

ES 401	Geologic and Hydrologic Hazards (same as <b>GL 417</b> )	2	20	20		√
ES 402	Cleaner Production for Industry (same as <b>AS 432</b> )	2	30			
ES 403	Environmental Management and Sustainable Development ( <i>new</i> )	2	30			√
ES 404	Air and noise Pollution ( <i>new</i> )	3	30	30		√
ES 405	Waste and Waste Management ( <i>new</i> )	3	30	30		√
ES 406	Environmental Analysis Laboratory ( <i>new</i> )	2		60	ES 309, CH 238	√
ES 407	Ecotourism and Nature Conservation (same as <b>ZL 405</b> )	3	30	30		
ES 408	Biodiversity and Conservation Biology (same as <b>ZL 412</b> )	3	30	30		
ES 409	Oceanography and Coastal Geomorphology (same as <b>GL 406</b> )	3	45			
ES 410	Environmental Biotechnology (same as <b>MB 416</b> )	2	30			
ES 411	Medical Geology and Environmental Toxicology ( <i>new</i> )	2	30			
ES 412	Nanotechnology and the Environment ( <i>new</i> )	2	30			
ES 413	Environmental Economics ( <i>new</i> )	2	30			
ES 414	Applied Microbiology (same as <b>BT 412</b> )	2	15	30	BT 302	
ES 415	Research Methodology & Scientific Writing (same as <b>AS 402</b> )	2	30			√
ES 416	Seminar	1	--			√
ES 417	Research Project	6		180		√
	<b>Total credits of the forth year courses</b>	<b>42</b>				

**Syllabi of the 400 level courses:**

<b>Assessment</b>	<b>Percentage Mark</b>
Continuous assessment	40%
End semester examination	60%

<p><b>Course No.</b> : ES 401 (same as GL 417)  <b>Course Title</b> : Geological and Hydrologic Hazards  <b>Credits</b> : 02  <b>Prerequisites</b> : None</p>
<p><b>Compulsory/Optional:</b> Compulsory</p>
<p><b>Aims and/or Objectives and/or Intended Learning Outcomes:</b>  This course aims to introduce to geological and hydrologic hazards and their mitigations.</p>
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> <p>Landslides: Causes, types and processes of slope movement, slope stabilization and mitigation, landslide hazard zonation maps; Earthquake: ground shaking, surface faulting, ground failure, subsidence; Tsunamis: Tsunami warning system, reduction of losses from earthquakes and tsunamis; Floods: causes of flooding, flash flooding, riverine floods, tidal floods, reduction of losses from floods; Volcanic eruptions: different kinds, hazards from volcanoes, forecasting of volcanism, reduction of losses from volcanism.</p>
<p><b>Recommended Texts:</b></p> <ol style="list-style-type: none"> <li>1. Our Geologic Environment, H. Blatt, Prentice Hill, 1997.</li> <li>2. Earthquake Protection, A. Coburn and R. Spencer, Wiley Publishers, 1992.</li> <li>3. Facing Geologic and Hydrologic Hazards – Earth Science considerations. USGS Professional Paper, W.W. Hays 1240-B ,p 108, 1981.</li> <li>4. Environmental Geology, B.W. Murck, John Wiley, 1996 .</li> <li>5. Geohazards-Natural and Man made, G.J.H. McCall, Chapman and Hall, 1992.</li> </ol> <ol style="list-style-type: none"> <li>1. Goals, Opportunities and Priorities for the USGS Earthquake Hazard Reduction Program, A. Robert, USGS Circular 1079, 1992.</li> </ol>

<b>Assessment</b>	<b>Percentage Mark</b>
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 402 (same as AS 432) <b>Course Title</b> : Cleaner Production for Industry <b>Credits</b> : 02 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Optional
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide a comprehensive knowledge on cleaner production (CP) in an enterprise, CP as a cost and waste reduction methodology and case studies on cleaner production.
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> 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; 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 pay back period; ISO 14000 standards; case studies and group exercises.
<b>Recommended Texts:</b> 1. Cleaner Production, A Way to Improve Your Enterprise, National Cleaner Production Centre, Sri Lanka, 2005.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 403 <b>Course Title</b> : Environmental Management and Sustainable Development <b>Credits</b> : 02 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Compulsory
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to educate undergraduates with the importance of environmental management for sustainable development.
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> Basic principles of management; Renewable and non renewable natural resources; Management of natural resources; Sustainable development; Local and international quality standards; Traditional and recent management practices; Land use policies and legislation; Education and research in conservation management.
<b>Recommended Texts:</b> 1. Sustainable Environmental Management: Principles and Practice R. Ker Turner Belhaven Press, London, 1988.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 404 <b>Course Title</b> : Air and noise Pollution <b>Credits</b> : 02 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Compulsory
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide a theoretical background on atmosphere and atmospheric pollution, mitigation of atmospheric pollution and to provide practical exposure on air quality monitoring via laboratory experiments.
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> Atmospheric composition and climate: Air pollution: Classes of air pollutants; Urban air pollution, air pollution modeling, 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. What is sound pollution, sources of sound pollution, measurements, Decibel scale, adverse effects, legal aspects and regulations, Noise prevention and reduction. Laboratory Component: Air sampling and air quality monitoring, biomonitoring of air pollution, Effects of pollutants on plants.
<b>Recommended Texts:</b> <ol style="list-style-type: none"> <li>1. Atmosphere, Ocean and Climatic Dynamics: An introductory Text, J. Marshall and R.A. Plump, 2007.</li> <li>2. Environmental Chemistry, S.E Manahan, Lewis Publishers, 1994.</li> </ol>

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 405 <b>Course Title</b> : Waste and Waste Management <b>Credits</b> : 03 credits <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Compulsory
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide a detailed knowledge on all types of waste and waste management.
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> Disposal of waste water and waste water treatment: physical, chemical and biological. Design and specification of air, land and water pollution control and systems. Hazardous waste management and treatment; Industrial effluent treatment; Hospital waste treatment. Types of solid waste, disposal of solid waste; Municipal waste management, 3R's (reduce, recover and recycle) strategy, Incineration of solid waste, Biological treatment and its incineration; Waste as a resource for energy and fertilizer; Useful products from waste; Control of gaseous pollutants, cyclones, electrostatic precipitators. Laboratory exercises and field studies.

**Recommended Texts:**

1. Hazardous Industrial Waste Treatment, L.K. Wang, H.H. Lo, CRC Press, 2006.
2. Solid waste Management, Second edition by P.T. Williams, John Wiley & Sons, 2005.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

**Course No.** : ES 406**Course Title** : Environmental Analysis Laboratory**Credits** : 02**Prerequisites** : ES 309, CH 238**Compulsory/Optional:** Compulsory**Aims and/or Objectives and/or Intended Learning Outcomes:**

This course aims to provide practical knowledge on chemical/instrumental analytical techniques for environmental analysis.

**Course Syllabus / Course Description**

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); Field work related to purification of drinking water and industrial effluent treatment; Water quality analysis including both biological and chemical analysis.

**Recommended Texts:**

1. Principles of Instrumental Analysis, S.A. Skoog, F.J. Holler and T.A. Nieman, Harcourt Asia PTE Ltd, 2001.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

**Course No.** : ES 407 (same as ZL 405)**Course Title** : Ecotourism and Nature Conservation**Credits** : 03**Prerequisites** : None**Compulsory/Optional:** Optional**Aims and/or Objectives and/or Intended Learning Outcomes:**

This course aims to deliver a comprehensive knowledge on ecotourism and nature conservation.

### Course Syllabus / Course Description

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:

1. Tourism, Ecotourism and Protected Areas: The State of Nature-Based Tourism around the World and Guidelines for Its Development. H. Cebellos-Lascurdin, 2005.
2. Ecotourism: An Introduction. D.A. Fennell, 2006.
3. Ecotourism: Sustainable Nature and Conservation Based Tourism. P.S. Ashton, R.E. Jr Ashton, 2002.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

**Course No.** : ES 408 (same as ZL 412)

**Course Title** : Biodiversity and Conservation Biology

**Credits** : 03

**Prerequisites** : None

**Compulsory/Optional:** Optional

#### Aims and/or Objectives and/or Intended Learning Outcomes:

This course aims to strengthen student's knowledge on biodiversity modified ecosystems, and economics and politics of conservation.

### Course Syllabus / Course Description

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:

1. Principles of Conservation Biology, G.K. Meffe & C.R. Carroll. 1997.
2. A Primer of Conservation Biology, R.B. Primack., 1994.
3. Global Biodiversity Assessment, V.H. Heywood, 2002.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 409 (same as GL 406) <b>Course Title</b> : Oceanography and Coastal Geomorphology <b>Credits</b> : 03 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Optional
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide a comprehensive coverage on important topics in Oceanography and Coastal Geomorphology.
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> Sea flow spreading and tectonic history of the Indian Ocean; Physical properties of sea water, distribution of temperature, salinity and density in space and time, light in the sea, oceanic water circulation, major and minor elements in sea water, geochemical balance of the oceans, residence times, dissolved gasses in sea water, sea as a biological environment, effects of temperature, salinity, pressure and light on marine organisms. Distribution and composition of marine sediments; Formative processes and classification of coastal land forms with emphasis on coastal geomorphology of Sri Lanka. Coastal process and environments. Coastal and marine pollution.
<b>Recommended Texts:</b> <ol style="list-style-type: none"> <li>1. Marine Geochemistry, A. Chester, 1990.</li> <li>2. Chemical Oceanography, Millcro and M.L. Saha, 1992.</li> <li>3. Elements of Oceanography, M.J. McCormick and J.V. Thiruvathukal, Saunders College Publishing, 1981.</li> <li>4. An Introduction to the Coastal Geomorphology of Sri Lanka, National Museums of Sri Lanka, B. Swan, 1983.</li> </ol>

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 410 (same as MB 416) <b>Course Title</b> : Environmental Biotechnology <b>Credits</b> : 02 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Optional
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide a comprehensive coverage on Environmental Biotechnology
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> Living organisms as pollution indicators; biodegradation; waste management; pollution treatment; bio-mining; biogas production; microbes in environmental management.
<b>Recommended Texts:</b> <ol style="list-style-type: none"> <li>1. R. Barry King, Gilbert M. Long, John K. Sheldon (1997) <i>Practical</i></li> </ol>

*Environmental Bioremediation: The Field Guide* (Second Edition) Publisher: CRC Press.

2. Sarina J. Ergas, Daniel P. Y. Chang, Edward D. Schroeder, Juana B. Eweis (Editor) (1998) *Bioremediation Principals*, McGraw-Hill

3. Gareth M. Evans, Judith C. Furlong (2002) *Environmental Biotechnology : Theory and Application* John Wiley & Sons

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

**Course No.** : ES 411

**Course Title** : Medical Geology & Environmental Toxicology

**Credits** : 02

**Prerequisites** : None

**Compulsory/Optional:** Optional

**Aims and/or Objectives and/or Intended Learning Outcomes:**

This course aims to deliver introductory materials on geological elements and their health issues, case studies on specific geological elements.

**Course Syllabus / Course Description**

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 in human health; Tropical environmental geochemistry; Case studies- (fluoride, iodine, water hardness, arsenic, selenium etc.); Geophagy; Natural radioactivity and health; Environmental toxicology of natural dust; Analytical methods; Health benefits of rocks and minerals. Toxic chemicals in the environment, persistent organic pollutants, heavy metal toxicity, carcinogenic and Mutagenic effects of industrial chemicals, 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; Bioaccumulation and biomagnifications; Chronic toxicity; Mixture of poisons; Sub lethal effects; Environmental factors affecting toxicity, Biochemical assays in environmental toxicology; Environmental Risk assessment.

**Recommended Texts:**

1. Essentials of Medical Geology - Impacts of the Natural Environment on Public Health, O.B.J. Selinus, J.A. Alloway, R.B. Centeno, R. Finkelman, U. Fuge Lind and P. Smedle, Elsevier Academic Press, 2005.
2. Medical Geology - Effects of Geological Environments on Human Health, M. Komatina, Elsevier Science Publishing Co., 2004.
3. Geosciences, Environment and Man, H. Chamley, Boston, MA: Elsevier Science Publishing Co., 2003.
4. C.B. Dissanayaka, R. Chandrajith, Medical Geochemistry of Tropical Environments, Earth Science Reviews 47: 219-258, 1999.
5. Chemical Fate and Transport in the Environment, H.F. Hemond and E.J. Fechner-Levy, 2000.
6. Environmental Toxicology, Cambridge Environmental Chemistry Series (No 11) D.A. Wrightk, P Welbourn, Cambridge Press, 2002.



Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 412 <b>Course Title</b> : Nanotechnology and the Environment <b>Credits</b> : 02 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Optional
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide basics on nanotechnology and its environmental applications.
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> 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.
<b>Recommended Texts:</b> 1. Spinger Hand Book of Nanotechnology, Bharat Bhushan, 2004.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<b>Course No.</b> : ES 413 <b>Course Title</b> : Environmental Economics <b>Credits</b> : 02 <b>Prerequisites</b> : None
<b>Compulsory/Optional:</b> Optional
<b>Aims and/or Objectives and/or Intended Learning Outcomes:</b> This course aims to provide a knowledge on Environmental economics
<b>Environmental Economics:</b> 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.
<b>Recommended Texts:</b> 1. Environmental Economics, C. Kolstad, Oxford University Press, 2000.

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<p><b>Course No.</b> : ES 414 (same as BT 412)  <b>Course Title</b> : Applied Microbiology  <b>Credits</b> : 02  <b>Prerequisites</b> : BT 302</p>
<p><b>Compulsory/Optional:</b> Optional</p>
<p><b>Aims and/or Objectives and/or Intended Learning Outcomes:</b>  This course aims to provide knowledge on applied microbiology in environmental remediation.</p>
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> <p>Microorganisms with industrial and environmental use and their products; Growth and product formation in industrial processes, large scale fermentations: Food, alcoholic beverages, animal feed, single cell proteins, antibiotics, organic acids, amino acids, enzymes, vitamins; Fuel and energy; Water microbiology; Waste water treatment and utilization; Setting up a microbiological laboratory; Selected titles from the above course content will be offered each year.</p>
<p><b>Recommended Texts:</b></p> <ol style="list-style-type: none"> <li>1. Principles of Microbiology, R.M. Atlas, Mosby Publishing, 1995.</li> <li>2. Microbial Biotechnology. Fundamentals of Applied Microbiology, A.N. Glazer, and H. Nikaido, W.H. Freeman &amp; Company, 1995.</li> <li>3. Brock Biology of Microorganisms. M.T. Madigan, J.M. Martinko, J. Parker (10<sup>th</sup> Edition). Prentice Hall, 2002.</li> </ol>

Assessment	Percentage Mark
Continuous assessment	40%
End semester examination	60%

<p><b>Course No.</b> : ES 415 (same as AS 402)  <b>Course Title</b> : Research Methodology and Scientific writing  <b>Credits</b> : 02  <b>Prerequisites</b> : None</p>
<p><b>Compulsory/Optional:</b> Compulsory</p>
<p><b>Aims and/or Objectives and/or Intended Learning Outcomes:</b>  This course aims to train students in literature search, scientific writing and to develop skills in presentations.</p>
<p style="text-align: center;"><b>Course Syllabus / Course Description</b></p> <p>Literature survey and quantitative research method; Writing scientific papers and project Proposals; Organization and content; Guidelines for writing under different headings;</p>

Scientific presentations; Guidelines for preparation of presentations; Effective use of visual aids; Delivery and presentation style.

Assessment	Percentage Mark
Oral presentation	40%
Report	60%

**Course No.** : ES 416

**Course Title** : Seminar

**Credits** : 01

**Prerequisites** : None

**Aims and/or Objectives and/or Intended Learning Outcomes:**

This course aims to train students to acquire knowledge on a selected topic, to develop presentation skills and to be confident in oral defense.

Seminars on assigned topics in Environmental Science should be presented after due preparation and literature survey by the students.

**Evaluation:** Students will be graded by the supervisor and two examiners on the basis of their performance.

**Course No.** : ES 417

**Course Title** : Research Project

**Credits** : 06

**Prerequisites** : None

**Aims and/or Objectives and/or Intended Learning Outcomes:**

This course aims to train students to carry out independent research projects and to prepare research reports and papers.

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 and prepare a comprehensive report containing Title page, Abstract, Introduction and Literature Review, Objectives, Materials & Methods, Results, Discussion and References.

**Evaluation:** Students will be graded by the supervisor and two examiners on the basis of their report and oral presentation.