photoluminescence, continuity equation and time-dependent diffusion equation, ambipolar transport equation and its applications, quasi Fermi level, excess carrier lifetimes, surface effects. **The p-n junction:** Basic structure of the p-n junction, p-n junction at equilibrium (built-in barrier potential, built-in electric field, space charge width and junction capacitance), p-n junction under reverse applied bias (space charge width and junction capacitance),one sided junctions, minority carrier distribution, ideal p-n junction current and temperature effects, junction breakdown (avalanche and Zener breakdown), tunnel diode, optical devices, optical absorption and absorption coefficient, electroluminescence, photodetectors, photodiodes, LEDs, laser diodes, solar cells and quantum well devices. **Metal-semiconductor junctions and Heterojunctions:** Schottky barrier diode, ideal junction properties, *I-V* characteristics and comparison with p-n junction, Ohmic contacts, Heterojunctions, materials and energy band diagrams. **Transistors:** Bipolar transistor action, basic principle of operation, simplified current relations, modes of operation, amplification, introduction to Junction Field Effect (JFET) Transistors and Metal-Oxide-Semiconductor Field Effect (MOSFET) Transistors and their action.	
Recommended Texts	
• Neamen, D.A. *Semiconductor Physics and Devices.* 3rd Edition, McGraw-Hill • Tyagi, M.S. (2008). *Introduction to Semiconductor Materials and Devices.* 1st Edition, Wiley • Seeger, K. (2004). *Semiconductor Physics: An Introduction.* 9th Edition, Springer	

Course Code	**PHY3622**
Course Title	**Structures and Properties of Materials**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Structure–Property relations: atomistic basics of elastic deformation, thermal properties,

Elastic behaviour: relationship between elastic constants, stresses in cylindrical and spherical shells, bending and buckling of beams;

Plastic behaviour: dislocations; edge and screw; dislocation motion; micro-plasticity of single crystals, behaviour of polycrystalline materials; fracture and creep theories;

Mechanical testing of materials: stress-strain relation, hardness, impact test, bend test, fracture (fast and slow fracture), fatigue and creep tests;

Microstructure and properties, solid solutions and intermediate phases, phase diagrams, free energy, phase equilibria, nucleation and growth, non-equilibrium phase transformation, some commercial alloy systems.

Recommended Texts

- Lovell, M., Avery, A. and Vernon, M. *Physical Properties of Materials,* Springer
- Moffat, W.G., Pearsall, G.W. and Wulff, J. *The Structure and Properties of Materials*, Wiley
- Raghavan, V. *Materials Science and Engineering,* PHI Learning
- Bolton, W. (1998). *Engineering Materials Technology*. 3rd Edition, Butterworth-Heinemann
- Hearn, E.J. (1997). *Mechanics of Material.* 3rd Edition, Butterworth-Heinemann

Course Code	**PHY3703**
Course Title	**Mathematical Methods in Physics**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Vector analysis: Vectors in mechanics, differential operators, gradient of a scalar function, divergence of a vector field, curl of a vector field, vector integrals

Application of vector calculus in Physics: Equation of continuity of flowing fluids, angular velocity of a rotating body, Gauss's theorem in electrostatics, heat flow in solids, motion of a charged particle in electromagnetic field

Coordinate systems: Cartesian coordinates, cylindrical coordinates and spherical coordinates, applications of coordinate systems in Physics problems

Vector Spaces and Matrices: Linear vector spaces, linear operators, matrices, coordinate transformation, evaluation of determinants, Cramer's rule, eigenvalue problems, diagonalization of matrices, introduction to Dirac notation in quantum mechanics and other physics applications

Ordinary differential equations: 1st and 2nd order ordinary differential equations, physical applications, pressure variation for a static compressible fluid, time of cooling, falling body under gravity, motion of time varying masses, electrical currents varying with time in LCR circuits, bending of beams, dynamics of a particle, oscillatory motion,

Power series method: Bessel Equation and Bessel functions, Legendre differential equation and Legendre polynomials, eigenfunctions, eigenvalues and Green's functions, application of Green's function in

electrodynamics **Partial differential equations:** General methods, Laplace's equation, Poisson's equation **Infinite series:** Taylor series, binomial expansion, Fourier series and periodic functions and their applications in Physics **Integral Transforms:** Fourier analysis and Fourier transforms, Laplace transforms, physical applications in integral transformations **Contour integration:** Cauchy's theorem and integral formula, Residue theorem, simple applications of contour integration
Recommended Texts
• Jordan, D. and Smith, P. (2008). *Mathematical Techniques: An Introduction for the Engineering, Physical, and Mathematical Sciences.* 4th Edition, Oxford University Press • Arfken, G.B., Weber, H.J. and Harris, F.E. (2013). *Mathematical Methods for Physicists.* 7th Edition, Elsevier Inc. • Boas, M. L. (2006). *Mathematical Methods in the Physical Sciences.* 3rd Edition, John Wiley & Sons, Inc.

Course Code	**PHY3712**
Course Title	**Computational Physics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Basic mathematical operations: Numerical differentiation and integration, matrix computation, ordinary differential equations, boundary value and eigenvalue problems, Fourier transforms, partial differential equations, Monte Carlo methods, Error, Precision, and Stability **Numerical Integration:** Trapezoidal, Simpson **Interpolation, Extrapolation and Data Fitting:** Polynomial interpolation, data fitting, least-squares fits **Deterministic Randomness:** Random number generators, random walk **Monte Carlo Methods:** Integration by rejection, integration by importance sampling, numerical root Finding and equation solving **Systems of Linear Equations:** Gauss-Jordan elimination. L-U decomposition, eigenvalue problems, derivatives using finite-differences **Ordinary Differential Equations (ODEs):** Order reduction, boundary conditions, Euler method, Runge-Kutta method. **Partial Differential Equations (PDEs):** Classification: hyperbolic, parabolic and elliptic equations, initial vs. boundary value problems **Fourier Transforms:** Properties, Convolution and Correlation **Discrete Sampled Data**: Sampling theorem, discrete Fourier transform, Fast Fourier Transform (FFT)	
Recommended Texts	
• Koonin, Steven E. (1986). *Computational physics.* Addision -Weley pub. • Thijssen, J. M. (2001). *Computational Physics.* Cambridge University Press • Giordano N. J., and Nakanishi, H. (2006). *Computational Physics.* Pearson Prentice hall • Press, W. H., Teukolsky, S. A., Vetterling, W., and Flannery, B. P. (2007). *Numerical Recipes The Art*	

of Scientific Computing. 3rd Edition, Cambridge University Press • Rubin H. Landau, Manuel J. Paez, and Cristian C. Bordeianu (2007). *Computational Physics.* Wiley-VCH, Weinheim • Alejandro L. Garcia (2000), *Numerical Methods for Physics.* 2nd Edition, Prentice Hall, Upper Saddle River, NJ • Paul L. De Vries and Javier E. Hasbun (2010). *A First Course in Computational Physics.* Jones & Bartlett, Burlington, MA

Course Code	**PHY3812**
Course Title	**Astrophysics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Stellar Physics: Hydrostatic equilibrium and the virial thereom, mass continuity, radiative energy transport, energy conservation, equations of stellar structure, the equation of state, opacity, scaling relations on the main sequence, nuclear energy production, solution of the equations of stellar structure **Radiative transfer in stars:** Radiative opacities, specific intensity, radiative transfer equation, local thermodynamic equilibrium, solution of the radiative transfer equation, stellar atmospheres **Stellar evolution and stellar remnants:** Stellar evolution, white dwarfs, supernovae and neutron stars, pulsars **Cosmology:** Basic observations, Olbers paradox, the Friedmann equations, Newtonian derivation of the Friedmann equations, dark energy and the accelerating universe	
Recommended Texts	
• Choudhuri, A.R. (2010). *Astrophysics for physicists*, Cambridge University Press • Maoz D. (2016). *Astrophysics in a nutshell*, Princeton University Press • Leblanc F. *An introduction to stellar astrophysics.* 1st Edition, John Wiley & Sons • Ryden B. *Introduction to cosmology.* 1st Edition, Cambridge University Press • Liddle A. *An introduction to modern cosmology.* 3rd Edition, John Wiley & Sons	

Course Code	**PHY3822**
Course Title	**Biophysics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Transport of matters across membrane: Introduction to cell and bio membranes, Active and passive transport, diffusion, Fick's law **Membrane potential:** Nernst-Plank equation, Goldman equation, transference equation **Neurobiophysics:** Neurons, electric analog of membrane, nerve excitation, action potential, conduction of action potential, electrical activity of heart and ECG **Thermodynamics of biosystems:** Equilibrium thermodynamics, Gibbs free energy, chemical potential	

Bioenergetics: Energy path ways in biology, photosynthesis **Radiation biology**: interaction of ionization radiation with biomaterials, biological effects of radiation, quantitative and qualitative analysis of radiation effect
Recommended Texts
• Hoppe, W. and Lohmann (1983). W., *Biophysics.* Springer-Verlag Berlin Heidelberg • Cotterill, M.J. (2002). *Biophysics: An Introduction.* John Wiley & Sons Ltd. • Srivastava, P.K. (2005). *Elementary Biophysics.* Narosa Publishing House • Glaser, R. (1996). *Biophysics.* Springer-Verlag Berlin Heidelberg

Course Code	**PHY3832**
Course Title	**Health Physics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to radiation physics: Radiation sources, radioactivity and types of radiation, interaction of radiation with matter **Radiation hazards:** Effects of radiation **Radiation safety and personnel dosimetry:** Quantities related to radiation protection, radiation protection principles, dosimetry, radiation safety during medical diagnostic and therapeutic procedures **Radiation dose limits, guidelines and regulations:** recommendations from ICRP, NCRP, IAEA etc, radiation monitoring systems, Sri Lankan regulations **Radiation detection and shielding:** Different types of detectors and shielding mechanisms **Emergency procedures and risks:** Decontamination and safety procedures **Radiation waste management and disposal:** General and standard procedures	
Recommended Texts	
• Stabin, M. G. (2007). *Radiation Protection and Dosimetry*. Springer • Cember, H. and Johnson, T. E. (2009). *Introduction to Health Physics.* McGraw-Hill • Trapp, J. V. and Kron, T. (2008). *An Introduction to Radiation Protection in Medicine*. Taylor & Francis Inc. • Meredith, W.J., Massey, J.B. (2013), *Fundamental Physics of Radiology*. Butterworth-Heinemann • Huda, W. (2009). *Review of Radiologic Physics.* LWW Publishers • Coggle, J.E. (1983). *Biological Effects of Radiation.* Taylor & Francis Ltd. • ICRP and IAEA publications	

Course Code	**PHY3842**
Course Title	**Physics of Atmosphere, Weather and Climate**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content
Atmospheric dynamics: Total and partial derivatives, momentum equation, equation of motion in meteorological context, hydrostatic equation, horizontal equation of motion, geostropic wind equation, cyclonic and anti-cyclonic motions, hurricanes, Rosby number, thermal wind equation, conservation of energy **The atmosphere:** Thermal structure of the atmosphere, troposphere, stratosphere, role of startostopic ozone, ozone hole, ozone depleting compounds, Montreal protocol, mesosphere, exosphere, thermosphere, ionosphere, magnetosphere **Atmospheric radiation:** Solar and terrestrial radiation, seasons, effect of earth's curvature, radiation balance, zero dimensional energy balance model, planetary albedo, effective surface temperature, greenhouse effect, annual mean surface temperature, global energy balance, greenhouse gases, global warming, climate change, international conventions and protocols on global warming, annual mean rainfall, pole-equator radiation balance, poleward energy transport **Atmospheric circulation:** Scale of motion **Atmospheric stability:** Variation of pressure with height, pressure as the vertical coordinate, variation of temperature with height, dry adiabatic lapse rate, physical meaning of lapse rate, saturated lapse rate, potential temperature, stable, unstable an neutral atmospheres, water in the atmosphere, dry and wet bulb temperature, humidity, phases of water, precipitation, fog, clouds, classification of clouds **Synoptic scale weather systems:** Cyclones, life cycle of a cyclone, path of cyclones, anticyclones, blocking systems, air masses and fronts, tropical cyclones (hurricanes), tracks of hurricanes **Effects of continents and oceans:** Inter tropical convergence zone, monsoons, east-asian monsoons, inter monsoon period, monsoon rain fall over Sri Lanka **Thunderstorms and lightning:** Life cycle of a thunderstorm, electrification of thunder cloud, structure of a thundercloud, lightning, lightning protection, tornado, super cell and squall line, small scale systems **Local Circulations:** Sea breeze, land breeze, vally/mountain breez, Katabatic wind, urban heat island, temperature inversion **Air pollution:** Smog, effect of thermal inversion on air pollution, pollution standards, effects of legislation **ENSO:** Effect of ENSO on climate and economy, atmospheric modeling, models and forecasting
Recommended Texts
• Wallace, J.M. and Hobbs, P.V. (2006). Atmospheric *Science: An introductory survey*. 2nd Edition, Elsevier • Moran, J. M. and Morgan, M. D. (1996). *Meteorology*. Prentice Hall • Houghton, J. T. (2002). *The physics of atmospheres.* 3rd Edition, Cambridge University Press • Saha, K. (2008). *The Earth's Atmosphere: Its physics and Dynamics*. Springer • Green, J. (2008). *Atmospheric Dynamics.* Cambridge University Press

Course Code	**PHY3852**
Course Title	**Advanced Electronics**
Credit Value	**2**
Pre-requisites	**PHY2852**
Compulsory/Optional	**Optional**
Course Content	
Bipolar Junction Transistor: Departure from ideal, Eber's Moll equation, push-pull pair, class of amplifiers, frequency response and band width, differential amplifier, G_{diff}, G_{CM}, CMRR, current mirrors, power amplifiers, Miller effect, bootstrapping **Field Effect Transistor**: JFET, I_C, V_{DS} characteristics, comparison with BJT, FET current source	

FET amplifiers: FET as a variable resister

FET switches: MOSFET logic switches; PMOS, NMOS, CMOS, CMOS inverter, CMOS logic gates, NAND and NOR circuits, MOSFET power switching

Operational amplifier: Transfer curve, open loop gain, negative feedback, basic op amp circuits, logarithmic amplifier, Schmitt trigger, op amp departure from ideal, instrumentation amplifier

Oscillators: Relaxation oscillator, sinusoidal, Wien bridge, LC, IC and crystal oscillators, timer IC 555, noise in electronic circuits

Recommended Texts

- Horowitz, P. and Hill. (1994). *The Art of Electronics.* 2nd Edition, Cambridge uni. press
- Malvino, A. P. (2016). *Electronics Principles.* 8th Edition, McGraw-Hill
- Thomas L. Floyd (2012). *Electronic devices: Electron Flow.* 9th Edition, Prentice Hall

Course Code	**PHY3862**
Course Title	**Experimental Techniques and Material Characterization**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM)

Scanning Probe Microscopic methods: Atomic Force Microscopy (AFM) and Scanning Tunnelling Microscopy (STM) it's various modes of operation

Electrical techniques: Electrical conductivity, Four probe method, Van der Pauw method, Wagner's polarization method, Tubandt's method, AC impedance method

Spectroscopic techniques: UV-Visible, IR (FTIR), Raman and NMR

X-ray Techniques: XRF, XRD…etc.

Recommended Texts

- Preston, D.W. and Dietz, E.R., *The Art of the Experimental Physics*, Wiley
- Baird, D.C., *Experimentation: An Introduction to Measurement Theory and Experimental Design,* Prentice-Hall
- Thirsk, H.R., Archer, W.I., and Armstrong, R.D., *Application of AC impedance methods for solid electrolytes*, Royal Society of Chemistry
- Grundy, P.J. and Jones, G.A., *Electron Microscopy and the Study of Materials*, Edward Arnold
- Donald L. Pav, *Introduction to Spectroscopy*, Cengage Learning

Course Code	**PHY3872**
Course Title	**Introductory Nanoscience**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction to nanoscience and nanotechnology: Materials, structure, and the Nano surface: Importance of surface, Engineering materials, Surface and volume, Geometrical surface to volume ratio, Specific surface area, Spherical cluster approximation, Particle orientation (optical responses, surface Plasmon resonance) **Nanotools:** Electron probe methods, Scanning probe microscopy methods, Spectroscopic methods, Nonradiative and non-electron characterization methods **Fabrication methods:** Top-down methods (Mechanical methods, Thermal methods, High energy methods, Chemical fabrication methods, Lithographic methods); Bottom-up methods (Gaseous phase method, Liquid phase method, Template synthesis) **Energy at nanoscale:** Liquid state: Cohesive forces, Adhesive forces; Solid state: Interaction pair potentials, Surface energy of low index crystals, Surface energy minimization methods **Quantum dots:** Schrodinger's Equation for confined systems, Bandgap variation with size, Properties of quantum dots (electronic Conductivity, Thermal and Optical properties), Plasmon resonance in metallic dots, Fabrication methods, Applications **Carbon based nanostructures:** Graphene, Fullerenes, Nanotubes
Recommended Texts
• Gabor L. Hornyak, H.F., Tibbals, Joydeep Dutta, John J. Moore. *Introduction to Nanoscience and Nanotechnology*, CRC Press • C. Poole, F. Owens, Wiley (2007). *Introduction to Nanotechnology Paperback*, John Wiley & Sons • J. Ramsden. *Essentials of Nanotechnology.* Venus publishing

Course Code	**PHY3911**
Course Title	**General Physics Laboratory III**
Credit Value	**1**
Pre-requisites	**PHY1911, PHY1921**
Compulsory/Optional	**Compulsory**
Course Content	
Determination of various quantities using bridge circuits such as Rayleigh's bridge, Owen's bridge, Carey Foster's bridge etc. Performing electricity experiments using high sensitive electrical instruments Determination of various optical parameters such as Cauchy's constants, Resolving power of prisms and gratings etc. Performing experiments related to interference and diffraction using diffraction gratings and Fresnel's biprism	
Recommended Texts	
• Nichols, F.R. and Smith, C.H. (2010). *Manual of Experimental Physics.* Kessinger Publishing, LLC.	

Course Code	**PHY3921**
Course Title	**Applied Physics Laboratory**
Credit Value	**1**
Pre-requisites	**PHY3911**
Compulsory/Optional	**Optional**
Course Content	

Determination of various quantities related to materials and their characteristics Determination of fundamental quantities such as speed of light, Plank’s constant etc. from investigative type experiments Performing experiments using GM counters and NaI detectors in nuclear Physics Performing experiments using programmable electronic ICs
Recommended Texts
• Nichols, F.R. and Smith, C.H. (2010). *Manual of Experimental Physics.* Kessinger Publishing, LLC.

Course Code	**PHY3932**
Course Title	**Advanced Physics Laboratory I**
Credit Value	**2**
Pre-requisites	**PHY2911, PHY2921**
Compulsory/Optional	**Compulsory**
Course Content	
Optics: Michelson's interferometer, Rayleigh refractometer, Haloes method, Cornus method, Pyrometer, laser, Fizau’s interferometer configuration **Properties of Matter:** Rheology, strain gauge, viscosity, tensiometer **Nuclear:** Geiger counter **Heat:** Angstrom’s method, Stefan-Boltzmann law	
Recommended Texts	
• Worsnop, B.L., and Flint, H.T. (1962). *Advanced Practical Physics for Students.* Methun & Co. Ltd., London	

Course Code	**PHY3942**
Course Title	**Advanced Physics Laboratory II**
Credit Value	**2**
Pre-requisites	**PHY2911, PHY2921**
Compulsory/Optional	**Compulsory**
Course Content	
Electromagnetism: Magnetic susceptibility, cathode ray tube **Electronics:** Construction of digital thermometer **Semiconductor:** Diode characteristics, solar cell **Computational:** MATLAB	
Recommended Texts	
• Worsnop, B.L., and Flint, H.T. (1962). *Advanced Practical Physics for Students.* Methun & Co. Ltd., London	

Course Code	PHY3951
Course Title	**Electronics Laboratory II**
Credit Value	**1**
Pre-requisites	**PHY2931**
Compulsory/Optional	**Optional**

Course Content

Analog circuits: Field effect transistors, op-amps and oscillators, combinational and sequential. **Logic circuits:** Full adders/ half Adders, counters, multiplexors, decoders and registers

Recommended Texts

- Horowitz, P. and Hill. (1994). *The Art of Electronics*.2nd Edition, Cambridge uni. press
- Malvino, A. P. (2016). *Electronics Principles*.8th Edition, McGraw-Hill
- Thomas L. Floyd (2012). *Electronic devices: electron flow.* 9th Edition, Prentice hall

Course Code	PHY3992
Course Title	**Scientific Writing and Seminar**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Literature Survey: Thorough literature survey on a selected topic related to Physics

Scientific Writing: Introduction on components of scientific documents such as research papers, theses, scientific reports etc., ethics and plagiarism in scientific writing, Citation of references

Presentation Skills: Basics of preparing a presentation, presentation skills

In this course, students conduct a systematic literature review on given topics, prepare, conduct oral and poster presentations and submit scientific reports

4000 Level Courses

Course Code	PHY4112
Course Title	**General Relativity**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Vector and tensor fields: Coordinate systems in Euclidean space, suffix notation, tangents and gradients, coordinate transformations in Euclidean space, tensor fields in Euclidean space, surfaces in Euclidean space, manifolds, tensor fields on manifolds, metric properties

The space-time of General Relativity and paths of particles: Geodesics, parallel vectors along a curve, absolute and covariant differentiation, geodesic coordinates, the spacetime of General Relativity

Field equations and curvature: The stress tensor and fluid motion, curvature tensor and related tensors,

curvature and parallel transport, geodesic deviation, Einstein’s field equations, the Schwarzschild solution **Physics in the vicinity of a massive object:** Length and time, radar sounding, spectral shift, general particle motion (including photons), bending of light, black holes
Recommended Texts
• Hobson, M. P., Efstathiou, G. P. and Lasenby, A. N. (2006). *General Relativity: An Introduction for Physicists,* Cambridge University Press • Foster, J. and Nightingale, J. D. (2006). *A Short Course in General Relativity*. 3rd Edition, Springer • Wald, R. M. (1984). *General Relativity*. University of Chicago Press • Moore, T. A. (2012). *A General Relativity Workbook*. University Science Books • Hartle, J. B. (2003). *Gravity: An Introduction to Einstein’s General Relativity*. Pearson • Schutz, B. (2009). *A First Course in General Relativity*. 2nd Edition, Cambridge University Press

Course Code	**PHY4122**
Course Title	**Introduction to Cosmology**
Credit Value	**2**
Pre-requisites	**PHY4112**
Compulsory/Optional	**Optional**
Course Content	
General relativistic cosmology: The metric of spacetime, the Einstein’s equations **Distances and luminosities:** Light propagation and redshift, the observable universe, luminosity and distance, angular diameter distance, source counts **Structures in the universe:** Observed structures, gravitational instability, clustering of galaxies, cosmic microwave background anisotropy, the origin of structure **Constraining cosmological models:** Cosmological models and parameters, key cosmological observations, the standard cosmological model	
Recommended Texts	
• Hobson, M. P., Efstathiou, G. P. and Lasenby, A. N. (2006). *General Relativity: An Introduction for Physicists,* Cambridge University Press • Foster, J. and Nightingale, J. D. (2006). *A Short Course in General Relativity*. 3rd Edition, Springer • Ryden, B. (2002). *Introduction to Cosmology*. Addison-Wesley • Liddle, A. (2015). *An Introduction to Modern Cosmology*. 3rd Edition, John Wiley & Sons	

Course Code	**PHY4202**
Course Title	**Electromagnetic Theory**
Credit Value	**2**
Pre-requisites	**PHY3202**
Compulsory/Optional	**Compulsory for Honours degree in Physics**
Course Content	
Electrostatics: Gauss’s law, Poisson's equation and Laplace's equation, electric dipole and quadruple fields, dielectrics, boundary conditions for B and H **Magnetostatics:** Equations of continuity, Biot-Savart law, vector potential of a current distribution, Ampère's	

circuital law; magnetic scalar potential, magnetic field due to simple current distributions, magnetic dipole moment of a current distribution, magnetic materials, boundary conditions for *B* and *H*

Maxwell's equations: Faraday's law of induction, *E* and *B* due to a charge/current, Maxwell's equations; wave equation for Φ and *A*, Lorentz condition and gauge transformations, Poynting's theorem and Poynting's vector, electromagnetic momentum

Plane electromagnetic waves and wave propagation: Derivation of wave equation for *E* and *B*, nature of electromagnetic waves, intrinsic impedance, electromagnetic waves in isotropic dielectrics and refraction of plane electromagnetic waves, Fresnel's equations, Snell's law, total internal reflection and metallic reflection, dispersion of electromagnetic waves, Lorentz and Drude models

Wave guides: Propagation of electromagnetic waves in wave guides

Generation of electromagnetic waves: Retarded potentials, radiation from a short wire antenna, radiation from a moving charge

Recommended Texts

- Grant, I. S. and Phillips, W. R. (1990). *Electromagnetism.* 2nd Edition, John Wiley & Sons, Inc.
- Griffiths, D. J. (2017). *Introduction to Electrodynamics.* 4th Edition, Pearson
- Jackson, J. D. (1999). *Classical Electrodynamics.* 3rd Edition, John Wiley & Sons, Inc.
- Lorrain, P. and Corson, D. (1988). *Electromagnetic Fields and Waves.* 3rd Edition, W. H. Freeman Company
- Zahn, M. (2003). *Electromagnetic Field Theory: A Problem Solving Approach*. Krieger Publishing Company

Course Code	**PHY4302**
Course Title	**Quantum Mechanics II**
Credit Value	**2**
Pre-requisites	**PHY3302**
Compulsory/Optional	**Compulsory for Honours degree in Physics**

Course Content

Vectors in a Complex N-dimensional Linear Space: Orthonormal basis, linear operators, matrix representation, eigenvalues and eigenvectors, theorems of Hermitian operators, commutators, projection operator

Postulates of Quantum Mechanics: Dynamical observables, state of a system, probability of an observable, expectation value, uncertainty, Heisenberg's uncertainty principle

Quantum Dynamics: Stationary states, dimensionality of quantum space, coordinate representation, transition to wave mechanics, Schrodinger wave equation, probability flow

Operators in Quantum Mechanics: Parity, linear harmonic oscillator and ladder operator method, orbital angular momentum operators and ladder method, spin angular momentum, Pauli spin matrices for spin ½ systems, electrons in magnetic field and Larmor precession, Stern-Gerlach experiment, addition of angular momenta and Clebsch-Gordan coefficients, spin-orbit interactions

Recommended Texts

- Weider, S. (1973). *The Foundation of Quantum Theory*. Academic Press
- David J. Griffiths (2004). *Introduction to Quantum Mechanics.* 2nd Edition, Pearson
- Liboff, R.L. (2002). *Introductory Quantum Mechanics.* 4th Edition, Addison Wesley

Course Code	**PHY4312**
Course Title	**Quantum Mechanics III**
Credit Value	**2**
Pre-requisites	**PHY4302**
Compulsory/Optional	**Optional**

Course Content

Perturbation Theory: Non-degenerate and degenerate perturbation theories, the fine structure of Hydrogen, Zeeman effect, hyperfine splitting, Stark effect, time dependent perturbation theory: two-level systems, emission, absorption of radiation and spontaneous emission

Variational method: Ground state of He atom

WKB Approximation: Tunneling

Many particle atoms: Introduction, permutation operator, Pauli exclusive principle, distinguishable and indistinguishable ideal systems, statistical correlations in ideal Bose and Fermi systems, ideal Helium atoms

Scattering: Born approximation

Recommended Texts

- Weider, S. (1973). *The Foundation of Quantum Theory*. Academic Press
- David J. Griffiths (2004). *Introduction to Quantum Mechanics.* 2nd Edition, Pearson
- Liboff, R.L. (2002). *Introductory Quantum Mechanic*s. 4th Edition, Addison Wesley

Course Code	**PHY4402**
Course Title	**Statistical Physics**
Credit Value	**2**
Pre-requisites	**PHY2402**
Compulsory/Optional	**Compulsory**

Course Content

Introduction and Review: Review of thermodynamics, Lagrange multipliers

Ensemble Theory: Introduction, micro canonical ensemble, canonical ensemble, partition function, equi-partition theorem, ensemble average, method of most probable distribution, evaluation of undetermined multipliers, grand canonical ensemble

Applications of ensemble theory: Einstein and Debye theory of heat capacity, phonons, harmonic oscillator, monoatomic ideal gas

Quantum statistics: Fermi Dirac Statistics and Bose-Einstein statistics, Fermi function, Fermi gas, Bosons, blackbody radiation

Special Topics: Langevin theory of Brownian motion, hard sphere potential

Recommended Texts

- Pathria, R.K. (2011). *Statistical Mechanics.* 3rd Edition, Academic Press
- McQuarrie, D.A. (2010). *Statistical Mechanics.* 1st Edition, University Science Books
- Reif, F. (1965). *Fundamentals of Statistical & Thermal Physics*. 1st Edition, McGraw Hill

Course Code	**PHY4502**
Course Title	**Nuclear Physics II**
Credit Value	**2**
Pre-requisites	**PHY3502**
Compulsory/Optional	**This or PHY4602 is compulsory**

Course Content

Nuclear Properties: Charge, size, high energy electron scattering, X-ray isotope shifts, muonic atoms, mirror nuclei, Rutherford scattering, α-decay, π-mesic X-ray, elastic scattering of neutrons, charge and matter distribution, mass, mass spectrometer, nuclear reaction methods, radioactivity decay methods, binding energy, angular momentum, spin, magnetic dipole moment, electric quadrupole moment, parity, isospin, excited states of nuclei

Nuclear force: Properties of nuclear force, n-p bound state, deuteron, n-p scattering, scattering cross section, phase shift, scattering length and hard repulsive core, exchange properties, Meson theory

Nuclear models: Liquid drop model, shell model, Fermi gas model, collective models

Nuclear reactions: General characteristics and conservation laws, energetics of nuclear reaction, reaction cross–section, experimental techniques, coulomb scattering, nuclear scattering, compound nuclear reactions, direct reactions, resonance reactions

Recommended Texts

- Krane, K.S. (1987). *Introductory Nuclear Physics.* 3rd Edition, Wiley
- Cottingham, W. N. and Greenwood, D. A. (2001). An *Introduction to Nuclear Physics*.2nd Edition, Cambridge University Press
- Burcham, W.E. (1973). *Nuclear Physics: An Introduction*. Longman
- Wong, S.S.M. (1999). *Introductory Nuclear Physics.* 2nd Edition, Wiley-VCH

Course Code	**PHY4512**
Course Title	**Nuclear Reactor Physics**
Credit Value	**2**
Pre-requisites	**PHY3502**
Compulsory/Optional	**Optional**

Course Content

Introduction: Reactor fundamentals, nuclear reactors, nuclear stability, neutron sources, fission process, chart of nuclides

Neutron Interactions: Elastic and inelastic scattering, radiative capture, charged particle reactions, fission, cross sections, neutron attenuation, neutron flux, neutron current density vector

Energy loss in scattering collisions: Maximum fractional loss of energy, average logarithmic energy decrement, neutron lethargy

Neutron Diffusion and Moderation: Fick's law, equation of continuity, the diffusion equation; boundary conditions, the diffusion length, solutions of diffusion equation of simple geometry, the group diffusion method, thermal neutron diffusion; two-group calculation of neutron moderation, neutron activation techniques

Nuclear Reactor Theory: One-group reactor equation, consideration of different reactor geometry: infinite slab, spherical (bare), infinite cylinder, parallelepiped (rectangular), one-group critical equation, bare thermal reactors, criticality calculations

Time-Dependent Reactor: Reactor kinetics, prompt neutron lifetime and mean diffusion time of thermal neutrons, reactor with no delayed neutrons: reactor with delayed neutrons, reactivity equation, the prompt

critical state, the prompt jump (drop), reactor control: control rods and chemical shims rod worth, temperature effects on reactivity
Recommended Texts
• Krane, K.S. (1987). *Introductory Nuclear Physics.* 3rd Edition, Wiley • Bryan, J.C. (2013). *Introduction to Nuclear Physics.* 2nd Edition, CRC Press • Burcham, W.E. (1973). *Nuclear Physics: An Introduction.* Longman • Wong, S.S.M. (1999). *Introductory Nuclear Physics.* 2nd Edition, Wiley-VCH • Lewis, E.E. (2008). *Fundamentals of Nuclear Reactor Physics.* 1st Edition, Academic Press

Course Code	**PHY4522**
Course Title	**Radiation Detection and Measurement**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Radiation Detection: Radiation sources, radiation interactions**,** counting statistics**,** general properties of radiation detectors **Radiation Detectors:** Ionization chambers, proportional counters, Geiger Mueller counters, G-M survey meter, scintillation detectors, semiconductor detectors **Miscellaneous detectors:** Cerenkov detector, superconducting detectors, photographic emulsions, thermoluminescent dosimeters, neutron detection by activation	
Recommended Texts	
• Knoll, G. F. (2010). *Radiation Detection and Measurement.* 4th Edition, Wiley • Leo, W.R. (1994). *Techniques for Nuclear and Particle Physics Experiments.* 2nd Edition, Springer • Gilmore, G. (2008). *Practical Gamma - Ray Spectrometry.* 2nd Edition, Wiley • Nicholas, T. and Sheldon, L. (2015). *Measurement and Detection of Radiation.* 4th Edition, CRC Press	

Course Code	**PHY4602**
Course Title	**Solid State Physics II**
Credit Value	**2**
Pre-requisites	**PHY3602**
Compulsory/Optional	**This or PHY4502 is compulsory**
Course Content	
Free electron theories: Review of classical free electron theory (Drude model): conductivity, optical properties, Hall Effect and thermoelectric effect, quantum mechanical free electron theory (Summerfeld's theory), Fermi temperature **Band Theory:** Bloch Electron and Bloch theorem and remarks on Bloch theorem, Kronig-Penney model, nearly free electron model, energy bands in 1D and formation energy gaps, Brillouin zones and zone schemes, Fermi surfaces, empty lattice model, tight binding model **Electron dynamics in Electric field:** Electrical and thermal conductions, the concept of holes, effective mass of the electron, conduction in conductors, insulators, semiconductors	

Electron dynamics in magnetic field: Cyclotron motion and Landau orbits, Fermi surface determination (Cyclotron resonance and de Hass-van Alphen effect)
Recommended Texts
• Kittel, C. (1996). *Introduction to Solid State Physics.* 7th Edition, John Wiley & Sons • Ashcroft, N.W. and Mermin, N.D. (1976). *Solid State Physics.* Saunders College Publishing • Omar, A. (1975). *Elementary Solid State Physics.* Addision-Wesley Publishing Company • Blakemore, J.S. (1987). *Solid State Physics.* 2nd Edition, Cambridge University Press

Course Code	**PHY4622**
Course Title	**Magnetic Materials and Superconducting Phenomena**
Credit Value	**2**
Pre-requisites	**PHY2402**
Compulsory/Optional	**Optional**
Course Content	
Basic theories in magnetism: Ewing's molecular theory, Faraday's law, Lenz's law, origin of atomic magnetic moment, orbital motion and spin of electron, principal quantum number, angular momentum quantum numbers, spin quantum number, magnetic quantum number, Russel-Saunders coupling, Pauli exclusion principle, Hund's rule **Classification of types of magnetic materials:** Magnetization, magnetic field intensity, magnetic induction, magnetic field in a material, susceptibility, permeability, temperature dependence of susceptibility, diamagnetism, Langevin theory, Larmor precession, paramagnetism, Curie's law, energy of magnetic moment in a magnetic field, energy levels, populations in different energy levels, equation for magnetization of paramagnetic materials, effective magnetic moment, effective number of Bohr magnetons, rare earth group, transition metal group, nuclear magnetic moment, ferromagnetism, ferromagnetic elements, ferromagnetic curie temperature, Curie-Weiss law, magnetic domains, spin exchange interaction, Weiss molecular field, antiferromagnetism, spiral spin structure, uniaxial anisotropy, positive and negative spin exchange interactions, ferrimagnetism, super exchange interaction, sublattices, tetrahedral and octahedral sites, normal spinel and inverse spinel ferrites, soft and hard ferrites, uniaxial and nonuniaxial ferrites, cubic, hexagonal structures of ferrites **Bulk magnetic properties:** Hysteresis loop, reversible and irreversible magnetizations, remanence, coercivity, saturated magnetization, anisotropy field, hysteresis lost, classification and applications of soft and hard magnetic materials, magnetostatic energy, crystalline energy, domain wall energy, magnetostriction energy, magnetostriction coefficient, anisotropy energy, magnetic easy and hard directions, anisotropy constants, domain walls, Bloch wall energy, magnetoelastic energy, domain wall movement versus spin rotation, demagnetizing field, demagnetization factor, demagnetization energy, closure domains, thickness of Bloch wall, bitter patterns, magneto-optical Kerr effect, Faraday rotation, determination of domain structure using TEM, magnetic bubbles **Applications:** Magnetic resonance, paramagnetic resonance and the maser, magnetic relaxation, nuclear magnetic resonance (NMR), ferromagnetic resonance and spin waves, magnetic memory devices **Basic properties of superconductors:** Zero resistance, perfect diamagnetism and Meissner effect, type I and type II superconductors, heat capacity, energy gap, isotope effect **Phenomenology of superconductivity:** London equation, London penetration depth, coherence length, BCS theory, magnetic flux quantization, persistent currents, type II superconductors and vortex state **Effects and applications of superconductivity:** Josephson superconductor tunneling, dc Josephson effect, ac Josephson effect, SQUID (superconducting quantum interference device) **High temperature superconductors:** Cuprates, iron-based superconductors, other high temperature superconducting materials (magnesium diboride, hydrogen sulfide etc.)	
Recommended Texts	

- Cullity, B.D. and Graham, C.D. (2011). *Introduction to Magnetic Materials.* Wiley IEEE-Press
- Coey, J.M.D. (2009). *Magnetism and Magnetic materials.* Cambridge University Press
- Ashcroft, N.W. and Mermin, N.D. (1976). *Solid State Physics.* Saunders College Publishing
- Omar, M.A. (1975). *Elementary Solid State Physics.* Addision-Wesley Publishing Company
- Crangle, J. (1977). *The Magnetic Properties of Solids.* Edward Arnold

Course Code	**PHY4632**
Course Title	**Ion Conducting Materials and Devices**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Introduction: Electrical conductivity, types of solid electrolytes, Kröger-Vink point defect notation, intrinsic and extrinsic defects, conductivity mechanisms, theoretical explanation of ionic conductivity, relation between diffusion and ionic conductivity, Expression for ionic conductivity using jump diffusion, Arrhenius relationship, ionic mobility, activation energy, requirements for high ionic conductivity

Some representative solid electrolytes: Crystalline solid electrolytes: silver iodide, sodium-β-alumina, stabilized zirconia, lithium nitride, lithium sulphate, composite solid electrolyte, grain boundary and bulk conductivity, Ion conducting glass, definition and preparation techniques of amorphous materials, glass transition temperature, the role of glass formers, doping salts and network modifiers, class structure, Zachariasen rules and diagrams of glass, mixed alkali effect and mixed former effect, Solid and gel polymer electrolytes, advantages of polymer electrolytes, ability of formation of polymer-salt complexes, some representative examples, VTF behaviour of conductivity, conductivity variation with salt concentration, improving properties using structure modification of polymers, preparation of polymer electrolytes

Characterization: Sample preparation, differential scanning calorimetry, XRD, phase diagrams, electrode types, complex impedance technique, conductivity variation with temperature, transference number, DC polarization method

Applications: Solid oxide fuel cells, oxygen sensor, sodium-sulphur batteries, anode and cathode materials for high energy density batteries, lithium-ion batteries, electrochromic devices

Recommended Texts

- Hagenmuller, P. and Gool, W. V. (2015). *Solid Electrolytes: General Principles, Characterization, Materials, Applications.* Elsevier
- Laskar, A. (2012). *Superionic Solids and Solid Electrolytes Recent Trends*. Elsevier
- Gray, F.M. (1991). *Solid Polymer Electrolytes: Fundamentals and Technological Applications*. 1st Edition, Wiley
- MacCallum, J.R. and Vincent, C.A. (1987). *Polymer Electrolyte Reviews-Vol. 1 & 2*. Springer
- Chandra, S. (1981). *Superionic Solids: Principles and Applications.* Elsevier
- Anthony R. West (1999). *Basic Solid State Chemistry*. 2nd Edition, Wiley

Course Code	**PHY4642**
Course Title	**Polymer Physics**
Credit Value	**2**
Pre-requisites	**None**

Compulsory/Optional	Optional
Course Content	
Development of Synthetic Polymers, Chemical Structure of Macromolecules **Classification of Polymers**: Thermoplastic versus thermoset polymers, amorphous versus semi-crystalline polymers, polymer types based on molecular architecture **Molecular Weight Distributions:** Weight and number average molecular weights, polydistersity **Polymer Conformations and chain statistics:** Chain conformations**,** end to end distances, random walk, flights and real chains **Morphology:** Polymer single crystals, chain folding and spherulites **Mechanical and Rheological Properties:** Strength, moduli, elongation, hardness, viscosity and viscoelasticity; deformation yield, cracking effect of microstructure on properties **Thermal Properties**: Glass transition and other thermal transitions, heat capacity, thermal conductivity, thermal expansion coefficient.**Optical Properties**: Light transmission, refractive index **Electrical Properties**: Surface and volume resistivity, dielectric constant, electronic conductivity, ionic conductivity, piezoelectricity, Ionically and electronically conducting polymers and their applications **Polymer Characterization**: Differential Scanning Calorimetry (DSC) and Differential Thermal Analysis (DTA), Dynamic Mechanical Analysis (DMA), density measurements, light Scattering, X-ray Diffractometry, Infrared and Raman spectroscopy, NMR spectroscopy, optical, electron microscopy studies of polymers **Polymers in the real world:** Applications, processing, environmental issues and recycling	
Recommended Texts	
• Bower, D.I. (1996). *An Introduction to Polymer Physics.* Cambridge University Press • Young, R.J. and Lovell, P.A. (1996). *Introduction to Polymers.* 2nd Edition, Chapman & Hall • Painter, P.C. and Coleman, M.M. (1997). *Fundamentals of Polymer Sciences.* 2nd Edition, Technomic Pub. Co. Inc. • Nicholson, J.W. (1991). *The Chemistry of Polymers.* Royal Society of Chemistry • Chandra, S. (1981). *Superionic solids: Principles and Applications*. Elsevier	

Course Code	PHY4852
Course Title	**Data Acquisition and Signal Processing**
Credit Value	**2**
Pre-requisites	**PHY3852**
Compulsory/Optional	**Optional**
Course Content	
Transducers and actuators: Propagation delay, rise and fall time, set up time, hold time, noise margins, fan in and fan out; logic families; RTL, DTL, TTL, CMOS, etc., TTL/CMOS characteristics; Optoelectronics; LED's CCD's, 7-segment, 16-segment and 5x7 dot matrix displays, driving LED displays, Optocouplers; Data acquisition; sample and hold, noise and signal processing; A/D and D/A conversions; D/A techniques; scaled resistors, R-2R ladder, current sources, A/D converters; parallel encoder, successive approximation, frequency-to-voltage, voltage-to-frequency conversion **Commercial A/D and D/A converters and their applications:** Digital filters; microprocessors and micro computers; computer architecture, microprocessor support chips, processor example, programmed input/output interrupts, bus signals and interfacing, data communication concepts; design and construction of a practical electronic circuit **Introduction to computer interfacing and embedded devices**	

Recommended Texts
• Horowitz, P. and Hill,W. (1994). *The Art of Electronics.* 2^{nd} Edition, Cambridge University Press • Malvino, A. P. (2016). *Electronics Principles.* 8^{th} Edition, McGraw-Hill • Floyd, T.L. (2012). *Electronic Devices.* 9^{th} Edition, Pearson

Course Code	**PHY4872**
Course Title	**Nanophysics**
Credit Value	**2**
Pre-requisites	**PHY3872/ CHE3723**
Compulsory/Optional	**Optional**
Course Content	
Confined electronic Systems: Quantum dots and quantum dot lasing, plasmon resonance **Electrical Properties and electronics at nanoscale**: Coulomb blockage, single electron transistors, nanocapacitors **Optical Properties at nanoscale:** Reflection, transmission, absorption and emission of electromagnetic radiation **Scanning Probe Microscopy**: Detection and operation mechanism of AFM, Force-distance curves, Dip pen lithography and its applications, use of CNT in AFM tips, AFM artifacts, Tunneling mechanism of STM, Imaging atoms **Carbon Nanotubes**: Electronic structure, optical and mechanical properties, growth models of CNT **Applications of nanotechnology**: bio molecule labeling, drug delivery, nanofibers and composites, applications in solar cells, engineering of novel materials	
Recommended Texts	
• C. Poole and F. Owens (2003). *Introduction to nanotechnology*. Wiley Inter Science • G.L Hornyak, J. Dutta, H. Tibbals, A.K. Rao (2008). *Introduction to Nanoscience.* CRC Press • Other necessary materials and articles will be provided	

Course Code	**PHY4912**
Course Title	**Advanced Physics Laboratory III**
Credit Value	**2**
Pre-requisites	**PHY3942**
Compulsory/Optional	**Compulsory**
Course Content	
Small project type experiments carried out in this course vary depending on the availability of the instructors and the facilities of the research laboratories of the department. Accordingly, assignment of experiments varies from one academic year to another. Research activity base experiments were carried out in the following laboratories: (i) Computational Laboratory (ii) Electronics Laboratory (iii) Nuclear Physics Laboratory (iv) Solid State Ionics Laboratory	

(v) Polymer Laboratory (vi) Semiconductor Laboratory (vii) Advanced Practical Laboratory
Recommended Texts
• Students are expected to carry out the necessary literature survey

Course Code	**PHY4922**
Course Title	**Investigatory Physics Laboratory**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
There is no specific course content. In this course, several investigative type practical physics problems are given. The problem may have multiple solutions as in an open-ended question. There may be no best way of solving the problem. Students have the freedom in choosing more than one procedure of their own design and the instruments required. Students are expected to use their own initiative and creativity to design their own experiments. Opportunities are created for students to work with others as a team.	
Recommended Texts	
• Students are expected to carry out the necessary literature survey	

Course Code	**PHY4996**
Course Title	**Research Project**
Credit Value	**6**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
There is no specific course content. This is a year-round course. Each student will carry out a research project during the final year. Students are expected to make a presentation on the progress halfway through the project. At the end, students are required to give oral presentations based on the research findings and submit project reports. The oral presentation will be evaluated by a panel of academic staff members of the department.	
Recommended Texts	
• Students are expected to carry out the necessary literature survey	

Course Code	**PHY4003**
Course Title	**Industrial training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Students will be assigned to an industry for which they should undergo a full-time training of four to six weeks. A relevant expert in the field will be assigned as the external supervisor and he/she will be monitoring the progress of the project. Student should maintain a project logbook in which they should keep daily records. After completion of the training, the student should do a presentation regarding the work carried out during the training and submit a report.	
Recommended Texts	
• Reading material and manuals relevant to industrial training	

8. DEPARTMENT OF STATISTICS & COMPUTER SCIENCE

8.1 Computer Science Course Modules

1000 LEVEL – COMPUTER SCIENCE					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
CSC1013	Introduction to Computer Science and Programming	3	CSC1002	√	√
CSC1023	Object-oriented Programming	3	CSC1013	√	√
CSC1041	Programming Laboratory I	1	CSC1013	√	√
CSC1051	Programming Laboratory II	1	CSC1023 CSC1041	√	√
Total		**08**		**08**	**08**

2000 LEVEL – COMPUTER SCIENCE					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
CSC2012	Data Structures	2	CSC1023	√	√
CSC2021	Programming using Data Structures	1	CSC1051 CSC2012	√	√
CSC2032	Database Management Systems	2	CSC1023	√	√
CSC2041	Programming using Database Management Systems	1	CSC2032	√	√
CSC2052	Computer Architecture	2	CSC1013	√	
CSC2102	Web Programming I	2	CSC1023		
CSC2112	Introduction to Computer Networks	2	CSC1013	√	√
CSC2312	Computing for Science I	2	CSC1002		
CSC2321	Computing for Science Programming Laboratory I	1	CSC2312		
Total		**15**		**10**	**08**

3000 LEVEL – COMPUTER SCIENCE					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
CSC3033	Operating Systems Concepts	3	CSC2032	√	√
CSC3073	Computer Graphics	3	CSC3152	√	
CSC3081	Computer Graphics Programming	1	CSC3073	√	
CSC3093	Object Oriented Analysis and Design	3	CSC1023 CSC1051		
CSC3103	Server Side Web Programming	3	CSC2021 CSC2041 CSC2102	√	
CSC3112	Software Engineering	2	CSC1013	√	√
CSC3122	Human Computer Interaction Design	2	CSC1051		
CSC3132	Digital Image Processing	2	CSC3152		
CSC3141	Image Processing Laboratory	1	CSC3132		

CSC3152	Design and Analysis of Algorithms	2	CSC2012	√	√
CSC3173	Artificial Intelligence	3	CSC2012 CSC3152	√	
CSC3182	Advanced Computer Networks	2	CSC2112		
CSC3213	Project in Computer Science I	3	CSC2041 CSC3093 CSC3103	√	
CSC3252	Scientific Writing and Presentation	2	None	√	
CSC3312	Computing for Science II	2	CSC2312		
CSC3321	Computing for Science Programming Laboratory II	1	CSC3312		
Total		**35**		**22**	**07**

4000 LEVEL – COMPUTER SCIENCE				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
				Hons.
CSC4043	Parallel Processing	3	CSC3033	
CSC4063	Distributed Computing	3	CSC2112 CSC3033	
CSC4082	Computer Vision	2	CSC3143	
CSC4093	Neural Networks and Deep Learning	3	CSC3173	
CSC4103	Internet and Multimedia Systems	3	CSC2112 CSC3143	
CSC4122	Internet of Things	2	CSC2053 CSC2112 CSC3173	
CSC4132	Information and Network Security	2	CSC2112	
CSC4142	Software Project Management	2	CSC3112	
CSC4162	Special Topics in Computer Science	2	None	
CSC4173	Machine Learning	3	CSC3173	
CSC4182	Natural Language Processing	2	CSC3173	
CSC4996	Project in Computer Science II – Research Project	6	CSC3252	√
SCI4003	Industrial Training	3		
Total		**36**		**06**

1000 Level Courses

Course Code	**CSC1002**
Course Title	**Computer Applications**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory (Foundation Course)**
Course Content	
History of Computing: Major milestones of history of computing, hardware and software evolution. Main Components of Computer Systems: Computational / commanding units, memory hierarchies, input / output devices and storage devices. Data Security: Data security methods, computer viruses and prevention. Ethics in ICT: Ethics and best practices of email composing, social and professional media. Data Synchronization: Data backup and data synchronization among multiple devices. Microcomputer applications: Word processing, spreadsheet processing and electronic presentations.	
Recommended Texts	
• Wempen, F. (2014). Computing Fundamentals: Introduction to Computers, Wiley. 1st Ed. Willey. • Abid, M. and Amjad, M. (2015). Fundamentals of Computers. I K International Publishing House.	

Course Code	**CSC1013**
Course Title	**Introduction to Computer Science and Programming**
Credit Value	**3**
Pre-requisites	**CSC1002**
Compulsory/Optional	**Compulsory**
Course Content	
Basic Concepts in Computer Science: Abstraction, Encapsulation, Algorithms, Programming, Data Structures, Resource Management, Security, Software Engineering, Web Development, Application areas. Data Representation and Basic Computer Architecture: Data representation methods, Number systems, Combinational logic and digital systems. Introduction to Algorithms: The concept and properties of algorithms, program decomposition, simple algorithms. Fundamentals of Programming: Basic syntax and semantics of a higher-level language, Managing data (variables and primitive data types), Expressions and assignments, Declarations, Basic input and output, Built-in, user-defined and recursive functions, Error handling and File handling.	
Recommended Texts	
• Kernighan, B. and Ritchie, D. (1988). The C Programming Language. 2nd Ed. Prentice Hall. • Guttag, J. V. (2016). Introduction to Computation and Programming Using Python: With Application to Understanding Data. 2nd Ed. MIT Press. • Tremblay, J.P. and Bunt, R.B. (1988). An Introduction to Computer Science: An Algorithmic Approach. 2nd Ed. McGraw-Hill College.	

Course Code	**CSC1023**
Course Title	**Object-oriented Programming**
Credit Value	**3**
Pre-requisites	**CSC1013**

Compulsory/Optional	Compulsory
Course Content	
Program execution cycle, Compilation and interpretation, Data types, Variables and literals, Flow control structures, Functions, Object oriented concepts, Classes and interfaces, Exception handling, Built-in data structures, Input/output handling, File handling, Optimizing problem execution.	
Recommended Texts	
• Wu, C. T. (2009). *An Introduction to Object-Oriented Programming with Java*. 5th Ed. McGraw-Hill Education. • Litvin, M. and Litvin, G. (2015). *Java Methods: Object-Oriented Programming and Data Structures*.3rd Ed. Skylight Publishing.	

Course Code	CSC1041
Course Title	Programming Laboratory I
Credit Value	1
Pre-requisites	CSC1013
Compulsory/Optional	Compulsory
Course Content	
Programming assignments will be given covering the following concepts. Language constructs: data types, data declarations, flow-control, input/output, files, subprograms/functions, basic data structures, and integrated development environments. Design and implementation of simple programs: top-down and bottom-up design, decomposition, structuring, design for reuse, documentation.	
Recommended Texts	
• Kochan, S.G. (2014). *Programming in C*. 4th Ed. Addison-Wesley • Kernighan, B. and Ritchie, D. (1988). *The C Programming Language*. 2nd Ed. Prentice Hall. • Lutz, M. (2018). *Learning Python*. 5th Ed. O'Reilly Media, Inc.	

Course Code	CSC1051
Course Title	Programming Laboratory II
Credit Value	1
Pre-requisites	CSC1023, CSC1041
Compulsory/Optional	Compulsory
Course Content	
Programming assignments will be given covering the following concepts. Object-oriented language constructs: abstraction, encapsulation, inheritance, aggregation, composition and polymorphism, classes, objects, interfaces, packages, input/output handling, file handling, exception handling, built-in data structures.	
Recommended Texts	
• Wu, C. T. (2009). *An Introduction to Object-Oriented Programming with Java*. 5th Ed. McGraw-Hill Education. • Litvin, M. and Litvin, G. (2015). *Java Methods: Object-Oriented Programming and Data Structures*. 3rd Ed. Skylight Publishing	

2000 Level Courses

Course Code	CSC2012
Course Title	**Data Structures**
Credit Value	**2**
Pre-requisites	**CSC1023**
Compulsory/Optional	**Compulsory**
Course Content	
Linear data structures; Arrays, Lists (Linked Lists, Ordered Linked Lists, Doubly Linked Lists), Pushdown stacks, Queues. Non-linear data structures: General tree structures and binary trees, Graphs and their applications, Hashing. Operations for data structures (Insertion, Deletion, Modification, Search). Applications of data structures.	
Recommended Texts	
• Shaffer, C.A (2010). *A Practical Introduction to Data Structures and Algorithm* Analysis *(C++ Version)*. 3rd Ed. Prentice Hall. • Sedgwick, R. (1998). *Algorithms in C*. 3rd Ed. Addison-Wesley Professional. • Lafore, R. (2002). *Data Structures and Algorithms in Java*. 2nd Ed. Sams Publishing.	

Course Code	CSC2021
Course Title	**Programming using Data Structures**
Credit Value	**1**
Pre-requisites	**CSC1051, CSC2012**
Compulsory/Optional	**Compulsory**
Course Content	
Implementations and applications of Lists, Stacks, Queues, Trees, Graphs and Hashing.	
Recommended Texts	
• Shaffer, C.A (2010). *A Practical Introduction to Data Structures and Algorithm* Analysis *(C++ Version)*. 3rd Ed. Prentice Hall. • Sedgwick, R. (1998). *Algorithms in C*. 3rd Ed. Addison-Wesley Professional. • Lafore, R. (2002). *Data Structures and Algorithms in Java*. 2nd Ed. Sams Publishing.	

Course Code	CSC2032
Course Title	**Database Management Systems**
Credit Value	**2**
Pre-requisites	**CSC1023**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to databases and database management systems (DBMS), Conceptual Modeling: Entities, attributes, associations, functional determination, 3-level structure, graphical representation. Relational Databases: Relational algebra, Relational databases and tables, Query languages. The entity-relationship model, Logical organization of databases, Functional dependencies and normal forms, Physical organization of databases: Characteristics of disks and disk blocks, Storage of relations, Introduction to Query processing,	

Concurrency control: Transactions, Serializability, Locking, Recovery, Introduction to other types of DBMSs.
Recommended Texts
• Elmasri, R. and Navathe, S.B. (2010). *Fundamentals of Database Systems.* 6th Ed. Pearson. • Date, C.J. (2003). *An Introduction to Database Systems*. 8th Ed. Pearson.

Course Code	**CSC2041**
Course Title	**Programming using Database Management Systems**
Credit Value	**1**
Pre-requisites	**CSC2032**
Compulsory/Optional	**Compulsory**
Course Content	
Overview of Database Management Systems (DBMS), SQL (data definition, query formulation, constraints, integrity, Selections, Projections, Select-project-join, Aggregates and group-by, Subqueries), Transactions, Stored procedures, Backup and recovery, User privileges, Connecting databases using programming languages.	
Recommended Texts	
• DuBois, P. (2013). *MySQL*.5th Ed. Addison-Wesley Professional	

Course Code	**CSC2052**
Course Title	**Computer Architecture**
Credit Value	**2**
Pre-requisites	**CSC1013**
Compulsory/Optional	**Compulsory**
Course Content	
Applications of Computer Arithmetic, General architecture of the computer and the conceptual design of the computer, Memory and input/output systems, Analogue and Digital signal processing, Combinational and Sequential logics, Design of the general purpose manual processor and microprocessor, Instruction set architecture, Memory organization, Microprocessor and Microcontroller programming.	
Recommended Texts	
• Horowitz, P., Hill, W. (2015). The Art of Electronics, 3rd Edition, • Monk, S. (2016). Programming Arduino: Getting Started with Sketches, McGraw-Hill Education TAB, 2nd Edition.	

Course Code	**CSC2102**
Course Title	**Web Programming I**
Credit Value	**2**
Pre-requisites	**CSC1023**
Compulsory/Optional	**Optional**
Course Content	
Foundations of web applications, HTTP protocol, Structure of HTML documents, Cascading Style Sheets (CSS), JavaScript, Server-side concept and application development, Connecting front-end with server-side,	

Hybrid and native mobile support application development.
Recommended Texts
• Robbins, J. N. (2012). *Learning Web Design: A Beginners Guide to HTML, CSS, JavaScript, and Web Graphics*.4th Ed. O'Reilly Media. • Lassoff, M. (2015). *Mobile App Development with HTML5.* 1st Ed. Learn To Program, Incorporated

Course Code	**CSC2112**
Course Title	**Introduction to Computer Networks**
Credit Value	**2**
Pre-requisites	**CSC1013**
Compulsory/Optional	**Compulsory**
Course Content	
Main requirements for setting up a network, data/resource sharing concepts, basic centralization and distribution concepts, Network topologies, Layered architecture: ISO-OSI / TCP/IP reference models, Modulation and multiplexing basics, collision detection and avoidance mechanisms, Wireless networks, Data collision detection and avoidance in wireless medium, Introduction to Request for Comment (RFC) documenting style.	
Recommended Texts	
• Mir, N.F. (2014). *Computer and Communication Networks*. 2nd Ed. Prentice Hall. • Tanenbaum, A. S. (2012). *Computer Networks*.5th Ed. Pearson. • On-line Material : IEEE Standards Association (http://standards.ieee.org/) • On-line Material : Internet Engineering Task Force (IETF) (http://www.ietf.org/)	

Course Code	**CSC2312**
Course Title	**Computing for Science I**
Credit Value	**2**
Pre-requisites	**CSC1002**
Compulsory/Optional	**Optional**
Course Content	
Data representation and Computer organization, Life cycle of a program, Syntax and semantic of programming languages, Variables, identifiers and literals, Flow control structures, Applications of built-in functions and define new functions, Exception handling, Input / output resource handling, Introduction to data structures and algorithms.	
Recommended Texts	
• Connors, K. (2017). *The Ultimate Beginners Guide to the Python Programming Language*. CreateSpace Independent Publishing Platform • Guttag, J. V. (2016). *Introduction to Computation and Programming Using Python: With Application to Understanding Data*. 2nd Ed. MIT Press. • Langtangen, H. P. (2016). *A Primer on Scientific Programming with Python*. Springer.	

Course Code	**CSC2321**
Course Title	**Computing for Science Programming Laboratory I**
Credit Value	**1**

Pre-requisites	**CSC2312**
Compulsory/Optional	**Optional**
Course Content	
Lab assignments will be given covering the following concepts. Introduction to Unix-based and Windows-based operating systems. Computer Programming: data types, data declarations, flow-control, input/output, files, subprograms/functions, basic data structures, integrated development environments. Design and implementation of simple programs: decomposition, structuring, design for reuse, documentation.	
Recommended Texts	
• Connors, K. (2017). *The Ultimate Beginners Guide to the Python Programming Language*. CreateSpace Independent Publishing Platform • Guttag, J. V. (2016). *Introduction to Computation and Programming Using Python: With Application to Understanding Data*. 2nd Ed. MIT Press. • Langtangen, H. P. (2016). *A Primer on Scientific Programming with Python*. Springer.	

3000 Level Courses

Course Code	**CSC3033**
Course Title	**Operating Systems Concepts**
Credit Value	**3**
Pre-requisites	**CSC2032**
Compulsory/Optional	**Compulsory**
Course Content	
Operating Systems (OS) objectives and functions, Evolution of OS, Process and thread management, Concurrency: Mutual Exclusion and Synchronization, Uniprocessor and multiprocessor scheduling, Memory management, Virtual memory, I/O management and disk scheduling, File management, Introduction to network operating systems. Some practical assignments will be given for this course.	
Recommended Texts	
• Stallings, W. (2017). Operating Systems Internal and Design Principles. 9th Ed. Pearson. • Silberschatz, A., Galvin, P. B. and Gagne, G. (2013). Operating Systems Concepts. 9th Ed. John Wiley & sons, Inc. • Tanenbaum, A.S. (2015). Modern Operating Systems. 4th Ed. Pearson.	

Course Code	**CSC3073**
Course Title	**Computer Graphics**
Credit Value	**3**
Pre-requisites	**CSC3152**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
Introduction to Computer Graphics; Overview of graphics systems; Components of graphics systems; Software Standards; Graphics Primitives and Basic Raster Algorithms; Viewing Pipelines; Geometric Transformations; Hierarchical Models; 3D-object representation and manipulation: Polygon mesh, Fractal geometry, Splines,	

Octrees; Data structures for Graphics; 3D Viewing; Parallel and Perspective Projections; Visible surface identification; Colour models; Illumination, Shading and Surface rendering.
Recommended Texts
• Hearn, D. and Baker p. (1997). *Computer Graphics - C Version*. 2nd Ed. Prentice Hall. • Foley, J.D., Van Dam, A., Feiner, S.K. and Hughes, J. F. (1995). *Computer Graphics: Principles and Practice.* 2nd Ed. in C. Addison-Wesley.

Course Code	**CSC3081**
Course Title	**Computer Graphics Programming**
Credit Value	**1**
Pre-requisites	**CSC3073**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
Introduction to Graphics APIs, Main programming blocks of graphics programs, 2D and 3D coordinate system handling, Represent 2D shapes and 3D objects in device coordinate systems, Perspective and orthographic projections, Transformations stack, Light and shade models, Design splines and NURBS, Fractal designs, Create and display complex objects using primitives.	
Recommended Texts	
• Kessenich, J.M, Sellers, G. and Shreiner, D. (2016). *OpenGL Programming Guide: The Official Guide to Learning OpenGL*, Version 4.5, 9th Ed. Addison-Wesley Professional. • Sellers, G., Wright Jr., R. S. and Haemel, N. (2015). *OpenGL Superbible: Comprehensive Tutorial and Reference*.7th Ed. Addison-Wesley Professional.	

Course Code	**CSC3093**
Course Title	**Object Oriented Analysis and Design**
Credit Value	**3**
Pre-requisites	**CSC1023, CSC1051**
Compulsory/Optional	**Optional**
Course Content	
Fundamentals of object-oriented analysis and design (OOAD): Abstraction, Encapsulation, Classes and objects, Inheritance, Polymorphism, Composition and Aggregation, Delegation. Object-oriented modeling with Unified Modelling Language (UML). Object-oriented analysis: Use cases, Use case diagrams. Object-oriented design: Class diagrams, Sequence diagrams, State diagrams, Activity diagrams and Deployment diagrams. Design Patterns: Overview of design patterns, Creational patterns, Structural patterns, and Behavioral patterns. Advanced object-oriented concepts. Practical assignments will be given for mapping design to code.	
Recommended Texts	
• Larman, C. (2004). *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and the Unified Process*. 3rd Ed. Prentice Hall Inc. • Vlisside, J., Helm, R., Johnson, R. and Gamma, E. (1995). Design Patterns: Elements of Reusable Object-Oriented Software. 1st Ed. Addison-Wesley Professional.	

Course Code	**CSC3103**
Course Title	**Server Side Web Programming**
Credit Value	**3**
Pre-requisites	**CSC2021, CSC2041, CSC2102**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
CGI concept, Server side program structure, Introduction to Server side programming languages, Session management, Database connectivity, Introduction to architectural patterns and frameworks, JSON and XML, AJAX, Web API, Web Services. Practical assignments will be given for this course.	
Recommended Texts	
• Robbins, J. N., *Learning Web Design: A Beginners Guide to HTML, CSS, JavaScript, and Web Graphics;* 4th Edition; O'Reilly Media; (August 24, 2012) • Downey, T. (2012) *Guide to Web Development with Java: Understanding Website Creation*. 2012th Ed. Springer.	

Course Code	**CSC3112**
Course Title	**Software Engineering**
Credit Value	**2**
Pre-requisites	**CSC1013**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to software development; Software engineering life cycle: requirements engineering, design, implementation, testing and maintenance; Software process models: Traditional, Agile and Modern models; Software engineering ethics; Requirements engineering: functional and non-functional requirements, requirements documentation; Software design: system modeling, architectural design; Implementation: coding standards, version control; Software testing: static testing, dynamic testing, test automation; Software reuse; Introduction to software management; CASE tools; Software agreements. Practical assignments will be given for this course.	
Recommended Texts	
• Somerville, I. (2015). *Software Engineering*. 10th Ed. Pearson. • Pressman, R. S. and Maxim, B. (2015). *Software Engineering, A Practitioner's Approach*. 8th Ed. McGraw-Hill Education	

Course Code	**CSC3122**
Course Title	**Human Computer Interaction Design**
Credit Value	**2**
Pre-requisites	**CSC1051**
Compulsory/Optional	**Optional**
Course Content	
Understanding the human: possibilities and limitations; Human Computer Interaction (HCI); Computing devices; Interaction design basics; HCI in the software development process; Design rules; Task Analysis; People, Activities, Context, and Technologies (PACT) Analysis; User-centered and Participatory design; A/B testing; HCI in mobile applications; Emerging HCI technologies; Real world HCI design case studies.	

Practical assignments will be given for this course.
Recommended Texts
• Dix, A., Finlay, J., Abowd, G.D. and Beale, R. (2004) Human Computer Interaction, 3rd Ed. Pearson Education Limited.

Course Code	**CSC3132 / DSC3182**
Course Title	**Digital Image Processing**
Credit Value	**2**
Pre-requisites	**CSC3152**
Compulsory/Optional	**Optional**
Course Content	
Introduction to digital images: why digital images, the digital camera, 2D, 3D and higher dimensional representations, fundamental steps in digital image processing, elements of visual perception, light and electro-magnetic spectrum, image sensing and acquisition , sampling and quantization, relationships between pixels; Image operations: histogram processing, spatial filtering; Filtering in the frequency domain: Fourier transform, Discrete Fourier transform (DFT), filtering; Morphological image processing: erosion , dilation , opening, closing, hit-or-miss transform, gray scale morphology; Image segmentation: point, line and edge detection, threshold, region based segmentation, watersheds; Representation and description: boundary descriptors, regional descriptors; Introduction to object recognition: patterns, pattern classes, classification; Color image processing: color models, image segmentation based on color.	
Recommended Texts	
• Gonzalez, R. and Woods, R. (2008). *Digital Image Processing*, 3rd Ed. Prentice Hall.	

Course Code	**CSC3141**
Course Title	**Image Processing Laboratory**
Credit Value	**1**
Pre-requisites	**CSC3132**
Compulsory/Optional	**Optional**
Course Content	
Programming assignments will be given covering the following concepts. Introduction to image processing tools, Digital image representations, Reading, displaying and writing images, Image types, Histogram processing, Intensity transformations, Filtering, Morphological processing, Color image processing, Image segmentation, Object representation and description.	
Recommended Texts	
• Gonzalez, R. and Woods, R. (2008). *Digital Image Processing*, 3rd Ed., Prentice Hall. • OpenCV documentation, https://docs.opencv.org/master/ • Solem, J.E. (2012). *Programming Computer Vision with Python: Tools and algorithms for analyzing images*, 1st Ed. O'Reilly.	

Course Code	**CSC3152 / DSC3152**
Course Title	**Design and Analysis of Algorithms**
Credit Value	**2**

Pre-requisites	**CSC2012**
Compulsory/Optional	**Compulsory**
Course Content	
Analysis of algorithms: Time complexity, Big-O notation, Complexity classes; Sorting algorithms and their analysis: Insertion sort, Bubble sort, Selection sort, Quick sort, Heap sort, Merge sort; Algorithm Design Paradigms**:** Divide and Conquer, Dynamic Programming, Greedy algorithms; Algorithms by field of study: Graph algorithms, Searching algorithms, Optimization algorithms; NP-completeness: Polynomial time, NP-completeness and reducibility, NP-complete problems. Practical assignments will be given for this course.	
Recommended Texts	
• Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C. (2009) Introduction to Algorithms, 3rd Ed, The MIT Press.	

Course Code	**CSC3173 / DSC3173**
Course Title	**Artificial Intelligence**
Credit Value	**3**
Pre-requisites	**CSC2012, CSC3152**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
Overview of Artificial Intelligence (AI): Modern AI, General AI, Agents and environments, Application of AI in various fields. Problem Solving**:** Problem spaces, Classical search, Local search, Adversarial search, Constraint satisfaction, Genetic algorithms. Knowledge Representation and Reasoning**:** First-order logic, resolution theorem proving, Fuzzy logic and Fuzzy inference systems, Ontologies. Introduction to Machine Learning**:** Supervised and unsupervised learning, Inductive learning, Naive Bayes, Decision trees, SVM, Neural networks, Clustering. Reasoning Under Uncertainty**:** Probabilistic reasoning, Introduction to decision theory. Programming in AI**:** Logic programming and Modern AI programming frameworks. Programming assignments will be given for this course	
Recommended Texts	
• Russell, S.J. and Norvig, P. (2014). Artificial Intelligence: A Modern Approach. 3rd Ed. Pearson, Education Inc.	

Course Code	**CSC3182**
Course Title	**Advanced Computer Networks**
Credit Value	**2**
Pre-requisites	**CSC2112**
Compulsory/Optional	**Optional**
Course Content	
Issues in networking and protocols to handle the issues, Wireless networks , Difference between Ad-hoc, nomadic and infrastructure networks, Evolution of mobile networks and their infrastructure advancements, Introduction to distributed systems, Network Virtualization, Mobility handling techniques (Mobile IP and extensions), Software Defined Networking (SDN), Content Delivery Networks (CDN), Introduction to sensor networks and their protocol design basics and algorithms, Modern networking trends.	
Recommended Texts	
• Mir, N.F. (2014). Computer and Communication Networks. 2nd Ed. Prentice Hall.	

- On-line material : IEEE Standards Association (http://standards.ieee.org/)
- On-line material : Internet Engineering Taskforce (IETF) (http://www.ietf.org/)
- On-line material : 3GPP (http://www.3gpp.org/)

Course Code	**CSC3213**
Course Title	**Project in Computer Science I**
Credit Value	**3**
Pre-requisites	**CSC2041, CSC2102, CSC3093, CSC3103, CSC3112**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
The students will conduct a sufficient amount of work on a chosen software design problem under the guidance provided by an assigned supervisor(s), make a presentation of the developed solution, produce a report and conduct a presentation.	

Course Code	**CSC3252/STA3252/DSC3252**
Course Title	**Scientific Writing and Presentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
Introduction to Scientific writing: Searching the scientific literature, Plagiarism and how to avoid it, Fundamentals of effective scientific writing. Scientific writing: Standard formats for scientific papers, research projects and theses, Style guides, Creating a literature review, Preparing other sections of a research report (abstract, introduction, materials and methods, results and discussion, conclusions), Including and summarizing research data, Reference citations within the text and making a list of references, Use of Software tools (Latex, Lyx, Bibtex, Mendaley, etc). Poster Presentations: Guidelines for designing posters, Use of software and online resources. Oral Presentations: Designing and preparing slides for an oral presentation, Important guidelines to make a good presentation.	
Recommended Texts	
• Alley, M. (2003). The Craft of Scientific Presentations: Critical steps to succeed and critical errors to avoid. Springer, NY. ISBN:0-387-95555-0. • Alley, M. (2003). The Craft of Scientific Writing. Springer, NY, ISBN-13: 978-0131888555 • Matthews, J.R., Bowen, J.M. and Matthews, R.W. (2005). Successful Scientific Writing: A step-by-step guide for biomedical scientists, Cambridge University Press, ISBN 0 521 78962 1 • Godin, S. (2007). Really bad PowerPoint (and how to avoid it). Available at: http://www.sethgodin.com/freeprize/reallybad-1.pdf.	

Course Code	**CSC3312**
Course Title	**Computing for Science II**
Credit Value	**2**
Pre-requisites	**CSC2312**
Compulsory/Optional	**Optional**

Course Content
Main requirements for setting up a network, data / resource sharing concepts, basic centralization and distribution concepts, Network topologies, Layered architecture: ISO-OSI / TCP/IP reference models. History and evolution of database management systems, Entity relationship diagrams, Relational models, Normalization, Relational database management systems (RDBMS), Physical database implementations, Connecting front-end and back-end of an information system.
Recommended Texts
• Elmasri, R. and Navathe, S.B. (2010). *Fundamentals of Database Systems.* 6th Ed. Pearson. • Date, C.J. (2003). *An Introduction to Database Systems*. 8th Ed. Pearson. • Mir, N.F. (2014). *Computer and Communication Networks*. 2nd Ed. Prentice Hall. • Tanenbaum, A. S. (2012). *Computer Networks*.5th Ed. Pearson.

Course Code	**CSC3321**
Course Title	**Computing for Science Programming Laboratory II**
Credit Value	**1**
Pre-requisites	**CSC2321**
Compulsory/Optional	**Optional**
Course Content	
Overview of Database Management Systems (DBMS), Applications of SQL: data definition, query formulation, constraints, integrity, Selections, Projections, Select-project-join, Aggregates and group-by, Subqueries, Backup and recovery, User privileges, Connecting databases using programming languages.	
Recommended Texts	
• Connolly, T. and Begg, C. (2014). *A Practical Approach to Design, Implementation, and Management.* 6th Ed. Pearson. • Hernandez, M.J. (2013). *Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design*. 3rd Ed. Addison-Wesley Professional.	

4000 Level Courses

Course Code	**CSC4043**
Course Title	**Parallel Processing**
Credit Value	**3**
Pre-requisites	**CSC3033**
Compulsory/Optional	**Optional**
Course Content	
Introduction: History and evolution of parallelism, Types of parallelism, Classes of parallel computers: Single Instruction, Multiple Data (SIMD), Multiple Instruction, Single Data (MISD) and Multiple Instruction, Multiple Data (MIMD) architectures, Multicores and GPUs, Scalability issues, Interconnection networks, Routing and communication techniques, Clustering, Cloud Computing; Basic Parallel Programming: Inter-process communications, Programming models, SIMD, MIMD and SPMD programming, Parallelism issues, Synchronization, Computing styles of commercial machines; Performance Analysis Methods: Various performance measures, Performance analysis methods, Amdahl's Law Gustafson-Barsis Law, Speedup and scalability, Benchmarking; Parallel Paradigms and Programming Models: Distributed-memory message passing programming (MPI), Shared memory programming (Threads), SIMD and GPU programming, Comparison of programming models; Parallel Algorithms: Parallelizing algorithms, Linear equation solvers, Matrix algorithms,	

Sorting algorithms, Resource Management, Partitioning techniques, Mapping algorithms, Static and dynamic load balancing, Scheduling.
Recommended Texts
• Dubois, M., Annavaram, M. and Stenström, P. (2012). Parallel Computer Organization and Design.1st Ed. Cambridge University Press. • Hwang, K. (1993). Advanced Computer Architecture: Parallelism, Scalability, Programmability. McGraw Hill. • Culler, D., Singh, J. P. and Kaufmann, M. (1999). Parallel Computer Architecture: A Hardware/Software Approach. Morgan Kaufmann. • Grama, A., Karypis, G., Kumar, V. and Gupta, A. (2003). Introduction to Parallel Computing. 2nd Wesley, E. A. • Dally, W.J. and Towles, B. (2003). Principles and Practices of Interconnection Networks. Morgan Kaufmann.

Course Code	**CSC4063**
Course Title	**Distributed Computing**
Credit Value	**3**
Pre-requisites	**CSC2112, CSC3033**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Distributed Systems: Key characteristics of Distributed Systems (DS), Resource Sharing, Openness, Concurrency, Scalability, Fault tolerance and Transparency. Design Concepts of DS: Naming, Communication, Software structure, Workload allocation and Consistency maintenance. Inter-process Communication: Building blocks, Client-Server communication, Group communication, Client-server applications, Message Passing Interface (MPI) case study. Remote procedure calling (RPC): Design issues, Case study and Implementation, Remote method invocation (RMI). Distributed Objects and Components (CORBA). Replication and Transaction: advantages, replication models and their applications, Concurrent transactions and issues, Linearizability, serial equivalence. Introduction to Cloud Computing: Basic concepts of could computing, Cloud services. Distributed Networks: Introduction to distributed networks, Mobile network basics, Advantages and challenges of such networks. Introduction to Pervasive Computing: Basic concepts of mobile and pervasive computing. Distributed Protocols: Neighbor discovery protocols and other distributed protocols for distributed networks. Security in Distributed Systems: Security concerns of Distributed Systems, identification of security threats and prevention, distributed backup services and failure management.	
Recommended Texts	
• Coulouris, G.,Dollimore, J. and Kindberg, T. (2011). *Distributed Systems, Concepts and design*. 5^{th} Ed. Pearson.	

Course Code	**CSC4082 / DSC4252**
Course Title	**Computer Vision**
Credit Value	**2**
Pre-requisites	**CSC3141**
Compulsory/Optional	**Optional**
Course Content	
Discrete geometry and quantization stereo geometry and correspondence; Feature extraction, description and matching; Object recognition and identification; Object tracking, Motion analysis, Applications of Computer	

Vision: biomedical imaging, document processing, target tracking, industrial inspections, automated visual inspections. Group discussions, practical assignments, and presentations on selected topics from current research will be conducted in this course.
Recommended Texts
• Forsyth, D.A. and Ponce, J. (2011). *Computer Vision: A Modern Approach*. 2nd Ed. Prentice Hall. • Szeliski, R. (2010). *Computer Vision: Algorithms and Applications*. Springer. • Nixon, M. (2012). *Feature Extraction & Image Processing for Computer Vision*. 3rd Ed. Academic Press. • Duda, R.O. and Har, P.E. and Stork, D.G. (2010). *Pattern Classification*. 2nd Ed. Wiley-Interscience. • Bradsk, G. and Kaehler, A. (2008). *Learning OpenCV: Computer Vision with the OpenCV Library*. O'Reilly Media.

Course Code	**CSC4093 / DSC4153**
Course Title	**Neural Networks and Deep Learning**
Credit Value	**3**
Pre-requisites	**CSC3173**
Compulsory/Optional	**Optional**
Course Content	
Neural Networks Basics: Neural network representation, Biological neuron vs artificial neuron, Activation functions, McCulloch-Pitts Model, Perceptron, Binary Classification, Logistic Regression, Cost function, Gradient Descent; Shallow Neural Networks: Supervised learning with neural networks, Neural network architectures, Feedforward networks, Gradient descent for neural networks, Backpropagation, Training neural networks; Unsupervised learning: Self-organizing maps; Introduction to Deep Learning: Key concepts of Deep Learning, Applications of Deep Learning. Deep Neural Networks: Building blocks of deep neural networks, Convolutional Neural Networks, Recurrent Neural Networks and LSTMs, Parameters and Hyperparameters; Programming Libraries and tools for Neural Networks. Programming assignments will be given for this course.	
Recommended Texts	
• Goodfellow, I., Bengio, Y. and Courville, A. (2016). *Deep Learning*. MIT Press.	

Course Code	**CSC4103**
Course Title	**Internet and Multimedia Systems**
Credit Value	**3**
Pre-requisites	**CSC2112, CSC3141**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Multimedia Systems: Types of media, Analysis of multimedia systems; Data Compression algorithms: Lossless and Lossy compression, Huffman coding, Run-length, Lempel-Ziv-Welch (LZW); Audio and Audio Compression Techniques: Analogue and digital form: Sample rate, bits/sample, nyquist rate, Pulse Code Modulations (PCM) and its variations. Image Compression: JPEG; Video: Video data type, TV Standards, Interlacing vs progressive scan; Video Compression: H.261, MPEG 1, MPEG 2, MPEG 4; Multimedia Network Communications and Applications: Quality of multimedia data transmission, Quality of Service (QoS), QoS for IP Protocols, Multimedia over IP, Real-time traffic congestion control; Introduction to Digital rights management: Legal issues, Watermarking Multimedia software packages and tools**:** sound editing, video editing, 2D and 3D animation design, multimedia	

authoring.
Recommended Texts
• Bhatnagar, G., Mehta, S., Mitra, S. (2001). Introduction to Multimedia Systems (Communications, Networking and Multimedia). 1st Ed. Academic Press.

Course Code	**CSC4122**
Course Title	**Internet of Things**
Credit Value	**2**
Pre-requisites	**CSC2053, CSC2112, CSC3173**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Internet of things (IoT) and its development life-cycle, IoT related serial and parallel communication techniques. Applications of micro-controllers and sensors, IoT frameworks.	
Recommended Texts	
• McEwen, A. and Cassimally, H. (2013). Designing the Internet of Things. 1st Ed. Wiley. • Rowland, C., Goodman, E., Charlier, M., Light, A. and Lui, A., (2015). *Designing Connected Products: UX for the Consumer Internet of Things*, 1st Ed. O'Reilly Media. • Horowitz, P. and Hill, W. (2015). *The art of Electronics*.2nd Ed. Cambridge University Press.	

Course Code	**CSC4132**
Course Title	**Information and Network Security**
Credit Value	**2**
Pre-requisites	**CSC2112**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Security, Threats and Attacks, Application, Data, and Host Security, Cryptography, Network Security, Web Security, Mobile Security, Access Control and Identity Management, Compliance and Operational Security, Digital Forensics.	
Recommended Texts	
• Ciampa, M. (2014). Security + Guide to Network Security Fundamentals. 5th Ed. Cengage Learning.	

Course Code	**CSC4142**
Course Title	**Software Project Management**
Credit Value	**2**
Pre-requisites	**CSC3112**
Compulsory/Optional	**Optional**
Course Content	
Introduction to software project management: Project phases and project life cycle, Project proposal, Project Stakeholders. Organizational influence: Organizational structure; Integration management: Portfolio, development, execution and control. Scope management: requirement specification development, Work Breakdown Structure (WBS), change control. Time management: Activity definition, sequencing, schedule	

control; Cost management: Estimation, budgeting, break-even, cost control. Quality management: Quality assurance and control; Human resource management: organizational planning, staff acquisition, load balancing, staff development. Communication management: Defining stakeholder information requirements, planning communication, best practices in reporting. Project risk management: risk management planning, risk identification and analysis, risk response planning, risk monitoring and control. Procurement management: procurement planning, solicitation, source selection, contract administration and closure.
Recommended Texts
• Fuller, M., Valacich, J. and George, J. (2010). *Information Systems Project Management: A process and team approach*. 1st Ed. Prentice Hall. • *Project Management Institute (2018). A Guide to the Project Management Body of Knowledge (PMBOK Guide®- Agile Practice Guide*), 6th Ed. PMI- Project Management Institute.

Course Code	**CSC4162**
Course Title	**Special Topics in Computer Science**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
The special topics will be announced each year in the course schedule.	
Recommended Texts	
• Text books and other references will be selected based on the selected topic.	

Course Code	**CSC4173 / DSC4173**
Course Title	**Machine Learning**
Credit Value	**3**
Pre-requisites	**CSC3173**
Compulsory/Optional	**Optional**
Course Content	
Basic machine learning concepts and examples: Supervised leaning, Unsupervised learning and Reinforcement learning, Machine learning system design. Classification: Linear classification, Nearest-neighbor algorithms, Support vector machines, Kernel methods, Bayesian classification, Multi-class classification. Neural Networks: Perceptron, Feed-forward neural networks and Backpropagation. Linear prediction: Linear methods for regression. Ensemble methods: Boosting and Bagging, Random forests. Regularization, Evaluation and Model Selection: Bias and variance, Regularization methods, Learning curves, Evaluation metrics. Feature selection methods: Filters, Wrappers and Embedded methods. Unsupervised learning. Introduction to reinforcement learning. Introduction to online learning. Applying Machine Learning: Machine learning frameworks in Python/R/Matlab, Recommendation systems and other applications. Introduction to large-scale machine learning.	
Recommended Texts	
• Bishop, C.M. (2007). *Pattern Recognition and Machine Learning*, Springer. • Hastie, T., Tibshirani, R. and Friedman, J. (2009). *The Elements of Statistical Learning.* 2nd Ed., Springer.	

Course Code	**CSC4182 / DSC4182**
Course Title	**Natural Language Processing**
Credit Value	**2**
Pre-requisites	**CSC3173**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Natural Language Processing(NLP), Language Models, Morphological Analysis, Part-of-Speech Tagging and Hidden Markov Models (HMMs), Parsing, Word Sense Disambiguation, Vector-Space Lexical Semantics (Word Vectors), Text Classification, Text Summarization, Sentiment Analysis, Introduction to Information Extraction, Machine Translation, Spoken dialog systems, Question Answering, NLP with LSTM Recurrent Neural Networks, Python Natural Language Toolkit (NLTK).	
Recommended Texts	
• Jurafsky D. and MartinJ. (2009). *Speech and Language Processing (2nd Ed.)*. Prentice Hall • Manning C. and Schütze H. (1999). *Foundations of Statistical Natural Language Processing.* (1st Ed.). MIT Press • Bird S., Klein E., and Loper E. (2009). *Natural Language Processing with Python*. O'Reilly Media.	

Course Code	**CSC4996**
Course Title	**Project in Computer Science II – Research Project**
Credit Value	**6**
Pre-requisites	**CSC3213**
Compulsory/Optional	**Compulsory for Computer Science Honours Students**
Course Content	
The students will conduct a sufficient amount of work on a chosen research topic under the guidance provided by an assigned supervisor(s), make a presentation of research findings, produce a thesis and conduct a presentation.	
Recommended Texts	
There is no required text in this course. The students are required to consult with their research supervisor for recommendations on the textbooks in order to perform their project tasks.	

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Students are expected to work under an assigned supervisor at a software development or related industry.	

8.2 Data Science Course Modules

3000 LEVEL – DATA SCIENCE				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
				Hons.
DSC3013	Regression Analysis	3	STA2033	√
DSC3023	Big Data Analytics I	3	CSC2042, STA1041	√
DSC3032	Multivariate Methods I	2	STA2033	√
DSC3042	Time Series Analysis	2	STA2033	
DSC3052	Data Visualization	2	DSC3091	
DSC3063	Decision and Game Theory	3	STA2033	
DSC3073	Non-parametric and Categorical Data Analysis	3	STA2033	
DSC3083	Statistical Simulation	3	STA2033	
DSC3091	Advanced Statistical Applications I	1	DSC3013	√
DSC3101	Advanced Statistical Applications II	1	DSC3091	√
DSC3152	Design and Analysis of Algorithms	2	CSC2021	√
DSC3163	Advanced Database Management Systems	3	CSC2032	√
DSC3173	Artificial Intelligence	3	CSC2012, DSC3152	√
DSC3182	Digital Image Processing	2	DSC3152	
DSC3192	Computing for Data Science	2	CSC2021, DSC3091	√
DSC3252	Scientific Writing and Presentation	2	None	√
DSC3263	Independent Study in Data Science	3	DSC3252	√
Total		**40**		**25**

4000 LEVEL – DATA SCIENCE				
Course Code	**Course Title**	**No. of Credits**	**Pre -requisites**	**Compulsory**
				Hons.
DSC4013	Big Data Analytics II	3	DSC3023	√
DSC4023	Statistical Data Mining	3	DSC3032	
DSC4033	Multivariate Methods II	3	DSC3032	
DSC4043	Bayesian Statistics	3	STA2033	
DSC4052	Advanced Time Series Analysis	2	DSC3042	
DSC4063	Reliability Theory and Survival Analysis	3	STA2033	
DSC4162	Advanced Topics in Algorithms and Optimization	2	DSC3152	
DSC4173	Machine Learning	3	DSC3173	√
DSC4182	Natural Language Processing	2	DSC3173	
DSC4192	Internet of Things	2	CSC2052, CSC2112, DSC3173	
DSC4202	Information Retrieval	2	DSC3173	

DSC4213	Neural Networks and Deep Learning	3	DSC3173	√
DSC4222	Special Topics in Data Science	2	None	
DSC4243	Distributed Computing	3	CSC2113	
DSC4252	Computer Vision	2	DSC3173, DSC3183	
DSC4996	Project in Data Science	6	DSC3193, DSC3263	√
SCI4003	Industrial Training	3		
Total		**47**		**15**

3000 Level Courses

Course Code	**DSC3013/STA3013**
Course Title	**Regression Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory**

Course Content

Simple linear regression, Tests for regression coefficients, Interval estimation, Prediction, Analysis of variance approach, Diagnostic and remedial measures, Matrix approach to simple linear regression, Multiple regression, Polynomial regression, Nonlinear regression, Penalized regression and bias estimators. Introduction to Generalized Linear Models. Introduction to divided analysis of regression for big data.
Some practical assignments will be given for this course.

Recommended Texts

- Neter, J., Wasserman, W. and Kunter, M.H. (2004). *Applied Linear Statistical Models*. 5th Ed. McGraw-Hill/Irwin.
- Myers, R.H. (2000) *Classical and Modern Regression with Applications*. 2nd Ed. Duxbury Press.
- Christensen, R. (2015) *Analysis of Variance, Design and Regression*. 2nd Ed. Chapman & Hall/CRC.

Course Code	**DSC3023**
Course Title	**Big Data Analytics I**
Credit Value	**3**
Pre-requisites	**CSC2041, STA1041**
Compulsory/Optional	**Compulsory for Data Science Honours Students**

Course Content

Introduction big data: Sources of big data, Characteristics of big data. Applications of big data: Recommendation systems, Sentiment Analysis, Computational Advertising. Working with different data types: Streaming data, Unstructured data, Large textual data. Big data models: Vector space model, Graph data model. Big Data processing Pipeline. Introduction to big data processing platforms and programming: MapReduce and Hadoop, Hadoop Distributed Files Systems (HDFS), Big Data Processing using existing tools, Apache Mahout. NoSQL databases: Mongo DB, Cassendra.

Recommended Texts

- Mayer-Schönberger V. and Cukier K. (2013). *Big Data: A Revolution That Will Transform How We*

Live, Work, and Think. 1st Ed. Amon Dolan/Houghton Mifflin Harcourt. • White T. (2012). *Hadoop: The Definitive Guide*. 3rd Ed. Yahoo Press. • Karau H., Konwinski A., Wendell P. and Zaharia M. (2015). *Learning Spark: Lightning-Fast Big Data Analysis*. 1st Ed. O'Reilly Media.

Course Code	**DSC3032/STA3052**
Course Title	**Multivariate Methods I**
Credit Value	**2**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Properties of random vectors and Matrices, The Multivariate Normal distribution, Estimation of parameters in the Multivariate Normal distribution, Wishart distribution, Inferences on multivariate mean, and Hotelling's T2 tests, Multivariate Analysis of Variance, Cluster Analysis.	
Recommended Texts	
• Johnson, R.A. and Wichern, D.W. (2014). *Applied Multivariate Statistical Analysis*. 6th Ed. Pearson Publications. • Rencher, A.C. and Christensen, W. F. (2012). *Methods of Multivariate Analysis*. 3rd Ed. Wiley.	

Course Code	**DSC3042/STA3072**
Course Title	**Time Series Analysis**
Credit Value	**2**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Introduction: objective of time series analysis, components of time series. Classical method of time series decomposition: estimation of trend, seasonal effect and cyclic effects. Auto-covariance, auto-correlation function and correlogram. Processes: purely random, random walk, strictly stationary, weakly stationary, non-stationary, moving averages, auto-regressive, mixed models, and seasonal models. Parameter estimation, Diagnostic checking, Forecasting, Box-Jenkins methodology, Introduction to nonlinear models, multivariate time series analysis, and wavelet decomposition. Some practical assignments will be given for this course.	
Recommended Texts	
• Brockwell, P.J. and Davis, R.A. (2016). *Introduction to Time Series and Forecasting (Springer Series in Statistics)*. 3rd Ed. Springer. • Chatfield, C. (2003). *The Analysis of Time Series: An Introduction*. 6th Ed. Chapman and Hall/CRC. • Shumway, R.H. and Stoffer, D.S. (2017). *Time Series Analysis and Its Applications: With R Examples*. 4th Ed. Springer.	

Course Code	**DSC3052**
Course Title	**Data Visualization**
Credit Value	**2**
Pre-requisites	**DSC3091**
Compulsory/Optional	**Optional**

Course Content
Introduction to Data Visualization: Design principles for charts and graphs. Common tools for creating data visualizations, graphic concepts, multiple charts. Multivariate Data distributions and scatter plots: Histograms overlay, Box plots for groups, Pyramid with Multiple Colours, outer area and inner area, Lorenz Curve, Scatter Plot with outliers highlighted, Scatter Plot with areas highlighted, Scatter Plot with superimposed ellipse, Scatter Plot with connected points. Maps: Points, Diagrams, and Symbols in Maps, Choropleth Maps. Data visualization for categorical data: Bar Chart Simple, Bar Chart for Multiple Response Questions, Column Chart with Two-Line Labelling, Profile Plot for Multiple Response Questions, Pie Charts and Radial Diagrams, Simplified Gantt Chart, Bump Chart, Heat Map, Mosaic Plot (Panel), Balloon Plot, Tree Map. Data visualization for numerical data: Visualizing Regression and Time Series data, Multivariate and Spatial data. Data visualization using advanced tools: Introduction to some existing advanced tools (ggplot, Plotly, RShiny, Python etc). Animation and interactive graphs: Scalable vector graphics, HTML5
Recommended Texts
• Yau, N. (2013). Data Points: Visualization that means something. Wiley, ISBN: 978-1-118-46219-5 • Kirk A. (2013). Data Visualisation: A Handbook for Data Driven Design 1st Edition, ISBN-13: 978-1473912144 • Tufte E.R. (2013). The Visual Display of Quantitative Information, ISBN-13: 978-961392109 • Rahlf T. (2017). Data Visualization with R, Springer, ISBN: 978-3-319-49750-1

Course Code	**DSC3063**
Course Title	**Statistical Decision and Game Theory**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Introduction and philosophy: Loss function and risk, Foundations of optimal decision making, Bayes rule, minimax rule, admissibility, Sufficiency and Rao-Blackwellization. Utility Theory: Utility and loss, Personal utility function, Standard loss functions, loss functions for inference problems and predictive problems. Prior information: Prior and posterior, Conjugate families, Noninformative priors, Generalized Bayes rules. Game theory: General techniques for solving games, The minimax theorem, Statistical Games.	
Recommended Texts	
• James O. Berger (2010) Statistical Decision Theory and Bayesian Analysis, 2nd Edition, New York: Springer, ISBN-13: 978-1441930743. • John Pratt, Howard Raiffa and Robert Schlaifer (2008) Introduction to Statistical Decision Theory, The MIT Press, ISBN: 9780262662062	

Course Code	**DSC3073/STA3093**
Course Title	**Non-Parametric Methods and Categorical Data Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Non-parametric: One sample sign test, Binomial test, Two sample sign test, Wilcoxon paired samples, Signed rank test, Wilcoxon and Mann-Whitney U test, Test of independence, Wald Wolfowitz runs test, Kruskal-Wallis test, Friedman test, Correlation tests, Non-Parametric simple linear regression. Categorical Data Analysis: Chi-Square Goodness of fit tests, The Kolomogorov-Simrnov test, Lillifor's test,	

Anderson-Darling test. Comparing two proportions and confidence intervals, Relative risk and confidence intervals, odd ratios and confidence interval, Likelihood ratio test Likelihood function for generalized linear models, Logistic regression, Estimating parameters, Wald test and the confidence intervals, Logit models, Probit models, Model diagnostics, Log-linear models. Some practical assignments will be given for this course.
Recommended Texts
• Agresti, A. (2007). *An Introduction to Categorical Data Analysis*. 2nd Ed. John Wiley & Sons. • Sprent, P. and Smeeton, N.C. (2007). *Applied Nonparametric Statistical Method*. 4th Ed. Chapman & Hall/CRC. • Kolke, J. and McKean, J.W. (2014). *Nonparametric Statistical Methods Using R*. Chapman & Hall/CRC.

Course Code	**DSC3083/STA3113**
Course Title	**Statistical Simulation**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction and Overview of Simulation: Simulation examples, Statistical models in simulation, Modelling and estimating input processes, Random-number generation. Generation of random variates: Discrete and Continuous, Statistical analysis of simulation output, Comparison, ranking, and selection of simulation models, Variance-reduction techniques, Designing simulation experiments, gradient estimation, and optimization. Computer intensive inference methods: Jack-Knife, Bootstrap, cross validation, Monte Carlo methods and permutation tests.	
Recommended Texts	
• Ross, S.M. (2012). *Simulation (Statistical Modeling and Decision Science)*. 5th Ed. Academic Press. • Rubinstein, R.Y. and Kroese, D.P. (2007*). Simulation and the Monte Carlo Method*. 2nd Ed. Wiley-Interscience.	

Course Code	**DSC3091/STA3131**
Course Title	**Advanced Statistical Applications I**
Credit Value	**1**
Pre-requisites	**DSC3013**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Declaring advanced functions, complex data manipulation, pattern matching, writing efficient programs, point estimation, confidence interval and hypothesis testing, using a statistical software with quality control tools for statistical process control, generating quality control charts, multiple linear regression, modal diagnostic, generate reports for statistical analysis. All the concepts are demonstrated using R software.	
Recommended Texts	
• Lander, J.P. (2017). *R for Everyone: Advanced Analytics and Graphics*. 2nd Ed. Addison-Wesley Data & Analytics Series. • de Micheaux, P.L., Drouilhet, R. and Liquet, B. (2014*). The R Software: Fundamentals of Programming and Statistical Analysis*. 2013 Ed., Springer. • Matloff, N. (2011). *The Art of R Programming: A Tour of Statistical Software Design*, 1st Ed. No Starch Press.	

Course Code	DSC3101/STA3141
Course Title	**Advanced Statistical Applications II**
Credit Value	**1**
Pre-requisites	**DSC3091**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Statistical simulation methods: Bootstrapping, Cross validation, Permutation tests , Analysis of variance (ANOVA) models: One-way ANOVA, Two-way ANOVA, Experimental designs, Multivariate data analysis: similarity measures, multivariate probability distributions, multivariate inference, Multivariate Analysis of variance (MANOVA), multiple comparison tests, Cluster analysis, Nonparametric statistical inference, Analysing Categorical data: Contingency tables, graphical summaries of two-way contingency tables, three-way contingency tables, modelling categorical data, compile and self-publish scientific reports. All the concepts are demonstrated using R software.	
Recommended Texts	
• Lander, J.P. (2017). *R for Everyone: Advanced Analytics and Graphics*. 2nd Ed. Addison-Wesley Data & Analytics Series. • Peng, R. D. (2018). *R Programming for Data Science*. https://leanpub.com/rprogramming • Wickham (2017). Advanced R. https://adv-r.hadley.nz/	

Course Code	DSC3152/CSC3152
Course Title	**Design and Analysis of Algorithms**
Credit Value	**2**
Pre-requisites	**CSC2012**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Analysis of algorithms: Time complexity, Big-O notation, Complexity classes; Sorting algorithms and their analysis: Insertion sort, Bubble sort, Selection sort, Quick sort, Heap sort, Merge sort; Algorithm Design Paradigms: Divide and Conquer, Dynamic Programming, Greedy algorithms; Algorithms by field of study: Graph algorithms, Searching algorithms, Optimization algorithms; NP-completeness: Polynomial time, NP-completeness and reducibility, NP-complete problems. Practical assignments will be given for this course.	
Recommended Texts	
• Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C., *Introduction to Algorithms,* 3rd Ed. The MIT Press.	

Course Code	DSC3163
Course Title	**Advanced Database Management Systems**
Credit Value	**3**
Pre-requisites	**CSC2032**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Relational database programming: Algebraic and logical query languages, SQL, use of Unified Modeling Language (UML), Constraints and triggers, Views and indexes, Advanced topics in relational databases. Modelling and programming for semi structured data: Semi-structured data model and XML	

Database system implementation: Secondary storage management, Index structures, query execution, handling system failures, concurrency control, transaction management, parallel and distributed databases. Modern database technologies: Enhanced data models for advanced applications, NoSQL database designs, scaling databases, issues related to the management of big data, spatial, text and multimedia databases, database systems and the Internet.
Recommended Texts
• Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom**,** *Database Systems: The Complete Book*, Pearson (2008), 2^{nd} Edition, ISBN-13: 978-0131873254 • Carlos Coronel, Steven Morris, *Database Systems: Design, Implementation, & Management*, Course Technology; 12^{th} edition (January 26, 2016), ISBN-13: 978-1305627482

Course Code	**DSC3173/CSC3173**
Course Title	**Artificial Intelligence**
Credit Value	**3**
Pre-requisites	**CSC2012, DSC3152**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Overview of Artificial Intelligence (AI): Modern AI, General AI, Agents and environments, Application of AI in various fields. Problem Solving: Problem spaces, Classical search, Local search, Adversarial search, Constraint satisfaction, Genetic algorithms. Knowledge Representation and Reasoning: First-order logic, resolution theorem proving, Fuzzy logic and Fuzzy inference systems, Ontologies. Introduction to Machine Learning: Supervised and unsupervised learning, Inductive learning, Naive Bayes, Decision trees, SVM, Neural networks, Clustering. Reasoning Under Uncertainty: Probabilistic reasoning, Introduction to decision theory. Programming in AI: Logic programming and Modern AI programming frameworks Practical assignments will be given for this course.	
Recommended Texts	
• Russell, S.J. and Norvig, P. (2014) *Artificial Intelligence: A Modern Approach*. 3rd Ed. Pearson Education Inc.	

Course Code	**DSC3182/CSC3132**
Course Title	**Digital Image Processing**
Credit Value	**2**
Pre-requisites	**DSC3152**
Compulsory/Optional	**Optional**
Course Content	
Introduction to digital images: why digital images, the digital camera, 2D, 3D and higher dimensional representations, fundamental steps in digital image processing, elements of visual perception, light and electro-magnetic spectrum, image sensing and acquisition , sampling and quantization, relationships between pixels; Image operations: histogram processing, spatial filtering; Filtering in the frequency domain: Fourier transform, Discrete Fourier transform (DFT), filtering; Morphological image processing: erosion , dilation , opening, closing, hit-or-miss transform, gray scale morphology; Image segmentation: point, line and edge detection, threshold, region based segmentation, watersheds; Representation and description: boundary descriptors, regional descriptors; Introduction to object recognition: patterns, pattern classes, classification; Color image processing: color models, image segmentation based on color.	
Recommended Texts	
• Gonzalez, R. and Woods, R. (2008). *Digital Image Processing*, 3^{rd} Ed. Prentice Hall.	

Course Code	**DSC3192**
Course Title	**Computing for Data Science**
Credit Value	**2**
Pre-requisites	**CSC2021, DSC3091**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Advanced operating system management (Unix, SLURM etc), High-performance Computing Clusters (HPCCs), Cloud computing platforms, Fundamentals of Parallel Computing and Parallel Programming, Java programing primer to prepare for Big Data design patterns, GPU Programming with CUDA, Parallel Programming for Data Science with examples in R, Python etc.	
Recommended Texts	
• Matloff N. (2015). *Parallel Computing for Data Science: With Examples in R, C++ and CUDA.* CRC Press. • Sterling T., Anderson M. and Brodowicz M. (2017). *High Performance Computing: Modern Systems and Practices*, *1st Ed.*, Morgan Kaufmann, ISBN-13: 978-0124201583.	

Course Code	**DSC3252/CSC3252/STA3252**
Course Title	**Scientific Writing and Presentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Introduction to Scientific writing: Searching the scientific literature, Plagiarism and how to avoid it, Fundamentals of effective scientific writing Scientific writing: Standard formats for scientific papers, research projects and theses, Style guides, Creating a literature review, Preparing other sections of a research report (abstract, introduction, materials and methods, results and discussion, conclusions), Including and summarizing research data, Reference citations within the text and making a list of references, Use of Software tools (Latex, Lyx, Bibtex, Mendaley, etc) Poster Presentations: Guidelines for designing posters, Use of software and online resources Oral Presentations: Designing and preparing slides for an oral presentation, Important guidelines to make a good presentation	
Recommended Texts	
• Alley, M. 2003. The Craft of Scientific Presentations: Critical steps to succeed and critical errors to avoid. Springer, NY. ISBN:0-387-95555-0. • Alley, M. 2003. The Craft of Scientific Writing. Springer, NY, ISBN-13: 978-0131888555 • Matthews, J.R., Bowen, J.M. and Matthews, R.W. 2005. Successful Scientific Writing: A step-by-step guide for biomedical scientists, Cambridge University Press, ISBN 0 521 78962 1 • Godin, S. (2007). Really bad PowerPoint (and how to avoid it). Available at: http://www.sethgodin.com/freeprize/reallybad-1.pdf	

Course Code	**DSC3263**
Course Title	**Independent Study in Data Science**
Credit Value	**3**
Pre-requisites	**DSC3252**
Compulsory/Optional	**Compulsory for Data Science Honours Students**

Course Content
The students will conduct a sufficient amount of work on developing an end-to-end solution to a real-world data science problem, preferably from the related industry who are developing data science products and services. The students are expected to write a technical report on the developed solution and make a presentation.
Recommended Texts
There is no required text for this course. The students are required to explore the necessary materials available on the web.

4000 Level Courses

Course Code	DSC4013
Course Title	Big Data Analytics II
Credit Value	3
Pre-requisites	DSC3023
Compulsory/Optional	Compulsory for Data Science Honours Students
Course Content	
Predictive analytics for big data. Statistical/Machine learning with big data. Graph analytics, Advanced big data analytics with R, Python, Hadoop, Spark, Apache Mahout or similar software. Case studies in big data analytics: Recommendation Systems, Sentiment Analysis etc.	
Recommended Texts	
• Siegel E. (2016), *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie or Die*. 1st Ed. Wiley. • Leskovec J., Rajaraman A., and Ullman J. D. (2014). *Mining of Massive Datasets*. 2nd Ed. Cambridge University Press. • White T. (2012). *Hadoop: The Definitive Guide*. 3rd Ed. Yahoo Press. • Karau H., Konwinski A., Wendell P. and Zaharia M. (2015). *Learning Spark: Lightning-Fast Big Data Analysis*. 1st Ed. O'Reilly Media.	

Course Code	DSC4023/STA4023
Course Title	Statistical Data Mining
Credit Value	3
Pre-requisites	STA3052
Compulsory/Optional	Optional
Course Content	
Introduction to Data Mining and Big data, Data Mining tasks, processes, database/online transaction processing (OLTP), data warehousing / online analytical processing (OLAP), feature selection and dimension reduction techniques, Classification and Clustering: Similarity and Distance Measures, Hierarchical Algorithms, Partitional Algorithms, Clustering Large Data Bases, Clustering with Categorical Attributes, Comparison. Association Rules: Large Item Sets, Algorithms, Comparing Approaches, Measuring the Quality of Rules. Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining. Overview of Spatial Data mining, Temporal Mining: Modelling Temporal Events, Pattern Detection, Sequences, Temporal Association Rules, Introduction to Spatio-temporal data mining. Some practical assignments will be given for this course.	

Recommended Texts
• James, G., Witten, D., Hastie, T. and Tibshirani, R. (2017). *An Introduction to Statistical Learning: with Applications in R*, 1st Ed. Corr. 7th Printing Ed. Springer Texts in Statistics. • Kuhn, M. and Johnson, K. (2018*). Applied Predictive Modeling*, 1st Ed. 2013, Corr. 2nd Printing 2018 Ed., Springer. • Hastie, T., Tibshirani, R. and Friedman, J. (2016), *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. 2nd Ed. Springer Series in Statistics.

Course Code	**DSC4033/STA4053**
Course Title	**Multivariate methods II**
Credit Value	**3**
Pre-requisites	**DSC3032**
Compulsory/Optional	**Optional**
Course Content	
Principal component analysis (PCA), Interpretation using illustrative examples. Factor analysis, Comparison with PCA, factor loadings and rotations, Geometric Interpretation, Discriminant analysis of two group and multiple groups, Canonical correlation, Covariance structure models, Correspondence analysis, Multidimensional Scaling, Multivariate Analysis of Covariance. Some practical assignments will be given for this course.	
Recommended Texts	
• Hardle, W. and Simar, L. (2003). *Applied Multivariate Statistical Analysis*. Springer. • Anderson, T.W. (2003). *An Introduction to Multivariate Statistical Analysis*. 3rd Ed. Wiley. • Johnson, A.R. and Wichern, D. W. (2007). *Applied Multivariate Statistical Analysis*. Prentice Hall.	

Course Code	**DSC4043/STA4063**
Course Title	**Bayesian Statistics**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Fundamentals of Bayesian inference, Bayesian Estimation, Credible sets, Hypothesis testing, Bayesian Prediction, Model checking and improvement, Posterior simulation, Bayesian models: Regression models, Hierarchical linear models, Generalized linear models, Models for robust inference, Mixture models, Multivariate models, Nonlinear models, Models for missing data. Some practical assignments will be given for this course.	
Recommended Texts	
• Marin, J.-M., Robert, C. P. (2007). *Bayesian core: A practical approach to computational Bayesian statistics*, 1st Ed., Springer Texts in Statistics. • Gelman, A., Carlin, J. B., Stern, H. S. and Rubin, D. B. (2013). *Bayesian Data Analysis*, 3rd Ed. Chapman & Hall/CRC Texts in Statistical Science. • Berger, J.O. (1993). *Statistical Decision Theory and Bayesian Analysis*. 2nd Ed., Springer.	

Course Code	**DSC4052**
Course Title	**Advanced Time Series Analysis**
Credit Value	**2**
Pre-requisites	**DSC3042**
Compulsory/Optional	**Optional**
Course Content	
Vector Autoregressive (VAR) Processes: Assumptions, Estimation, Order selection and Model adequacy, Forecasting, Structural Analysis, VAR processes with constraints, Higher Dimensional VAR models, Co-integrated Processes: Vector error correction models, estimation. Multivariate ARCH and GARCH Models, State Space models, Dynamic Linear Models, Stochastic Volatility, Frequency domain clustering. Some practical assignments will be given for this course.	
Recommended Texts	
• Lütkepohl H. (2007), *New Introduction to Multiple Time Series Analysis (Corr. 2nd Ed.)*, Springer. • Durbin J. and Koopman S.J. (2012), *Time Series Analysis by State Space Methods (2nd Revised Ed.)*, Oxford University Press.	

Course Code	**DSC4063/STA4083**
Course Title	**Reliability Theory and Survival Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Reliability Theory: General introduction, Reliability concepts, Classical model, Censored observations, Parameter estimation, Asymptotic results, Accelerated Life Testing (ALT). Survival Analysis: preliminaries of time-to-event data, Kaplan-Meier estimation, survival curves, parametric modelling with Cox’s proportional hazard (PH) models, stratified Cox's PH model, extended Cox's PH model, Overview of non-parametric techniques for survival data. Some practical assignments will be given for this course.	
Recommended Texts	
• Machin, D., Cheung, Y.B. and Parmar, M. (2006), *Survival Analysis: A practical approach*, 2nd Ed., Wiley. • Meker, M.Q. and Escobar, L.A. (1998), *Statistical Methods for Reliability Data*, 1st Ed. Wiley-Interscience.	

Course Code	**DSC4162**
Course Title	**Advanced Topics in Algorithms and Optimization**
Credit Value	**2**
Pre-requisites	**DSC3152**
Compulsory/Optional	**Optional**
Course Content	
Convexity and optimality. Optimality condition for unlimited optimization. Numerical methods for unlimited optimization: Bracketing methods, Newton's method, Steepest descent method, and quasi-Newton methods. Methods to guarantee descent directions, line search. Algorithms for Non-linear least squares optimization (Gauss-Newton). Optimality condition for optimization with constraint, Methods for optimisation with	

constraints (penalty and barrier methods, Simplex method). Duality and complementarity. Non-conventional optimization. NP completeness and approximation algorithms. Some practical assignments will be given for this course.
Recommended Texts
• Guenin B., Könemann J. and Tuncel L. (2014), A Gentle Introduction to Optimization (1st Edition), Cambridge University Press. • Boyd S. and Vandenberghe L. (2008), Convex Optimization, (1st Edition), Cambridge University Press.

Course Code	**DSC4173/CSC4173**
Course Title	**Machine Learning**
Credit Value	**3**
Pre-requisites	**DSC3173**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Basic machine learning concepts and examples: Supervised leaning, Unsupervised learning and Reinforcement learning, Machine learning system design. Classification: Linear classification, Nearest-neighbor algorithms, Support vector machines, Kernel methods, Bayesian classification, Multi-class classification. Neural Networks: Perceptron, Feed-forward neural networks and Backpropagation. Linear prediction: Linear methods for regression. Ensemble methods: Boosting and Bagging, Random forests. Regularization, Evaluation and Model Selection: Bias and variance, Regularization methods, Learning curves, Evaluation metrics. Feature selection methods: Filters, Wrappers and Embedded methods. Unsupervised learning. Introduction to reinforcement learning. Introduction to online learning. Applying Machine Learning: Machine learning frameworks in Python/R/Matlab, Recommendation systems and other applications. Introduction to large-scale machine learning.	
Recommended Texts	
• Bishop, C.M. (2007). *Pattern Recognition and Machine Learning*, Springer. • Hastie, T., Tibshirani, R. and Friedman, J. (2009). *The Elements of Statistical Learning*.2nd Ed., Springer	

Course Code	**DSC4182/CSC4182**
Course Title	**Natural Language Processing**
Credit Value	**2**
Pre-requisites	**DSC3173**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Introduction to Natural Language Processing(NLP), Language Models, Morphological Analysis, Part-of-Speech Tagging and Hidden Markov Models (HMMs), Parsing, Word Sense Disambiguation, Vector-Space Lexical Semantics (Word Vectors), Text Classification, Text Summarization, Sentiment Analysis, Introduction to Information Extraction, Machine Translation, Spoken dialogue systems, Question Answering, NLP with LSTM Recurrent Neural Networks, Python Natural Language Toolkit (NLTK)	
Recommended Texts	
• Jurafsky D. and MartinJ. (2009). Speech and Language Processing (2nd Ed.). Prentice Hall. • Manning C. and Schütze H. (1999). *Foundations of Statistical Natural Language Processing.* (1st Ed.). MIT Press • Bird S., Klein E., and Loper E. (2009), *Natural Language Processing with Python*. O'Reilly Media	

Course Code	**DSC4192**
Course Title	**Internet of Things**
Credit Value	**2**
Pre-requisites	**CSC2052, CSC2112, CSC3173**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Internet of things (IoT) and its development life-cycle, IoT related serial and parallel communication techniques. Applications of micro-controllers and sensors, IoT frameworks.	
Recommended Texts	
• McEwen, A. and Cassimally, H. (2013). Designing the Internet of Things. 1st Ed. Wiley. • Rowland, C., Goodman, E., Charlier, M., Light, A. and Lui, A., (2015). *Designing Connected Products: UX for the Consumer Internet of Things*, 1st Ed. O'Reilly Media. • Horowitz, P. and Hill, W. (2015). *The art of Electronics*.2nd Ed. Cambridge University Press.	

Course Code	**DSC4202**
Course Title	**Information Retrieval**
Credit Value	**2**
Pre-requisites	**DSC3173**
Compulsory/Optional	**Optional**
Course Content	
Introduction: Structured and unstructured data, database and data warehouse. Architecture of search engines: Components of modern search engines, web crawlers and meta search engines. Indexing and searching: Index construction and compression. Text searching techniques: Sequential search, pattern matching and semantic search, text classification (supervised) and topic modeling (unsupervised). Query languages: Keyword-based, single word, context and Boolean queries. Scoring and ranking: Text-based, PageRank and topic sensitive ranking algorithms. Link Analysis: Elements of link analysis and applications. Multimedia retrieval: Introduction to multimedia information retrieval.	
Recommended Texts	
• Manning C.D.,, Raghavan P. and Schuetze H.(2008). Introduction to Information Retrieval, 1st Edition, Cambridge University Press. • Ricardo, B. and Ribeiro-Neto, B (2011). *Modern Information Retrieval, 2nd Edition*, Addison-Wesley.	

Course Code	**DSC4213/CSC4093**
Course Title	**Neural Networks and Deep Learning**
Credit Value	**3**
Pre-requisites	**CSC3173**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
Neural Networks Basics: Neural network representation, Biological neuron vs artificial neuron, Activation functions, McCulloch-Pitts Model, Perceptron, Binary Classification, Logistic Regression, Cost function, Gradient Descent; Shallow Neural Networks: Supervised learning with neural networks, Neural network architectures, Feedforward networks, Gradient descent for neural networks, Backpropagation, Training neural networks; Unsupervised learning: Self-organizing maps; Introduction to Deep Learning: Key concepts of Deep Learning, Applications of Deep Learning. Deep Neural Networks: Building blocks of deep neural networks, Convolutional Neural Networks, Recurrent Neural Networks and LSTMs, Parameters and Hyperparameters;	

Programming Libraries and tools for Neural Networks. Practical assignments will be given for this course.
Recommended Texts
• Goodfellow, I., Bengio, Y. and Courville, A. (2016). *Deep Learning*. MIT Press

Course Code	**DSC4222**
Course Title	**Special Topics in Data Science**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
The special topics will be announced each year in the course schedule.	
Recommended Texts	
Text books and other references will be selected based on the selected topic.	

Course Code	**DSC4243/CSC4063**
Course Title	**Distributed Computing**
Credit Value	**3**
Pre-requisites	**CSC2112**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Distributed Systems: Key characteristics of Distributed Systems (DS), Resource Sharing, Openness, Concurrency, Scalability, Fault tolerance and Transparency. Design Concepts of DS: Naming, Communication, Software structure, Workload allocation and Consistency maintenance. Inter-process Communication: Building blocks, Client-Server communication, Group communication, Client-server applications, Message Passing Interface(MPI) case study. Remote procedure calling (RPC): Design issues, Case study and Implementation, Remote method invocation (RMI). Distributed Objects and Components (CORBA). Replication and Transaction: advantages, replication models and their applications, Concurrent transactions and issues, Linearizability, serial equivalence. Introduction to Cloud Computing: Basic concepts of could computing, Cloud services. Distributed Networks: Introduction to distributed networks, Mobile network basics, Advantages and challenges of such networks. Introduction to Pervasive Computing: Basic concepts of mobile and pervasive computing. Distributed Protocols: Neighbor discovery protocols and other distributed protocols for distributed networks. Security in Distributed Systems: Security concerns of Distributed Systems, identification of security threats and prevention, distributed backup services and failure management.	
Recommended Texts	
• Coulouris, G.,Dollimore, J. and Kindberg, T. (2011). *Distributed Systems, Concepts and design*. 5th Ed. Pearson.	

Course Code	**DSC4252/CSC4082**
Course Title	**Computer Vision**
Credit Value	**2**

Pre-requisites	**DSC3173, DSC3182**
Compulsory/Optional	**Optional**
Course Content	
Discrete geometry and quantization stereo geometry and correspondence; Feature extraction, description and matching; Object recognition and identification; Object tracking, Motion analysis, Applications of Computer Vision: biomedical imaging, document processing, target tracking, industrial inspections, automated visual inspections Group discussions, practical assignments, and presentations on selected topics from current research will be conducted in this course.	
Recommended Texts	
• Forsyth, D.A. and Ponce, J. (2011). *Computer Vision: A Modern Approach*. 2nd Ed. Prentice Hall. • Szeliski, R. (2010). *Computer Vision: Algorithms and Applications*. Springer. • Nixon, M. (2012). *Feature Extraction & Image Processing for Computer Vision*. 3rd Ed. Academic Press. • Duda, R.O. and Har, P.E. and Stork, D.G. (2010). *Pattern Classification*. 2nd Ed. Wiley-Interscience. • Bradsk, G. and Kaehler, A. (2008). *Learning OpenCV: Computer Vision with the OpenCV Library*. O'Reilly Media.	

Course Code	**DSC4996**
Course Title	**Project in Data Science**
Credit Value	**6**
Pre-requisites	**DSC3192, DSC3263**
Compulsory/Optional	**Compulsory for Data Science Honours Students**
Course Content	
The students will conduct a sufficient amount of work on a chosen research topic under the guidance provided by an assigned supervisor(s), make a presentation of research findings, produce a thesis and conduct a presentation.	
Recommended Texts	
There is no required text in this course. The students are required to consult with their research supervisor for recommendations on the textbooks in order to perform their project tasks.	

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Students are expected to work under an assigned supervisor in a data analytics or related industry.	
Recommended Texts	
There is no required text in this course. The students are required to consult with their assigned supervisor for recommendations on the textbooks in order to perform their industrial training.	

8.3 Statistics Course Modules

1000 LEVEL – STATISTICS					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
STA1013	Introduction to Statistics	3		√	√
STA1023	Introduction to Probability Theory	3		√	√
STA1031	Statistics Applications I	1	STA1013	√	√
STA1041	Statistics Applications II	1	STA1031	√	√
Total		**08**		**08**	**08**

2000 LEVEL – STATISTICS					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
STA2013	Probability Theory	3	STA1023 MAT1063	√	√
STA2033	Theory of Statistics	3	STA2013	√	√
STA2042	Sampling Techniques	2	STA2033	√	√
STA2102	Statistical Quality Control	2	STA2033	√	
Total		**10**		**10**	**08**

3000 LEVEL – STATISTICS					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	**B.Sc.**
STA3013	Regression Analysis	3	STA2033	√	√
STA3033	Design and Analysis of experiments	3	STA2033	√	√
STA3052	Multivariate Methods I	2	STA1031 STA2033	√	
STA3072	Time Series Analysis	2	STA2033	√	
STA3093	Non-Parametric & Categorical Data Analysis	3	STA2033	√	√
STA3113	Statistical Simulation	3		√	
STA3131	Advanced Statistical Applications I	1	STA1041 STA2033	√	
STA3141	Advanced Statistical Applications II	1	STA3121	√	
*STA3213	Statistics for Scientists	3			
STA3252	Scientific Writing and Presentation	2		√	
Total		**23**		**20**	**09**

*STA3213 - Statistics for Scientists is offered only for the students who have not followed statistics as a principal subject

4000 LEVEL – STATISTICS					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**	
				Hons.	
STA4012	Actuarial Statistics	2	STA2033		
STA4023	Statistical Data Mining	3	STA3053		
STA4033	Statistics for Bioinformatics	3	STA3093		
STA4043	Stochastic Processes	3	STA2033		
STA4053	Multivariate Methods II	3	STA3053	√	
STA4063	Bayesian Statistics	3	STA2033		
STA4073	Linear Models	3	STA2033	√	
STA4083	Reliability Theory and Survival Analysis	3	STA2033		
STA4112	Advanced Probability Theory	2	STA2033 MAT1053		
STA4122	Asymptotic Theory	2	STA4112		
STA4203	Medical Statistics	3	STA2033		
STA4212	Spatial Statistics	2	STA2033		
STA4222	Special Topics in Statistics	2			
SCI4003	Industrial Training	3			
STA4996	Research Project	6	STA3141 STA3252	√	
Total		**43**		**12**	

1000 Level Courses

Course Code	STA1013
Course Title	Introduction to Statistics
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Basic ideas in Statistics: Fundamental elements of statistics, Sources of data, Methods of collecting data, Data types. Measures of Location: Various Means (AM, GM, HM, TM), Median, Mode, Quantiles, Deciles, Percentiles. Measures of Dispersion: Range, Interquartile range, Variance, Standard deviation, Chebyshev's rule for sample, Coefficient of variance, Moments of higher order, Skewness, Kurtosis. Representation of data: Histograms, Box plots, Bar charts, Pie charts, Scatter plots, Stem-Leaf diagrams, Contingency tables. Regression and Correlation: Scatter diagrams, Linear Regression, Method of least squares, Correlation, Coefficient of correlation, Rank correlation, Spearman's rank correlation coefficient. Index numbers: Introduction, Price Relatives, Quantity Relatives and Value Relatives, Link and Chain Relatives, Cost of living Index Numbers, Methods of construction of Index Numbers, Quantity Index Numbers, Tests for Index numbers.

Recommended Texts

- Freedman, D., Pisani, R. and Purves, R. (2007). *Statistics*. 4th Ed. Norton, W. W. & Company, Inc.
- Johnson, R. A. and Bhattacharyya, G. K. (2014). *Statistics: Principles and Methods.* 7th Ed. John Wiley & Sons.

Course Code	STA1023
Course Title	Introduction to Probability Theory
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Counting Techniques: Combinations, Permutations, Set partitions. Elements of Probability: Experiments, Events, Sample space, Laws of Probability, Bayes' Theorem, Independence of events. Random variables: Discrete and continuous random variables, Probability mass function, Probability density function, Cumulative distribution function, Functions of a random variable, Expectation, Moments, Mean and variance, Moment Generating function. Probability inequalities: Chebyshev's and Markov's etc. Distributions: Discrete: Uniform, Bernoulli & Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Multinomial, Continuous: Uniform, Normal, Gamma, Exponential. Properties and applications of distributions, Probability Generating functions. Approximation to Binomial using Poisson, Binomial using Normal, and Poisson using Normal.

Recommended Texts

- Ross, S.M. (2013). *A First Course in Probability*. 9th Ed. Pearson Education.
- Hogg, R.V. (2013). *Introduction to Mathematical Statistics*. 7th Ed. Pearson India.

Course Code	STA1031
Course Title	Statistics Applications I
Credit Value	1
Pre-requisites	STA1013

Compulsory/Optional	**Compulsory**
Course Content	
Introduction to programming, Presentation of the software: Installation and update packages, Graphical User Interfaces, Integrated Development environment, Documenting scripts, Commenting and Sharing the code, Errors and warnings, Basic concepts and Data organization: Data types and Data structures, Importing/Exporting/Producing data, Flow control structures, Reproducible research, data pre-processing, drawing curves and plots, basic descriptive statistics, simple linear regression and correlation. All the concepts are demonstrated using R software.	
Recommended Texts	
• de Micheaux, P.L., Drouilhet, R. and Liquet, B. (2014). The R Software: Fundamentals of Programming and Statistical Analysis. Springer. • Matloff, N. (2011). The Art of R Programming: A Tour of Statistical Software Design. 1st Ed. No Starch Press.	

Course Code	**STA1041**
Course Title	**Statistics Applications II**
Credit Value	**1**
Pre-requisites	**STA1031**
Compulsory/Optional	**Compulsory**
Course Content	
Basic concept of a function, declaring/creating and calling functions, debugging functions, attributes, fine tuning the data visualizations, matrix operations, numerical differentiation and integration, Basic optimization, density function, distribution function, quantile function and generation of random data, simple random sampling, comparing the population and the sample, managing sessions, creating simple packages. All the concepts are demonstrated using R software.	
Recommended Texts	
• de Micheaux, P.L., Drouilhet, R. and Liquet, B. (2014). *The R Software: Fundamentals of Programming and Statistical Analysis*. Ed. Springer. • Matloff, N (2011). *The Art of R Programming: A Tour of Statistical Software Design*. 1st Ed., No Starch Press.	

2000 Level Courses

Course Code	**STA2013**
Course Title	**Probability Theory**
Credit Value	**3**
Pre-requisites	**STA1023/MAT1023**
Compulsory/Optional	**Compulsory**
Course Content	
Joint distribution of two or more discrete or continuous random variables, Marginal distributions, Conditional distribution, Independence of random variables, Expectation, Conditional Expectation, Covariance, Correlation Coefficient, Transformations involving two or more random variables, Probability density functions of sum, difference, product and quotient of two random variables, Random samples, Empirical distributions, Order statistics, Distribution of minimum and maximum, Distribution of sample mean and sample variance; t, F and $\chi 2$ distributions and their properties, Laws of large numbers, Central limit theorem.	

Recommended Texts
• Canavos, G.C. (1984). *Applied Probability and Statistical methods*. 1st Ed. Little, Brown and Company. • Freund, J.E. (1994). *Mathematical Statistics*. 5th Ed. Prentice Hall. • Wackerly, D., Mendenhall, W. and Scheaffer, R.L. (1995). *Mathematical Statistics with Applications*. 7th Ed. Thomson Brooks/Cole.

Course Code	**STA2033**
Course Title	**Theory of Statistics**
Credit Value	**3**
Pre-requisites	**STA2013**
Compulsory/Optional	**Compulsory**
Course Content	
Point estimation: Properties of estimators; Unbiasedness, Consistency, Relative efficiency, Efficiency, Sufficiency, Factorization theorem, Rao-Blackwell theorem, UMVUE, Exponential families, Cramer-Rao inequality, Methods of obtaining estimators; Method of moments, Maximum likelihood estimators etc. Interval estimation: Constructing confidence intervals for population parameters under various assumptions. Hypothesis Testing: Tests on population parameters, Tests on independent and paired samples, Neyman-Pearson lemma, Uniformly Most Powerful tests, Likelihood Ratio tests.	
Recommended Texts	
• Casella, G. and Berger, R. (2002). *Statistical Inference*. 2nd Ed. Duxbury *Press.* • Freund, J.E. (1994). *Mathematical Statistics*. Prentice Hall.	

Course Code	**STA2042**
Course Title	**Sampling Techniques**
Credit Value	**2**
Pre-requisites	**STA2013**
Compulsory/Optional	**Optional**
Course Content	
Introduction: Population, sample, sampling frame, census, surveys, advantages and disadvantages of sampling, principle steps in sample survey, Data collection method, questionnaire design, simple random sampling: with replacement and without replacement, ordered and unordered. Random Number Tables and Random Number Generators, Simple Random Sampling: estimations of population mean, total, proportion, and ratio, variance of the estimators, confidence limits, and determination of sample size. Stratified Random Sampling: estimation of population mean, variance of the estimators, determination of sample size based on equal allocation, proportion allocation, Neyman allocation, cost and variability of the strata, Bowley's allocation. Relative Precision of Simple random sampling, proportional allocation & optimum allocation, Cluster Sampling: sample mean and sample variance, efficiency of cluster sampling vs. simple random sampling. Ratio Estimators, Sub Sampling, Multi Stage Sampling, Double sampling, Capture Mark Recapture Method, Systematic Sampling, Regression Estimates, Bias and Mean Square Error of Ratio Estimators. Some programming assignments will be given for this course.	
Recommended Texts	
• Cochran, W.G. (1977). *Sampling Techniques*. 3rd Ed. John Wiley & Sons. • Scheaffer, R.L., Mendenhall, W., Ott, R.L. and Gerow, K.G. (2011). *Elementary Survey Sampling*. 7th Ed. Cengage Learning.	

Course Code	**STA2102**
Course Title	**Statistical Quality Control**
Credit Value	**2**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Introduction: classical and modern definition, dimensions of quality, quality characteristics, specification limits, chance and assignable variations, non-confirming and defects. Statistical Process Control: magnificent seven, control charts, control limits, choice of control limits and interpretation of control charts. Natural Tolerance Limits, Types of Errors: consumer's risk and producer's risk. Decision Rules for Detecting Non-random Patterns, Variable Control Charts: mean, range and standard deviation. Control Charts for Variable Sample Size, Trial Control Limits, Tolerance Diagram, Process Capability, Process Capability indices, Evaluating Two Types of Risk, Effect of Sample Size on Ability to Detect Process Shifts, Average Run Length, Average Time to Signal. Control Charts for Attribute Data: p-charts, c-charts, u-charts. OC-Curves: single sampling and multiple sampling plan, acceptance number, acceptable quality level and lot-tolerance percent defectives. Overview of Six-Sigma concept.	
Recommended Texts	
• D.C. Montgomery, (2008). *Introduction to Statistical Quality Control*. 6th Ed. John Willey and Sons. • Hansen, B.L. and Ghare, P.M. (1987). *Quality Control and Application*. Prentice Hall.	

3000 Level Courses

Course Code	**STA3013/DSC3013**
Course Title	**Regression Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory**
Course Content	
Simple linear regression, Tests for regression coefficients, Interval estimation, Prediction, Analysis of variance approach, Diagnostic and remedial measures, Matrix approach to simple linear regression, Multiple regression, Polynomial regression, Nonlinear regression, Penalized regression and bias estimators. Introduction to Generalized Linear Models. Introduction to divided analysis of regression for big data. Some programming assignments will be given for this course.	
Recommended Texts	
• Neter, J., Wasserman, W. and Kunter, M.H. (2004). *Applied Linear Statistical Models*. 5th Ed. McGraw-Hill/Irwin. • Myers, R.H. (2000). *Classical and Modern Regression with Applications*. 2nd Ed. Duxbury Press. • Christensen, R. (2015). *Analysis of Variance, Design and Regression*. 2nd Ed. Chapman & Hall/CRC.	

Course Code	**STA3033**
Course Title	**Design and Analysis of Experiments**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory**

Course Content
Comparison of two samples (independent, dependent), One-way ANOVA: Assumptions, Normal theory, F-tests. Multiple comparisons: LSD method, Tuckey's method, Bonferroni method, Scheffe's method, Duncan's multiple range method. Two-way ANOVA: Normal theory, Randomized block design, The two-factor factorial, Multifactor Factorials, Confounding, Introduction to Analysis of covariance, Latin square, Split-plot, Nested designs. Some programming assignments and a field visit will be conducted.
Recommended Texts
• Montgomery, D.C. (2012). *Design and Analysis of Experiments*. 8th Ed. Wiley. • Neter, J., Wasserman, W. and Kunter, M.H. (1996). *Applied Linear Statistical Models*. 4th Ed. Irwin Inc. • Jobson, J.D. (1991). *Applied multivariate data analysis: Regression and Experimental Design*. 1st Ed. Springer. • Lindman, H.R. (1992). *Analysis of Variance in Experimental Design*.1st Ed. Springer Series.

Course Code	STA3052/DSC3032
Course Title	Multivariate Methods I
Credit Value	2
Pre-requisites	STA1031, STA2033
Compulsory/Optional	Compulsory for Statistics Honours Students
Course Content	
Properties of random vectors and Matrices, The Multivariate Normal distribution, Estimation of parameters in the Multivariate Normal distribution, Wishart distribution, Inferences on multivariate mean, and Hotelling's T2 tests, Multivariate Analysis of Variance, Cluster Analysis.	
Recommended Texts	
• Johnson, R.A. and Wichern, D.W. (2014). *Applied Multivariate Statistical Analysis*. 6th Ed. Pearson Publications. • Rencher, A.C. and Christensen, W. F. (2012). *Methods of Multivariate Analysis*. 3rd Ed. Wiley.	

Course Code	STA3072/DSC3042
Course Title	Time Series Analysis
Credit Value	2
Pre-requisites	STA2033
Compulsory/Optional	Compulsory for Statistics Honours Students
Course Content	
Introduction: objective of time series analysis, components of time series. Classical method of time series decomposition: estimation of trend, seasonal effect and cyclic effects. Auto-covariance, auto-correlation function and correlogram. Processes: purely random, random walk, strictly stationary, weakly stationary, non-stationary, moving averages, auto-regressive, mixed models, and seasonal models. Parameter estimation, Diagnostic checking, Forecasting, Box-Jenkins methodology, Introduction to nonlinear models, multivariate time series analysis, and wavelet decomposition.	
Recommended Texts	
• Brockwell, P.J. and Davis, R.A. (2016). *Introduction to Time Series and Forecasting (Springer Series in Statistics)*. 3rd Ed. Springer. • Chatfield, C. (2003). *The Analysis of Time Series: An Introduction*. 6th Ed. Chapman and Hall/CRC. • Shumway, R.H. and Stoffer, D.S. (2017). *Time Series Analysis and Its Applications: With R Examples*. 4th Ed. Springer.	

Course Code	**STA3093/DSC3073**
Course Title	**Non-Parametric Methods and Categorical Data Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Non-parametric: One sample sign test, Binomial test, Two sample sign test, Wilcoxon paired samples, Signed rank test, Wilcoxon and Mann-Whitney U test, Test of independence, Wald Wolfowitz runs test, Kruskal-Wallis test, Friedman test, Correlation tests, Non-Parametric simple linear regression. Categorical Data Analysis: Chi-Square Goodness of fit tests, The Kolomogorov-Simrnov test, Lillifor's test, Anderson-Darling test. Comparing two proportions and confidence intervals, Relative risk and confidence intervals, odd ratios and confidence interval, Likelihood ratio test Likelihood function for generalized linear models, Logistic regression, Estimating parameters, Wald test and the confidence intervals, Logit models, Probit models, Model diagnostics, Log-linear models. Some practical assignments will be given for this course.	
Recommended Texts	
• Agresti, A. (2007). *An Introduction to Categorical Data Analysis*. 2nd Ed. John Wiley & Sons. • Sprent, P. and Smeeton, N.C. (2007). *Applied Nonparametric Statistical Method*. 4th Ed. Chapman & Hall/CRC. • Kolke, J. and McKean, J.W. (2014). *Nonparametric Statistical Methods Using R*. Chapman & Hall/CRC.	

Course Code	**STA3113/DSC3083**
Course Title	**Statistical Simulation**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for Statistics Honours Students**
Course Content	
Introduction and Overview of Simulation: Simulation examples, Statistical models in simulation, Modelling and estimating input processes, Random-number generation. Generation of random variates: Discrete and Continuous, Statistical analysis of simulation output, Comparison, ranking, and selection of simulation models, Variance-reduction techniques, Designing simulation experiments, gradient estimation, and optimization. Computer intensive inference methods: Jack-Knife, Bootstrap, cross validation, Monte Carlo methods and permutation tests.	
Recommended Texts	
• Ross, S.M. (2012). *Simulation (Statistical Modeling and Decision Science)*. 5th Ed. Academic Press. • Rubinstein, R.Y. and Kroese, D.P. (2007*). Simulation and the Monte Carlo Method*. 2nd Ed. Wiley-Interscience.	

Course Code	**STA3131/DSC3091**
Course Title	**Advanced Statistical Applications I**
Credit Value	**1**
Pre-requisites	**STA1041, STA2033**
Compulsory/Optional	**Compulsory for Statistics Honours Students**

Course Content
Declaring advanced functions, complex data manipulation, pattern matching, writing efficient programs, point estimation, confidence interval and hypothesis testing, using a statistical software with quality control tools for statistical process control, generating quality control charts, multiple linear regression, modal diagnostic, generate reports for statistical analysis. All the concepts are demonstrated using R software.
Recommended Texts
• Lander, J.P. (2017). *R for Everyone: Advanced Analytics and Graphics*. 2nd Ed. Addison-Wesley Data & Analytics Series. • de Micheaux, P.L., Drouilhet, R. and Liquet, B. (2014). *The R Software: Fundamentals of Programming and Statistical Analysis*. 2013 Ed., Springer. • Matloff, N. (2011). *The Art of R Programming: A Tour of Statistical Software Design*, 1st Ed. No Starch Press.

Course Code	**STA3141/DSC3101**
Course Title	**Advanced Statistical Applications II**
Credit Value	**1**
Pre-requisites	**STA3052, STA3113, STA3131**
Compulsory/Optional	**Compulsory for Statistics Honours Students**
Course Content	
Statistical simulation methods: Bootstrapping, Cross validation, Permutation tests , Analysis of variance (ANOVA) models: One-way ANOVA, Two-way ANOVA, Experimental designs, Multivariate data analysis: similarity measures, multivariate probability distributions, multivariate inference, Multivariate Analysis of variance (MANOVA), multiple comparison tests, Cluster analysis, Nonparametric statistical inference, Analysing Categorical data: Contingency tables, graphical summaries of two-way contingency tables, three-way contingency tables, modelling categorical data, compile and self-publish scientific reports. All the concepts are demonstrated using R software.	
Recommended Texts	
• Lander, J.P. (2017). *R for Everyone: Advanced Analytics and Graphics*. 2nd Ed. Addison-Wesley Data & Analytics Series. • Peng, R. D. (2018). *R Programming for Data Science*. https://leanpub.com/rprogramming • Wickham (2017). Advanced R. https://adv-r.hadley.nz/	

Course Code	**STA3213**
Course Title	**Statistics for Scientists**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Basic ideas in Statistics: Fundamental elements of statistics, Sources of data, Methods of collecting data, Data types, Summarization and Presentation of data Measures of Location: Mean, Median, Mode, Quantiles, Deciles, Percentiles. Measures of Dispersion: Range, Interquartile range, Variance, Standard deviation, Standard error, Coefficient of variance, Skewness, Kurtosis. Representation of data using Stem-Leaf diagrams and Box plots Counting principles and probability theory, discrete and continuous probability distributions (Uniform, Bernoulli, Binomial, Poisson, Exponential, Normal, Gamma, Beta, Weibull, t, Chi-squared, F) Hypothesis Tests: one sample tests for mean, variance and proportions, two sample tests (independent/paired)	

for mean, variance and proportion comparisons, ANOVA for comparing multiple samples. Non-parametric Tests: Sign test, Mann-Whitney U test, Kruskal-Wallis test, Friedmann test Correlation and Regression: scatter plots, correlation, simple linear regression Statistical Process Control: Fundamentals of process control, Process capability and process measures, control charts for variables, control charts for attributes Design of Experiments: Basic concepts, Complete Randomized Designs (CRD), Complete Randomized Block Designs (RCBD), Latin Square Design (LSD) Introduction to Categorical Data Analysis: Relative risk and Odds ratio, Chi squared test for independence, proportion tests Introduction to Multivariate Data Analysis: Principle Component Analysis, Cluster Analysis, Factor Analysis
Recommended Texts
• Freedman, D., Pisani, R. and Purves, R. (2007). *Statistics,* 4th Ed., Norton, W. W. & Company, Inc. • Johnson, R. A. and Bhattacharyya, G. K. (2014). *Statistics: Principles and Methods*, 7th Ed., John Wiley & Sons.

Course Code	**STA3252/CSC3252/DSC3252**
Course Title	**Scientific Writing and Presentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for Statistics Honours Students**
Course Content	
Introduction to Scientific writing: Searching the scientific literature, Plagiarism and how to avoid it, Fundamentals of effective scientific writing. Scientific writing: Standard formats for scientific papers, research projects and theses, Style guides, Creating a literature review, Preparing other sections of a research report (abstract, introduction, materials and methods, results and discussion, conclusions), Including and summarizing research data, Reference citations within the text and making a list of references, Use of Software tools (Latex, Lyx, Bibtex, Mendaley, etc). Poster Presentations: Guidelines for designing posters, Use of software and online resources. Oral Presentations: Designing and preparing slides for an oral presentation, Important guidelines to make a good presentation	
Recommended Texts	
• Alley, M. (2003). The Craft of Scientific Presentations: Critical steps to succeed and critical errors to avoid. Springer, NY. ISBN:0-387-95555-0. • Alley, M. (2003). The Craft of Scientific Writing. Springer, NY, ISBN-13: 978-0131888555 • Matthews, J.R., Bowen, J.M. and Matthews, R.W. (2005). Successful Scientific Writing: A step-by-step guide for biomedical scientists, Cambridge University Press, ISBN 0 521 78962 1 • Godin, S. (2007). Really bad PowerPoint (and how to avoid it). Available at: http://www.sethgodin.com/freeprize/reallybad-1.pdf	

4000 Level Courses

Course Code	STA4102
Course Title	**Actuarial Statistics**
Credit Value	**2**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Economics of uncertainty. Risk theory and utility. Jensen's inequality. Sums of random variables and convolutions. Applications to individual risk models. Failure rates and the force of mortality. Mixtures of random variables and mixtures of distributions. Loss distribution, Reinsurance. Risk models. Actuarial applications of statistical inference. Life tables. Aggregate and Select survival models. Estimating distribution by simulation.	
Recommended Texts	
• McCutcheon, J.J. and Scott, W.F. (1998). *An introduction to the Mathematics of Finance*. 1st Ed. Oxford, Butterworth-Heinemann. • Bowers, N. L., Gerber, H.U. , Hickman, J. C., Jones, D. A. and Nesbitt, C. J. (1997). Actuarial Mathematics, 2nd Ed. Illinois, Society of Actuaries. • Neil, A. (1977). *Life Contingencies*. Trafalgar Square.	

Course Code	STA4023/DSC4023
Course Title	**Statistical Data Mining**
Credit Value	**3**
Pre-requisites	**STA3052**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Data Mining and Big data, Data Mining tasks, processes, database/online transaction processing (OLTP), data warehousing / online analytical processing (OLAP), feature selection and dimension reduction techniques, Classification and Clustering: Similarity and Distance Measures, Hierarchical Algorithms, Partitional Algorithms, Clustering Large Data Bases, Clustering with Categorical Attributes, Comparison. Association Rules: Large Item Sets, Algorithms, Comparing Approaches, Measuring the Quality of Rules. Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining. Overview of Spatial Data mining, Temporal Mining: Modelling Temporal Events, Pattern Detection, Sequences, Temporal Association Rules, Introduction to Spatio-temporal data mining. Some practical assignments will be given for this course.	
Recommended Texts	
• James, G., Witten, D., Hastie, T. and Tibshirani, R. (2017). *An Introduction to Statistical Learning: with Applications in R*, 1st Ed. Corr. 7th Printing Ed. Springer Texts in Statistics. • Kuhn, M. and Johnson, K. (2018*). Applied Predictive Modeling*, 1st Ed. 2013, Corr. 2nd Printing 2018 Ed., Springer. • Hastie, T., Tibshirani, R. and Friedman, J. (2016). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. 2nd Ed. Springer Series in Statistics.	

Course Code	STA4033
Course Title	**Statistics for Bioinformatics**
Credit Value	**3**
Pre-requisites	**STA3093**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Cell biology and genetics: Cell, DNA and chromosomes, functions of the cell and DNA. Gene Expression analysis: Pre-processing, Visualization, Inference. Sequence Analysis and alignment: DNA/Protein sequence analysis, aligning sequences, Markov chains. Genetic frequencies: Hardy-Weinberg equilibrium, Maximum Likelihood estimation, Exact test, Microarray experiments, gene expression and analysis, Phylogenetic Tree construction. Some programming assignments will be given for this course.	
Recommended Texts	
• Ewes, W. J. and Grant, G. R. (2005). *Statistical Methods in Bioinformatics: An introduction (Statistics for Biology and Health)*. 2nd Ed. Springer. • Durbin, R., Eddy, S. R., Krogh, A. and Mitchison, G. (1998). *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids*, 1st Ed. Cambridge University Press.	

Course Code	STA4043
Course Title	**Stochastic Processes**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Stochastic processes, Markov Chains, Chapman–Kolmogorov Equations, Classification of States, Limiting Probabilities, Applications of Markov chains, Markov Processes with Discrete state space, Markov Processes with Continuous state space, Stationary processes, Branching Processes, Birth and Death processes, Hidden Markov Chains, Exponential Distribution and the Poisson Process, Queuing Theory, Reliability Theory. Some programming assignments will be given for this course.	
Recommended Texts	
• Medhi, J. (2010). *Stochastic Processes*, 3rd Revised Ed. New Age Science. • Ross, S.M. (2014). *Introduction to Probability Models*. 11th Ed. Academic Press.	

Course Code	STA4053/DSC4033
Course Title	**Multivariate Methods II**
Credit Value	**3**
Pre-requisites	**STA3052**
Compulsory/Optional	**Compulsory for Statistics Honours Students**
Course Content	
Principal component analysis (PCA), Interpretation using illustrative examples. Factor analysis, Comparison with PCA, factor loadings and rotations, Geometric Interpretation, Discriminant analysis of two group and	

multiple groups, Canonical correlation, Covariance structure models, Correspondence analysis, Multidimensional Scaling, Multivariate Analysis of Covariance.
Some programming assignments will be given for this course.

Recommended Texts

- Hardle, W. and Simar, L. (2003). *Applied Multivariate Statistical Analysis*. Springer.
- Anderson, T.W. (2003). *An Introduction to Multivariate Statistical Analysis*. 3rd Ed. Wiley.
- Johnson, A.R. and Wichern, D. W. (2007). *Applied Multivariate Statistical Analysis*. Prentice Hall.

Course Code	**STA4063/DSC4043**
Course Title	**Bayesian Statistics**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**

Course Content

Fundamentals of Bayesian inference, Bayesian Estimation, Credible sets, Hypothesis testing, Bayesian Prediction, Model checking and improvement, Posterior simulation, Bayesian models: Regression models, Hierarchical linear models, Generalized linear models, Models for robust inference, Mixture models, Multivariate models, Nonlinear models, Models for missing data.

Recommended Texts

- Marin, J.-M., Robert, C. P. (2007). *Bayesian core: A practical approach to computational Bayesian statistics*, 1st Ed., Springer Texts in Statistics.
- Gelman, A., Carlin, J. B., Stern, H. S. and Rubin, D. B. (2013). *Bayesian Data Analysis*, 3rd Ed. Chapman & Hall/CRC Texts in Statistical Science.
- Berger, J.O. (1993). *Statistical Decision Theory and Bayesian Analysis*. 2nd Ed., Springer.

Course Code	**STA4073**
Course Title	**Linear Models**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory for Statistics Honours Students**

Course Content

Review of linear algebra: Elementary Theorems on Linear and Matrix Algebra, Partitioned Matrices, Nonnegative Matrices; Generalized Inverses of Matrix; Solutions of Linear Equations; Idempotent Matrices, Trace of Matrices, Random vectors and matrices, quadratic forms, Multivariate Normal Distribution, Distribution of Quadratic Forms, General Linear Model: Estimation, Inference and Hypothesis Testing Procedures of the full rank linear model, The non-full rank case (e.g., ANOVA models), Dealing with multicollinearity using biased estimation techniques, parameter estimation of Non-Linear Regression, Generalized Linear Models, Introduction to Mixed Effects Models.

Recommended Texts

- Graybill, F.A. (2000). *Theory and Application of the Linear Model*. 1st Ed. Duxbury Press.
- Searle, S.R. (2012). *Linear Models*. Wiley-Interscience.
- McCullagh, P., Nelder, J.A. (1989). *Generalized Linear Models*. 2nd Ed. Chapman and Hall/CRC.

Course Code	**STA4083/DSC4063**
Course Title	**Reliability Theory and Survival Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Reliability Theory: General introduction, Reliability concepts, Classical model, Censored observations, Parameter estimation, Asymptotic results, Accelerated Life Testing (ALT). Survival Analysis: preliminaries of time-to-event data, Kaplan-Meier estimation, survival curves, parametric modelling with Cox's proportional hazard (PH) models, stratified Cox's PH model, extended Cox's PH model, Overview of non-parametric techniques for survival data. Some programming assignments will be given for this course.	
Recommended Texts	
• Machin, D., Cheung, Y.B. and Parmar, M. (2006). *Survival Analysis: A practical approach*, 2nd Ed., Wiley. • Meker, M.Q. and Escobar, L.A. (1998). *Statistical Methods for Reliability Data*, 1st Ed. Wiley-Interscience.	

Course Code	**STA4112**
Course Title	**Advanced Probability Theory**
Credit Value	**2**
Pre-requisites	**STA2033, MAT1053**
Compulsory/Optional	**Optional**
Course Content	
Introduction to probability measure theory, σ-fields, random elements. Types of convergence, convergence in distribution, Borell-Cantelli lemma, Radon-Nikodym theorem, Fubini theorem, and general central limit theorems. Hilbert space methods, linear functional, orthogonality, projections and bases, random elements in Hilbert space. Characteristic functions. Infinite divisibility and stable laws. Conditional probability and expectation.	
Recommended Texts	
• Athreya, K. B. and Lahiri, S. N. (2013). *Measure Theory and Probability Theory*, 2006 Ed. Springer. • Folland, G. B. (1999). *Real Analysis: Modern Techniques and Their Applications*. Wiley-Blackwell. • Shiryaev, A. N. and Boas, R.P. (1995). *Probability (Graduate Texts in Mathematics)*. 2nd Ed. Springer.	

Course Code	**STA4122**
Course Title	**Asymptotic Theory**
Credit Value	**2**
Pre-requisites	**STA4112**
Compulsory/Optional	**Optional**
Course Content	
Introduction to large sample theory, Approximate statistical procedures, Asymptotic optimality theory, Stochastic Convergence: almost sure convergence, convergence of moments, Lindeberg-Feller Theorem, convergence in total variation, Delta method, M-estimators, Z-estimators, Local asymptotic normality, Efficiency of estimators, Convolution Theorem, Local Asymptotic Minimax Theorem.	

Recommended Texts
• Van de Vaart, A.W. (2000). *Asymptotic Statistics (Cambridge Series in Statistical and Probabilistic Mathematics)*. Cambridge University Press. • Lehman, E.L. (2004). *Elements of Large-Sample Theory*. Corrected Ed. Springer-Verlag New York, LLC.

Course Code	**STA4203**
Course Title	**Medical Statistics**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Role of statistics in medical research, Ethical Considerations, Epidemiology: Basic designs for epidemiological studies, Hypotheses, Study Designs, Case Definition, Measures of Disease Frequency, Issues Related to Prevalence, Comparing Groups, Surveillance; Clinical trials: Clinical Trial Designs, Clinical Trial Phases, Clinical Bias; Analysis of data from cohort and case control studies, Interim Analyses and Stopping Rules, Estimating Clinical Events: Odds Ratio, Mantel-Haenszel Test for the Odds Ratio, Trend Analysis, Survival Analysis; Medical Diagnostic Testing: Describing Diagnostic Tests, Estimating the Probability of Disease, Screening biases, sensitivity and specificity, Comparing Two Diagnostic Tests, Selecting a Positivity Criterion; Measures of Agreement: Use and Misuse of Correlation Coefficients, Kendall Tau Correlation Coefficient, Concordance Correlation Coefficient, Total Deviation Index, Cohen's Kappa Statistic for Measuring Agreement. Some programming assignments will be given for this course.	
Recommended Texts	
• Armitage, P., Berry, G. and Matthews, J. N. S. (2001). *Statistical methods in medical research*, 4th Ed. Wiley-Blackwell. • Peacock, J. and Peacock, P. (2011). *Oxford Handbook of Medical Statistics*. 1st Ed. Oxford University Press. • Woodward, M. (2013). *Epidemiology: Study design and data analysis*. 3rd Ed., Chapman and Hall/CRC.	

Course Code	**STA4213**
Course Title	**Spatial Statistics**
Credit Value	**3**
Pre-requisites	**STA2033, STA3113, STA3072**
Compulsory/Optional	**Optional**
Course Content	
Introduction to spatial data, Spatial scale, Grain and extent, First order properties, Second order properties, Univariate and bivariate patterns, Edge effects, Stationary and non-stationary process, Isotropy and anisotropy, Complete spatial randomness process: Index of dispersion, Quadrate count method, Pielou's index of randomness, Kolmogorov-Simrnov test, Nearest neighbour distance, Clarke-Evans test, Clumping, Over dispersion, Ripley's K-function, L-function; Pair correlation function, O-ring and Omega-function, Null models, Monte Carlo test, Simulation envelope, Memory effect, Random labelling, Torus translation test, Edge corrections, Homogeneous/Inhomogeneous Poisson processes, Poisson Cluster process, Overview of spatio-temporal models.	
Recommended Texts	
• Stoyan, D. and Stoyan, H. (1994). *Fractals, random shapes and point fields: methods of geometrical*	

statistics. 1st Ed. Wiley. • Illian, J., Penttinen, A., Stoyan, H. and Stoyan, D. (2008). *Statistical Analysis and Modelling of Spatial Point Patterns.* John Wiley & Sons, Ltd. • Bivand, R.S., Pebesma, E. and Gómez-Rubio, V. (2013). *Applied Spatial Data Analysis with R*, Springer.

Course Code	**STA4222**
Course Title	**Special Topics in Statistics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Topics will be related to recent developments in statistics and probability of interest.	
Recommended Texts	
• Textbooks will be recommended based on the selected topic.	

Course Code	**SCI4003**
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Students are expected to work under an assigned supervisor at a software development or related industry.	

Course Code	**STA4996**
Course Title	**Research Project**
Credit Value	**6**
Pre-requisites	**STA3141, STA3252**
Compulsory/Optional	**Compulsory for Statistics Honours Students**
Course Content	
Research project may involve ethics, inquiry, design, investigation, scholarship, discovery, or application, depending on the topic, and the student is aware of how the project fits into and contributes to solving the larger problem to which it belongs.	
Recommended Texts	
• National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009). *On Being a Scientist: Responsible Conduct in Research*, 3rd Ed. National Academy Press. • Alley, M. (1998). *The Craft of Scientific Writing*, 3rd Ed. Springer-Verlag, NY.	

9. DEPARTMENT OF ZOOLOGY

9.1 Zoology Course Modules

1000 LEVEL – BIOLOGY					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Bio.*	Bio.**
BIO1022	Plant and Animal Form and Function	2		√	√
BIO1032	Basic Ecology	2		√	√
BIO1162	Introductory Environmental Biology	2			√
BIO1182	Introductory Evolutionary Biology	2			√
Total		**08**		**04**	**08**

2000 LEVEL					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
ZOO2012	Animal Embryology	2		√	√
ZOO2052	Biostatistics	2			
ZOO2152	Zoogeography & Sri Lankan Fauna	2			
ZOO2172	Coastal Ecosystems & Coral Reefs	2			
ZOO2192	Functional Histology	2		√	√
ZOO2212	Invertebrate Diversity	2		√	√
ZOO2222	Vertebrate Diversity	2		√	√
ZOO2232	Animal Ecology	2		√	√
Total		**16**		**10**	**10**

3000 LEVEL					
Course Code	Course Title	No. of Credits	Pre-requisites	Compulsory	
				Hons.	B.Sc.
ZOO3022	Comparative Anatomy & Animal Physiology	2	BIO1022	√	√
ZOO3072	Fish Biology	2	ZOO2222	√	
ZOO3142	Evolutionary Biology & Systematics	2		√	√
ZOO3222	Insect Pest Management	2	ZOO2212	√	
ZOO3232	Vector Borne Diseases	2	ZOO2212	√	
ZOO3262	Animal Behavior	2		√	√
ZOO3272	Animal Genetics & Molecular Biological Techniques	2		√	√
ZOO3312	Limnology & Wetland Ecology	2		√	
ZOO3322	Amphibian & Reptilian Biology	2	ZOO2222	√	
ZOO3332	Avian & Mammalian Biology	2	ZOO2222	√	
ZOO3342	Ecotourism	2			

ZOO3353	Inland Fisheries and Aquaculture	3	ZOO3072	√	
Total		**25**		**23**	**08**

4000 LEVEL				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Comments**
				Hons.
ZOO4043	Applied Parasitology	3	ZOO3232	
ZOO4063	Environmental Biology	3		
ZOO4073	Immunobiology	3		
ZOO4103	Marine Biology & Fisheries	3		
ZOO4113	Wildlife Management	3		
ZOO4212	Scientific Writing & Presentation	2		√
ZOO4242	Research Methods and Data Analysis	2	ZOO2052	√
ZOO4253	Entomology	3	ZOO3222	
ZOO4262	Developmental Biology	2	ZOO2012	
ZOO4282	Independent Study & Seminar	2		√
ZOO4293	Conservation Biology	3		
ZOO4998	Research Project	8		√
SCI4003	Industrial Training	3		
Total		**40**		**14**

1000 Level Courses

Course Code	BIO1022
Course Title	Plant & Animal Form and Function
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Transport systems in plants: transport across biological membranes; passive and active transport, involvement of membrane proteins in transport, trans cellular transport (apoplastic and symplastic), transport processes (diffusion, osmosis and bulk flow), water potential and factors affecting water potential, water absorption by roots and their mechanism

Plant mineral nutrition: role of essential elements in plant growth and the deficiency symptoms, special nutritional strategies and phytoremediation process in brief

Sensory systems in plants: plant response to gravity, light and other environmental stimuli, light sensitive receptors, detail description of phytochromes and photomorphogenesis, plant growth regulators and their physiological effects.

Animal form and function

Common challenges and diverse forms: The correlation between body form and function in animal nutrition, circulation and gas exchange, osmoregulation and excretion. Homeostasis and feedback control mechanisms in animals. Thermoregulation in relation to form, function and behavior. Energy requirements in relation to animal size, activity and environment.

Laboratory exercises related to above topics.

Recommended Texts

- Srivastava, L.M. (2002). *Plant Growth and Development*, Academic Press, USA
- Taiz, L. and Zeiger, E. (2002). *Plant Physiology.* The Benjamin Cummings Publishing Company, Inc. California
- Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V. and Jackson, R.B. (2011). Campbell Biology. 9th Edition, Pearson Benjamin Cummings, CA

Course Code	BIO1032
Course Title	Basic Ecology
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Compulsory

Course Content

Introduction to Ecology: Ecological levels (individuals, populations, communities, ecosystems, biomes, biosphere); Ecology of populations: populations, demes, demography, population growth and distribution; Ecology of communities: Species diversity and basics of vegetation succession; Ecosystem structure and function: Abiotic component [space, energy (different sources of energy, radiation and temperature) and raw materials of the physical environment (water, atmospheric gases, wind, fire, gravity, topography, geologic substratum and soil)], Living component, the biotic environment and biogeochemical cycles; Energy flow in ecosystems (trophic levels, food webs, productivity), carrying capacity and sustainability of ecosystems; Practical based on above.

Recommended Texts

- Raven, P. H., Johnson, G. B., Mason, K. A., Losos, J. B., and Singer, S. R. (2020). *Biology*. 12th Ed. McGraw-Hill Education, New York
- Sadava, D., Hillis, D. M., Heller, H. C., and Berenbaum, M. R. (2011). *Life: The Science of Biology*. 9th Ed. Sinauer Associates, Sunderland, MA
- Smith, T. M. and Smith, R. L. (2012). *Elements of Ecology*. 8thEdn. Benjamin Cummings, Boston
- Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Orr, R. B. (2021). *Campbell Biology*. 12th Ed. Pearson, New York

Course Code	**BIO1162**
Course Title	**Introductory Environmental Biology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Basic concepts in environmental biology; Hydrosphere; Lithosphere; Atmosphere; Biosphere; renewable & nonrenewable resources and cycling of energy & matter; Climate &life; human population growth & problems of overpopulation; Atmospheric pollution and global changes: impacts of atmospheric pollution on biota-plants, animals, humans, carbon footprint; World food resources & green revolution; Effect of agriculture on environment; Water resources: pollution and treatment methods; Solid and hazardous wastes; Environmental health & toxicology; Sustaining terrestrial biodiversity and urban biodiversity. Global resources and associated problems. Practical based on above.	
Recommended Texts	
• Tyler, G. and Miller Jr. (2004). *Living in the Environment: Principles, Connections and Solutions*, Thompson books • Peter H. Raven & George B. Johnson, *Biology* , 6th Edition. McGraw Hill, Boston	

Course Code	**BIO1182**
Course Title	**Introductory Evolutionary Biology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction; Evidence for evolution; Mechanisms of evolution; Micro and macroevolution; Speciation; Co-evolution; Adaptation; Adaptive radiation; Phylogenetics; Phenotypic plasticity; Kin selection; Parent offspring conflict; Human evolution; Health and evolution; Evolution of photosynthesis, angiosperms and crop plants. Practical based on above.	
Recommended Texts	
• Scott Freeman and Jon C. Herron (2015). *Evolutionary Analysis*, 5th Edition, Prentice-Hall, Inc. • Campbell, Neil A., Reece, Jane B., Winickoff, Beth, Jackson, Robert B. and Wasserman, Steven (2007). *Biology with Mastering Biology*, 8th Edition, Benjamin Cummings • Schluter Dolph (2000). *The Ecology of adaptive radiation*, 1st Edition, Oxford University press • Willis K. J. and McElwain J. C. (2002). *The Evolution of Plants*, Oxford University press	

2000 Level Courses

Course Code	**ZOO2012**
Course Title	**Animal Embryology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Historical background of embryology; Gametogenesis, structure and function of gametes; Process of fertilization; Principles and concepts of different embryonic stages and processes: zygote, cleavage, blastula, gastrulation, gastrula, neurulation, neurula and organogenesis; Early embryonic development selected invertebrates and vertebrates.
Practical based on above.

Recommended Texts

- S. F. Gilbert (2011). *Developmental Biology* , 11th Edition, Sinauer Associates, Inc., Publishers, USA
- W. H. Freeman and B. Bracegirdle. *An Atlas of Embryology*, 3rd Edition, Heinemann Educational Books, UK
- T.W. Sadler (2011). *Langman's Medical Embryology* , 12th Edition, Lippincott Williams and Wilkins, a Wolters Kluwer business, USA

Course Code	**ZOO2152**
Course Title	**Zoogeography and Sri Lankan Fauna**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Continental drift and plate tectonics; Wegner's Hypothesis; Earth's mantle core; Tectonic plates and their motion; The supercontinent cycle; History of Zoogeography; Patterns of Zoogeography; Biological processes in Zoogeography; Ecological Zoogeography; dispersal of plants and animals and migrations, barriers of dispersal; Present biogeographic regions; terrestrial and oceanic biogeographic regions and inland waters; Centers of origination and divergence of species; extinction of species; island biogeography; patterns of biogeography; Taxonomy, distribution, habitat and mode of life; conservation status; endemism and threats to selected invertebrates; and vertebrates with special reference to terrestrial fauna. Practical based on above.

Recommended Texts

- J.S. Monroe and R. Wicander (2001). *Changing Earth: Exploring Geology and Evolution*, 3rd Edition, Wadsworth Group
- P.J.Jr. Darlington (1957). *Zoogeography: The geographic distribution of animals*, Harvard University Press
- J.H. Brown & M.V. Lomolino. (1998). *Biogeography*, 2nd Edition, Sinauer Associates, Inc., Sunderland, Massachusetts

Course Code	**ZOO2172**
Course Title	**Coastal Ecosystems and Coral reefs**
Credit Value	**2**

Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to the coastal environment; Biology and ecology of communities in rocky intertidal zone, estuaries, salt marshes, mangroves, coral reefs, seagrass beds; Human impact on the coastal zone; Disturbances and restoration; Coastal zone management; Regulations and laws. Practical based on above.	
Recommended Texts	
• J.W. Nybakken (2004). *Marine Biology: An Ecological Approach*, 6th Edition, Benjamin Cummings • Clive Wilkinson (2002). *Status of Coral Reefs of the World*, Australian Institute of Marine Science	

Course Code	**ZOO2192**
Course Title	**Functional Histology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Light and Electron Microscopy; Cell structure and Function; Cell cycle and replication; Structure and function of basic tissue types (epithelial, connective, muscle and nerve tissue); Histological organization of organ systems (digestive, reproductive, excretory, nervous and sensory systems); Histological techniques (Fixation and fixatives, Tissue processing, microtomy and paraffin sections, staining, histochemistry); Safety. Practical based on above.	
Recommended Texts	
• Pawlina, W. and Ross, M. H. (2018). *Histology: a text and atlas: with correlated cell and molecular biology*, 7th Edition, Lippincott Williams & Wilkins • E.M. Smith and M.L. Calhoun (1968). *The Microscopic Anatomy of the White rat: A Photographic Atlas*, 1st Edition, Ames: Iowa State University Press • P.R. Wheater and H.G. Burkitt (1987). *Functional Histology: A Text and Colour Atlas*, 2nd Edition, English Language Book Society, UK • B. Young, J.S. Lowe and A. Stevens (2006). *Wheater's Functional Histology: A text and Colour Atlas*, 5th Edition, Churchill Livingstone Elsevier, Edinburgh	

Course Code	**ZOO2212**
Course Title	**Invertebrate Diversity**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Metazoa; Characteristic features, diversity, ecology, life history and phylogenetic relationships of invertebrate phyla including: Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata, Hemichordata, Practical based on above.	
Recommended Texts	

- C. Brusca, Gary J. Brusca and Nancy J. *Haver*, *Invertebrates*, 2nd Edition, Sinauer Associates, Inc. Publishers, USA
- E. E. Ruppert, R. S. Fox, and R. D. Barnes, *Invertebrate Zoology*, 7th Edition, Saunders College Publishing, USA

Course Code	**ZOO2222**
Course Title	**Vertebrate Diversity**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Diversity, distribution, and classification of protochordates (urochordates and cephalochordates) and vertebrates; jawless fishes, cartilaginous fishes, bony fishes, amphibians, reptiles, birds, and mammals. Practical based on above.	
Recommended Texts	
• Linzey, D. W. (2020). *Vertebrate Biology*, 3rd Edition, Johns Hopkins University Press, Baltimore • Pough, F.H., Janis, C.M., and Heiser, J.B. (2012). *Vertebrate Life*, 9th Edition, Pearson, Boston	

Course Code	**ZOO2232**
Course Title	**Animal Ecology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to animal ecology; Terrestrial and aquatic ecosystems; Structure and function of ecosystems; Habitat fragmentation; Extinction vortex; Introduction to population ecology: population growth, life tables, and fecundity tables, population regulation, life history characteristics; Introduction to community ecology: Interspecific interactions, competition, predation, herbivory, mutualism, niches and resource partitioning, species diversity, character displacement, community similarity.	
Recommended Texts	
• P. J. Morin (2011). *Community Ecology*, 2nd Edition, Boston: Wiley/Blackwell • M. Begon, J. L Harper, and C. R. Townsend (1996). *Ecology: Individuals, Populations, and Communities*, Boston: Wiley/Blackwell • E. P. Odum and G. W. Barret (2004). *Fundamentals of Ecology*, 5th Edition, New York: Cengage Learning	

3000 Level Courses

Course Code	**ZOO3022**
Course Title	**Comparative Anatomy & Animal Physiology**
Credit Value	**2**
Pre-requisites	**BIO1022**
Compulsory/Optional	**Compulsory**
Course Content	
Comparative anatomy and physiology of digestive, respiratory, excretory, circulatory, nervous, musculoskeletal, reproductive and endocrine systems in selected invertebrates and vertebrates; Homeostasis in vertebrates.	
Recommended Texts	
• R. W. Hill, G. A. Wyse and M. Anderson (2012). *Animal Physiology*, 3rd Edition • R. Eckert, D. Randall and G. Augastine (2001). *Eckert Animal Physiology: Mechanisms and Adaptations*, 5th Edition • Moyes, Christopher D., and Patricia M. Schulte (2005). *Animal Physiology*, 2nd Edition • K. Schmidt-Nielsen (1997). *Animal Physiology: Adaptation and Environment*, 5th Edition	

Course Code	**ZOO3072**
Course Title	**Fish Biology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Morphological, physiological and ecological diversity of fishes; Behavior, growth, life history strategies; Composition of major fish assemblages; Fishes and their habitats; Fish community structure, food webs and pollution dynamics. Practical based on above.	
Recommended Texts	
• G.S. Heklfman, B.B. Collettte & D.E. Facy and W. Brain. *The Diversity of Fishes: Biology, Evolution and Ecology*. 2nd Edition, Bowen Blackwell-Wiley	

Course Code	**ZOO3142**
Course Title	**Evolutionary Biology and Systematics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
The major questions in evolution, Evolution since Darwin: Modern Synthesis and post-modern synthesis, Natural selection, Mechanisms of Evolution ; Gene frequencies and the Hardy-Weinberg equilibrium, Direct and indirect measures of fitness, Diversity of selective pressures (optimality theory, inclusive fitness), Phylogenies to test evolutionary questions, Evolution and human health, Biogeography and fossil history, Species concepts and speciation; allopatry, sympatry, vicariance, Adaptive and non-adaptive radiation,	

Evolutionary outcomes of competitive interactions, Predator-prey, Mutualisms, Cooperation, kin selection and altruism, Life history and reproductive strategies (r- and K-selection), Sexual selection and the social behavior concepts
Recommended Texts
• Freeman, Scott, and Jon C. Herron (2007). *Evolutionary Analysis*, 4th Edition, Pearson Prentice Hall, Upper Saddle River, NJ USA • Mark Ridley (2003). *Evolution*, 2nd Edition, Oxford University Press

Course Code	**ZOO3222**
Course Title	**Insect Pest Management**
Credit Value	**2**
Pre-requisites	**ZOO2212**
Compulsory/Optional	**Optional**
Course Content	
Introduction to insect pests; Insect population dynamics and pest status; Insect pests of agriculture, stored products, plantation crops, forestry, horticultural and export crops; household insect pests; Insect pest control; physical, biological, chemical and integrated pest management. Insecticide resistance and mechanisms of resistance. Success stories of pest control.	
Recommended Texts	
• D.S. Hill (1983). *Agricultural Insect Pests of the Tropics and Their Control*, Cambridge University Press • R.E. Pfadt (1985). *Fundamentals of Applied Entomology*, 4th Edition, Macmillan Publishing Co. • D. Dent (2000). *Insect Pest Management*, CABI Pub.	

Course Code	**ZOO3232**
Course Title	**Vector Borne Diseases**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory for B.Sc. Honours in Zoology**
Course Content	
Emergence and resurgence of vector borne diseases, Athrophophilic mosquitoes and disease transmission Identification and natural history of pathogens transmitted by vectors, Zoophilic mosquitoes and disease transmission, Natural history of pathogens transmitted by vectors, case study on a currently important vector borne disease in Sri Lanka, epidemiology of insect borne diseases and disease control, Introduction to ticks and tick borne infections (TBIs), SFGR & other TBIs of global significance, Epidemiology and Public health importance of TBI, Snails as vectors, Geographic spread of vectors and disease outbreaks, Vectors of veterinary importance and diseases of livestock and pets, Wildlife diseases and threatened species, One Health approach to promote health at the human-animal-environment interface	
Recommended Texts	
• W. C. Marquardt, R.S. Demaree and R.B. Grieve (2000). *Parasitology and Vector Biology*, 2nd Edition, Harcourt/Academic Press • Mullen, G. R., & Durden, L. A. (Eds.) (2009). *Medical and veterinary entomology*, Academic press • B.A. Bannister, N.T. Begg and S.A. Gillespie (2000). *Infectious diseases*, 2nd Edition, Blackwell Science Ltd. • M.E. Scott and G. Smith Eds. (1994). *Parasitic and Infectious Diseases: Epidemiology and Ecology*, Academic Press Ltd.	

Course Code	ZOO3262
Course Title	**Animal Behaviour**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

An evolutionary approach to animal behaviour; Proximate and ultimate causes of behaviour; Development of behavior; Heredity and environment; Economic decisions; Evolutionary arms race; Competition for resources; Living in groups; Fighting and assessment; Sexual conflict; Parental care and mating systems; Selfishness and altruism.

Recommended Texts

- J.R. Krebs and N.B. Davies (1981). *An Introduction to Behavioural Ecology,* 3rd Edition, Blackwell Science
- Alcock John (2001). *Animal behaviour,* 8th Edition, Sinauer Association, Inc.

Course Code	ZOO3272
Course Title	**Animal Genetics and Molecular Biological Techniques**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Theory: Introduction to animal genetics - Mendelism; Structure of DNA and RNA, DNA replication; RNA transcription and protein synthesis; Pedigree analyses & genetic counselling; Extensions of Mendelism / Non-Mendelian genetics (incomplete dominance, co-dominance, multiple alleles, gene mutations, sterile mutations, lethal mutations, gene interactions, epistasis & pleiotropy); Chromosomal basis of inheritance & gene mapping; Chromosomal mutations & extra-chromosomal inheritance (X-inactivation, aneuploidy, chromosomal rearrangements, chloroplast inheritance, mitochondrial inheritance, etc.); Regulation of gene expression, genetic disorders and gene therapy; Genome organization, coding and non-coding sequences, alternative splicing and differential gene expression; DNA extraction and purification, agarose and polyacrylamide gel electrophoresis, DNA manipulative enzymes, restriction fragment length polymorphism; Amplifying DNA: polymerase chain reaction – PCR, gene cloning; DNA sequencing, genomic DNA and cDNA, repetitive gene sequences; DNA fingerprinting, genetically modified organisms, diagnosis of inherited disorders; Microarray analysis, DNA barcoding, RNA interference (RNAi) & gene silencing, CRISPR/ Cas 9 gene editing system and other advances in molecular biological techniques.

Practical: DNA extraction, quantification and detection using gel electrophoresis system; DNA amplification using PCR; Culturing bacteria for gene cloning, single colony selection, blue white colony selection; Sequencing of DNA samples, matching DNA sequences using DNA databases; Use of computer software related to molecular biological studies/Bioinformatics (Use NCBI database to BLAST search a given DNA sequence of a selected pathogen, align the sequence of interest with reference sequences using BioEdit Sequence Alignment software and use MEGA software to perform the phylogenetic analysis); Tutorials on monohybrid crosses, dihybrid crosses and the application of probability method, pedigree diagrams, non-mendelian genetics, gene mapping, X-inactivation and extra-chromosomal inheritance.

Recommended Texts

- D.P. Snustad and M.J. Simmons (2012). *Principles of Genetics,* 6th Edition, John Wiley and Sons
- R.F. Weaver (2011). *Molecular Biology* , 5th Edition, McGraw-Hill
- T.A. Brown (2010). *Gene Cloning and DNA Analysis,* 6th Edition, Wiley-Blackwell
- S.H.P.P. Karunaratne and S.D.S.S. Sooriyapathirana (2012). *Understanding DNA Technology,* Science Education Unit, Faculty of Science, University of Peradeniya

Course Code	ZOO3312
Course Title	**Limnology and Wetland Ecology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Physics, chemistry and biology of freshwater systems; Emphasis on: morphometry; Light and temperature; Water chemistry in relation to nutrients; Physiological requirements; Composition and interaction of algal and invertebrate populations; Eutrophication; Pollution; Environmental change of freshwater systems.

Recommended Texts

- R.G. Wetzel (2001). *Limnology: Lake and River Ecosystems*, 3rd Edition, Academic Press
- P.A. Keddy (2000). *Wetland Ecology: Principles and Conservation*, Cambridge University Press

Course Code	ZOO3322
Course Title	**Amphibian & Reptilian Biology**
Credit Value	**2**
Pre-requisites	**ZOO2222**
Compulsory/Optional	**Compulsory**

Course Content

Transition from water to land; Evolution and adaptive radiation of amphibians and reptiles; Biology of herpetofauna; Communication and behavior of amphibians and reptiles; Parental care and reproductive strategies; Herpetofauna as bio-indicators; Global and local threats to herpetofauna; Conservation and management of amphibians and reptiles; K/T extinction of dinosaurs.

Recommended Texts

- Zug, L.J. Vitt and J.P. Caldwell (2001). *Herpetology: An Introductory Biology of Amphibians and Reptiles*, 4th Edition, Academic Press
- W.E. Duellman (1994). *Biology of Amphibians*, JHU Press
- Z. Vogel. London (1964). *Reptiles and Amphibians, their care and behaviour*, Studio Vista Press
- K.V. Kardong (2006). *Vertebrates: Comparative Anatomy, Function, Evolution*, 4th Edition, Boston: McGraw-Hill
- A.D.A. Bellairs (1970). *The Life of Reptiles* (Vol. 1), New York: Universe books

Course Code	ZOO3332
Course Title	**Avian & Mammalian Biology**
Credit Value	**2**
Pre-requisites	**ZOO2222**
Compulsory/Optional	**Compulsory**

Course Content

Origin and evolution of birds; Dynamics of bird flight; Migration and navigation; Bird song and territory; Breeding systems; Adaptive radiation of birds: Darwin's finches and Hawaiian honeycreepers; Origin and evolution of mammals; Mammalian characteristics; Biology of prototherians (egg-laying mammals), metatherians (marsupials), and eutherians (selected groups including bats, carnivores, cetaceans, and herbivores).

Recommended Texts
• Gill, F.B. and Prum, R.O. (2019). *Ornithology*, 4th Edition, W.H. Freeman, New York • Feldhamer, G.A., Drickamer, L.C., Vessey, S.H., Merritt, J.F. and Krajewski, C. (2015). *Mammalogy: Adaptation, Diversity, Ecology*, Johns Hopkins University Press, Baltimore • Martin, R. E., Pine, R. H., and DeBlase, A. F. (2001). *A Manual of Mammalogy with Keys to Families of the World*, 3rd Edition, Waveland Press, Inc., Long Grove, IL • Proctor, N.S. and Lynch, P.J. (1993). *Manual of Ornithology: Avian Structure and Function*, Yale University Press, New Haven and London • Santiapillai, C. and Wijesundara, C. (2002). *An Illustrated Guide to the Endemic Birds of Sri Lanka*, Science Education Unit, University of Peradeniya, Peradeniya • Vaughan, T.A., Ryan, J.M., and Czaplewski, N.J. (2015). *Mammalogy*, 6th Edition. Jones and Bartlett Learning, Burlington, Massachusetts

Course Code	**ZOO3342**
Course Title	**Ecotourism**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Historical perspective of ecotourism; Ecotourism vs. mass tourism; Socio-cultural impact; Regional economic development; Zoos, wildlife parks, and other ecotouristic attractions; Ecotourism resorts and tour companies; International and domestic ecotourism; Constraints and pitfalls.	
Recommended Texts	
• Fennell, D. A. (2003). *Ecotourism: An Introduction*, 2nd Edition, Routledge, London • Wearing, S. and Neil, J. (2009). *Ecotourism: Impacts, Potentials, and Possibilities*, 2nd Edition, Elsevier, Boston	

Course Code	**ZOO3353**
Course Title	**Inland Fisheries & Aquaculture**
Credit Value	**3**
Pre-requisites	**ZOO3072**
Compulsory/Optional	**Compulsory**
Course Content	
Aquaculture principles and practices, scope and role of aquaculture, history and present status: Different types of aquaculture systems, species selection: Site selection, environmental demands, Pond Construction: Propagation; reproductive cycles of cultured aquatic animals and brood stock management, spawning induction: larval rearing of fin fish and shell fish: Aquaculture Management; water quality management in fish ponds, aeration, aquatic weed management, predators in aquaculture, fish handling and transport. Island fisheries of Sri Lanka, its importance and potential: species involved, fishing gear and methods: preservation and processing of food fish: techniques of natural stock enhancements in inland fisheries: fishery regulation and management Practical activities based on above.	
Recommended Texts	
• T.V.R. Pillay and M.N. Kutty (1993). *Aquaculture: Principles and Practices*, 2nd Edition, Blackwell Publishing	

• Donald R. Swift (1993). *Aquaculture Training Manual*, 2nd Edition, Fishing News Boo • *Sri Lanka Fisheries Year Book 2012*. National Aquatic Resources Agency • *Fisheries Sector in Sri Lanka* (2009). Compiled by the Ceylon Chamber of Commerce

4000 Level Courses

Course Code	**ZOO4043**
Course Title	**Applied Parasitology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Theory: Zoonoses and public health; Epidemiology and control of helminths in livestock; Evolution of parasitism; Parasite behaviours, parasite-induced alterations in host behaviour, reproduction and survival; Food, water and soil transmitted parasitic diseases; Medically and veterinary important arthropods and vector borne diseases; Impact of parasites on wild animal health and population declines; Emerging and re-emerging infectious diseases; Drug resistance of parasites; Physiology and biochemistry of parasites; Diagnostic techniques of parasitic diseases; Bioinvasions, bioterrorism, biosecurity and public health; Epidemiology of parasitic diseases with special reference to Sri Lanka. **Practicals:** Case studies based on zoonotic diseases including cysticercosis, toxoplasmosis, echinococcosis, etc.; Morphology, taxonomy, life cycle, disease caused, diagnosis, control and prevention of selected protozoan and helminths; Questionnaire survey on soil-transmitted helminth infections and treatment; Subsequent data analyses using SPSS software; Arthropods as parasites and vectors; Coprological survey of livestock using simple salt flotation, modified sucrose flotation, preparation of larval cultures and microscopic analysis; post-mortem examination of the cattle rumen, reticulum, abomassum and small intestine; Bioinformatics in Parasitology (Use NCBI database to BLAST search a given DNA sequence of a selected protozoan/nematode parasite, align the sequence of interest with reference sequences using BioEdit Sequence Alignment software and use MEGA software to perform the phylogenetic analysis).	
Recommended Texts	
• Burton J Bogitsh & Thomas C Cheng (2005). *Human Parasitology*, 3rd Edition • Project Management Institute (2013). *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 5th Edition, Project Management Institute, Inc., USA • T.A. Brown (2010). *Gene Cloning and DNA Analysis*, 6th Edition, Wiley-Blackwell • J.D. Smyth (1994). *Introduction to Animal Parasitology*, 3rd Edition • W.C. Marquardt, R.S. Demaree and R.B. Grieve (2000). *Parasitology and Vector Biology*, 2nd Edition • L.R. Ash and T.C. Orihel. *Atlas of Human Parasitology* • M.A. Taylor, R.L. Coop and R.L. Wall (2016). *Veterinary Parasitology*, 4th Edition	

Course Code	**ZOO4063**
Course Title	**Environmental Biology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Adaptation to environment and adapting environment: man's position and his impact on earth, overpopulation	

and environmental degradation, worldwide population trends; Atmosphere; Greenhouse effect and global warming; Ozone depletion; Types, Sources and Effects of air pollution: acid rain, photochemical smog; organic pollution; Carcinogenic and mutagenic effects of chemicals; Agrochemicals and their problems; Aquatic pollution; Algal toxins; Heavy metal pollution; Thermal pollution; Sound and noise pollution; Biological effects of radiation: health effects on humans and other animals; Land use; Urbanization; Sewage; Soil and land pollution; Industrial pollution; Introduction to Climatology: El Nino and southern oscillation; Earthquakes; Volcanism & Tsunamis; Resource development and Environmental Impact Assessment (EIA) in Sri Lanka; Government and environmental policy; International conventions and protocols related to environment. Practical based on above.
Recommended Texts
• Tyler, G. and Miller Jr. (2004). *Living in the Environment: Principles, Connections and Solutions*. Thompson books • J.G. Henry and G.W. Heinke. *Environmental Science and Engineering*, 2nd Edition, Prentice Hall

Course Code	**ZOO4073**
Course Title	**Immunobiology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Adaptive and innate immunity; cells and soluble mediators of immune system; Antigens and antigen presentation; inflammation; Antibodies; T-cell receptors; Major histocompatibility complex; Cytokines and cytokine receptors; Evolution of immunity; Vaccination; Tumor immunology; Immunodeficiency; Transplantation and rejection; Autoimmunity and autoimmune diseases; Hypersensitivity; immunological techniques. Practical and discussions based on above.	
Recommended Texts	
• David Male. Jonathan Brostoff, Davis B. Roth and Ivan Roitt (2013). *Immunology*, 8th Edition, Elsevier • I. Roitt, J. Brostoff and D. Male (2001). *Immunology*, 6th Edition, Mosby • Selected scientific publications	

Course Code	**ZOO4103**
Course Title	**Marine Biology and Fisheries**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to marine ecosystem and the main zones of the world oceans; the coastal environment - biology and ecology of communities in rocky intertidal zone, estuaries, salt marshes, mangroves and sea grass beds; role of world oceans in global protein food supply; Human impact on the coastal zone and the sea; methods of protecting marine environment; Regulations and laws.	
Recommended Texts	
• Gene.S.Heklfman, Bruce .B. Collettte, Douglas .E. Facey & Brain W. Bowen (2009). *The Diversity of Fishes; Biology, Evolution and Ecology*, Wiley-Blackwell • S.J. Hall (1999). *The effects of fishing om marine ecosystems and communities*, Blackwell Science	

- R.B. Clark (2001). *Marine Pollution*, 5th Edition, Oxford Univrsity Press
- Nair, N.B. and D.M. Thampy (1980). *A textbook of marine biology*, Macmillan

Course Code	**ZOO4113**
Course Title	**Wildlife Management**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Wildlife Census Techniques; Population: Growth and Regulation; Carrying capacity; Sustainable Yield Harvesting; Effective Population Size (EPS); Minimum Viable Population (MVP); In-situ and Ex-situ conservation; Extinction; Vertebrate Pest Control; Management of Threatened Wildlife; Island Biogeography and Principles of Reserve Design; Categories of Protected Areas; Protected Areas of Sri Lanka; Wildlife and Society; International Conventions.

Practical based on above.

Recommended Texts

- Fryxell, J.M., Sinclair, A.R.E., and Caughley, G. (2014). *Wildlife Ecology, Conservation, and Management*, 3rd Edition, Wiley-Blackwell
- Krausman, P.R. and Cain, J.W. (2013). *Wildlife Management and Conservation: Contemporary Principles and Applications*, Johns Hopkins University Press

Course Code	**ZOO4212**
Course Title	**Scientific Writing and Presentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to scientific writing, Historical perspective; Types of science writing; Language usage and style; IMRaD format and deviations from IMRaD; Main components of a research article/ project report/ thesis; Literature survey; How to write the Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, References; Reference Managers; A class project based on data collected during the course; How to make an oral presentation; Author and Journal indexing systems and impact factors; Ethics in scientific writing and publishing;
Quizzes and assignments based on above throughout the course.

Recommended Texts

- Gastel, B and Day, R.A. (2016). *How to write and publish a scientific paper*, 8th Edition, (E-copy available in the Library)

Course Code	**ZOO4242**
Course Title	**Research Methods and Data Analysis**
Credit Value	**2**
Pre-requisites	**None**

Compulsory/Optional	**Compulsory**
Course Content	
Introduction to statistics and experimental design; hypothesis testing, types of data and variables, normal distribution parametric and non-parametric analyses, Probability, Confidence intervals, Minitab and Data Analysis, Analyzing proportions and data distribution, Describing data, Mean comparisons, Variances comparisons, Sample errors, Regression and Correlation, Linear Regression, General Linear Models, Principle Component Analysis, Sampling Methods: probability and non-probability methods, Ecological and epidemiological data collection; Qualitative research: designing, pretesting and launching a questionnaire, Entering qualitative data into spreadsheet and analysis, Presentation of qualitative data, Writing a report based on questionnaire survey carried out during course.	
Recommended Texts	
• Queen, J. P., Quinn, G. P., & Keough, M. J. (2002). *Experimental Design and Data Analysis for Biologists*, Cambridge university press • Bailey, N. T. (1995). *Statistical Methods in Biology*, Cambridge university press • Whitlock, M. & Schluter, D. (2015). *The Analysis of Biological Data*. Roberts Publishers	

Course Code	**ZOO4253**
Course Title	**Entomology**
Credit Value	**3**
Pre-requisites	**ZOO3222**
Compulsory/Optional	**Optional**
Course Content	
Insect systematics; Anatomy and physiology of insect organ systems; Development and growth; Sensory perception; Communication and behavior of insects; Insect adaptations to live in different environments, Social insects; Apiculture; Insect pollination; Predatory and parasitic insects; Insects of forensic importance. Practical based on above.	
Recommended Texts	
• R. F. Chapman (2012). *The Insects Structure and Function*, 5th Edition, Cambridge University Press • O.W. Richards and R. G. Davies (1977). *Imms' General Textbook of Entomology: Volume 1: Structure, Physiology and Development*, Springer Science & Business Media • O.W. Richards and R. G. Davies (1977). *Imms' General Textbook of Entomology: Volume 2: Structure, Physiology and Development,* Springer Science & Business Media • Jason H. Byrd & James L. Castner (2010). *Forensic Entomology: The Utility of Arthropods in Legal Investigations*, Taylor and Francis, CRC Press	

Course Code	**ZOO4262**
Course Title	**Developmental Biology**
Credit Value	**2**
Pre-requisites	**ZOO2012**
Compulsory/Optional	**Optional**
Course Content	
Fate, potency, cell specification and differentiation, morphogenesis, cell adhesion in embryonic development; Genome equivalency and differential gene expression; Stem cells, regeneration, animal cloning, maternal and zygotic control of gene expression; Cell-cell communication during development: inductive events, signal	

transduction cascades, cell death pathways; Patterning the embryonic body plan: embryonic axes and germ layers, tetrapod limb development; developmental mechanisms of evolutionary change.
Recommended Texts
• S. F. Gilbert (2011). *Developmental Biology*, 11th Edition, Sinauer Associates, Inc., Publishers, USA • J. Smith, P, Lawrence and L. Wollpert (2007). *Principles of Development*, 3rd Edition, Oxford University Press • B. K. Hall (1999). *Evolutionary Developmental Biology*, 2nd Edition, Kluwer Academic Publishers

Course Code	**ZOO4282**
Course Title	**Independent Study and Seminar**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Theory: Discussion with students on course tasks & assessment methods; How to write a comprehensive essay; Improving presentation skills; Identification of keywords, literature search strategies and critical appraisal of literature; Discussion classes following each assessment task. **Practical:** None **Assessments:** Essay 1; Essay 2; Seminar; Review article	
Recommended Texts	
• Primary literature relevant to the topic • Michael Alley (2003). *The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors to Avoid,* Springer-Verlag New York, Inc. (Available online) • Matt Carter (2013). *Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More,* 1st Edition, Elsevier Inc.	

Course Code	**ZOO4293**
Course Title	**Conservation Biology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Ecological principles of conservation; Causes of extinction, preventing extinctions, rescue and recovery of near extinctions; Conservation at population and species levels: population biology, problems of small populations, establishing new populations; Ex-situ conservation strategies, in-situ conservation strategies.	
Recommended Texts	
• Hunter, M. L. and Gibbs, J. P. (2007). *Fundamentals of Conservation Biology,* 3rd Edition, Blackwell Publishing, Malden, Massachusetts • Primack, R. B. (2010). *Essentials of Conservation Biology*, 5th Edition, Sinauer Associates, Inc., Sunderland, Massachusetts	

Course Code	ZOO4998
Course Title	**Research Project**
Credit Value	**8**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Each student will be conducted a research project with the supervision of an academic staff members(s). The student is expected to conduct a literature review to plan a research project for a given research question. The student is expected to conduct the research project, collect and analyze data and synthesize and interpret results under the supervision of the supervisor(s). The student is expected to maintain a diary and report progress to the supervisor(s) at each stage. After completion of the project, the student is required to write and submit a comprehensive project report and make an oral presentation on the research findings to the evaluation committee.	

Course Code	SCI4003
Course Title	**Industrial Training**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Each student will undergo full time training in the industry for the period prescribed, on projects assigned to them. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the projects assigned to them.	
Recommended Texts	
• Reading material relevant to their industrial training	

9.2 Biomedical Science Course Modules

3000 LEVEL – BIOMEDICAL SCIENCE				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
				Hons.
BMS3012	Anatomy & Physiology 1	2		√
BMS3022	Anatomy & Physiology 2	2		√
BMS3032	Principles of Pharmacology & Toxicology	2		√
BMS3042	General Pathology & Haematology	2		√
BMS3052	Laboratory Safety & Risk Management	2		√
BMS3062	Biomedical Informatics	2		√
BMS3072	Biochemistry & Molecular Biology Laboratory	2	MBB2013 MBB2263	√
BMS3083	Molecular Cell Biology	3	MBB2013	√
BMS3093	Bioinformatics	3	MBB2263	√
BMS3103	Molecular Virology	3	MBB2263	-
BMS3112	DNA and Forensic Medicine Laboratory	2	MBB2263	-
BMS3122	Vector Borne Diseases	2		√
BMS3133	Remote Sensing and Geographical Information Systems (GIS)	3		-
BMS3142	Biophysics	2		√
BMS3152	Health Physics	2		-
BMS3163	Analytical Chemistry	3	CHE2313	√
Total		**37**		**27**

4000 LEVEL – BIOMEDICAL SCIENCE				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
				Hons.
BMS4013	Principle of Epidemiology	3		√
BMS4022	Neuroscience	2		-
BMS4031	Ethics in Medical Sciences	1		√
BMS4043	Pharmaceutical Design and Development	3		-
BMS4052	Biomaterials	2		-
BMS4063	Immunobiology	3		√
BMS4073	Applied Parasitology	3		-
BMS4082	Scientific Writing & Presentation	2		√
BMS4092	Research Methods and Data Analysis	2		√
BMS4103	Entomology	3		-
BMS4112	Developmental Biology	2		-
BMS4122	Independent Study & Seminar	2		√
BMS4133	Special topics in Cell & Molecular Biology	3	MBB3113	-
BMS4142	Medical Statistics	2		-
SCI4003	Industrial Training	3		-
BMS4998	Research Project	8		√
Total		**44**		**21**

3000 Level Courses

Course Code	**BMS3012**
Course Title	**Anatomy & Physiology 1**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Comparative anatomy and physiology of digestive, respiratory, excretory, circulatory, musculoskeletal, nervous, reproductive and endocrine systems in invertebrates and vertebrates; Homeostasis in vertebrates.	
Recommended Texts	
• *Animal Physiology* – R. W. Hill, G. A. Wyse and M. Anderson (2012). 3rd Edition. • *Eckert Animal Physiology: Mechanisms and Adaptations* – R. Eckert, D. Randall and G. Augastine (2001). 5th Edition. • *Animal Physiology: Adaptation and Environment*. K. Schmidt-Nielsen (1997). 5th Edition.	

Course Code	**BMS3022**
Course Title	**Anatomy & Physiology 2**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
This course provides a comprehensive study of the anatomy and physiology of the human body. Topics include body organization; homeostasis; cytology; histology; and the integumentary, skeletal, muscular, nervous systems and special senses. Upon completion, students should be able to demonstrate an in-depth understanding of principles of anatomy and physiology and their interrelationships.	
Recommended Texts	
• Human Anatomy and Physiology - 10th Edition by Elaine N. Marieb	

Course Code	**BMS3032**
Course Title	**Principles of Pharmacology & Toxicology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Principles of toxicology and mechanisms of toxic action, developmental and reproductive toxicology, environmental epidemiology, and human, carcinogen and environmental risk assessment. Pharmacodynamics and pharmacokinetics a drug on the various drug targets in the body; Significance and mechanism of adverse effects of toxic drug; Methods of measuring and monitoring response to drugs; Antimicrobial drugs in pharmaceutical agents and th mechanisms of how these drugs work; Pharmacogenetics on response to drug therapy; Antineoplastic drug pharmacology; Biological agents as therapeutic agents of diseases.	

Recommended Texts
• Principles of Toxicology K.E. Stine and T.M. Brown 3rd Edition CRC Press 2015 • Basics in Pharmacology by Prof. Niroshani S. Soyza • Rang & Dales's Pharmacology by Rang H.P, Dale M.M, Ritter J.M, Flower R.J and Henderson G

Course Code	**BMS3042**
Course Title	**General Pathology & Haematology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Cell response to injury and cell death/necrosis, acute & chronic inflammation, cellular adaptations of growth and differentiation, cellular accumulations, healing & repair, Congestion &oedema , thrombosis, embolism, ischaemia and infarction, neoplasia, Haemopoiesis, red cells, nutritional anaemia, haemolyticanaemia, thalassaemias and haemoglobinopathies, white cells, myeloproliferative disorders, leukaemias , myeloma, bleeding disorders, coagulation disorders, immunohaematology.	
Recommended Texts	
• Robbins and Cotran Pathologic basis of disease by Vinay Kumar, Abdul Abbas and Jon Aster. • Text book of Pathology by Harsh Mohan • Lecture notes in Haematology by S. N. Wickramasinghe	

Course Code	**BMS3052**
Course Title	**Laboratory Safety & Risk Management**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Principles of safety; Preparing for emergencies; Recognizing and identifying hazards; Assessing and evaluating risks of hazards: Minimizing and preventing exposure to hazards; Fume Hoods and Other Ventilation Devices and Systems; Chemical Toxicology and Permissible Exposure Limits; Laboratory quality assurance; Environmental Protection and Hazardous Waste; Chemical Segregation and Storage; Gases, Refrigerated Chemicals, and Cryogenics; Peroxide Formers and other Time Sensitive Chemicals; Laboratory Close-outs and Chemical Transportation; Safety Data Sheets and the new Globally Harmonized System (GHS) of Chemical Classification and Labeling; Sterilization & disinfection (Infection control) - Standard laboratory set up- clinical & other Waste disposal; Controlled Substances and Regulated Explosives Programs; Cyanide Safety; Inspections, and Fume Hood and biosafety cabinet Evaluations; Accidents, Investigations, and Spill Response; First Aid;Laboratory Fire Safety and Response.	
Recommended Texts	
• Laboratory Safety: Theory and Practice First edition 1980. Edited by A.A. Fuscaldo, B.J. Erlink and B. Hindman. Elsevier • Complete Guide to Laboratory Safety. Fourth Edition. T.J. Gile, D. Scungio, 2014	

Course Code	**BMS3062**
Course Title	**Biomedical Informatics**

Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Principles of health informatics, educational and instructional design theory, History of medical informatics, informatics drivers and trends, develop landmark documents, nature of health informatics, competencies in health informatics.

Recommended Texts

- Introduction to Health Informatics by Christo El Morr 2018
- Health Informatics: An Overview E.J.S. Hovenga, M.R. Kidd, S. Garde and C.H. L. Cossio. IOS Press 2010

Course Code	**BMS3072**
Course Title	**Biochemistry & Molecular Biology Laboratory**
Credit Value	**2**
Pre-requisites	**MBB2013 & MBB2263**
Compulsory/Optional	**Compulsory**

Course Content

UV-visible spectroscopy; chromatographic methods; elctrophoresis; DNA and RNA purification and analysis; polymerase chain reaction; restriction fragment length polymorphism (RFLP) and random amplified polymorphic DNA (RAPD) techniques; DNA sequencing; southern and northern transfer techniques; immunochemical methods; radioactive and non radioactive detection methods; biosensors.

Recommended Texts

- Green, M.R., Sambrook, J. (2012) Molecular Cloning – A Laboratory Manual, (Fourth Edition). Cold Spring Harbor Laboratory.
- Ninfa A.J., Ballou, D.P., Benore, M. (2009) Fundamental Laboratory Approaches for Biochemistry and Biotechnology, (Second Edition). John Wiley and Sons, INC.
- Greenfield, E.a. (2014) Antibodies: A Laboratory Manual, (Second Edition), Cold Spring Harbor Laboratory.

Course Code	**BMS3083**
Course Title	**Molecular Cell Biology**
Credit Value	**3**
Pre-requisites	**MBB2013**
Compulsory/Optional	**Compulsory**

Course Content

Structure of eukaryotic and prokaryotic cells; cell organelles and functions; cell membrane, function and transport cross membranes; protein trafficking; organelle biogenesis; cytoskeleton and cell motility; extracellular matrix and cell adhesion; cell-to cell signaling; signaling in the sensory system; cell cycle, regulation and apoptosis.

Recommended Texts

- Lodish, H., Berk, A., Kaiser, C.A., Krieger M., Bretscher, A., Ploegh, H., Amon, A., Scott M. P. (2012) Molecular Cell Biology, (Seventh Edition). Freeman, W.H. and Company.
- Alberts, B., Johnson, A., Lewis, J., Morgan D., Raff, m., Roberts, K., Walter, P. (2004) Molecular Biology of the Cell, (Sixth Edition). Garland Science.

- Craig, N., Green, R., Greider, C., Storz, G., Wolberger, C., Cohen-Fix, O. (2014) Molecular Biology: Principles of Genome Function, (Second Edition). Oxford University Press.

Course Code	**BMS3093**
Course Title	**Bioinformatics**
Credit Value	**3**
Pre-requisites	**MBB2263**
Compulsory/Optional	**Compulsory**
Course Content	
Molecular data bases; bioinformatics and computational biology software; sequence alignment; phylogenetic analysis; functional genomics; genome analysis; complete genome; DNA microarrays; protein structure analysis; motif identification; evolutionary alignments and structure prediction; drug design; archives and information retrieval; introduction of system Biology.	
Recommended Texts	
• Lesk, A.M. (2014). Introduction to Bioinformatics, (Fourth Edition). Oxford University Press. • Ghosh, Z., Mallick, B. (2015). Bioinformatic principles and applications, (First Edition). Oxford Higher Education. • Pevsner, J., (2009). Bioinformatics and Fundamental Genomics, (Second Edition). Willey Blackwell.	

Course Code	**BMS3103**
Course Title	**Molecular Virology**
Credit Value	**3**
Pre-requisites	**MBB2263**
Compulsory/Optional	**Optional**
Course Content	
History of virology and general characteristics of viruses; virus classification; structure and genomes; virological methods; virus infection cycle; virus receptors and mechanism of virus entry; replication and transcription of RNA viruses; reverse transcription and integration of DNA viruses; replication and transcription of DNA viruses; viral protein synthesis; virus assembly and exit; virus pathogenesis; oncogenic transformation; host resistance to viral infection; antiviral treatment; HIV and AIDS; exploitation of viruses in gene therapy.	
Recommended Texts	
• Flint, S.J., Racaniello, V.R. (2015) Principles of Virology, Vol. 1 and 2 (Fourth Edition). ASM Press. • Shors, T. (2011) Understanding Viruses (Second Edition). Jones & Bartlett Learning. • Cann, A.J. (2015) Principles of Molecular Virology, (Sixth Edition). Elsevier.	

Course Code	**BMS3112**
Course Title	**DNA and Forensic Medicine Laboratory**
Credit Value	**2**
Pre-requisites	**MBB2263**
Compulsory/Optional	**Optional**
Course Content	
Principles and methods of DNA profiling; recent examples; biological evidences and serology, distribution and spattering f blood and other useful biological samples, isolation of DNA from forensic samples, techniques in DNA analysis ; forensic DNA databases ; STR population data analysis , forensic genetics, challenges and case studies, accreditation and quality control , applications such as criminal investigations and paternity analysis , implications in law enforcements , future trends.	
Recommended Texts	
• Dehlinder , C.A.(2014) Molecular Biotechnology, Jones and BartletLearnings. • Rudin, N., Inman , K.(2001) An Introduction to Forensic DNA Analysis (Second edition). CRC Press. • Buttler, J.M. (2014) Advance Topics in DNA Typing: Interpretation. Elsevier.	

Course Code	**BMS3122**
Course Title	**Vector Borne Diseases**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Taxonomy, morphology, distribution and life cycle of medically and veterinary important vector borne pathogens; Emergence and resurgence of vector borne diseases; Dynamics of transmission; Detection and control; Integrated strategies to address vector borne diseases; Environmental and ecological relations; Outbreaks and geographic spread of vectors and pathogens; Vectors of medically and veterinary importance, and their control;Case study on currently important vector borne disease in Sri Lanka.	
Recommended Texts	
• *Parasitology and Vector Biology* (2000) W. C. Marquardt, R.S. Demaree and R.B. Grieve. 2nd Ed. Harcourt/Academic Press. • *Infectious diseases* (2000) B.A. Bannister, N.T. Begg and S.A. Gillespie 2nd ed. Blackwell Science Ltd. • *Parasitic and Infectious Diseases*: *Epidemiology and Ecology* (1994) M.E. Scott and G. Smith Eds. Academic Press Ltd.	

Course Code	**BMS3133**
Course Title	**Remote Sensing and Geographical Information Systems (GIS)**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Overview and basic concepts of Remote Sensing (RS), Aerial Photography, fundamental characteristics of electromagnetic radiation, concepts of resolution, Remote sensing platforms. Satellite systems and sensors,	

active and passive sensing systems, overview of RS applications, Introduction to GPS, application of GPS technology in geology. Introduction to GIS, overview and concepts of GIS, scope and application areas, purpose and benefits of GIS. Hardware and software in for GIS. Functions of GIS software. Installation of GIS. Mapping Concept, map elements, map scales and representations, map projection, Raster and Vector data structures, input of geospatial data, sources of data and input devices. Geo referencing, concept of spatial databases, data acquisition and management techniques, data manipulation and analysis. Map output generation.
Recommended Texts
• Burrough, P.A. and McDonnell, R.A. (1998). Principles of Geographical Information Systems. Oxford University Press. • Gupta, R.P. (2002). Remote Sensing Geology. 2nd Edition, Springer. • Canada Centre for Mapping and Earth Observation (2014). Fundamentals of Remote Sensing. Natural Resources, Canada.

Course Code	**BMS3142**
Course Title	**Biophysics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to cell and bio membranes **Transport of matters across membrane:** Active and passive transport, diffusion, Fick‘s law. **Membrane potential:** Nernst-Plank equation, Goldman equation, transference equation. **Neurobiophysics:** Neurons, electric analog of membrane, nerve excitation, action potential, conduction of action potential, electrical activity of heart and ECG. **Thermodynamics of biosystems:** Equilibrium thermodynamics, Gibbs free energy, chemical potential. **Bioenergetics:** Energy path ways in biology, photosynthesis. **Radiation biology**: interaction of ionization radiation with biomaterials, biological effects of radiation, quantitative and qualitative analysis of radiation effect.	
Recommended Texts	
• Hoppe, W. and Lohmann, W., Biophysics (1983), Springer-Verlag Berlin Heidelberg. • Cotterill, M.J., Biophysics*: An Introduction* (2002), John Wiley & Sons Ltd. • Srivastava, P.K., *Elementary Biophysics* (2005), Narosa Publishing House. • Glaser, R., *Biophysics* (1996), Springer-Verlag Berlin Heidelberg.	

Course Code	**BMS3152**
Course Title	**Health Physics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to radiation physics: Radiation sources, radioactivity and types of radiation, interaction of radiation with matter. **Radiation hazard:** Physical, chemical and biological effects. **Radiation safety and personnel dosimetry:** Quantities related to radiation protection, radiation protection principles, dosimetry, radiation safety during medical diagnostic and therapeutic procedures. **Radiation dose limits, guidelines and regulations:** recommendations from ICRP, NCRP, IAEA etc, radiation monitoring systems, Sri Lankan regulations.	

Radiation detection and shielding: Different types of detectors and shielding mechanisms.
Emergency procedures and risks: Decontamination and safety procedures.
Radiation waste management and disposal: General and standard procedures.

Recommended Texts

- Stabin, M. G., *Radiation Protection and Dosimetry*(2007), Springer.
- Cember, H. and Johnson, T. E., *Introduction to Health Physics* (2009), McGraw-Hill.
- Trapp, J. V. and Kron, T., *An Introduction to Radiation Protection in Medicine* (2008), Taylor &Francis Inc.
- Meredith, W.J., Massey, J.B., *Fundamental Physics of Radiology* (2013), Butterworth-Heinemann.
- Huda, W. *Review of Radiologic Physics* (2009), LWW Publishers.
- Coggle, J.E., *Biological Effects of Radiation* (1983), Taylor & Francis Ltd.

- ICRP and IAEA publications.

Course Code	**BMS3163**
Course Title	**Analytical Chemistry**
Credit Value	**3**
Pre-requisites	**CHE2313**
Compulsory/Optional	**Compulsory**

Course Content

Advanced Calculations (12 L):
Review of statistics in chemical analysis: test of significance, paired t-test, F-test, etc.; Statistics of linear chemical relationships; Performance characteristics of analytical methods; Interlaboratory testing; Sensor characteristics; Advanced calculations as applied to chemical analysis: derivation and error calculations associated with acid-base, redox and complexometric titrations; Iteration methods; metal-complex equilibria; Solubility equilibria.
Analytical Aspects of Spectrophotometry (9 L):
Atomic absorption and emission methods, molecular UV and visible absorption spectroscopy.
Separation Methods (12 L)
Solvent Extraction, partition coefficient, distribution ratio, multiple extractions, extraction of metals, introduction to chromatographic techniques and classifications, gas chromatography, van-Deemter equation, ion-exchange chromatography, thin layer and paper chromatography, introduction to liquid-liquid chromatography, Trouble shooting in Gas Chromatographic separations, Role of organic solvents in Liquid Chromatographic separations.
Electroanalytical Chemistry (10 L):
Potentiometric applications; voltammetry including polarographic methods, pulsed techniques, steady-state and flow injection amperometric methods, bulk electrolysis methods, microelectrodes in chemical analysis, electrochemical sensors
Non-aqueous and ionic solvents (2 L)***:***
Polar aprotic and polar protic solvents, Leveling effects of liquid ammonia, Non-aqueous titrations.

Recommended Texts

- DA Skoog, West and Holler, *Analytical Chemistry*; Marcel Dekker.
- P Kissinger and WR Heineman, *Laboratory Techniques in Electroanalytical Chemistry*; Freeman.
- Marcel Dekker; AJ Bard and L Faulkner, *Electrochemical Methods*ICRP and IAEA publications.

4000 Level Courses

Course Code	**BMS4013**
Course Title	**Principles of Epidemiology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Basic concepts of epidemiology; Epidemiological study designs; Practices of public health and statistics; Descriptive studies: case reports and case series, cross sectional studies, correlational studies; Analytical studies: case-control and cohort; Experimental studies: controlled clinical trials, community intervention trials; Disease surveillance and screening in public health.	
Recommended Texts	
• Epidemiology for public Health Practice. Robert H Friis and Thoma A Sellers, 5th Edition 2013 Jones & Bartlett Publishers • Epidemiology in Medicine. Charles H. Hennekens and Julie Buring 1987	

Course Code	**BMS4022**
Course Title	**Neuroscience**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
History of neuroscience, overview of the nervous system; membrane physiology, resting membrane potentials, action potentials, synpases, neuromuscular junction, sensory and motor systems; special senses (vision, hearing, taste and smell) ; physiology of pain; cerebellum and motor coordination; basal ganglia; posture, balance; memory and limbic system; speech and language; sleep and arousal; applied physiology of neurological disorders, electrencephalography, nerve conduction techniques, evoked potentials and electropmyography	
Recommended Texts	
• Textbook of Medical Physiology by A.C. Guyton and J.E. Hall • Review of Medical Physiology by William F. Ganong	

Course Code	**BMS4031**
Course Title	**Ethics in Medical Sciences**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Definitions. History of medical ethics. Basic principles of medical ethics. Human rights and ethics. Reports, codes and declarations. Ethics of biomedical research. Ethics of scientific publications. Ethical dilemmas. Ethics pertaining to new advances in medical sciences – gene manipulation, surrogate pregnancies, cloning, etc. advances in the pharmacological industry. Biomedical research misconduct and research fraud	
Recommended Texts	

- Principles of Biomedical ethics- Beauchamp.T. &Childress.J, (2013), NY. Oxford University Press
- Ethics by Jonsen,A., Siegler,M..Windslade.W. Ny. McGrow-Hill Medical, (2010)
- International Ethical Guidelines for Biomedical Research Involving Human Subjects. Council for International Organizations of Medical Sciences.(CIOMS) (2002)
- Codes of Ethics and Declaration Released to the Health Professions Amnesty International.

Course Code	**BMS4043**
Course Title	**Pharmaceutical Design and Development**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Principles of drug discovery; Pharmacognosy and the evolution of drugs from natural products; Complementary and Alternative Medicines; Synthetic chemistry and modification of chemical structure; Chemical component of a structure that determines the biological activity of a pharmaceutical agent;structure activity relationship and mode of action of selected drugs; Modern and innovative new drug technologies; Understanding of various drug targets including protein molecules; Concept of immunological drug targets; Future trends applied in drug discovery; Introduction to regulatory affairs in drug discovery; Patenting, registration and marketing.	
Recommended Texts	
• Daan, D.J., Crommelin, J.A., Sindelar, R. D., Meibohm, B. (2008). Pharmaceutical Biotechnology: Fundamentals and Applications. Informa Healthcare. USA. • Gupta, V.K. (2010). Medicinal Plants: Phytochemistry, Pharmacology & Therapeutics, 1st edn. Riddhi International, India. • Ross, I.A. (1999). Medicinal Plants of the World: Chemical constituents, traditional and modern medicinal uses. Humana Press, USA.	

Course Code	**BMS4052**
Course Title	**Biomaterials**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Biomaterials, Structure and properties of hard & soft materials, Processing and characterization of Biomaterials, Introduction to biological structures utilized in Medicine & Dentistry, *In-vitro* evaluation of biocompatibility of materials, Biological performances and interactions of materials with living tissues (in-vivo) and Introduction to Tissue engineering and applications.	
Recommended Texts	
• Biomaterials Science – Ratner, Hoffman, Schoen, Lemons (Elsevier; ISBN 0-12- 582461) • Biomaterials – Temenoff and Mikos (Pearson Prentice Hall; ISBN 0-13-009710-1) • Materials Science & Engineering: An Introduction – Callister (John Wiley & Sons; ISBN 0-471-13576-3) • Cellular Responses to Biomaterials – Di Silvio (Elsevier, ISBN 1845693582) • Any Cell biology, Organic Chemistry books	

Course Code	**BMS4063**
Course Title	**Immunobiology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Adaptive and innate immunity; cells and soluble mediators of immune system; Antigens and antigen presentation; inflammation; Antibodies; T-cell receptors; Major histocompatibility complex; Cytokines and cytokine receptors; Evolution of immunity; Vaccination; Tumor immunology; Immunodeficiency; Transplantation and rejection; Autoimmunity and autoimmune diseases; Hypersensitivity; immunological techniques. Practicals and discussions based on above.	
Recommended Texts	
• *Immunology*. David Male, Jonathan Brostoff, David Roth and Ivan Roitt, 7th Edition. • *Immunology*. Roitt I., Brostoff J., Male D., 6th Edition.	

Course Code	**BMS4073**
Course Title	**Applied Parasitology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Epidemiology of parasitic diseases with special reference to Sri Lanka; Drug resistance of parasites; Zoonoses and public health; Emerging and re-emerging infectious diseases; Epidemiology and control of helminthes in livestock; Parasite behaviours, Parasite-induced alterations in host behavior, reproduction and survival; Evolution of parasitism; Impact of parasites on wild animal health and population declines; Food, water and soil transmitted parasitic diseases, Medically and veterinary important arthropods and vector borne diseases; Physiology and biochemistry of parasites; Diagnostic techniques of parasitic diseases; Bioinvasions, Bioterrorism, Biosecurity and Public Health.	
Recommended Texts	
• Human Parasitology – Burton J Bogitsh& Thomas C Cheng (3rded 2005) • Parasitology in Focus – Heinz Mehlhorn (1988) • Introduction to Animal Parasitology – J D Smyth (3rded 1994) • Parasitology and Vector Biology – W C Marquardt, RS Demaree and RB Grieve (2nded 2000) • Atlas of Human Parasitology – LR Ash and TC Orihel	

Course Code	**BMS4082**
Course Title	**Scientific Writing & Presentation**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Importance of scientific writing, History of scientific writing and scientific publications, Nature and process of different scientific publications, Ethics in scientific writing and publishing, Language usage and style in scientific writing, Main components of a research article/ project report/ thesis. IMRAD structure and	

deviations from IMRAD structure, Literature survey, Writing the Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusions and Outcome of a scientific report, Developing Tables and Figures, Data analysis and interpretation, Referencing using the number system and Harvard referencing system, Author and Journal indexing systems and impact factors, Nature of different scientific gatherings and presentations, Making oral presentations of scientific material: organization, preparation of the script and visuals, delivery of the presentation and handling questions.
Recommended Texts
• Robert A. Day and Barbara Gastel (2006) How to write and publish a scientific paper. 6th Edition • A. Gillett, A. Hammond & M. Martala (2009) Successful Academic Writing. • K.L. Turabian (1996) A Manual for Writers.

Course Code	**BMS4092**
Course Title	**Research Methods and Data Analysis**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Designing and conducting research; Data collection; Concepts of probability and probability distributions and how they are applied in statistical testing; developing and testing hypothesis; Errors in hypothesis testing; Parametric and nonparametric statistics; Univariate and multivariate data analysis; Applications of statistical packages.	
Recommended Texts	
• *The Analysis of Biological Data* (2009) M.C. Whitlock &D. Schluter. Greenwood Village, Colorado: Roberts and Company Publishers. • *Multivariate Statistics for Wildlife and Ecology Research* (2002) K.S. McGarigal, S. Cushman and S. Stafford. 2nd Ed. Springer, New York. • *Ecological Diversity and Its Measurement (Vol. 168)* (1998) A.E. Magurran&A.E. Magurran. Princeton: Princeton university press. • *Statistical Methods: An Introductory Text* (1992) J. Medhi. 2nd Ed. New Age International. • *Fundamental Statistics for Behavioral Sciences* (1990) B.M. Robert 5th Ed. Harcourt Brace Jovanovich, New York.	

Course Code	**BMS4103**
Course Title	**Entomology**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Insect systematics; Anatomy and physiology of insect organ systems; Development and growth; Sensory perception; Communication and behavior of insects; Insect adaptations to live in different environments, Social insects; Apiculture; Insect pollination; Predatory and parasitic insects; Insects of forensic importance.	
Recommended Texts	
• *The Insects Structure and Function* (2012)R. F. Chapman 5th Ed. Cambridge University Press. • *Forensic Entomology. The Utility of Arthropods in Legal Investigations*. (2010) Jason H. Byrd & James L. Castner. Taylor and Francis, CRC Press.	

• *Imms' General Textbook of Entomology: Volume 1: Structure, Physiology and Development* (1977) O.W. Richards and R. G. Davies. Springer Science & Business Media. • *Imms' General Textbook of Entomology: Volume 2: Classification and Biology* (1977) A.D. Imms, O.W. Richards and R. G. Davies. Springer Science & Business Media.

Course Code	**BMS4112**
Course Title	**Developmental Biology**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Fate, potency, cell specification and differentiation, morphogenesis, cell adhesion in embryonic development; Genome equivalency and differential gene expression; Stem cells, regeneration, animal cloning, maternal and zygotic control of gene expression; Cell-cell communication during development: inductive events, signal transduction cascades, cell death pathways; Patterning the embryonic body plan: embryonic axes and germ layers, tetrapod limb development.	
Recommended Texts	
• *Developmental Biology* (2014) S. F. Gilbert 10th Ed. Sinauer Associates, Inc., Publishers. • *Principles of Development* (2007) J. Smith, P. Lawrence and L. Wollpert. 3rd Ed. Oxford University Press. • *Evolutionary Developmental Biology* (1999). B. K. Hall (1999). 2nd Ed. Kluwer Academic Publishers • *An Atlas of Embryology* (1978) W. H. Freeman and B. Bracegirdle. 3rd Ed. Heinemann Educational Books, UK. • *Langman's Medical Embryology* (2011). T.W. Sadler Lippincott Williams and Wilkins, 12th Ed. Wolters Kluwer Business, USA.	

Course Code	**BMS4122**
Course Title	**Independent Study & Seminar**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Make a presentation of an assigned topic after literature survey and produce a written article on the topic critically analyzing primary literature. Write two essays in the class on given topics after due preparation and literature survey.	
Recommended Texts	
• Primary Literature relevant to the topic. • *The Craft of Scientific Presentations; Critical Steps to Succeed and Critical Errors to Avoid* (2003) Michael Alley Springer-Verlag New York, Inc. (Available online). • *Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More* (2013). Matt Carter 1st Ed. Elsevier Inc.	

Course Code	**BMS4133**
Course Title	**Special topics in Cell & Molecular Biology**
Credit Value	**3**
Pre-requisites	**MBB3113**
Compulsory/Optional	**Optional**
Course Content	
Cancer as a micro-evolutionary process; the preventable causes of cancer, finding the cancer critical genes; the molecular basis of cancer cell behavior; cancer treatment: present and future, epidemics and renewal by stem cells, renewal by multipotent stem cells; blood cell formation; fibroblasts and their transformations, stem cell engineering, primodial germ cells and sex determination in mammals; eggs; sperm; fertilization.	
Recommended Texts	
• Alberts B, Johnson A, Lewis J, et al. (2004). Molecular Biology of the Cell. 6th edition. New York: Garland Science; 2002. • Lodish H, Berk A, Zipursky SL, et al. (2012). Molecular Cell Biology. 7 thedition. New York: W. H. Freeman • Karp, G. (2013) Cell & Molecular Biology Concepts and Experiments, (7th Edition). Wiley PLU	

Course Code	**BMS4142**
Course Title	**Medical Statistics**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Role of statistics in medical research, Ethical Considerations, Epidemiology: Basic designs for epidemiological studies, Hypotheses, Study Designs, Case Definition, Measures of Disease Frequency, Issues Related to Prevalence, Comparing Groups, Surveillance; Clinical trials: Clinical Trial Designs, Clinical Trial Phases, Clinical Bias; Analysis of data from cohort and case control studies, Interim Analyses and Stopping Rules, Estimating Clinical Events: Odds Ratio, Mantel-Haenszel Test for the Odds Ratio, Trend Analysis, Survival Analysis; Medical Diagnostic Testing: Describing Diagnostic Tests, Estimating the Probability of Disease, Screening biases, sensitivity and specificity, Comparing Two Diagnostic Tests, Selecting a Positivity Criterion; Measures of Agreement: Use and Misuse of Correlation Coefficients, Kendall Tau Correlation Coefficient, Concordance Correlation Coefficient, Total Deviation Index, Cohen's Kappa Statistic for Measuring Agreement.	
Recommended Texts	
• Armitage, P., Berry, G. and Matthews, J. N. S. (2001). Statistical methods in medical research, 4th Edition, Wiley-Blackwell. • Peacock, J. and Peacock, P. (2011) Oxford Handbook of Medical Statistics, 1st Edition, Oxford University Press. • Woodward, M. (2013). Epidemiology: Study design and data analysis, 3rd Edition, Chapman and Hall/CRC.	

Course Code	**BMS4998**
Course Title	**Research Project**
Credit Value	**8**

Pre-requisites	None
Compulsory/Optional	**Compulsory**
Course Content	
The student will conduct sufficient amount of laboratory / fieldwork on a chosen research topic under the guidance provided by an assigned supervisor/s, make a presentation of research findings at a Department/ University/ National/ International conference, and write a complete report.	
Recommended Texts	
• Backwell, J, Martin, J. (2011).A scientific Approach to Scientific Writing, Springer • Guidelines provided by the Department of Zoology.	

10. SUPPLEMENTARY COURSE MODULES

Course Code	Course Title	No. of Credits	Pre-requisites
ECONOMICS			
ECN2013	Introductory Economic Theory	3	
ECN3012	The Sri Lankan Economy	2	ECN2013
MANAGEMENT STUDIES			
MGT2012	Management Studies I	2	
MGT3012	Management Studies II	2	
SCIENCE EDUCATION			
SED2012	Foundations in Science Education	2	
SED2022	Educational Philosophy and Educational Management	2	SED2012
SED3012	Methodology in Teaching Science	2	SED2012
SED3022	Teaching Practice	2	SED2012
SED3032	Assessing Students in the Learning Process	2	SED2012

2000 Level Courses

Course Code	**MGT2012**
Course Title	**Management Studies I**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

Business Organizations and Environment: Why Organization Exists, Vision, Missions, Goals. An introduction to the Type of Businesses. The Business and Its Environment Evolution of Management: Managerial Roles and Skills. Model of effective management

Planning: Plan, Goal Setting, Assess Alternatives, Selecting Best Path, Implementation of Plan

Organizing: Division of Labor, Co-ordination, and Guideline for organizing, Staffing: HR Planning, Job Analysis & Design, Recruitment and Selections, Motivation, Communication, Team Building, Trades Unions, Industrial Relations, Inter-personnel Relations, Conflict Management. Directing: Leadership. Controlling Accounting: Introduction to Financial Statements. Preparation & Analysis of Financial Statements.

Recommended Texts

- Wood, Frank. (2012). Business Accounting, 7th ed., Pitman, London.
- Stephen P. Robbins and Mary Coulter (2018) Management, 14th ed., Pearson Education Limited.
- William J. S. (2018). Operations Management, 13th ed., McGraw Hill/Irwin Series.

Course Code	ECN2013
Course Title	Introduction to Microeconomics
Credit Value	3
Pre-requisites	None
Compulsory/Optional	Optional

Course Content

Microeconomics: Basic economic problem (BEP) faced by the society, modeling the (BEP) using Production possibility frontier, Opportunity concept, Different approaches in solving (BEP): Perfectly competitive market economic approach, Socialist Economic approach, and Mixed Economic approach

Consumer and supplier behavior of the market: Ascertaining the Market demand and supply curves and determining the equilibrium price and quantity of a market, role of market forces. Concept of elasticity, Intervention of the government in the market.

Production economics: importance of efficient utilization of resources, role of technology in production, Theories of diminishing marginal productivity and returns to scale.

Theory of market: different market structures: Competitive, monopoly, monopolistic competition, oligopoly.

Macroeconomics: Modelling an economy using circular flow of income concept, determination of the values of macroeconomic variables, Fiscal policies and monetary policies, Money supply, Balance of payment and determination of exchange rate

Recommended Texts

- N. Gregory Mankiw, (2012), Principles of Economics, 6th Edition South-Western, Cengage Learning.
- William F. Samuelson, and Stephen G. Marks, (2012), 7th Edition, John Wiley & Sons, Inc.
- Paul Samuelson and William Nordhaus , 19th Edition, Paul A Samuelson, William Nordhaus,
- Hal R .Varian, (1992) 3rd Edition, W. W. Norton & Company, Inc

Course Code	SED2012
Course Title	Foundations of Science Education
Credit Value	2
Pre-requisites	None
Compulsory/Optional	Optional

Course Content

Socialization process in classroom and society, Define science education, Science learning in the past and present (globally and Sri Lanka), Goals of science education, Importance of science education, Introduction to child development, Introduction to philosophical aspects of science education, Cultural aspects on science education, Assessing students in the science classrooms (formative and summative assessment), New trends in science education, Science teacher education.

Recommended Texts

- Harlen, W. (2005). Teaching, learning and assessing science 5-12. Sage.
- Taber, K.S. and Akpan, B. eds. (2016). Science education: An international course companion. Springer.

Course Code	**SED2022**
Course Title	**Educational Philosophy and Educational Management**
Credit Value	**2**
Pre-requisites	**SED2012**
Compulsory/Optional	**Optional**
Course Content	
Definition of philosophy, features of philosophy, Branches of philosophy: Metaphysics, epistemology, and axiology, Definition of education, Definition of science education, Interdependence/ nature of philosophy and education, Objectives of studying educational philosophy, Ancient philosophers and their ideas, Western schools of philosophy (idealism, pragmatism, naturalism, realism, existentialism, reconstructivism etc), Eastern schools of philosophy, Contribution of ancient and modern philosophers for the development of science and science education, examples for scientific revolutions . Definition of management, nature and scope of educational management, Features of a good manager, Difference between administration and management, Process of educational management, Planning in educational management, Organizing in educational management, Controlling and staffing, decision making and implementation, Leadership styles and theories of leadership, Educational supervision: nature and types, Qualities of an effective supervisor, Management of Sri Lankan education system, Management of an education system of another selected country, Classroom management techniques	
Recommended Texts	
• Noddings, N. (2018). Philosophy of education. Routledge. • Sindhu, I. H. (2012). Educational administration and management. Pearson Education India.	

3000 Level Courses

Course Code	**MGT3012**
Course Title	**Management Studies II**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Operation Management: The Process, Planning and controlling, scheduling & Loading and Designing, Quality control, Quality Circle. Industrial Engineering: Plat location & layout, Material handling, Work & Method Study, MIS for operation, Equipment Replacement Management. Design Project and Project management Inventory & Ware-House Management. Productivity and 5 S' system Marketing Management: The role of Marketing organization and society. Fundamentals of Marketing. Marketing Mix and Production Mix. Product Life Cycle & Consumer Behavior. Issues in Market Segmentation and Target Market. Corporate Marketing Strategies. Financial Management: Evolution of Financial Management. Goals of FM. Financing, Investing and Dividend Decisions. Capital Budgeting, Working Capital Management, Financing and Financial Institutions Management Quantitative Techniques: Business Mathematics and Decision-Making, Business Forecasting. Project Evaluation, Linear Programming, Quality Control, Inventory model, Network Analysis, Queuing theory, Regression Analysis, Transportation Model.	
Recommended Texts	
• Ross, S. A., Jaffee, J., Jordan, B.D. & Westerfield, R.W., (2019), Corporate Finance, 12th ed., McGraw-Hill- Bosto.	

- Kotler, P. and Armstrong, G. (2016) Principles of Marketing, 16th ed., Pearson.
- Dessler , G., 2014 Human Resource Management, 11th edition. Pearson

Course Code	**ECN3012**
Course Title	**The Sri Lankan Economy**
Credit Value	**2**
Pre-requisites	**ECN2013**
Compulsory/Optional	**Optional**

Course Content

Economic management practices and achievements by first and second generation of countries e.g. Britain and European countries after industrial revolution. Path followed by socialist countries, Russia and China since 1910s. Economic management practices of New Nation Countries evolved after 1940s. (1) Newly Industrialized countries (2) Emerging Market Nations, (3) other developing countries. Changes in economics after British in Sri Lanka. Initial conditions at the time of independence of Sri Lanka. Agricultural development prospects and issues. Industrial development prospects and issues. Service sector development prospects and issues. Future growth path, Balance of payment problems, savings- investment gap, role of Foreign Direct Investment in economic development.
Usefulness of Bilateral and Multilateral agreements for economic development.

Recommended Texts

- Central Bank Annual Reports of recent years.
- Survey Reports and statistical newsletters of Department of Census and statistics Ministry of finance,
  economic and policy development.in Sri Lanka.
- Reports published by the Center for Poverty Analysis (CIPA).
- Lakshman, W. D. and Tisdell, Clement A. (2000). Sri Lanka's development since independence: socio-economic perspectives and analyses, UK Edition. NOVA, Science Publishers, inc, SBN-13: 978-1560727842.
- Lakshman, W. D. (Eds) (1997). Dilemmas of Development Fifty Years of Economic Changes in Sri Lanka, Sri Lanka Association of Economists, Colombo.
- Senanayake, S. M. P., Wimalaratana, W. and de Silva, Amala (2008). Development Perspectives, Growth and Equity in Sri Lanka, Department of Economics, University of Colombo.

Course Code	**SED3012**
Course Title	**Teaching Methods in Science**
Credit Value	**2**
Pre-requisites	**SED2012**
Compulsory/Optional	**Optional**

Course Content

Science as a school subject (nature of science, science as a process, science as a product, importance and values of science), Aims and objectives of teaching science (taxonomy of educational objectives and writing teaching objectives), Instructional planning in science teaching (need for instructional planning, types of instructional planning, steps in instructional planning), Methods of teaching science (selecting appropriate method, methods of teaching), Teaching aids in science (need and importance of teaching aids, types of teaching aids, Dale’s cone of experience, effective use of teaching aids), Unit planning and lesson planning, Science laboratory (importance of a science laboratory, features of a good laboratory, ideal science laboratory designs, maintenance of records, guidelines for teachers, Laboratory discipline, common accidents (burning, cuts, eye injuries, inhalation of toxic gases and their remedies)), Meaningful learning in science education,

Introduction to STEM education, Problem based learning, corporative learning and collaborative learning in science education.
Recommended Texts
• Barry, K., and King, L. (1993). Beginning teaching: A developmental text for effective teaching. Social Science Press. • Nilson, L. B. (2016). Teaching at its best: A research-based resource for college instructors. John Wiley & Sons. • Sale, D. (2015). Creative teaching: An evidence-based approach. Springer. • Zhai, J. (2015). Teaching Science in out-of-School Settings. New York: Springer, 10, 978-981.

Course Code	**SED3022**
Course Title	**Teaching Practice**
Credit Value	**2**
Pre-requisites	**SED2012**
Compulsory/Optional	**Optional**
Course Content	
Planning lessons (at least 30) to teach a selected unit(s) in Grade 6 to 10 science/ mathematics syllabus and implement those lesson plans in classroom teaching.	
Recommended Texts	
• Barry, K., and King, L. (1993). Beginning teaching: A developmental text for effective teaching. Social Science Press. • Harlen, W. (2005). Teaching, learning and assessing science 5-12. Sage. • Zhai, J. (2015). Teaching Science in out-of-School Settings. New York: Springer, 10, 978-981.	

Course Code	**SED3032**
Course Title	**Assessing Students in the Learning Process**
Credit Value	**2**
Pre-requisites	**SED2012**
Compulsory/Optional	**Optional**
Course Content	
Assessment, scoring and evaluation, Need and the purpose of evaluation, Scales of measurement (nominal, ordinal, interval and ratio), Measures of central tendency (mean, median and mode), Frequency distribution, nominal and skewed distribution, Taxonomy of educational objectives in cognitive, affective and psychomotor domains, Different types of assessments, features and development of multiple choice, structured essay and essay questions, Ongoing assessment and assessing practical, School based assessments (SBA), Qualities of measuring instruments (validity, reliability and practicality), Steps of constructing tests (planning tests, framing questions, administering tests and scoring)	
Recommended Texts	
• Barry, K., and King, L. (1993). Beginning teaching: A developmental text for effective teaching. Social Science Press. • Harlen, W. (2005). Teaching, learning and assessing science 5-12. Sage.	

11. STATISTICS & OPERATIONS RESEARCH COURSE MODULES

1000 LEVEL – STATISTICS AND OPERATIONS RESEARCH				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
CSC1013	Introduction to Computer Science and Programming	3	CSC1002	√
CSC1023	Object-Oriented Programming	3	CSC1013	√
CSC1041	Programming Laboratory I	1	CSC1013	√
CSC1051	Programming Laboratory II	1	CSC1023, CSC1041	√
MAT1023	Real Analysis I	3		√
MAT1073	Mathematics for Operations Research	3		√
MAT1083	Mathematical Programming	3		√
MAT1092	Introduction to Mathematical Computing	2		√
STA1013	Introduction to Statistics	3		√
STA1023	Introduction to Probability Theory	3		√
STA1031	Statistics Applications I	1	STA1013	√
STA1041	Statistics Applications II	1	STA1031	√
Total		**27**		**27**

2000 LEVEL – STATISTICS AND OPERATIONS RESEARCH				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
CSC2012	Data Structures	2	CSC1023	√
CSC2021	Programming using Data Structures	1	CSC1051, CSC2012	√
CSC2032	Database Management Systems	2	CSC1023	√
CSC2041	Programming using Database Management Systems	1	CSC2032	√
MAT2023	Real Analysis II	3	MAT1023	√
MAT2043	Mathematical Methods	3	MAT1073	
MAT2072	Numerical Analysis I	2		√
MAT2092	Graph Theory	2		
MAT2113	Advanced Mathematical Programming	3	MAT1083	√
MAT2123	Operations Research I	3	MAT1083	√
MAT2132	Convex Analysis	2	MAT2023	√
STA2013	Probability Theory	3	STA1023	√
STA2033	Theory of Statistics	3	STA2013	√
STA2042	Sampling Techniques	2	STA2013	√
STA2102	Statistical Quality Control	2	STA2033	
Total		**34**		**27**

3000 LEVEL – STATISTICS AND OPERATIONS RESEARCH				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
CSC3152	Design and Analysis of Algorithms	2	CSC2012	
CSC3173	Artificial Intelligence	3	CSC2012, CSC3152	
MAT3023	Real Analysis III	3	MAT2023	
MAT3032	Partial Differential Equations	2	MAT1073/ MAT1032	
MAT3073	Numerical Analysis II	3	MAT2082	
MAT3103	Linear Algebra	3	MAT1073	√
MAT3143	Network Optimization Theory	3	MAT2113	√
MAT3152	Operations Research II	2	MAT1083, MAT3143	√
MAT3163	Nonlinear Programming	3	MAT2113	√
MAT3991	Seminar	1		√
HRM3013	Human Resource Management	3		
STA3013	Regression Analysis	3	STA2033	√
STA3033	Design and Analysis of Experiments	3	STA2033	√
STA3052	Multivariate Methods I	2	STA1031, STA2033	√
STA3072	Time Series Analysis	2	STA2033	
STA3093	Non-Parametric & Categorical Data Analysis	3	STA2033	√
STA3113	Statistical Simulation	3		
Total		**44**		**23**

4000 LEVEL – STATISTICS AND OPERATIONS RESEARCH				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
CSC4093	Neural Networks and Deep Learning	3	CSC3173	
MAT4023	Measure Theory	3	MAT3023	
MAT4083	Financial Mathematics	3		√
MAT4112	Selected Topics in Applied Operations Research	2	MAT3152, MAT3163	√
MAT4123	Optimization for Engineering Design	3	MAT3152, MAT3163	√
MAT4132	Optimization Modeling	2	MAT3152, MAT3163	√
MAT4006	Project Work/Industrial Training	6		√
STA4012	Actuarial Statistics	2	STA2033	
STA4023	Statistical Data Mining	3	STA3052	√
STA4033	Statistics for Bioinformatics	3	STA3093	
STA4043	Stochastic Processes	3	STA2033	√
STA4053	Multivariate Methods II	3	STA3052	
STA4063	Bayesian Statistics	3	STA2033	
Total		**39**		**22**

1000 Level Courses

Course Code	**CSC1002**
Course Title	**Computer Applications**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory (Foundation Course)**

Course Content

History of Computing: Major milestones of history of computing, Hardware and software evolution.

Main Components of Computer Systems: Computational / Commanding units, Memory hierarchies, Input / Output devices and storage devices.

Data Security: Data security methods, Computer viruses and prevention.

Ethics in ICT: Ethics and best practices of email composing, Social and professional media.

Data Synchronization: Data backup and data synchronization among multiple devices.

Microcomputer applications: Word processing, Spreadsheet processing and electronic presentations.

Recommended Texts

- Wempen, F. (2014). Computing Fundamentals: Introduction to Computers, 1st Ed, Willey.
- Abid, M. and Amjad, M. (2015). Fundamentals of Computers. 1st Ed, I K

Course Code	**CSC1013**
Course Title	**Introduction to Computer Science and Programming**
Credit Value	**3**
Pre-requisites	**CSC1002**
Compulsory/Optional	**Compulsory**

Course Content

Basic Concepts in Computer Science: Abstraction, Encapsulation, Algorithms, Programming, Data Structures, Resource Management, Security, Software Engineering, Web Development, Application areas.

Data Representation and Basic Computer Architecture: Data representation methods, Number systems, Combinational logic and digital systems.

Introduction to Algorithms: The concept and properties of algorithms, Program decomposition, Simple algorithms.

Fundamentals of Programming: Basic syntax and semantics of a higher-level language, Managing data (variables and primitive data types), Expressions and assignments, Declarations, Basic input and output, Built-in, user-defined and recursive functions, Error handling and File handling.

Recommended Texts

- Kernighan, B. and Ritchie, D. (1988). *The C Programming Language.* 2nd Ed, Prentice Hall.
- Guttag, J. V. (2016). *Introduction to Computation and Programming Using Python: With Application to Understanding Data*. 2nd Ed, MIT Press.
- Tremblay, J.P. and Bunt, R.B. (1988). *An Introduction to Computer Science: An Algorithmic Approach*. 2nd Ed, McGraw-Hill College.

Course Code	**CSC1023**
Course Title	**Object-Oriented Programming**
Credit Value	**3**
Pre-requisites	**CSC1013**
Compulsory/Optional	**Compulsory**

Course Content

Program execution cycle, Compilation and interpretation, Data types, Variables and literals, Flow control structures, Functions, Object oriented concepts, Classes and interfaces, Exception handling, Built-in data structures, Input/output handling, File handling, Optimizing problem execution.

Recommended Texts

- Wu, C. T. (2009). *An Introduction to Object-Oriented Programming with Java.* 5th Ed, McGraw-Hill Education.
- Litvin, M. and Litvin, G. (2015). *Java Methods: Object-Oriented Programming and Data Structures*. 3rd Ed, Skylight Publishing.

Course Code	**CSC1041**
Course Title	**Programming Laboratory I**
Credit Value	**1**
Pre-requisites	**CSC1013**
Compulsory/Optional	**Compulsory**

Course Content

Programming assignments will be given covering the following concepts.

Language Constructs: Data types, Data declarations, Flow-control, Input / Output, Files, Subprograms / Functions, Basic data structures, Integrated development environments.

Design and implementation of simple programs: Top-down and bottom-up design, Decomposition, Structuring, Design for reuse, Documentation.

Recommended Texts

- Kochan, S.G. (2014). *Programming in C*. 4th Ed, Addison-Wesley
- Kernighan, B. and Ritchie, D. (1988). *The C Programming Language*. 2nd Ed, Prentice Hall.
- Lutz, M. (2018). *Learning Python*. 5th Ed, O'Reilly Media, Inc.

Course Code	**CSC1051**
Course Title	**Programming Laboratory II**
Credit Value	**1**
Pre-requisites	**CSC1023, CSC1041**
Compulsory/Optional	**Compulsory**

Course Content

Programming assignments will be given covering the following concepts.

Object-oriented language constructs: Abstraction, Encapsulation, Inheritance, Aggregation, Composition and

polymorphism, Classes, Objects, Interfaces, Packages, Input / Output handling, File handling, Exception handling, Built-in data structures.
Recommended Texts
• Wu, C. T. (2009). *An Introduction to Object-Oriented Programming with Java*. 5th Ed, McGraw-Hill Education.   • Litvin, M. and Litvin, G. (2015). *Java Methods: Object-Oriented Programming and Data Structures*. 3rd Ed, Skylight Publishing

Course Code	**MAT1023**
Course Title	**Real Analysis I**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Elements of logic and set theory: Sentential and quantificational logic, Truth tables, Deductive reasoning and logical connectives, Proofs involving negation and conditionals/quantifiers/conjunction and biconditionals/disjunction, Existence and uniqueness proofs, Proof by mathematical induction, Proof by the method of contradiction, Finite and infinite sets, Cardinality of a set. **The real number system:** Real number system as a complete ordered field, Complex number system, Neighborhoods. **Sequences and limits:** Definition of convergence, Limit theorems, Monotonic sequences, Monotone convergence theorem, Algebra of limits. **Limits and continuity of real valued functions:** Limit of a function, Algebra of limits, Continuity of a function, Properties of continuous functions, Sequential criterion for limits and continuity, Intermediate value theorem and extreme value theorem. **Differentiability of real valued functions:** The definition of the derivative, Algebra of derivatives, Product and quotient rules, Rolle's theorem, Mean-value theorem and its applications, L'Hospital's rule, Applications of the derivative.	
Recommended Texts	
• R. G. Bartle and D. R. Sherbert (2011), *Introduction to Real Analysis*, 4th Ed, New York: Wiley. • S. R. Lay (2013), *Analysis: With an Introduction to Proof*, 5th Ed, Pearson Education.	

Course Code	**MAT1073**
Course Title	**Mathematics for Operations Research**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Vector methods: Introduction to vectors, Linear combinations, Linear dependence and independence, Bases and dimension, Scalar product, Vector product.	

Linear Algebra: Preliminaries, Determinants, Simultaneous linear equations, Eigenvalues and eigenvectors, Matrix calculations, Special matrices, Range and null space, Decomposition of matrices, Quadratic forms. **Differential equations:** First order ordinary differential equations, Initial value problems, Exact equations, Higher order linear ordinary differential equations with constant coefficients, Differentiation of scalar functions of matrices.
Recommended Texts
• C.E. Weatherburn,(1982), *Elementary Vector Analysis*, 1st Ed, G. Bell Sons Ltd. • D.G. Zill, (2013), *A First Course in Differential Equations with Modeling Applications*, 10th Ed, Books/Cole, Cengage Learning • K. Hoffman and R. Kunze, (1999), *Linear Algebra*, 2nd Ed, Prentice-Hall, Inc.

Course Code	**MAT1083**
Course Title	**Mathematical Programming**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction: Introduction to operations research, Operations research models (Probabilistic and Deterministic). **Convex analysis:** Convex combinations, Convex sets, Extreme points of a convex set, Convex polyhedron, Hyper planes, Half-spaces and polytopes, Convex functions. **Linear programming (LP):** Mathematical formulation of the LP problem, LP in two-dimensional space, Graphical solution methods, General LP problem. **Simplex method:** Simplex algorithm, Two-phase simplex algorithm, Revised simplex algorithm, LP problems with unrestricted variables, LP problems with bounded variables. **Duality in LP:** Duality in LP problems, Duality theorems, Applications of duality, Dual simplex algorithm. **Computer Practical**: Introduction to LINGO optimization software and Excel Solver in problem solving.	
Recommended Texts	
• G. B. Dantzig and M. N. Thapa (1997), *Linear Programming: Introduction*, 1st Ed, Springer-Verlag New York. • Frederick S. Hillier and Gerald J. Liberman (2001), *Introduction to Operations Research,* 7th Ed, The McGraw-Hill Companies, Inc. • Mokhtar S. Bazaraa, John J. Jarvis, Hanif D. Sherali (2010), *Linear Programming and Network Flows*, 4th Ed, A John Wiley & Sons, Inc.	

Course Code	**MAT1092**
Course Title	**Introduction to Mathematical Computing**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	

Introduction: Computational Mathematics and Symbolic Mathematics, Fundamental programming techniques including scripts, loops, conditional statements, logical operators, in-built functions. **Programming techniques for Linear Algebra and Basic Calculus:** Solving systems of linear and non-linear equations, Performing matrix algebra, Sketching and interpreting 2D and 3D graphs, Finding derivatives of mathematical functions ad interpreting graphically, Integrating mathematical functions, Finding maxima and minima of curves, Solving differential equations and interpreting the solutions graphically. **Programming techniques to solve mathematical models:** Using in-built functions to solve mathematical models and writing computer programs to solve mathematical models.
Recommended Texts
• Jaan Kiusalaas (2010). *Numerical Methods in Engineering with Python*, 2nd Ed, Cambridge University Press. • Kent D. Lee (2011). *Python Programming Fundamentals*, 1st Ed, Springer. • Stephan Wolfram (2003), *The Mathematica Book*, 4th Ed, Wolfram Media, Inc. • Rao V. Dukkipati (2010), *MATLAB An Introduction with Applications*, 1st Ed., New Age International (P) Ltd., Publishers.

Course Code	**STA1013**
Course Title	**Introduction to Statistics**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Basic ideas in Statistics: Fundamental elements of statistics, Sources of data, Methods of collecting data, Data types. Measures of Location: Various Means (AM, GM, HM, TM), Median, Mode, Quantiles, Deciles, Percentiles. **Measures of Dispersion**: Range, Interquartile range, Variance, Standard deviation, Chebyshev's rule for sample, Coefficient of variance, Moments of higher order, Skewness, Kurtosis. **Representation of data**: Histograms, Box plots, Bar charts, Pie charts, Scatter plots, Stem-Leaf diagrams, Contingency tables. **Regression and Correlation**: Scatter diagrams, Linear regression, Method of least squares, Correlation, Coefficient of correlation, Rank correlation, Spearman's rank correlation coefficient. **Index numbers**: Introduction, Price Relatives, Quantity Relatives and Value Relatives, Link and Chain Relatives, Cost of living Index Numbers, Methods of construction of Index Numbers, Quantity Index Numbers, Tests for Index numbers.	
Recommended Texts	
• Freedman, D., Pisani, R. and Purves, R. (2007). *Statistics*. 4th Ed, Norton, W. W. & Company, Inc. • Johnson, R. A. and Bhattacharyya, G. K. (2014). *Statistics: Principles and Methods*, 7th Ed, John Wiley & Sons.	

Course Code	**STA1023**
Course Title	**Introduction to Probability Theory**
Credit Value	**3**
Pre-requisites	**None**

Compulsory/Optional	**Compulsory**
Course Content	
Counting Techniques: Combinations, Permutations, Set partitions. Elements of Probability: Experiments, Events, Sample space, Laws of Probability, Bayes' Theorem, Independence of events. **Random variables**: Discrete and continuous random variables, Probability mass function, Probability density function, Cumulative distribution function, Functions of a random variable, Expectation, Moments, Mean and variance, Moment Generating function. **Probability inequalities**: Chebyshev's and Markov's etc. **Distributions: Discrete**: Uniform, Bernoulli & Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Multinomial. **Continuous**: Uniform, Normal, Gamma, Exponential. Properties and applications of distributions, Probability Generating functions. Approximation to Binomial using Poisson, Binomial using Normal, and Poisson using Normal.	
Recommended Texts	
• Ross, S.M. (2013). *A First Course in* Probability, 9th Ed., Pearson Education. • Hogg, R.V. (2013). *Introduction to Mathematical Statistics*, 7th Ed, Pearson India.	

Course Code	**STA1031**
Course Title	**Statistics Applications I**
Credit Value	**1**
Pre-requisites	**STA1013**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction to Programming, **Presentation of the Software**: Installation and update packages, Graphical User Interfaces, Integrated Development environment, Documenting scripts, Commenting and Sharing the code, Errors and warnings. **Basic concepts and Data organization**: Data types and Data structures, Importing / Exporting/Producing data, Flow control structures, Reproducible research, Data pre-processing, Drawing curves and plots, Basic descriptive statistics, Simple linear regression and correlation. All the concepts are demonstrated using R software.	
Recommended Texts	
• de Micheaux, P.L., Drouilhet, R. and Liquet, B. (2014). *The R Software: Fundamentals of Programming and Statistical Analysis*, 1st Ed, Springer. • Matloff , N. (2011). *The Art of R Programming: A Tour of Statistical Software Design*, 1st Ed, No Starch Press.	

Course Code	**STA1041**
Course Title	**Statistics Applications II**
Credit Value	**1**
Pre-requisites	**STA1031**
Compulsory/Optional	**Compulsory**
Course Content	

Basic concept of a function, Declaring / Creating and calling functions, Debugging functions, attributes, Fine tuning the data visualizations, Matrix operations, Numerical differentiation and integration, Basic optimization, Density function, Distribution function, Quantile function and generation of random data, Simple random sampling, Comparing the population and the sample, Managing sessions, Creating simple packages. All the concepts are demonstrated using R software.
Recommended Texts
• de Micheaux, P.L., Drouilhet, R. and Liquet, B. (2014). *The R Software: Fundamentals of Programming and Statistical Analysis,* 1st Ed, Springer. • Matloff, N (2011). *The Art of R Programming: A Tour of Statistical Software Design,* 1st Ed., No Starch Press.

2000 Level Courses

Course Code	**CSC2012**
Course Title	**Data Structures**
Credit Value	**2**
Pre-requisites	**CSC1023**
Compulsory/Optional	**Compulsory**
Course Content	
Linear data structures: Arrays, Lists (Linked Lists, Ordered Linked Lists, Doubly Linked Lists), Pushdown stacks, Queues. **Nonlinear data structures**: General tree structures and binary trees, Graphs and their applications, Hashing. **Operations for data structures** (Insertion, Deletion, Modification, Search). **Applications of data structures**.	
Recommended Texts	
• Shaffer, C.A (2010). *A Practical Introduction to Data Structures and Algorithm* Analysis *(C++ Version)*, 3rd Ed, Prentice Hall. • Sedgwick, R. (1998). *Algorithms in C*, 3rd Ed, Addison-Wesley Professional. • Lafore, R. (2002). *Data Structures and Algorithms in Java*, 2nd Ed, Sams Publishing.	

Course Code	**CSC2021**
Course Title	**Programming using Data Structures**
Credit Value	**1**
Pre-requisites	**CSC1051, CSC2012**
Compulsory/Optional	**Compulsory**
Course Content	
Implementations and applications of Lists, Stacks, Queues, Trees, Graphs and Hashing.	
Recommended Texts	
• Shaffer, C.A (2010). *A Practical Introduction to Data Structures and Algorithm* Analysis *(C++ Version),* 3rd Ed, Prentice Hall. • Sedgwick, R. (1998). *Algorithms in C*, 3rd Ed, Addison-Wesley Professional. • Lafore, R. (2002). *Data Structures and Algorithms in Java*, 2nd Ed, Sams Publishing.	

Course Code	**CSC2032**
Course Title	**Database Management Systems**
Credit Value	**2**
Pre-requisites	**CSC1023**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to databases and database management systems (DBMS),

Conceptual Modeling: Entities, attributes, associations, functional determination, 3-level structure, graphical representation.

Relational Databases: Relational algebra, Relational databases and tables, Query languages. The entity-relationship model, Logical organization of databases, Functional dependencies and normal forms,

Physical Organization of Databases: Characteristics of disks and disk blocks, Storage of relations, Introduction to Query processing,

Concurrency control: Transactions, Serializability, Locking, Recovery, Introduction to other types of DBMSs.

Recommended Texts

- Elmasri, R. and Navathe, S.B. (2010). *Fundamentals of Database Systems*, 6th Ed, Pearson.
- Date, C.J. (2003). *An Introduction to Database Systems*, 8th Ed, Pearson.

Course Code	**CSC2041**
Course Title	**Programming using Database Management Systems**
Credit Value	**1**
Pre-requisites	**CSC2032**
Compulsory/Optional	**Compulsory**

Course Content

Overview of Database Management Systems (DBMS), SQL (Data definition, Query formulation, Constraints, Integrity, Selections, Projections, Select-project-join, Aggregates and group-by, Subqueries), Transactions, Stored procedures, Backup and recovery, User privileges, Connecting databases using programming languages.

Recommended Texts

- DuBois, P. (2013). *MySQL*, 5th Ed, Addison-Wesley Professional.

Course Code	**MAT2023**
Course Title	**Real Analysis II**
Credit Value	**3**
Pre-requisites	**MAT1023**
Compulsory/Optional	**Compulsory**

Course Content

Cauchy sequences: Cauchy sequences and their properties, Cauchy convergence criterion.

Series: Tests for convergence, Absolute and conditional convergence.

Power series: Radius and interval of convergence of a power series, Integration and differentiation of power

series, Taylor and Maclaurin series, Power series representation of functions. **Uniform continuity:** Definition, Comparison with continuity, Conditions for uniform continuity. **Riemann Integrals:** Upper and lower Riemann integrals, Riemann integrable functions, Basic properties of the Riemann integral, Fundamental theorem of calculus, Improper integrals.
Recommended Texts
• T. M. Apostol (1974), *Mathematical Analysis*, 2^{nd} Ed, Addison-Wesley. • S. R. Lay (2013), *Analysis an Introduction to Proof*, 5^{th} Ed, Prentice-Hall.

Course Code	**MAT2043**
Course Title	**Mathematical Methods**
Credit Value	**3**
Pre-requisites	**MAT1073**
Compulsory/Optional	**Optional**
Course Content	
Differentiation of Vectors: Scalar and vector point functions and their partial derivatives with respect to coordinate variables, **Gradient of a scalar point function**: Directional derivative, Divergence and curl of a vector point function. **Integration of Vectors:** Line integrals and their evaluation using parametric representation, surface integrals, Green's theorem in the plane Stokes theorem, Circulation and flux of a vector point function, Volume integrals, Divergence Theorem, Irrotational and solenoidal vector fields, Orthogonal curvilinear coordinates, Grad, Div, Curl in OCC, Cylindrical polar and Spherical coordinate systems, use of these coordinate systems in evaluation of surface and volume integrals. **Special Solution of Laplace Equation:** Solutions in two-dimensions, Axi-symmetric solutions. **Laplace transforms:** Elementary properties, Inverse Laplace transform and its properties, Convolution theorem and its use in evaluation of integrals, Uses of special functions connected with Laplace transform, Evaluation of integrals using Laplace transform, Applications in ODE and integro-differential equations, Applications in PDE, **Fourier Transforms:** Infinite-Fourier sine/cosine transforms and their inverse formulae, Finite-Fourier sine/cosine transforms, Derivation of inverse formulae, Use of Fourier series, Boundary value problems-use of Fourier transforms.	
Recommended Texts	
• S. Hassani (2000), *Mathematical Methods: For Students of Physics and Related Fields*, 1^{st} Ed, Springer Science & Business Media. • M.D. Raisinghania (1995), *Integral Transforms*, 2^{nd} Ed, S. Chand & Comp. Ltd. • M.R. Spiegel (1968), *Vector Analysis*, McGraw-Hill	

Course Code	**MAT2082**
Course Title	**Numerical Analysis I**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Difference equations: Solutions to the homogenous and non homogenous difference linear equations. **Solutions of equations in one variable**: Bisection method, Fixed-point iteration, Newton-Raphson method,	

Error analysis for iterative methods. **Interpolation and Polynomial Approximation**: Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation, Divided differences, Hermite interpolation, Cubic spline interpolation. **Numerical Differentiation and Integration**: Numerical differentiation, Richardson's extrapolation, Elements of numerical integration.
Recommended Texts
• K. E. Atkinson (2008), *An introduction to numerical analysis*, 2nd Ed, Wiley India Pvt. Limited. • R. L. Burden and J. D. Faires (2011). *Numerical Analysis*, 9th Ed, Brooks/Cole.

Course Code	**MAT2092**
Course Title	**Graph Theory**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction to Graph Theory: Isomorphism of graphs, matrix representation of graphs, types of graphs. **Eulerian and Hamiltonian graphs:** Shortest path problem, Chinese postman problem, travelling salesman problem. **Trees**: Tree sorting, spanning trees, minimum weighted spanning tree. **Planar Graphs**: Planar representations of graphs, dual graphs. **Graph Coloring:** Vertex coloring, edge coloring, map coloring, time table scheduling, four- color Theorem. **Network Flows:** Directed graphs, Hall's theorem, transversal theory, maximum and minimum cut theorem.	
Recommended Texts	
• F. Harary (2001), Graph Theory, Narosa Publishing House. • R. J. Wilson (1996), Introduction to Graph Theory, 4th Ed, Addison-Wesley Longman.	

Course Code	**MAT2113**
Course Title	**Advanced Mathematical Programming**
Credit Value	**3**
Pre-requisites	**MAT1083**
Compulsory/Optional	**Compulsory**
Course Content	
Advanced Linear Programming: Dantzig-Wolf decomposition algorithm, Goal programming. Multi-objective Linear Programming. **Special Types of LP Problems**: Transportation Problem, Assignment Problem **Integer Programming:** Models formulation, Cutting plane algorithms (Dual Fractional Integer Programming, Dual Fractional Mixed Integer Programming), Branch and bound algorithms (Land & Doig Method and Dakin's Method), Search enumeration. **Computer Practical:** Introduction to IMPL optimization software and Excel Solver to solve optimization models.	
Recommended Texts	

- Mokhtar S. BazaraaL, John J. Jarvis, Hanif D. Sherali (2010), *Linear Programming and Network Flows*, 4th Ed, A John Wiley & Sons, Inc.
- H. A. Taha. (1975), *Integer programming, Theory, Applications and Computations*, 1st Ed, J. William Schmidt Imprint: Academic Press.
- Mokhtar S. Bazaraa, Hanif D. Sherali, C.M. Shetty (2006), Nonl*inear Programming*; *Theory and Algorithms,* 3rd Ed, A John Wiley & Sons, Inc.

Course Code	**MAT2123**
Course Title	**Operations Research I**
Credit Value	**3**
Pre-requisites	**MAT1083**
Compulsory/Optional	**Compulsory**

Course Content

Theory of games: Zero-Sum games, Games without Saddle Points-Mixed strategies, Graphical solution of $2\times n$ and $m\times 2$ games, Dominance property, Reducing the game problem to a LP problem.

Queuing theory: Introduction, Queuing system, Characteristics of Queuing systems, Poisson process and Exponential distribution,

Poisson queues: M/M/I Queuing Systems and M/M/C Queuing Systems with finite and infinite capacities.

Inventory management: Introduction, Economic order quantity (EOQ), Problem of EOQ with shortage, Multi-item deterministic problem.

Recommended Texts

- Hamdy A. Taha(2007), Operations Research: An Introduction, 8th Ed, Pearson, Prentice Hall
- Waune L. Winston (2003), Operations Research, Applications and Algorithms, 4th Ed, Thomson Learning, Inc.

Course Code	**MAT2132**
Course Title	**Convex Analysis**
Credit Value	**2**
Pre-requisites	**MAT2023**
Compulsory/Optional	**Compulsory**

Course Content

The basic concepts: Convex sets, Cones and polyhedral, Affine sets, Convex hulls and Carathéodory's theorem.

Projection and separation: Projection operator, Separation of convex sets.

Representation of convex sets: Faces of convex sets, Recession cone, Inner representation and Minkowski’s theorem, Polytopes and polyhedral.

Convex functions: Convex functions of several variables, Continuity and differentiability.

Recommended Texts

- R. Tyrell Rockafeller (1970), *Convex Analysis*, 1st Ed, Princeton University Press.
- Stephen Boyd, Lieven Leven Vandenberghe (2009), *Convex Optimization*, 1st Ed, Cambridge University Press.

Course Code	**STA2013**
Course Title	**Probability Theory**
Credit Value	**3**
Pre-requisites	**STA1023**
Compulsory/Optional	**Compulsory**

Course Content

Joint distribution of two or more discrete or continuous random variables, Marginal distributions, Conditional distribution, Independence of random variables, Expectation, Conditional expectation, Covariance, Correlation coefficient, Transformations involving two or more random variables, Probability density functions of sum, Difference, Product and quotient of two random variables, Random samples, Empirical distributions, Order statistics, Distribution of minimum and maximum,

Distribution of Sample Mean and Sample Variance: t, F and $\chi2$ distributions and their properties, Laws of large numbers, Central limit theorem.

Recommended Texts

- Canavos, G.C. (1984). *Applied Probability and Statistical methods,* 1^{st} Ed, Little, Brown and Company.
- Freund, J.E. (1994). *Mathematical Statistics,* 5^{th} Ed, Prentice Hall.
- Wackerly, D., Mendenhall, W. and Scheaffer, R.L. (1995). *Mathematical Statistics with Applications,* 7^{th} Ed, Thomson Brooks/Cole.

Course Code	**STA2033**
Course Title	**Theory of Statistics**
Credit Value	**3**
Pre-requisites	**STA2013**
Compulsory/Optional	**Compulsory**

Course Content

Point estimation, **Properties of Estimators**: Unbiasedness, Consistency, Relative efficiency, Efficiency, Sufficiency, Factorization theorem, Rao-Blackwell theorem, UMVUE, Exponential families, Cramer-Rao inequality,

Methods of Obtaining Estimators: Method of moments, Maximum likelihood estimators etc.

Interval Estimation: Constructing confidence intervals for population parameters under various assumptions.

Hypothesis Testing: Tests on population parameters, Tests on independent and paired samples, Neyman-Pearson lemma, Uniformly most powerful tests, Likelihood ratio tests.

Recommended Texts

- Casella, G. and Berger, R. (2002). *Statistical Inference*, 2^{nd} Ed, Duxbury *Press.*
- Freund, J.E. (1994). *Mathematical Statistics*. Prentice Hall.

Course Code	**STA2042**
Course Title	**Sampling Techniques**
Credit Value	**2**
Pre-requisites	**STA2013**
Compulsory/Optional	**Compulsory**

Course Content

Introduction: Population, Sample, Sampling frame, Census, Surveys, Advantages and disadvantages of sampling, Principle steps in sample survey, Data collection method, Questionnaire design, **Simple Random Sampling**: With replacement and without replacement, Ordered and unordered. Random number tables and random number generators, **Simple Random Sampling**: Estimations of population mean, Total, Proportion, and ratio, Variance of the estimators, Confidence limits, and Determination of sample size. **Stratified Random Sampling**: Estimation of population mean, Variance of the estimators, Determination of sample size based on equal allocation, Proportion allocation, Neyman allocation, Cost and variability of the strata, Bowley's allocation. Relative Precision of simple random sampling, Proportional allocation & optimum allocation, **Cluster Sampling**: Sample mean and sample variance, Efficiency of cluster sampling vs. simple random sampling. Ratio Estimators, Sub Sampling, Multi Stage Sampling, Double sampling, Capture Mark Recapture Method, Systematic Sampling, Regression Estimates, Bias and Mean Square Error of Ratio Estimators. Some practical assignments will be given for this course.
Recommended Texts
• Cochran, W.G. (1977). *Sampling Techniques,* 3rd Ed, John Wiley & Sons. • Scheaffer, R.L., Mendenhall, W., Ott, R.L. and Gerow, K.G. (2011). *Elementary Survey Sampling*, 7th Ed, Cengage Learning.

Course Code	**STA2102**
Course Title	**Statistical Quality Control**
Credit Value	**2**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Introduction: Classical and modern definition, Dimensions of quality, Quality characteristics, Specification limits, Chance and assignable variations, Non-confirming and defects. **Statistical Process Control**: Magnificent seven, Control charts, Control limits, Choice of control limits and interpretation of control charts. Natural Tolerance Limits, **Types of Errors**: Consumer's risk and producer's risk. Decision rules for detecting non-random Patterns, **Variable Control Charts**: Mean, Range and standard deviation. Control Charts for Variable Sample Size, Trial Control Limits, Tolerance Diagram, Process Capability, Process Capability indices, Evaluating Two Types of Risk, Effect of Sample Size on Ability to Detect Process Shifts, Average Run Length, and Average Time to Signal. **Control Charts for Attribute Data**: P-charts, C-charts, U-charts. **OC-Curves**: Single sampling and multiple sampling plan, Acceptance number, Acceptable quality level and lot-tolerance percent defectives. Overview of Six-Sigma concept.	
Recommended Texts	
• D.C. Montgomery, (2008). *Introduction to Statistical Quality Control,* 6th Ed, John Willey and Sons. • Hansen, B.L. and Ghare, P.M. (1987). *Quality Control and Application,* 1st Ed, Prentice Hall.	

3000 Level Courses

Course Code	**CSC3152**
Course Title	**Design and Analysis of Algorithms**
Credit Value	**2**
Pre-requisites	**CSC2012**
Compulsory/Optional	**Compulsory**

Course Content

Analysis of algorithms: Time complexity, Big-O notation, Complexity classes; Sorting algorithms and their analysis: Insertion sort, Bubble sort, Selection sort, Quick sort, Heap sort, Merge sort,

Algorithm Design Paradigms: Divide and Conquer, Dynamic Programming, Greedy algorithms.

Algorithms by field of study: Graph algorithms, Searching algorithms, Optimization algorithms.

NP-completeness: Polynomial time, NP-completeness and reducibility, NP-complete problems.

Practical assignments will be given for this course.

Recommended Texts

- Cormen,T.H. ,Leiserson, C.E., Rivest, R.L. and Stein, C. (2009) , *Introduction to Algorithms*, 3rd Ed. The MIT Press.

Course Code	**CSC3173**
Course Title	**Artificial Intelligence**
Credit Value	**3**
Pre-requisites	**CSC2012, CSC3152**
Compulsory/Optional	**Optional**

Course Content

Overview of Artificial Intelligence (AI): Modern AI, General AI, Agents and environments, Application of AI in various fields.

Problem Solving: Problem spaces, Classical search, Local search, Adversarial search, Constraint satisfaction, Genetic algorithms.

Knowledge Representation and Reasoning: First-order logic, Resolution theorem proving, Fuzzy logic and Fuzzy inference systems, Ontologies. Introduction to Machine Learning**:** Supervised and unsupervised learning, Inductive learning, Naive Bayes, Decision trees, SVM, Neural networks, Clustering**.**

Reasoning Under Uncertainty: Probabilistic reasoning, Introduction to decision theory.

Programming in AI: Logic programming and Modern AI programming frameworks

Practical assignments will be given for this course.

Recommended Texts

- Russell, S.J. and Norvig, P. (2014) *Artificial Intelligence: A Modern Approach*. 3rd Ed. Pearson Education Inc.

Course Code	**MAT3023**
Course Title	**Real Analysis III**
Credit Value	**3**
Pre-requisites	**MAT2023**
Compulsory/Optional	**Optional**

Course Content

Functions of several variables: Limits and continuity, Partial derivatives, Directional derivative, Extrema of functions of several variables, Lagrange multipliers, Jacobian, Multiple integrals, Change of variables in multiple integrals.

Special functions: Gamma functions, Probability Integral and related functions,

Exponential Integral and Related Functions: Power series solutions of differential equations,

Validity of the power series method: Legendre's equations, Legendre's polynomials, Generating functions of Legendre's polynomials, Orthogonality,

Recurrence formulae: Bessel's equation, Solutions of Bessel's equation, Bessel functions, Orthogonality, Recurrence formulae, Trigonometric expansions, Bessel's integral.

Special functions: Gamma, Beta, Bessel, Legendre, etc functions, Fourier series and their applications.

Recommended Texts

- T. M. Apostol (1974), *Mathematical Analysis*, 2nd Ed, Addison-Wesley Longman
- N. N. Lebedev, R.A. Silverman (1972), *Special Functions and Their Applications,* Prentice-Hall
- G. P. Tolstov, R.A. Silverman (1976), *Fourier Series,* Dover publications

Course Code	**MAT3032**
Course Title	**Partial Differential Equations**
Credit Value	**2**
Pre-requisites	**MAT1073/MAT1032**
Compulsory/Optional	**Optional**

Course Content

First Order Partial Differential Equations: Linear equations, Nonlinear equations, Method of characteristics

Second Order Partial Differential Equations: Equations with constant coefficients, Equations with variable coefficients, Laplace equation, Wave equation, Diffusion equation, Boundary value problems, Use of Fourier series in solving partial differential equations

Numerical Methods for solving partial differential equations

Recommended Texts

- P.J. Olver (2014), Introduction to Partial Differential Equations, 1st Edition, Springer.
- Y. Pinchover, and J. Rubinstein (2006), An Introduction to Partial Differential Equations, 1stEddition, Cambridge Press.
- R. V. Churchill and J.W. Brown (1993), Fourier Series and Boundary Value Problems, 5th Ed, McGraw-Hill.
- W. A. Strauss, Partial Differential Equations: An Introduction, 2nd Edition.
- E. C. Zachmanoglou and D. W. Thoe (1986), Introduction to Partial Differential Equations with Applications, Dover Publications, Inc., New York.

Course Code	**MAT3083**
Course Title	**Numerical Analysis II**
Credit Value	**3**
Pre-requisites	**MAT2082**
Compulsory/Optional	**Optional**

Course Content

Difference equations: Solutions to the homogenous and non-homogenous difference linear equations.

Solutions of Equations in One Variable: Bisection method, Fixed-point iteration, Newton-Raphson method, Error analysis for iterative methods.

Interpolation and Polynomial Approximation: Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation, Divided differences, Hermite interpolation, cubic spline interpolation.

Numerical Differentiation and Integration: Numerical differentiation, Richardson‘s extrapolation, Elements of numerical integration.

Recommended Texts

- K. E. Atkinson (2008), *An introduction to numerical analysis*, 2nd Ed, Wiley India Pvt. Limited.
- R. L. Burden and J. D. Faires (2011). *Numerical Analysis*, 9th Ed, Brooks/Cole.

Course Code	**MAT3103**
Course Title	**Linear Algebra**
Credit Value	**3**
Pre-requisites	**MAT1073/MAT2013**
Compulsory/Optional	**Compulsory**

Course Content

Elementary Matrices: Block matrices, Elementary matrix operations and elementary matrices.

Systems of Linear Equations in n-variables: Augmented matrix, Theoretical treatment of systems of linear equations, Row reduction.

Determinants: Determinants of order n, Properties of determinants, Cramer's rule**,** Properties of the adjoint, Diagonalisation of matrices, Eigenvalues and eigenvectors, Diagonalizability, Matrix polynomials and Cayley-Hamilton theorem, Minimal polynomial.

Vector Spaces: Vectors in n-dimensional Euclidean space, Abstract vector spaces, Subspaces, Basis and dimension, Spanning sets and linear independence, Isomorphism theorems.

Linear Transformations and Matrices: Kernel and range of a linear transformation, Rank-nullity theorem, Matrix representation of a linear transformation, Composition of linear transformations, Change of coordinate matrix, Similar matrices, Matrix of change of bases, symmetric, Hermitian and unitary matrices.

Inner Product Spaces: Inner product spaces, Cauchy -Schwarz inequality, The Gram-Schmidt Process.

Recommended Texts

- Ron Larson (2012), *Elementary Linear Algebra*, 7th Edition, Cengage Learning.
- David C. Lay, Steven R. Lay, Judi J. McDonald (2015), *Linear Algebra*, 5th Edition, Pearson.

Course Code	**MAT3163**
Course Title	**Network Optimization Theory**
Credit Value	**3**
Pre-requisites	**MAT2113**
Compulsory/Optional	**Compulsory**

Course Content

Minimal-Cost Network Flows: The minimal cost network flow problem, Review of graph theory, The simplex method for network flow problems, Examples, Finding an initial basic feasible solution, Network flows with lower and upper bounds, Degeneracy, Cycling and stalling, Generalized network problems.

The Out-of-Kilter Algorithm: The Out-of Kilter formulation of a minimal cost network flow problem, Strategy of the Out-of-Kilter algorithm, Examples, A labeling procedure for the Out-of-Kilter algorithm, Relaxation algorithms.

Maximal Flow, Shortest Path, Multi-Commodity Flow and Network Synthesis Problems: The Maximal flow problem, The shortest path problem, Multi-commodity flows, Synthesis of multi-terminal flow networks.

Computer Practical: Python programming language and Excel solver to solve network optimization models.

Recommended Texts

- Mokhtar S. Bazaraa, John J. Jarvis, Hanif D. Sherali (2010), *Linear Programming and Network Flows*, 4th Ed, A John Wiley & Sons, Inc.
- Bertsekas, D.P.(1998), *Network Optimization: Continuous and Discrete Models*, 1st Ed, Athena Scientific.
- Ahuja, R.K., Maganti, T.L. and Orlin, J.B.(1993), *Network Flow Theory, Algorithms and Applications*, 1st Ed, Prentice Hall.

Course Code	**MAT3172**
Course Title	**Operations Research II**
Credit Value	**2**
Pre-requisites	**MAT1083, MAT3163**
Compulsory/Optional	**Compulsory**

Course Content

Project Management: Introduction, Critical Path method (CPM), Programme Evaluation and Review Technique (PERT).

Simulation: Introduction, Formulating simulation models, Monte Carlo method, Solving simulation models using a computer software package.

Sequencing: Introduction, Sequencing problems with *n* jobs and two machines, Sequencing problems with *n* jobs and three machines, Sequencing problems with *n* jobs and *m* machines, Graphical solution

Dynamic programming: Introduction to Dynamic programming, Solving optimization models using Dynamic programming.

Replacement Problem: Introduction, Replacement Decisions, Types of Replacement Problems,

Replacement of Items that Deteriorate with time: Continuous and Discrete.

Recommended Texts

- Cliff T Ragsdale (2007), *Spreadsheet Modeling & Decision Analysis*, 5th Ed, Thomson South-Western.
- Winston, W.L. (2003). *Operations Research, Applications and Algorithms*, 4th Ed, Thomson, Brooks/Cole.
- Hillier, F.S. & Lieberman (2001), G.J. *Introduction to Operations Research*, 10th Ed, McGraw Hill.

Course Code	**MAT3183**
Course Title	**Nonlinear Programming**
Credit Value	**3**
Pre-requisites	**MAT2113**
Compulsory/Optional	**Compulsory**

Course Content

Non-linear Models formulation, Lagrangian method, Kuhn-Tucker conditions, Quadratic programming, Separable programming, Fractional programming and Geometric programming, Direct search and gradient method (One-dimensional search and Multi-dimensional search).

Computer Practical: Introduction to PYTHON to solve nonlinear models, Excel solver and Lingo to solve nonlinear models.

Recommended Texts

- Bazaraa, s., Jarvis, J. and Sherali, H. (2009). *Linear Programming and Network Flows*, 4th Ed, A John Wiley & Sons.
- Ragsdale, C. (2007). *Spreadsheet Modeling & Decision Analysis*, 5th Ed, Thomson South-Western.
- Mokthar, S., Sherali, H. and Shetty, C. (2016). *Nonlinear Programming Theory and Algorithms*, 3rd Ed, John Wiley & Sons.

Course Code	**HRM3013**
Course Title	**Human Resource Management (HRM)**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**

Course Content

The process of management: Planning, Organizing, Leading, and Controlling. HRM for Effective use of Human Resources in an Organization, Strategies for the Management of People-related Activities. Legal Issues, Grievance Handling, Recruitment and Selection, Performance management, Training, Compensation, Labour relations and technical support systems such as Human Resource Information Systems (HRIS). Financial resource management, optimum and sound employee relations for HRM. The strategies of HRM in international and multinational ventures. Industrial visits, Workshops and case studies to showcase real life experiences in HRM.

Recommended Texts

- Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
- Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
- Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

Course Code	**MAT3252**
Course Title	**Seminar**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content
Scientific Writing: Searching the Scientific Literature; Scientific Writing Style; Writing research papers, Proposals, Projects, and Thesis components; **Scientific Presentation:** Preparing Scientific Presentations; Presentation of Data; Using Visual Aids; and Using Word Processing, Spreadsheet, and Presentation software, Oral and Poster presentations, Ethics in research and scientific writing; Plagiarism; **Conducting a Project:** Students are formed into groups and each group is expected to conduct a project based on an industrial application. Completion of the project of each group is expected to write a project report and make a presentation based on the project.
Recommended Texts
• Day, R.A. (1998). How to Write and Publish a Scientific Paper, 1st Ed, Vikas Publishing House. • McMillan, K. and Weyers, J. (2011). How to Write Dissertations and Project Reports, 2nd Ed, Prentice-Hall. • Denicolo, P. and Becker, L. (2012). Developing a Research Proposal, 1st Ed, SAGE Publications.

Course Code	STA3013
Course Title	**Regression Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory**
Course Content	
Simple linear regression, Tests for regression coefficients, Interval estimation, Prediction, Analysis of variance approach, Diagnostic and remedial measures, Matrix approach to simple linear regression, Multiple regression, Polynomial regression, Nonlinear regression, Penalized regression and bias estimators. Introduction to Generalized Linear Models. Introduction to divided analysis of regression for big data. Some practical assignments will be given for this course.	
Recommended Texts	
• Neter, J., Wasserman, W. and Kunter, M.H. (2004). *Applied Linear Statistical Models,* 5th Ed, McGraw-Hill/Irwin. • Myers, R.H. (2000) *Classical and Modern Regression with Applications,* 2nd Ed, Duxbury Press. • Christensen, R. (2015) *Analysis of Variance, Design and Regression,* 2nd Ed, Chapman & Hall/CRC.	

Course Code	STA3033
Course Title	**Design and Analysis of Experiments**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory**
Course Content	
Comparison of two samples (independent, dependent), **One-Way ANOVA**: Assumptions, Normal theory, F-tests. **Multiple comparisons**: LSD method, Tuckey's method, Bonferroni method, Scheffe‘s method, Duncan‘s multiple range method.	

Two-Way ANOVA: Normal theory, Randomized block design, The two-factor factorial, Multifactor Factorials, Confounding, Introduction to Analysis of covariance, Latin square, Split-plot, Nested designs.

Some practical assignments and a field visit will be conducted.

Recommended Texts

- Montgomery, D.C. (2012). *Design and Analysis of Experiments,* 8^{th} Ed, Wiley.
- Neter, J., Wasserman, W. and Kunter, M.H. (1996). *Applied Linear Statistical Models,* 4^{th} Ed, Irwin Inc.
- Jobson, J.D. (1991). *Applied multivariate data analysis: Regression and Experimental Design,* 1st Ed, Springer.
- Lindman, H.R. (1992). *Analysis of Variance in Experimental Design,* 1^{st} Ed, Springer Series.

Course Code	**STA3052**
Course Title	**Multivariate Methods I**
Credit Value	**2**
Pre-requisites	**STA1031, STA2033**
Compulsory/Optional	**Compulsory**

Course Content

Properties of random vectors and matrices, The Multivariate Normal distribution, Estimation of parameters in the Multivariate Normal distribution, Wishart distribution, Inferences on multivariate mean, and Hotelling's T2 tests, Multivariate Analysis of variance, Cluster analysis.

Recommended Texts

- Johnson, R.A. and Wichern, D.W. (2014). *Applied Multivariate Statistical Analysis,* 6^{th} Ed, Pearson Publications.
- Rencher, A.C. and Christensen, W. F. (2012). *Methods of Multivariate Analysis,* 3^{rd} Ed, Wiley.

Course Code	**STA3072**
Course Title	**Time Series Analysis**
Credit Value	**2**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**

Course Content

Introduction: Objective of time series analysis, Components of time series.

Classical method of time series decomposition: Estimation of trend, Seasonal effect and cyclic effects. Auto-covariance, Auto-correlation function and correlogram.

Processes: Purely random, Random walk, Strictly stationary, Weakly stationary, Non-stationary, Moving averages, Auto-regressive, Mixed models, and Seasonal models. Parameter estimation, Diagnostic checking, Forecasting, Box-Jenkins methodology, Introduction to nonlinear models, Multivariate time series analysis, and Wavelet decomposition.

Some practical assignments will be given for this course.

Recommended Texts

- Brockwell, P.J. and Davis, R.A. (2016). *Introduction to Time Series and Forecasting (Springer Series*

in Statistics), 3rd Ed, Springer. • Chatfield, C. (2003). *The Analysis of Time Series: An Introduction*, 6th Ed, Chapman and Hall/CRC. • Shumway, R.H. and Stoffer, D.S. (2017). *Time Series Analysis and Its Applications: With R Examples,* 4th Ed, Springer.	

Course Code	**STA3093**
Course Title	**Non-Parametric and Categorical Data Analysis**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Compulsory**
Course Content	
Non-parametric: One sample sign test, Binomial test, Two sample sign test, Wilcoxon paired samples, Signed rank test, Wilcoxon and Mann-Whitney U test, Test of independence, Wald Wolfowitz runs test, Kruskal-Wallis test, Friedman test, Correlation tests, Non-parametric simple linear regression. **Categorical Data Analysis**: Chi-Square Goodness of fit tests, The Kolomogorov-Simrnov test, Lillifor's test, Anderson-Darling test. Comparing two proportions and confidence intervals, Relative risk and confidence intervals, Odd ratios and confidence interval, Likelihood ratio test, Likelihood function for generalized linear models, Logistic regression, Estimating parameters, Wald test and the confidence intervals, Logit models, Probit models, Model diagnostics, Log-linear models. Some practical assignments will be given for this course.	
Recommended Texts	
• Agresti, A. (2007). *An Introduction to Categorical Data Analysis,* 2nd Ed, John Wiley & Sons. • Sprent, P. and Smeeton, N.C. (2007). *Applied Nonparametric Statistical Method,* 4th Ed, Chapman & Hall/CRC. • Kolke, J. and McKean, J.W. (2014). *Nonparametric Statistical Methods Using R,* Chapman & Hall/CRC.	

Course Code	**STA3113**
Course Title	**Statistical Simulation**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
Introduction and Overview of Simulation: Simulation examples, Statistical models in simulation, Modelling and estimating input processes, Random-number generation. **Generation of random variates**: Discrete and continuous, Statistical analysis of simulation output, Comparison, Ranking, and Selection of simulation models, Variance-reduction techniques, Designing simulation experiments, Gradient estimation, and Optimization. **Computer intensive inference methods**: Jack-Knife, Bootstrap, Cross validation, Monte Carlo methods and permutation tests.	
Recommended Texts	
• Ross, S.M. (2012). *Simulation (Statistical Modeling and Decision Science),* 5th Ed, Academic Press. • Rubinstein, R.Y. and Kroese, D.P. (2007*). Simulation and the Monte Carlo Method*, 2nd Ed, Wiley-Interscience.	

4000 Level Courses

Course Code	**CSC4093**
Course Title	**Neural Networks and Deep Learning**
Credit Value	**3**
Pre-requisites	**CSC3173**
Compulsory/Optional	**Optional**

Course Content

Neural Networks Basics: Neural network representation, Biological neuron vs artificial neuron, Activation functions, McCulloch-pitts Model, Perceptron, Binary classification, Logistic regression, Cost function, Gradient descent;

Shallow Neural Networks: Supervised learning with neural networks, Neural network architectures, Feedforward networks, Gradient descent for neural networks, Backpropagation, Training neural networks;

Unsupervised learning: Self-organizing maps.

Introduction to Deep Learning: Key concepts of deep learning, Applications of deep learning.

Deep Neural Networks: Building blocks of deep neural networks, Convolutional neural networks, Recurrent neural networks and LSTMs, Parameters and hyperparameters; Programming libraries and tools for neural networks.

Practical assignments will be given for this course.

Recommended Texts

- Goodfellow, I., Bengio, Y. and Courville, A. (2016). *Deep Learning*, MIT Press

Course Code	**MAT4023**
Course Title	**Measure Theory**
Credit Value	**3**
Pre-requisites	**MAT3023**
Compulsory/Optional	**Optional**

Course Content

***Measures*:** Algebras, σ -algebras, Measures, Outer measures, Complete measures, Lebesgue measure on the real line, Existence of non-measurable sets, Measurable functions, Measure spaces.

Integration: Integration of simple functions, Lebesgue integral, Monotone convergence theorem, Dominated convergence theorem, Fatou's lemma, Characterizations of Riemann and Lebesgue integrability, Modes of convergence, Product measures, Fubini's theorem.

Recommended Texts

- R. G. Bartle (1995), *The Elements of Integration and Lebesgue Measure*, Wiley Interscience.
- G. B. Folland (2007), *Real Analysis Modern Techniques and Their Applications*, 2nd Ed, Wiley-Interscience.
- H. Royden and P. Fitzpatrick (2010), *Real Analysis*, 4th Ed, Pearson.

Course Code	**MAT4083**
Course Title	**Financial Mathematics**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
An introduction to options and markets, Interest and present value analysis, Geometric Brownian Motion, Pricing contract via arbitrage, Arbitrage theorem, Black-Scholes option pricing formula, The binomial option pricing model, More results on options, Valuing by expected utility, Exotic options.	
Recommended Texts	
• J. C. Hull (1998), *Options, Futures, and Other Derivatives*, Prentice Hall. • S. M. Ross, (1987), *An Elementary Introduction to Mathematical Finance: Options and other Topics.* • P. Wilmott, S. Howisan, and J. Dewynne, (2000), *The Mathematics of Financial Derivatives, A Student Introduction.*	

Course Code	**MAT4112**
Course Title	**Selected Topics in Applied Operations Research**
Credit Value	**2**
Pre-requisites	**MAT3172, MAT3183**
Compulsory/Optional	**Compulsory**
Course Content	
Topics will be selected from significant areas in Operations Research. Topics may vary each year.	
Recommended Texts	
None	

Course Code	**MAT4123**
Course Title	**Optimization for Engineering Design**
Credit Value	**3**
Pre-requisites	**MAT3172, MAT3183**
Compulsory/Optional	**Compulsory**
Course Content	
Introduction, Single-variable optimization algorithms, Multivariable optimization algorithms, Constrained optimization algorithms, Specialized algorithms, Nontraditional optimization algorithms.	
Recommended Texts	
• Kalyanmoy Deb (1999), Optimization for Engineering Design: Algorithms and Examples, 2nd Ed, Prentice Hall of India • Singiresu S. Rao (2009), Engineering Optimization Theory and Practice, 4th Ed, John Wiley & Sons	

Course Code	MAT4132
Course Title	**Optimization Modeling**
Credit Value	**2**
Pre-requisites	**MAT3172, MAT3183**
Compulsory/Optional	**Compulsory**

Course Content

Financial optimization, Discriminant analysis, Decision analysis and investment analysis, Replacement models, Regression and time series forecasting models, Computer software will be used to solve mathematical models.

Recommended Texts

- Bazaraa, s., Jarvis, J. and Sherali, H. (2009). Linear Programming and Network Flows, 4th Ed, A John Wiley & Sons.
- Ragsdale, C. (2016). Spreadsheet Modeling & Decision Analysis, 5th Ed, Thomson South-Western.
- Mokthar, S., Sherali, H. and Shetty, C. (2016). Nonlinear Programming Theory and Algorithms, 3rd Ed, John Wiley & Sons.

Course Code	MAT4998
Course Title	**Project Work/Industrial Training**
Credit Value	**6**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Reading a research paper critically and creatively, Highlighting crucial facts, Taking notes and summarizing, Comparing with other works.

Learning to Write a Research Paper (in Latex): Title, Abstract, Introduction, Results and discussion, Conclusions, Acknowledgement, References**.**

Preparing a Presentation (in Microsoft Power Point/Latex): Outlines, Slide structure, Fonts, Colour, Background, Graphs, Spelling and Grammar, Conclusions.

Developing Presentation Skills: Organizing, Time management, Confidence, Eye contact, Flow.

Industrial Training (4 months): To provide an opportunity for students to learn and familiarize with the industry, Observe real life practices and implementation of theoretical lessons and principles, To learn ethics in the industry, To gain soft skills such as; Leadership, Group work, Communication, Organization, etc., To be able to efficiently complete given tasks and also to foster good relationship with the employers and employees. Students are required to write a report based on the industrial training and submit for evaluation at the completion of the training programme. Also, the students are required to make a presentation describing the training programme underwent.

Recommended Texts

None

Course Code	STA4012
Course Title	**Actuarial Statistics**
Credit Value	**2**
Pre-requisites	**STA2033**

Compulsory/Optional	Optional

Course Content

Economics of uncertainty, Risk theory and utility, Jensen's inequality, Sums of random variables and convolutions, Applications to individual risk models, Failure rates and the force of mortality, Mixtures of random variables and mixtures of distributions, Loss distribution, Reinsurance, Risk models, Actuarial applications of statistical inference, Life tables, Aggregate and Select survival models, Estimating distribution by simulation.

Recommended Texts

- McCutcheon, J.J. and Scott, W.F. (1998). *An introduction to the Mathematics of Finance,* 1st Ed, Oxford, Butterworth-Heinemann.
- Bowers, N. L.,Gerber, H.U.,Hickman, J. C.,Jones, D. A.and Nesbitt, C. J. (1997), Actuarial Mathematics, 2nd Ed, Illinois, Society of Actuaries.
- Neil, A. (1977). *Life Contingencies*. Trafalgar Square.

Course Code	STA4023
Course Title	Statistical Data Mining
Credit Value	3
Pre-requisites	STA3052
Compulsory/Optional	Compulsory

Course Content

Introduction to data mining and big data, Data mining tasks, Processes, Database/online transaction processing (OLTP), Data warehousing / Online analytical processing (OLAP), feature selection and dimension reduction techniques,

Classification and Clustering: Similarity and distance measures, Hierarchical algorithms, Partitional algorithms, Clustering large data bases, Clustering with categorical attributes, Comparison.

Association Rules: Large item sets, Algorithms, Comparing approaches, Measuring the quality of rules.

Web Mining: Web content mining, Web structure mining, Web usage mining.

Overview of Spatial Data mining, Temporal Mining: Modeling temporal events, Pattern detection, Sequences, Temporal association rules, Introduction to spatio-temporal data mining.

Some practical assignments will be given for this course.

Recommended Texts

- James, G., Witten, D., Hastie, T. and Tibshirani, R. (2017). *An Introduction to Statistical Learning: with Applications in R*, 1st Ed. Corr, 7th Printing Ed, Springer Texts in Statistics.
- Kuhn, M. and Johnson, K. (2018). *Applied Predictive Modeling*, 1st Ed. 2013, Corr. 2nd Printing 2018 Ed, Springer.
- Hastie, T., Tibshirani, R. and Friedman, J. (2016), *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2nd Ed, Springer Series in Statistics.

Course Code	STA4033
Course Title	Statistics for Bioinformatics
Credit Value	3
Pre-requisites	STA3093

Compulsory/Optional	Optional
Course Content	
Introduction to Cell Biology and Genetics: Cell, DNA and chromosomes, Functions of the cell and DNA. **Gene Expression analysis**: Pre-processing, Visualization, Inference. **Sequence Analysis and Alignment**: DNA/Protein sequence analysis, Aligning sequences, Markov chains. **Genetic frequencies**: Hardy-Weinberg equilibrium, Maximum likelihood estimation, Exact test, Microarray experiments, Gene expression and analysis, Phylogenetic tree construction. Some practical assignments will be given for this course.	
Recommended Texts	
• Ewes, W. J. and Grant, G. R. (2005). *Statistical Methods in Bioinformatics: An introduction (Statistics for Biology and Health),* 2nd Ed, Springer. • Durbin, R., Eddy, S. R., Krogh, A. and Mitchison, G. (1998). *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids*, 1st Ed, Cambridge University Press.	

Course Code	STA4043
Course Title	**Stochastic Processes**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Introduction to stochastic processes, Markov chains, Chapman–Kolmogorov equations, Classification of states, Limiting probabilities, Applications of Markov chains, Markov processes with discrete state space, Markov processes with continuous state space, Stationary processes, Branching processes, Birth and death processes, Hidden Markov chains, Exponential distribution and the Poisson process, Queuing theory, Reliability theory. Some practical assignments will be given for this course.	
Recommended Texts	
• Medhi, J. (2010). *Stochastic Processes*, 3rd Revised Ed, New Age Science. • Ross, S.M. (2014). *Introduction to Probability Models*. 11th Ed, Academic Press.	

Course Code	STA4053
Course Title	**Multivariate methods II**
Credit Value	**3**
Pre-requisites	**STA3052**
Compulsory/Optional	**Compulsory**
Course Content	
Principal component analysis (PCA), Interpretation using illustrative examples. Factor analysis, Comparison with PCA, Factor loadings and rotations, Geometric interpretation, Discriminant analysis of two group and multiple groups, Canonical correlation, Covariance structure models, Correspondence analysis, Multidimensional scaling, Multivariate analysis of covariance. Some practical assignments will be given for this course.	

Recommended Texts
• Hardle, W. and Simar, L. (2003). *Applied Multivariate Statistical Analysis*. Springer. • Anderson, T.W. (2003). *An Introduction to Multivariate Statistical Analysis*, 3rd Ed, Wiley. • Johnson, A.R. and Wichern, D. W. (2007). *Applied Multivariate Statistical Analysis*. Prentice Hall.

Course Code	**STA4063**
Course Title	**Bayesian Statistics**
Credit Value	**3**
Pre-requisites	**STA2033**
Compulsory/Optional	**Optional**
Course Content	
Fundamentals of Bayesian inference, Bayesian estimation, Credible sets, Hypothesis testing, Bayesian prediction, Model checking and improvement, Posterior simulation, **Bayesian models**: Regression models, Hierarchical linear models, Generalized linear models, Models for robust inference, Mixture models, Multivariate models, Nonlinear models, Models for missing data. Some practical assignments will be given for this course.	
Recommended Texts	
• Marin, J.-M., Robert, C. P. (2007). *Bayesian core: A practical approach to computational Bayesian statistics*, 1st Ed., Springer Texts in Statistics. • Gelman, A., Carlin, J. B., Stern, H. S. and Rubin, D. B. (2013). *Bayesian Data Analysis*, 3rd Ed. Chapman & Hall/CRC Texts in Statistical Science. • Berger, J.O. (1993). *Statistical Decision Theory and Bayesian Analysis*. 2nd Ed., Springer.	

12. NON-GPA COURSES

12.1 English Courses

1000 LEVEL				
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory**
ENG1002	English for Academic Purposes	2		√
2000 LEVEL				
ENG2002	English for Professional Purposes	2		√
3000 LEVEL				
ENG3002	English for Special Purposes	2		
Total		**06**		**04**

1000 Level Courses

Course Code	**ENG1002**
Course Title	**English for Academic Purposes**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory (Non-GPA Foundation)**
Course Content	
Components of a lab report and a process; prepositions (time, place and direction); tenses (simple present, simple past, present continuous, past continuous and future); passive voice (present passive and past passive); sequence markers, conditionals, relative clauses (simple and complex); transitional signals; cohesive devices; conjunctions; reading and note taking; reading comprehension; listening and note taking (using symbols and abbreviations); speech.	
Recommended Texts	
• Murphy, R. (2007) Murphy's English Grammar, 3th Edition, Cambridge University Press • Oxford University Press. (1979) Basic English for Science 2nd Edition, Oxford University Press • Soars, J., Soars, L. (2014) New Headway Series, 4th Edition, Oxford University Press	

2000 Level Courses

Course Code	**ENG2002**
Course Title	**English for Professional Purposes**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory (Non-GPA)**
Course Content	
Graph interpretation (bar graphs, pie charts, line graphs), writing survey reports, essay writing (argumentative,	

discursive, problem and solution), writing official letters (request, complaint, reply, excuse, inquiry), direct and indirect speech, present and past perfect tenses, reading comprehension, listening for specific information, presentation skills, organizing information and compiling a semi-formal report.
Recommended Texts
• Hewings, M. (2005), Advanced Grammar in Use, 2nd Edition, Cambridge University Press • Murphy, R. (2007), Murphy's English Grammar, 2nd Edition, Cambridge UniversityPress • Bly, R.W (2004), Webster's New World Letter Writing Handbook, Indianapolis, Indiana Wiley Publishing, Inc., http://elibrary.bsu.az/books_250/N_111.pdf • British Council Learn English Teens, https://learnenglishteens.britishcouncil.org/sites/teens/files/writing_about_survey_results_exercises.pdf • Cambridge IELTS 9 (2014), Cambridge University Press, Cambridge • Cambridge IELTS 10 (2015), Cambridge University Press, Cambridge • Cambridge IELTS 11 (2016), Cambridge University Press, Cambridge

3000 Level Courses

Course Code	**ENG3002**
Course Title	**English for Special Purposes**
Credit Value	**2**
Pre-requisites	**ENG2002**
Compulsory/Optional	**Optional (Non-GPA)**
Course Content	
Vocabulary and etiquette in a social and professional context ; Preparing participants for the job market (CV preparation, cover letter writing, filling applications and SOP writing); Developing confidence in public speaking (Planning and organizing speeches); Report writing (Informational and analytical reports); Conducting meetings and taking down minutes; Professional Communication (Writing e-mails and memos). Practical sessions: Real life experience in a professional context ; Searching for job opportunities and facing interviews, body language, presentation skills ,demonstrations and presentations ; Panel discussions and mock meetings; Face to face conversations and telephone conversations.	
Recommended Texts	
• Bewes R (2015), Speaking in Public Effectively : How to prepare, How to present, How to Progress, Revised edition, Christian Focus Publications Ltd. • Stone J (2016), Effective Public Speaking: How To Be An Effective Public Speaker: The Easyway, New edition, Easyway Guides Publishers • Sweeney S (2003), English for Business Communication Student's Book, Revised edition, Cambridge University Press • Southam K & Kennedy J L (2016), Successful Job Interviews for Dummies, Australian & New Zealand Edition, John Wiley & Sons Australia Ltd • Rowe P (2012), Business Etiquette : Keep Your Competitive Edge and Maintain Successful Business Networks, 3rd Revised Edition, New Holland Publishers • Greenlaw R (2012), Technical Writing, Presentational Skills, and Online Communication: Professional Tools and Insights, Idea Group Publishers,US • Brieger N & Sweeney S (2012), Business Grammar & Practice: A2-B1, HarperCollins Publishers • Flockhart J &Robbins S & Capel W (2013), Business Vocabulary in Practice: B1-B2, 3rd Edition, HarperCollins Publishers	

12.2 Other Courses

Course code	Course Title	No. of Credits	Pre-requisites	Compulsory
SCI1011	Laboratory Safety	1		√
SCI1021	Academic Ethics and Integrity	1		√
SCI1031	Healthy Relationships and Interpersonal Dynamics	1		√
SCI1041	Essential Skills for Career Development	1		√
SCI3012	Advanced Strategies for Professional Development	2		√
Total		**6**		**6**

<u>1000 Level Courses</u>

Course Code	**SCI1011**
Course Title	**Laboratory Safety**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

This course is an online compulsory course, and all students must follow the introduction and either part A (for students following Chemistry or Biology subjects) or Part B (for all other science students)

Introduction: (04 hrs)
General laboratory safety rules. Effective organization of laboratory working place, experiments and proper disposal waste. Heating and fire safety and first aid. Management of emergency situations.

Part A: Chemical and Biological Laboratories. (08 hrs)
Chemical and Biological laboratory safety rules. Laboratory hazards categories in Chemical, Biological and Psychological. Laboratory safety precautions in the storage, transportation and utilization of scientific equipment, chemicals and biological materials. Animal and plant safety.
Categorizing and handling of hazardous chemicals, strong oxidizers, flammable liquids, carcinogenic, mutagenic and teratogenic substances etc. Short and long term health effects due to improper laboratory usage.

Part B: Physics and Computer Laboratories. (08 hrs)
Physical and information technology laboratory safety rules. Apparatus and instruments used in electrical, mechanical, physics, mathematics and Computer science laboratories. Laboratory safety precautions in the storage, transportation and utilization of scientific equipment, IT and office equipment. Sound and radiation safety. Short and long term health effects due to improper laboratory usage.

Recommended Texts

- CRC Handbook of Laboratory Safety, 5th Edition, A.Keith Furr. CRC Press (2000)
- Prudent Practices in the Laboratory: Handing and Management of Chemical Hazards, The National Academies Press (2011)
- Complete Guide to Laboratory Safety, Fourth Edition Fourth Edition, by Dan Scungio and Terry Jo Gile, HCPro a division of BLR (2014)

Course Code	**SCI1021**
Course Title	**Academic Ethics and Integrity**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction: Definition of academic ethics and integrity, lmportance of academic integrity, Forms of academic dishonesty, promoting integrity, policies and procedure that govern academic integrity and ethical conduct in the University.
Ethics: Definition of Ethics & History, Ethical Views, Rights and Rules, Law and Ethics
Plagiarism and cheating: Definition, Forms of Plagiarism, Levels of Plagiarism, offences, and punishments at university level, Tackling plagiarism, Plagiarism detection software, Forms of cheating, and scientific misconduct, Tutorials
Intellectual Property: Industrial Property & Trade Secrets, Copyright, Equitable-Benefit Sharing and Genetic Resources, Intellectual property and the law Sri Lanka, Fair Use policy, Creative Commons & Public Domain, Non-Disclosure Agreements
Research ethics: Maintaining integrity relative to authorship; data management and ownership, Protection of human and animal rights, research fraud.

Data Security and Privacy: Ethical Clearance, Data Collection and Informed Consent, Security of Data, Privacy & Confidentiality, Data Protection Acts

Recommended Texts

- Diane Pecorari, Teaching to Avoid Plagiarism: How to promote good source use. Berkshire, England: openUniversity Press, 2013
- Harris, Robert A. The Plagiarism Handbook: Strategies for Preventing, Detecting, and Dealing with Plagiarism. Los Angeles: Pyrczak Pub., 2001
- Barbara Gross Davis. Tools for teaching

Course Code	**SCI1031**
Course Title	**Healthy Relationships and Interpersonal Dynamics**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**

Course Content

Introduction to healthy relationships and interpersonal dynamics, and the positive outcomes of such relationships. Creating an awareness of sexual and gender based harassment and sexual violence (SGBV), terminology and concepts. University of Peradeniya bylaws on development of interpersonal relationships and the policy and regulations on SGBV: help sources, complaining mechanisms, disciplinary procedures. Case studies of different scenarios relating to development of interpersonal relationships and on SGBV.

Recommended Texts

- Policy and Regulations of sexual and gender based harassment and sexual violence of the University of Peradeniya
- Attitudes, ehavior and Social Content: The Role of Norms and Group Membership, Deborah J. Terry, Michael A. Hogg, Lawrence Erlbaum Associates publishers, London, 2000
- Paludi, M, and Paludi C.A. Jr. (2003) Academic and Workplace Sexual Harassment: A Handbook of Cultural, Social Science, Management, and Legal Perspectives, Westport, Connecticut & London: Praeger
- B.W. Dziech, and L.Weiner. 2nd Edition. The Lecherous Professor: Sexual Harassment on Campus. University of Illinois Press

Course Code	**SCI1041**
Course Title	**Essential Skills for Career Development**
Credit Value	**1**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Communication & Psychological Aspects: Story telling for personal & professional development, Body language in communication. Leadership, Networking and Professionalism: Build a professional online presence and identity, Continuing professional development (CDP), Attitudes, values and organizational culture, Emotional intelligence (EC). Entrepreneurship: Introduction to Entrepreneurship, develop courage for taking challengers. Industrial visits and inspirational speeches from industry leaders and successful entrepreneurs.	
Recommended Texts	
• Daniel Goleman, Working with Emotional Intelligence, Bantam Publishers, (2000) • Barbara Pease and Allan Pease, The Definitive Book of Body Language: The Hidden Meaning Behind People's gestures and Expressions, Bantam Publishers; First Edition (2006) • Simon Sinek, Leaders Eat Last, Brilliance Audio, (2017) • John Doerr, Measure What Matters: How Google, Bono, and the Gates Foundation Rock the World with OKRs, Portfolio, (2018)	

3000 Level Courses

Course Code	**SCI3012**
Course Title	**Advanced Strategies for Professional Development**
Credit Value	**2**
Pre-requisites	**None**
Compulsory/Optional	**Compulsory**
Course Content	
Communication & Psychological Aspects: Developing personal elevator pitch, Personality and Behavioral Assessment Test (eg. DISC, IDI), Points to be considered in preparation of CV and facing interview. Leadership and Professionalism: Developing executive presence, Transitioning out of the job. Entrepreneurship: Interpretation of Financial statements (Basic Level) Industrial visits and inspirational from industry leaders and successful entrepreneurs.	
Recommended Texts	
• Sylvia Ann Hewlett, Executive Presence: The Missing Link Between Merit and Success, Harper Business (2014). • Mary Buffet \t and David Clark, Warren Buffett and the Interpretation of Financial Statements: The Search for the Company with a Durable Competitive Advantage, Scribner Publisher, (2008). • Simon Sinek, Leaders Eat Last, Brilliance Audio, (2017) • John Doerr, Measure What Matters: How Google, Bono, and the Gates Foundation Rock the World with OKRs, Portfolio, (2018)	

13. INTER-FACULTY COURSES

Course code	Course Title	No. of Credits	Pre-requisites	Compulsory
HRM3013	Human Resource Management	3		
Total		**3**		

3000 Level Courses

Course Code	**HRM3013**
Course Title	**Human Resource Management**
Credit Value	**3**
Pre-requisites	**None**
Compulsory/Optional	**Optional**
Course Content	
The process of management: planning, organizing, leading and controlling. HRM for effective use of human resources in an organization, strategies for the management of people-related activities. Legal issues, grievance handling, recruitment and selection, performance management, training, compensation, labour relations and technical support systems such as Human Resource Information Systems (HRIS). Financial resource management, optimum and sound employee relations for HRM. The strategies of HRM in international and multinational ventures. Industrial visits, workshops and case studies to showcase real life experiences in HRM.	
Recommended Texts	
• Mathis, R.L., Jackson, J.H,. Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning. • Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson. • Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.	