South Eastern University of Sri Lanka

Faculty of Applied Sciences

Course Specifications

of the

Honours Degree Courses

2020/2021

Applied Biology

Course Title	Apiculture			Course Code	BLH 31212		
				Prerequest			
Level	3	Semester	I	Credits	2	Theory (hr)	22
						Practical/Field (hr)	16
						Independent Learning (hr)	62

Aim of the Course:

1. To become familiar with different equipment used in modern beekeeping for domesticating hive bees.
2. To get detailed information on the structure and size of movable frame hives used for domestication of *Apiscerana* and *Apis mellifera*.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Learn the history of bee keeping in South Asian Countries including Sri Lanka and the advance bee keeping techniques.
2. Identify the kinds of bees and characteristic features of their society.
3. Handle the bees and queen rearing and requeening.

Course Content:

History of bee keeping and importance, kinds of bees and their society, anatomy and life cycle of bee; Environment of bee keeping, artificial feeding, swarm, and its controls; Increasing bee colonies, bee diseases; Handling bees: queen rearing and requeening, bee migration; Extraction of honey: processing, storing and packaging honey, advanced bee keeping techniques; modern trend in apiculture and problems of bee keeping in Sri Lanka. Laboratory exercises/Field visits based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Bee keeping in India (1994) G. K. Ghosh, Published by s. G. Nangia.
2. The bee-master's companion, and assistant Bonner, James 1 edition - first published in1789
3. Keeping bees (1983), Franklin H.
4. Bees & bee-keeping (1886) Frank Richard Cheshire (ebook).
5. Tips and Tricks in Beekeeping (1999) Franklin H.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Economic Marine Biology</td><td colspan="2">Course Code</td><td colspan="3">BLH 31223</td></tr>
<tr><td colspan="2">Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>33</td></tr>
<tr><td>Practical/Field (hr)</td><td>36</td></tr>
<tr><td>Independent Learning (hr)</td><td>81</td></tr>
</table>

Aim of the Course:

To develop a critical understanding on the ecological issues of the islands and in coastal Sri Lanka pertaining to marine environments;
To demonstrate the marine resource depletion and over exploitation and the roles of state, and local governments.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Provide students with the fundamental knowledge of the basic ecological and oceanographic principles that influence marine life, and students with a survey of marine organismal biology and diversity.
2. comprehend the importance and unique characteristics of different marine ecosystems.
3. Demonstrate the marine resource depletion and over exploitation and the roles of state, and local governments.
4. Provide opportunities for students to apply fundamental knowledge of marine biology while conducting field investigations.

Course Content:

Aquaculture & conservation: Aquaculture of marine organisms, Principles of Marine Eco Physiology, Marine Biodiversity Conservation practices, Principles of sustainable development & Fisheries management; value addition to sea food: Preserving fish as food or specimens, Methods of food analysis, Sea Food & Human Nutrition, Biologically active fish products, Sea Food safety, regulations & quality control; marine ornamental fish and other organisms and its trade: Aquarium & Ornamental organisms, Rearing of marine aquarium fish, Aquarium fish trade. Laboratory exercises/Field visits based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Aquaculture 2nd Edn. Ed. John Lucas* and Paul C Southgate (School of Biological Sciences, James Cook University, Australia).
2. Seafood Processing: Adding Value Through Quick Freezing, Retortable Packaging and Cook-Chilling (Food Science and Technology) (2005) Ed.
3. Vazhiyil Venugopal, Blackwell CRC Press.
4. Marine Ornamental Species: Collection, Culture and Conservation (2008) JC. Cato and CL. Brown, John Wiley &Sons.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Natural Resource Management</td><td>Course Code</td><td colspan="3">BLH 31232</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide students with an understanding of environmental, socioeconomic and policy perspectives on resource relationships, with an insight into the paradigms of conservation and sustainable development, and with a policy background to an understanding of resource use and planning issues.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Identify and evaluate diverse sources of knowledge, arguments and approaches pertinent to exploring environment and resource management problems.
2. how basic economic theory can be used to understand and analyze natural resource utilization.
3. the relationship between human activity and the world's natural resources
4. analyze and understand "real world" natural resource issues, with a Sri Lankan perspective.

Course Content:

Introduction: Classification of resources- Renewable, non- renewable; Allocation of Depletable and Renewable Resources: Introduction: Resource taxonomy; depletable, non recyclable energy resources: Oil, gas, coal: Optimal extraction, Oil: The Cartel problem, Natural gas: Price controls; recyclable resources: minerals: Optimal extraction: replenishable but depletable resources: Water: Introduction, the efficient allocation of scarce water- surface water, ground water; reproducible private — property resources: agriculture: Introduction, Global Scarcity; storable renewable resources: forests: Introduction: Efficient management: Special attributes of timber resource, The biological dimension, The Economics of forest harvesting; renewable common property resources: property rights, externalities and environmental problems:

Property rights and efficient market allocations- Producer surplus, Scarcity rent, Externalities as a source of market failure- Concept introduced, Types of externalities, Public goods.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Environmental and Natural Resource Economics (2008) T. Titenberg, Pearson Education, USA.
2. Natural Resource and Environmental Economics (1999) T. prato. Wiley-Blackwell, UK.
3. Natural Resource Economic Notes and Problems (1987) JM Cornard and CW Clark, Cambridge Univ.Press.
4. Conservation of Biological Resources (1998) EJ. Milner- Galland and R Maie, Willey- Blackwell.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Animal Breeding</td><td>Course Code</td><td colspan="3">BLH 31241</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>11</td></tr>
<tr><td>Practical/Field (hr)</td><td>12</td></tr>
<tr><td>Independent Learning (hr)</td><td>27</td></tr>
</table>

Aim of the Course:

To impart knowledge on reproductive systems, the genetic basis of breeding, and scientific principles of conventional and molecular breeding techniques on increased yields, disease resistance, hardiness, and appearance of livestock.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Recognize the genetic and environmental interactions on production traits.
2. Demonstrate the understanding of scientific principles of inbreeding and cross-breeding on the production traits of livestock.
3. Identify conventional and modern breeding techniques in the enhancement of livestock.

Course Content:

Traits of economic importance of dairy and beef cattle. Measurements, correlation among production traits; genetics and environmental interaction; selection and response to selection; genetic defects; inbreeding; cross breeding; use of reproductive technologies in breeding, molecular breeding, QTL mapping, marker assisted selection. Laboratory exercises/Field visits based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Quantitative Genetics with Special Reference to Plant and Animal Breeding (1996) Ralph E. Comstock, Wiley-Blackwell; 1stedition.
2. Breeding plants and animals (2009) W. M. Willet Martins., Cornell University Library.

Course Title	Animal Husbandry			**Course Code**	BLH 41211		
				Prerequest			
Level	4	**Semester**	I	**Credits**	1	**Theory (hr)**	11
						Practical/Field (hr)	12
						Independent Learning (hr)	- 27

Aim of the Course:

. **Course Aim:**

1. To impart knowledge on scientific principles in animal physiology, behavior and bioethics.
2. To develop skills in breeding, data handling and veterinary analytical techniques.
3. To provide exposure to applied aspects of animal business, animal industry and animal husbandry with insight into conservation and integrated health management.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Recognize basic concepts in animal nutrition, animal physiology, behavior bioethics, animal health and welfare, integrated health management and epidemiology of diseases.
2. Identify the aspects of animal business practice, animal industry and land-based business management.
3. Demonstrate understanding of practical skills in the areas of breeding, data handling and basic laboratory and veterinary analytical techniques.

Course Content:

Introduction, Exotic and domestic animals, basic concepts in animal nutrition, animal psychology, applied animal health and welfare, applied aspects of animal business practice, animal industry and trade, behavior ecology, breeding, conservation and management. integrated health management; bioethics; epidemiology of disease; data handling; Animal adaptation land-based business management; applied animal husbandry, Basic laboratory and veterinary analytical techniques. Laboratory exercises/Field visits based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. A text book of Animal husbandry (1991) GC. Banerjee, Oxford and IBH.
2. Textbook of Animal Husbandry (2012) MK. Rai, Oxford Book Company.
3. Textbook of Animal Husbandry & Livestock Extension (3rd Revised &Enlarged) (2012) P. Mathialagan, Int. Book Distributing Co.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Parasitology and Vector Biology</td><td>Course Code</td><td colspan="3">BLH 41242</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>54</td></tr>
</table>

Aim of the Course:

1. To impart knowledge on scientific principles in animal physiology, behavior and bioethics.
2. To develop skills in breeding, data handling and veterinary analytical techniques.
3. To provide exposure to applied aspects of animal business, animal industry and animal husbandry with insight into conservation and integrated health management.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Explain cellular and humoral mechanisms involved in immunity, and the immunology of protozoan and helminth infections.
2. Understand the molecular basis of the life cycle of parasites, drug targets, and mechanism of resistance.
3. Explain vectors and diseases carried by them, lifecycles of medically important insects and arthropods, their behavior and transmission potential, and behavioral pattern of blood feeding vectors.
4. Explain molecular approaches of identification, taxonomy and application of modern techniques of vector control.

Course Content:

Introduction, Mammalian immune system, Cellular and humoral mechanisms involved in immunity, Regulation of the immune response, In depth studies into the immunology of selected helminthes and protozoan infections, Molecular biology of Plasmodium – lifecycle, drug targets and mechanisms of resistance, vaccine strategies and proteomic approaches, Molecular biology of Leishmania – virulence and drug resistance, Molecular biology of nematodes – lifecycles, chemotherapy, vaccine strategies; VECTOR BIOLOGY: Introduction, major vector groups in Medical Entomology (arthropods; insects), their behavior and transmission potential and the application of modern control techniques, Introduction to Culicidae and Anopheline Mosquitoes, Mosquito Reproduction, Molecular Insect Control, Blood Feeding in Vectors, Species Complex, New Approaches to Identification , Host Finding behavior, Molecular approaches to diagnosis and taxonomy & identification of vectors. Laboratory exercises based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Modern Parasitology: A Textbook of Parasitology 2nd Edn. (1993) FEG Cox Wiley-Blackwell.
2. Parasitism: The Diversity and Ecology of Animal Parasites (2001) AO. Bush et al., Cambridge University Press
3. Parasitology and Vector Biology, Second Edition (1999) WH. Marquardt et al., Academic Press.
4. Biology of Disease Vectors, Second Edition (Marquardt, Biology of Disease Vectors) (2004) Ed. WH. Marquardt, Academic Press
   Vector Biology, Ecology and Control (2009) Ed. PW. Atkinson

Course Title	Seminar – Applied Biology			**Course Code**	BLH 41221		
				Prerequest			
Level	4	**Semester**	1	**Credits**	1	**Theory (hr)**	
						Practical (hr)	-
						Independent Learning (hr)	50

Aim of the Course:

To develop interest on current developments and applications of the subject area.
To develop skills self-learning and oral communication.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Keep track on current developments in the subject area
2. Gather knowledge/relevant data and organize.
3. Prepare audiovisual aids for presentations.
4. Convey a scientific message orally in an attractive and concise manner.

Course Content:

Awareness lectures and discussions on presentation skills.
An individual seminar should be presented on a topic, on an issue at the forefront, selected with the consent of the assigned supervisor.

Mode of Assessment and weightage:

- Oral presentation – 100%

Course Title	Research Project - Applied Biology			**Course Code**	BLH 42216		
				Prerequest			
Level	4	**Semester**	II	**Credits**	6	**Student – Supervisor contact (hrs.)**	60
						Independent Learning (hrs.)	540

Aim of the Course:

To provide an opportunity for students to plan and execute a research project independently.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Search, analyze and summarize current literature relevant to a specific topic of his/her area of expertise.
2. Rationalize the research gap for innovation.
3. Design and implement a suitable experimental / theoretical procedure.
4. Comprehend expertise on maintaining a lab logbook, data analysis, scientific report writing.
5. Exposure for safe laboratory practices by handling high-end equipment.
6. Communicate any findings and defend the work in a professional manner.

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Industrial Training - Applied Biology</td><td>Course Code</td><td colspan="3">BLH 41232</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td></td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>200</td></tr>
</table>

Aim of the Course:

To expose students to real work of environment and gain knowledge and skills in work ethics, communication, management etc.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. apply subject knowledge and skills to real work situations.
2. work with responsibility, commitment and other good workhabits.
3. to write reports on technical works/projects.
4. perform with self-confidence, strength, teamwork spirit, good communication skills etc.

Course Content:

Working in some established subject relevant industry, institute, enterprise etc. either state or private full time for four weeks either continuously or staggered during semester end vacation periods, on a program agreed by the Department and the host institute with the supervision of a senior academic from the department and an executive of the host institute

Mode of Assessment and weightage:

Log book 20%
Progress reports 20%
Presentation and viva 20%
Final report 20%

Applied Geology

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Petrology for Applied Geology</td><td>Course Code</td><td colspan="3">ESH 31212</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the students with advanced knowledge in applications of petrology

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Interpret the cooling history of a given igneous rock by means of textures and mineralogy
- Deduce the magmatic hydrothermal systems for genesis different ore deposits
- Construct the paleo-sedimentological environment and provenance of a given sedimentary rock
- Construct the P-T-t history of a given metamorphic terrain
- Infer the petrogenesis of metamorphic mineralization

Course Content:

Processes in magma formation, transport, emplacement, and mechanisms of magmatic differentiation; Petrogenesis of specific igneous rocks, magmatic hydrothermal systems and ore formations; Depositional environments and diagenesis of clastic rocks, Carbonate sedimentary rocks, Stratigraphy and paleontology, Petroleum resources, Metamorphic phase equilibrium and P-T-t history, Introduction to thermodynamics, Geothermometry and geobarometry, metamorphic processes, fluids and associated mineralization

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Bucher, K., & Frey, M. (2002). Petrogenesis of metamorphic rocks. Springer Science & Business Media.
2. Burnham, C. W., & Yoder, H. S. (1979). The evolution of the igneous rocks.
3. Reineck, H. E., & Singh, I. B. (2012). Depositional sedimentary environments: with reference to terrigenous clastics. Springer Science & Business Media.
4. Ridley, J. (2013). Ore Deposit Geology.
5. Spear, F. S.(1995). Metamorphic phase equilibria and pressure-temperature-time paths.
6. Tucker, M. E. (Ed.). (2009). Sedimentary petrology: an introduction to the origin of sedimentary rocks. John Wiley & Sons.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Practical in Applications of Petrology</td><td>Course Code</td><td colspan="3">ESH 31221</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td></td></tr>
<tr><td>Practical/Field (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>05</td></tr>
</table>

Aim of the Course:

To provide the students with practical knowledge in applied petrology by means of micro-analytical and experimental methods

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the specific mineral textures of igneous and metamorphic rocks in the field and deduce the petrogenesis of the terrain
- Evaluate and interpret the origin of magmatic ore mineralization using field and micro-analytical methods.
- Evaluate and interpret the origin of metamorphic mineralization using field and micro-analytical methods.

Course Content:

Microscopic investigation of metamorphic and igneous mineral textures and reactions for understanding petrogenetic history, Identifying the ore minerals and their textures, Identifying the microscopic textures of metamorphic mineralization, Identification of mineral textures of igneous and metamorphic rock in the field, identify the field settings of magmatic and metamorphic mineralization.
Practical, Group Discussions and Field Visits

Mode of Assessment and weightage:

- Continuous Assessment (Field report, practical Report, oral Presentation etc.) – 50%
- End Semester Examination – 50%

References:

1. Bucher, K., & Frey, M. (2002). Petrogenesis of metamorphic rocks. Springer Science & Business Media.
2. Burnham, C. W., & Yoder, H. S. (1979). The evolution of the igneous rocks.
3. Reineck, H. E., & Singh, I. B. (2012). Depositional sedimentary environments: with reference to terrigenous clastics. Springer Science & Business Media.
4. Ridley, J. (2013). Ore Deposit Geology.
5. Spear, F. S.(1995). Metamorphic phase equilibria and pressure-temperature-time paths.
6. Tucker, M. E. (Ed.). (2009). Sedimentary petrology: an introduction to the origin of sedimentary rocks. John Wiley & Sons.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Mineral resources and processing</td><td>Course Code</td><td colspan="3">ESH 31232</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical/Field (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the students with economic mineral resources and their processing techniques

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify common economic mineral resources with their industrial uses
- Explain the principles associated with the simple mineral processing practices in the mineral processing industry
- Determine the appropriate techniques in value addition of minerals
- Explain the potentials in modern Nano-technological concepts in mineral processing

Course Content:

Economic minerals and their applications, Different geological processes for ore genesis, Identification of economic minerals, Particle size analysis, Fine particle production, Crushing and grinding Systems, Screening and classification, Gravity separation, Heavy-medium separation, Magnetic and electrostatic separation, Froth flotation, Dewatering, Mineral value addition, Nanotechnology in mineral processing.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Aswathanarayana, U. (2003). Mineral resources management and the environment. CRC Press.
2. Pohl, W. L. (2011). Economic geology: principles and practice. John Wiley & Sons.
3. Ridley, J. (2013). Ore Deposit Geology.
   Fuerstenau, M. C., & Han, K. N. (Eds.). (2003). Principles of mineral processing. SME.

Course Title	Practical in Mineral Processing			Course Code	ESH 31241		
				Prerequest			
Level	3	Semester	I	Credits	1	Theory (hr)	-
						Practical/Field (hr)	45
						Independent Learning (hr)	05

Aim of the Course:

To provide the students with the practical knowledge on mineral processing methods.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Operate metallurgical microscope for economic mineral identifications
- Identify common economic minerals in the field and using laboratory analysis
- Apply basic techniques in minerals processing
- Determine the suitable techniques for processing and value addition of minerals

Course Content:

Introduction to metallurgical microscope, Field and laboratory identifications and classification of economic minerals, Simple geochemical methods for economic mineral identifications, Grade of ore calculations, Physical liberation processes, Chemical upgrading processes, Metallic element extractions, Nanotechnological applications for processing.

Group discussions, Practical / Field visits, individual/group project, Case study

Mode of Assessment and weightage:

- Continuous Assessment (Assignments, Lab Report, Oral Presentation etc.) – 50%
- End Semester Examination – 50%

References:

1. Fuerstenau, M. C., & Han, K. N. (Eds.). (2003). Principles of mineral processing. SME.
2. Kelly, E. G., Spottiswood, D, J., 1982. Introduction to Mineral Processing.
3. Pryor, M. R. (2012). Mineral processing. Springer Science & Business Media.
4. Wills, B. A., & Finch, J. (2015). Wills' mineral processing technology: an introduction to the practical aspects of ore treatment and mineral recovery. Butterworth-Heinemann.

Course Title	Environmental Geology			Course Code	ESH 31252		
				Prerequest			
Level	3	Semester	I	Credits	1	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with the environmental issues related to Geology

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the principal techniques used in environmental geochemistry
- Characterize natural and anthropogenic processes and issues relevant to terrestrial systems
- Apply organic and geochemical tracers to understand natural processes
- Recognize the sources of water and air pollution and assess the impact of the pollutants on decline of environmental quality

Course Content:

Biogeochemical cycles, Rainwater chemistry, Elements acquisition during water-rock interaction, Anthropogenic inputs to water, Equilibrium thermodynamics, Activity-concentration relationships, Water quality standards, Water quality and health, Monitoring of water quality (sampling, laboratory analysis, reporting, etc.), Purification of water for domestic purposes, Natural and anthropogenic sources of air pollution, Main air pollutants, Acid rains, Greenhouse effect, Monitoring of air quality

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Andrews, J. E., Brimblecombe, P., Jickells, T. D., Liss, P. S., & Reid, B. (2009). An introduction to environmental chemistry. John Wiley & Sons.
2. Eby, G. N. (2016). Principles of environmental geochemistry. Waveland Press.
3. Gill, R. (2014). Chemical fundamentals of geology and environmental geoscience. John Wiley & Sons.
4. Merkel, B. J., Planer-Friedrich, B., & Nordstrom, D. K. (2005). Groundwater geochemistry. A practical guide to modeling of natural and contaminated aquatic systems, 2.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Geohazards Management</td><td>Course Code</td><td colspan="3">ESH 31261</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical/Field (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

To provide the students with the fundamentals of geo-hazards management

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe the nature and key processes behind a diverse range of geohazards
- Undertake a hazard zonation, vulnerability assessment, risk evaluation for a given geo-hazards prone area
- Recommend appropriate mitigation measures, risk reduction and management strategies for a particular geo-hazard.

Course Content:

Introduction to geo-hazards, Mass movements and land subsidence, Soil erosion, Floods, Earthquakes, Tsunamis, Volcanic activity, Thunderstorms & tornadoes, Hurricanes, Climate change & El Nino, Concepts in hazard mapping, Concepts in vulnerability assessment and risk analysis, Applications of Remote Sensing in management of geo-hazards.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Chu, J., Wardani, S. P., & Iizuka, A. (2013). Geotechnical predictions and practice in dealing with geohazards. Springer.
2. Coch, N. K. (1995). Geohazards: natural and human. Prentice Hall.
3. Jakob, M., Porter, M., & Savigny, W. (2006). Geohazard Risk Management for Linear Facilities. Springer Bln.
4. Waugh, W. L. (1999). Living with hazards, dealing with disasters: An introduction to emergency management. ME Sharpe.

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Field Geology</td><td>Course Code</td><td colspan="3">ESH 32211</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical/Field (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>05</td></tr>
</table>

Aim of the Course:

To provide the student with cutting-edge skills in field to develop a geological map.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Apply mapping methods, such as remote sensing, GIS and GPS for field mapping
- Produce a detailed geologic map of a complex geologic terrain
- Compile a geological field report
- Interpret a geological map/field report to understand the geological characteristics of a given terrain

Course Content:

Techniques used in field data collection, integrate geology and advanced structural measurements in regional scale, Analysis and interpretation of geological structures using stereographic projections, Presenting geological findings in written and oral forms for technical and non-technical communities, Planning field mapping project using available data, Obtain related field observations and measurements while maintaining a geological field note book, Compile the obtained data to a standard geological map, Present the data in the form of a comprehensive geological report, Interpretation of geological and structural data of a given area.

Field visits, Report writing

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Assaad, F. A., LaMoreaux, J. W., & Hughes, T. (Eds.). (2013). Field methods for geologists and hydrogeologists. Springer Science & Business Media.
2. Compton, R.R. (1985). Geology in the Field. John Wiley and Sons.
3. Passchier, C. W., Myers, J. S., & Kröner, A. (2012). Field geology of high-grade gneiss terrains. Springer Science & Business Media.
4. Lahee, F.H. (1981). Field Geology. McGraw-Hill Co., NY.

<table>
<tr><td>Course Title</td><td colspan="3">GIS and Remote Sensing</td><td>Course Code</td><td colspan="3">ESH 32221</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical/Field (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

To provide students with fundamentals and applications of remote sensing and GIS

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the data sources available for RS and GIS
- Extract main appropriate data sources for GIS and remote sensing applications

Course Content:

Introduction to remote sensing, Active vs. passive remote sensing, Principles of remotely sensed data (satellite and aerial photos, image radar, LiDAR), GPS assemblage and data structure, Differential GPS, Data logging schemes, GPS post-processing software, Map projections, Datum and reference frames, Vector- and raster-based data models, Geospatial data resources.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
2. Chang, K. T. (2006). Introduction to geographic information systems (pp. 117-122). Boston: McGraw-Hill Higher Education.
3. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote sensing and image interpretation. John Wiley & Sons.
4. Skidmore, A. (Ed.). (2017). Environmental modelling with GIS and remote sensing. CRC Press.
5. Star, J., & Estes, J. E. (1990). Geographic information systems: an introduction (Vol. 303). Englewood Cliffs, NJ: Prentice Hall.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Practical in GIS and Remote Sensing</td><td>Course Code</td><td colspan="4">ESH 32231</td></tr>
<tr><td>Prerequest</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical/Field (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>05</td></tr>
</table>

Aim of the Course:

To provide students with applications of remote sensing and GIS in data analysis

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Apply updated GIS/remote sensing software in map development
- Apply GIS/remote sensing knowledge to analyze geology related problems

Course Content:

Gathering GPS data, GPS post-processing software, GIS software, Cartographic principles in GIS mapping, Integration of GPS and GIS in mapmaking and interpolation, GIS applications in geology

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Bhatta, B. (2008). Remote sensing and GIS. Oxford University Press, USA.
2. Chang, K. T. (2006). Introduction to geographic information systems (pp. 117-122). Boston: McGraw-Hill Higher Education.
3. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote sensing and image interpretation. John Wiley & Sons.
4. Skidmore, A. (Ed.). (2017). Environmental modelling with GIS and remote sensing. CRC Press.
5. Star, J., & Estes, J. E. (1990). Geographic information systems: an introduction (Vol. 303). Englewood Cliffs, NJ: Prentice Hall.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Coastal Geology</td><td>Course Code</td><td colspan="4">ESH 32242</td></tr>
<tr><td>Prerequest</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical/Field (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the students with general knowledge in coastal geology

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Interpret and explain the relationships between coastal morphology and the coastal process.
- Identify coastal geomorphological features and different zones of the coast in the field.
- Interpret the morphological changes of coast with time.
- Deduce the provenance of coastal sediment/mineral deposit.

Course Content:

Introduction to the Coastal Zone, Ocean waves and currents, Coastal Processes vs. geomorphology, Estuaries, wetlands, and lagoons, Plate tectonic for understanding of continental margins and morphology of ocean floor, Coastal vs. marine sediments, Sediment transport and deposition regimes, Coastal mineral resources, Common minerals in Sri Lankan coastal sediments, Coastal evolution, Sea level fluctuations, Introduction to coastal zone hazards, Coastal ecosystem, conflicts and management.
Field visit and report writing.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Berd, E.C.F. (2007). Costal Geomorphology: an introduction. John Wiley & Sons.
2. Seibold, E., & Berger, W. (2017). The Sea Floor: An Introduction to Marine Geology. Springer
3. Krishnamurthy, R. R., Jonathan, M. P., Srinivasalu, S., & Glaeser, B. (Eds.). (2018). Coastal Management: Global Challenges and Innovations. Academic Press.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Geological Health Hazards</td><td>Course Code</td><td colspan="3">ESH 32252</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical/Field (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the students with comprehensive knowledge in geological health hazard

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the natural harmful substances in air, water and soil
- comprehend the physical, chemical, and biological processes associated with natural health risk
- Propose the cause for specific health hazard by understanding the connection between geological processes and human health

Course Content:

Fundamental concepts in medical geology, Natural Geological Process vs. Human Health, Geochemistry of hazardous elements, their sources and release to the environment, Anthropogenic influences on natural geological systems, Harmful accumulates in air, water and soil and their effects on human health, Geochemical tools in health potential and risk studies, Mitigation of health hazards, Discussion of case studies related to specific health hazards and their geological origin.Case studies, Group Discussions

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Botkin and Keller, Environmental Science: Earth as a Living Planet, Wiley.
2. Selinus and others, (2013). Essentials of Medical Geology, Revised, Springer.
3. Skinner and Berger, (2003). Geology and Health: Closing the Gap, by Oxford University Press.
4. Sahai and Schoonen, (2006). Medical Mineralogy and Geochemistry, by, Geochemical Society and Mineralogical Society of America.

Course Title	Industrial Training			Course Code	ESH 32262		
				Prerequest			
Level	3	Semester	II	Credits	2	Theory (hr)	-
						Practical/Field (hr)	-
						Independent Learning (hr)	200

Aim of the Course:

To produce Applied Geology honors degree graduates who are skilled in the variety of industrial activities specified by the geology related governmental, non-governmental agencies (NGO's) and private industries of Sri Lanka.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- improve personal maturity and professional attitude
- identify present day needs of Sri Lankan employers in the field of Geology
- conduct an independent literature review on a selected topic
- recognize methods used to analyze quantitative and qualitative data
- apply statistical methods to analyze quantitative data
- write a formal scientific report on a selected topic
- make a presentation on a selected topic

Course Content:

Each student will undergo full time training in the industry for the recommended period on projects assigned by the industry and are expected to attain hands on capabilities of Geology as well as other fields such as, administration, management, sustainable development, work ethics, safety, quality control etc. The minimum training period should be 8-weeks. Throughout their stay at the industry, they should, (i) maintain a daily diary and (ii) submit their employers report in every two weeks to the Head of the Department. In addition, the students are expected to submit a comprehensive report and make a presentation on their work carried out in industries within two weeks after completion of the training.

Mode of Assessment and weightage:

- Continuous Assessment (Attendance (15 %), Daily Diary (15 %), Employers Report (30 %))– 60%
- Oral examination (15%) Comprehensive Report (25 %)

References:

1. Blackwell, J., & Martin, J. (2011). A scientific approach to scientific writing. Springer Science & Business Media.
2. Creme, P., & Lea, M. (2008). Writing at university: A guide for students. McGraw-Hill Education (UK). Swales, J. M., & Feak, C. B. (2004). Academic writing for graduate students: Essential tasks and skills (Vol. 1). Ann Arbor, MI: University of Michigan Press.
3. Whetten, D. A. and Cameron, K. S. (2019) Developing management skills- 10th Ed.

Course Title	**Seminar on Current Earth Science Interest**			**Course Code**	**ESH 41211**		
				Prerequest			
Level	4	**Semester**	I	**Credits**	1	**Theory (hr)**	-
						Practical/Field (hr)	-
						Independent Learning (hr)	50

Aim of the Course:

To provide students with the capability to study and present on a given scientific topic individually

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Analyze scientific information published in research articles
- Interpret scientific data
- Organize a presentation for a scientific meeting
- Respond for scientific questions raised by a scientific community

Course Content:

Students should critically read selected research papers under the given themes published in leading indexed journals and other magazines, Based on this extensive literature review, student should present her/his finding under given theme at the seminar organized by the Department.

Mode of Assessment and weightage:

- Oral Presentation – 100%

References:

1. Amato N. (2008) How to make multimedia presentations for briefings, conferences and seminars effectively.
2. Reis, R. M. (2012). Tomorrow's professor: Preparing for academic careers in science and engineering. John Wiley & Sons.
3. Tigner, T. (2015) Seminars and Training Made Easy: Become A Polished Trainer, Presenter, and Leader of Seminars. Krishna Communications LLC.

Course Title	Analytical Techniques and Geo-statistics			Course Code	ESH 41222		
				Prerequest			
Level	4	Semester	I	Credits	2	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with common analytical techniques in geoscience

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the theoretical aspects of key analytical techniques and instruments
- Select appropriate sampling and analytical methods for a given geological sample
- Decide the correct sample preparation and characterization prior to analysis
- Statistically analyze geological data accurately and preciously
- Interpret the geological data with respect to the most appropriate statistical method
- Present geological data more simplified and comprehensible formats

Course Content:

Fundamental of geological materials analysis, Methods of sample collection, preservation, preparation and separation, Quality control in analytical process, Laboratory safety, instrumentation and calibration, Analytical instruments in field (pH meters, multiparameters, Thermometers, etc.), Spectroscopic methods (Atomic absorption spectroscopy (AAS), Inductive coupled Plasma Spectroscopy (ICP-MS/OES), UV Visible spectrophotometer), X-ray and IR techniques (X-ray powder diffraction (XRD), X-ray spectroscopy (XRF), Fourier Transformation Infra-Red (FTIR), Scanning Electron Microscopy (SEM)), Thermal analysis (Thermogravimetric analysis (TGA), Simultaneous thermal analyzer, Differential thermal analysis),Basic statistics, Graphical data interpretations and presentations, Simple software applications in Geo-statistics.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Davis, J.C. and Sampson, R.J., 1986. Statistics and data analysis in geology (Vol. 646). New York et al.: Wiley.
2. Grice, K. (Ed.). (2014). Principles and practice of analytical techniques in geosciences (Vol. 4). Royal Society of Chemistry.
3. Koch, G.S. and Link, R.F., 2002. Statistical analysis of geological data. Courier Corporation.
4. Swan, A. R. H. and Sandilands, M. 1995. Introduction to Geological Data Analysis, Blackwell, Oxford.

Course Title	Advanced Geochemistry			Course Code	ESH 41232		
				Prerequest			
Level	4	Semester	I	Credits	2	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students geochemistry behind the earth systems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the geochemistry in aqueous systems
- Elaborate the stability of an element in different systems
- Identify the geochemical reactions on the formation of mineral deposits
- Classify the biogeochemical cycles

Course Content:

Geochemical systems, Aqueous geochemistry and stability of minerals, Eh-pH diagrams, Biogeochemistry, Mineral reactions, Solid Earth geochemistry, Laws of thermodynamics

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Faure, G., (1997), Principles and applications of Geochemistry, Pearson publications.
2. White, W., (2020), Geochemistry, Kindle Edition
3. Holland, H. D., & Turekian, K. K. (Eds.). (2010). Geochemistry of earth surface systems: A derivative of the treatise on geochemistry. Academic Press.
4. Alexandre, P. (2021). Environmental Geochemistry. In Practical Geochemistry (pp. 85-99). Springer, Cham.

Course Title	Marine resources and protection			Course Code	ESH 41242		
				Prerequest			
Level	4	Semester	I	Credits	2	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with the basics on protection of Marine resources.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Classify Physical and Biological marine resources
- Categorize food, energy and mineral marine resources based on the utilizations
- Explain the significance of oceanic water for pervasiveness of renewable marine resources
- Discuss the importance of marine environment for the origin of offshore petroleum resources and methane hydrates
- Describe the sustainable use of marine resources

Course Content:

Introduction to physical and biological marine resources, Oceanic waters and sea floor chemistry to occur mineral resources, Biological entities as marine food resources and its significance, Connectivity of oceanic water and renewable marine resources, correlation between marine environment and offshore petroleum resources, sustainable use of marine resources.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Smith, H. D., Suárez de Vivero, J. L., & Agardy, T. S. (2015). Routledge Handbook of Ocean Resources and Management (p. 626).
2. Hailwood, E. A., & Kidd, R. (Eds.). (2012). Marine Geological Surveying and Sampling. Springer Science & Business Media.
3. Blake, G. H. (Ed.). (1987). Maritime boundaries and ocean resources. Rowman & Littlefield.

Course Title	**Applied Hydrogeology**			**Course Code**	**ESH 41252**		
				Prerequest			
Level	4	**Semester**	I	**Credits**	2	**Theory (hr)**	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with the fundamentals and applications of hydrogeology

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Distinguish different types of aquifers
- Estimate the aquifer properties
- Identify the groundwater distribution in crystalline terrain of Sri Lanka
- Apply groundwater exploration techniques in identifying groundwater resources
- Demonstrate an understanding in well designing and construction

Course Content:

Groundwater flow, Infiltration / Percolation and groundwater recharge, Groundwater distribution in saturated and unsaturated zone, Darcy's law for groundwater flow, Basic aquifer properties, principle types of aquifers, Groundwater distribution in Sri Lanka. Groundwater exploration techniques, Well / tube well designing and construction, Pumping tests, Draw-down discharge relationship with aquifer properties, Fundamentals of hydrogeological modeling

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Fetter, C. W. (2018). Applied hydrogeology. Waveland Press.
2. Hiscock, K. M. (2009). Hydrogeology: principles and practice. John Wiley & Sons.
3. Hudak, P. F. (2004). Principles of hydrogeology. CRC Press.
4. Schwartz, F. W., & Zhang, H. (2002). Fundamentals of ground water. John Wiley & Sons.

Course Title	Research Project			Course Code	ESH 41266		
				Prerequest			
Level	4	Semester	I	Credits	6	Student – Supervisor contact (hrs.)	60
						Independent Learning (hrs.)	540

Aim of the Course:

To provide an opportunity for students to plan and execute a research project independently.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Search, analyze and summarize current literature relevant to a specific topic of his/her area of expertise.
- Rationalize the research gap for innovation.
- Design and implement a suitable experimental / theoretical procedure.
- Comprehend expertise on maintaining a lab logbook, data analysis and scientific report writing.
- Exposure for safe laboratory practices by handling high-end equipment.
- Communicate any findings and defend the work in a professional manner.

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor

Course Title	Field assignment on individual site investigations			Course Code	ESH 42212		
				Prerequest			
Level	4	Semester	II	Credits	2	Theory (hr)	-
						Practical/Field (hr)	90
						Independent Learning (hr)	10

Aim of the Course:

To provide the students with competency to work independently in site investigations.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Prepare a detail (Engineering / Environmental) geological map considering a given (Engineering / Environmental) site
- Analyze and identify specific geological /structural standings in the investigated (Engineering / Environmental) site
- Formulate a detail standard technical report interpreting the site investigation results.
- Present the produced map and interpret the results for technical community.

Course Content:

Each and every student is required to individually prepare a detail geological map for a (Engineering / Environmental) site and submit a standard field report and make an oral presentation on his/her (Engineering / Environmental) site. The report and presentation should consist of analyzed results in addition to field observations. Required engineering / environmental laboratory test should be identified and carried out by the student.

Mode of Assessment and weightage:

- Final Assessment:
  Mid-term progress presentation – 10%
  Prepared Geological map – 40%
  Detail technical report – 30%
  Final Presentation – 20%

References:

1. Lahee, F.H. (1981). Field Geology. McGraw-Hill Co., NY.
2. Mosely, F. (1981). Methods in Field Geology. W.H. Freeman and Co. Publ., California.
3. Clayton, C. R., Matthews, M. C., & Simons, N. E. (1982). Site investigation (No. Monograph). London: Granada.
4. McLean, A. C., & Gribble, C. D. (2017). Geology for civil engineers. CRC Press.

Course Title	Oceanography			Course Code	ESH 42223		
				Prerequest			
Level	4	Semester	II	Credits	3	Theory (hr)	45
						Practical/Field (hr)	-
						Independent Learning (hr)	105

Aim of the Course:

To provide the students with the basics on oceanography

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the tropical and polar compositions of oceanic waters and their variations
- Describe properties of oceanic waters to understand the evolution of chemical cycles in the ocean system
- Explain surface and deep ocean circulation and their driving mechanisms
- Interpret the eutrophic equilibrium of the oceanic ecosystem
- Demonstrate an understanding of mechanisms generating ocean bathymetry and sedimentation
- Describe the sea level changes with respect to the oceanic stratigraphy

Course Content:

Introduction to physical, biological, chemical and geological oceanography, Ocean bathymetry, Ocean floor morphology, Marine stratigraphy, Ocean curst, Tropical and polar compositions of oceanic waters, Chemical cycles in the ocean system, Oceanic circulations, Sea level history and seismic stratigraphy, Continental shelf and continental margin, Ocean sediments, microfossils and mineral resources, Eutrophic equilibrium of the oceanic ecosystem, Threats on oceanic ecosystem equilibrium.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Garrison, T. S. (2012). Oceanography: an invitation to marine science. Cengage Learning. Trujillo, A. P., & Thurman, H. V. (2008). Essentials of oceanography (No. Sirsi) i9780132401227). Pearson Education.
2. Garrison, T. S. (2012). Essentials of oceanography. Cengage Learning.
3. Moran, J. M. (Ed.). (2011). Ocean studies: Introduction to oceanography. American Meteorological Society, Education Program.
4. Pinet, P. R. (2019). Invitation to oceanography. Jones & Bartlett Learning.

Course Title	Waste Management and treatments			Course Code	ESH 42232		
				Prerequest			
Level	4	Semester	II	Credits	2	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with the key concepts of solid, liquid or gaseous waste management and treatment methods

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Recognize the inappropriate waste management practices
- Identify the impacts of wastes on water, soil and sediment quality
- Carry out an assessment of the relationships between environmental guidelines, human activities and environmental quality of impacted soils and water
- Design an effective system for waste management

Course Content:

Classification, quantification and characterization of waste, Municipal versus industrial waste, Principles in solid, liquid, air and hazardous waste management, Concepts in construction of disposal yards, Pollution from landfills, Treatment of solid waste (primary treatment, solid-composting, pyrolysis, incineration, anaerobic digestion, bioreactors, sludge handling and disposal, management techniques for e-waste and hazardous waste), Emission control and management of gaseous waste, Legislation in waste management, Regulation and control

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Pichtel, J. (2005). Waste management practices: municipal, hazardous, and industrial. CRC press.
2. Peters, R. W. (2015). Basic environmental technology: Water supply, waste management, and pollution control, By Jerry A. Nathanson and Richard A. Schneider, Prentice Hall/Pearson Education, Inc., Boston, MA. pp 456.
3. Kreith, F. (1999). Handbook of solid waste management.
4. Van Guilder, C. (2018). Hazardous Waste Management: An Introduction. Stylus Publishing, LLC.

Course Title	Contaminated Land and Remediation			Course Code	ESH 42242		
				Prerequest			
Level	4	Semester	I	Credits	2	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with the science of the Land contaminations and the remediation that can be adopted

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe current legislation and best practice as it applies to land contamination
- Assess the content and suitability of contaminated land site investigation and remediation reports
- Evaluate development impacts resulting from land contamination issues

Course Content:

Identify the legislations and best practices, Identify the contaminated land, Site assessment, Define the contaminants, analytical methods and guidelines, Risk assessment (health and environment), Remediation techniques (funding, mapping, technological), Consultation of the community

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Hester, R. E., & Harrison, R. M. (Eds.). (1997). Contaminated land and its reclamation (Vol. 7). Royal Society of Chemistry.
2. Pratt, M. (Ed.). (1993). Remedial processes for contaminated land. IChemE.
3. Kumar, V., Sharma, A., & Cerdà, A. (2020). Heavy Metals in the Environment (Vol. 400). Elsevier.
4. Soesilo, J. A., & Wilson, S. (1997). Site remediation: planning and management. CRC Press.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Water Resources and Watershed Management</td><td>Course Code</td><td colspan="3">ESH 42252</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical/Field (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the students with comprehensive knowledge in Water Resources and watershed management

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the scientific background of hydrological processes in a watershed
- Characterize and quantify surface water resources
- Ensure some effective watershed management strategies
- Contribute to projects and issues in integrated water resource management

Course Content:

Introduction to watersheds, River networks, River morphology and morphometry, Water levels and discharges, Measurements of water levels and discharges, Discharge rating curves, Mean annual, monthly and daily discharges, Runoff regimes and variability, Flow duration curves, Concept of sustainable water resources development, Basic concepts of watershed management, Water allocation and water scheduling problem, Equitable manners of water management, Soil and Vegetation management, Soil erosion and conservation, Integrated watershed management, Water legislation.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Cech, T. V. (2009). Principles of water resources: history, development, management, and policy. John Wiley & Sons.
2. Grafton, R. Q., & Hussey, K. (Eds.). (2011). Water resources planning and management. Cambridge University Press.
3. Loucks, D. P., & Van Beek, E. (2017). Water resource systems planning and management: An introduction to methods, models, and applications. Springer.
4. Mays, L. W. (1996). Water Resources.

Course Title	**Mineral Water Interactions**			**Course Code**	**ESH 42262**		
				Prerequest			
Level	4	**Semester**	II	**Credits**	2	**Theory (hr)**	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students about the processes and reactions of minerals and water in underground movements

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- recognize the role of chemistry in processes acting in soil and water
- describe the chemical composition and equilibrium speciation of the water
- describe and apply basic processes of adsorption, regulating the behavior of minor components in the system
- explain and interpret graphically the basic redox processes in water-sediment systems

Course Content:

Rock water interaction, Surface decay, underground subversion, Deep water aggregation, Clay minerals and reactions with water, Mineral balance in water, Geothermal water, formation of mineral deposits

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Brantley, S. L., Kubicki, J. D., & White, A. F. (Eds.). (2008). Kinetics of water-rock interaction (Vol. 168). New York: Springer.
2. Evangelou, V. P. (1998). Environmental soil and water chemistry. John Wiley.
3. White, W. A., & Pichler, E. (1959). Water-sorption characteristics of clay minerals. Circular no. 266.

Course Title	Geotourism			Course Code	ESH 42272		
				Prerequest			
Level	4	Semester	II	Credits	2	Theory (hr)	30
						Practical/Field (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide the students with comprehensive knowledge in geotourism and its management.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the aspects of geotourism.
- Utilize the geoparks and geological resources for geotourism.
- Analyze the geoheritages, geodiversity and geoarcheology for geotourism.
- Apply the strategies of geotourism for rural development.

Course Content:

Introduction to tourism and geotourism, Geological attractions of tourists, geomorphological attractions of tourists, Geoheritage, geodiversity, geoarcheology, Geotourism management, Geoconservation practices of geotourism, Concept of geoparks, utilization of geological resources for geotourism, Importance of geotourism, Geotourism for rural development. Geotourism for Sri Lanka.
Field excursions.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Dowling, R. K., & Newsome, D. (Eds.). (2006). Geotourism. routledge.
2. Farsani, N. T., Coelho, C., & Costa, C. (2011). Geoparks and geotourism: new approaches to sustainability for the 21st century. Universal-Publishers.
3. Newsome, D. (2006). Geotourism. Routledge.
4. Farsani, N. T., Coelho, C., & Costa, C. (2011). Geotourism and geoparks as novel strategies for socio-economic development in rural areas. International Journal of Tourism Research, 13(1), 68-81.

Applied Statistics

Course Title	Advanced Experimental Designs			**Course Code**	ASH 31213		
				Pre-request	-		
Level	3	**Semester**	I	**Credits**	3	**Theory (hrs.)**	45
						Practical (hrs.)	-
						Independent Learning (hrs.)	105

Aim of the Course:

The aim of this course is to develop an understanding of advanced experimental design and its applications in real data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Design advanced experiments themselves
- Have a general insight into how data analysis is done in connection to designed experiments.
- Analyze the different methods used in the design of experiments and test how these methods are connected to statistical models.

Course Content:

Factorial experiments (2k and others); confounding and partial confounding in 2k experiments, Split- plot designs, Split-split plot designs, Analysis of covariance: Fractional replication, Use of a fraction of a complete factorial experiment, confounding in fractional replicates, Using Real Data, Interpretation of the Results.
Use of statistical software for advanced experimental design.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term)– 30%
- End Semester Examination – 70%

References:

1. Statistical Principles in Experimental Design [Hardcover] Benjamin J Winer (Author), Donald R Brown (Author), Kenneth M Michels (Author)
2. Thattil R.O (1999)., Design and Analysis of Experiments., PGIA, UPDN, SL. (DES 519.57)
3. Cochran WG & Cox GM (1957)., Experimental Designs, John Wiley & Sons, Canada (COC 519.5) ISBN 9971-51-311-0
4. Murray R.S & Larry J.S (1999)., Statistics (Third Edition), McGraw-Hill, Singapore (SPI 519.5) ISBN 0-07-043510-3, Chapter 16

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Data Analysis Using R</td><td>Course Code</td><td colspan="3">ASH 31223</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

The aim of this course is to develop an understanding of the R statistical software and its applications in real data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Recognize and make appropriate use of different types of data structures.
- Use R and R studio to create figures and graphs.
- Design and write functions in R / R studio and implement simple iterative algorithms
- Define, calculate, and implement probability and probability distributions to solve a variety of problems.
- Conduct and interpret a variety of hypothesis tests to help decision-making
- Select effective visualization and modelling approaches to understand relationships between variables, and make decisions with data.

Course Content:

Introduction, what is R, Notation, Data: Starting R, Entering Data, Data Vector. Univariate Data: Categorical Data and Numerical Data. Bivariate Data: Handling Bivariate Categorical Data, Categorical Vs. Numerical Data, Numerical Vs. Numerical Data, Linear Regression. Multivariate Data: Storing Multivariate Data in Data Frames, Accessing Data in Data Frames, Manipulating Data Frames: Stack and Unstack, Using R's Model Formula Notation, Ways to View Multivariate Data. Random Data: Random Number Generators in R, Simulations, The Central Limit Theorem. Exploratory Data Analysis: Introduction, Confidence Interval Estimation, Hypothesis Testing, Two-Sample Tests, Chi-Square Tests. Regression Analysis: Simple Linear Regression Model, Statistical Inference, Multiple Regression Model. Analysis of Variance: One Way Analysis of Variance.

Mode of Assessment and weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Introduction to the R Project for Statistical Computing for use at ITC, D G Rossiter 2010.
2. The R Guide, W.G. Owen 2010
3. An Introduction to R: Software for Statistical Modeling & Computing, P. Kuhnert and B. Venables ,2005

Course Title	Mathematical Modelling for Statistics			**Course Code**	ASH 31233		
				Pre-request	-		
Level	3	**Semester**	I	**Credits**	3	**Theory (hrs.)**	45
						Practical (hrs.)	-
						Independent Learning (hrs.)	105

Aim of the Course:

To provide rigorous instruction in fundamental mathematical concepts and skills to solve real-world problems.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Acquired basic skills in mathematical modelling
- Analyze mathematical models of real-world problems based on differential equations
- Use numerical methods to solve problems associated with mathematical modelling.
- Model situations requiring optimization with linear, non-linear, and integer programming models.

Course Content:

Models and reality, Properties of models, Building a model, Arguments from scale, Dimensional analysis, Comparative statics, Optimization by differentiation, Analytic models, Monte Carlo simulation, Quantitative differential equations: Analytical methods, Numerical methods; Differential-difference equations.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Edward A. Bender (2000), An Introduction to Mathematical Modeling, Dover Publications, INC.
2. J. N. Kapur (1994), Mathematical Modeling, Wiley Eastern Limited.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Mathematical Analysis</td><td>Course Code</td><td colspan="3">ASH 31243</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

To give students a solid foundation in the basic theory of differential equations and matrix theories and solving differential equations and linear equations.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify an ordinary differential equation and classify it by order and linearity
- Solve simple first-order ordinary differential equations
- Explain suitable methods of finding the solution of various types of first-order differential equations.
- Solve systems of linear equations
- Find the inverse of matrices and find the quadratic form of matrices.

Course Content:

Differential Equations: First-order differential equations: variables separable equations, homogeneous equations, linear equations, exact and Bernoulli's equations, integrating factor method, operator D, and short methods of obtaining the particular integrals. **Matrix Algebra:** Introduction to matrices, Types of matrices, Matrix addition, subtraction, and multiplication; Determinant of a matrix, Inverse matrix, solution of the system of linear equations. System of linear homogeneous and non-homogeneous equations, Quadratic forms and congruence of matrices, Hermitian matrices and forms, Orthogonal matrices, Characteristics roots and characteristic vectors of a matrix, similarity of matrices. Diagonalization and Spectral Decomposition of a Matrix, Conditional Number of a Matrix, Trace of a Matrix, Powers of a Matrix, Idempotent Matrices, Factoring a Matrix, The Generalized Inverse of a Matrix. Quadratic Forms and Definite Matrices: Nonnegative Definite Matrices, Idempotent Quadratic Forms, Ranking Matrices.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Raisinghania, M. D. (2013). Ordinary and partial differential equations. S. Chand Publishing, ISBN: 81-219-0892-2.
2. Farlow, S. J. (2006). An introduction to differential equations and their applications. Mc Graw-Hill International Edition, ISBN: 0-07-113316-1.
3. Narayan, S., & Mittal, P. K. (2010). A textbook of matrices. S. Chand Publishing.
4. Hamilton (1989), Linear Algebra, Cambridge University Press.

Course Title	Advanced Regression Analysis			Course Code	ASH 32213		
				Pre-request	-		
Level	3	Semester	II	Credits	3	Theory (hrs.)	45
						Practical (hrs.)	-
						Independent Learning (hrs.)	105

Aim of the Course:

The aim of this course is to develop an understanding and apply advanced regression techniques and their applications in data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the multiple regression model, polynomial regression model, model building, and variable selection procedures.
- Construct interval estimation for parameters.
- Test hypothesis for parameters.
- Estimate polynomial regression model.
- Identify appropriate statistical methods for variable selection.

Course Content:

Multiple Linear Regression Model: Introduction, Multiple Linear Regression Models in Matrix form, Estimation of the Model Parameters, Least Squares Estimation of the Regression Coefficients, Properties of the Least Squares estimators, Estimation of σ^2, Confidence Intervals in Multiple Regression: Regression Coefficients and Mean Response, Hypothesis Testing in Multiple Linear Regression: Test for Significance of Regression, Tests on Individual Regression Coefficients, Prediction of New Observations, Standardized Regression Coefficients, Regression Diagnostics and Model Adequacy.

Polynomial Regression Models: Introduction, Polynomial Models in One Variable, Polynomial Models in Two or More Variables, Orthogonal Polynomials.

Indicator Variables: The General Concept of Indicator Variables, Comments on the Use of Indicator Variables, and Regression Models with an Indicator Response Variable.

Variable Selection and Model Building: Introduction, Model-Building Problem, Consequences of Model Misspecification. Criteria for Evaluating Subset Regression Models, Computational Techniques for Variable Selection: All Possible Regressions, Stepwise Regression Models.

Use of statistical software for advanced regression analysis.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

Myers R.H. (1990) Classical and Modern Regression with Applications, Duxbury Press

1. Neter J. wasserman W. & Kunter M.H. (1990), Applied Statistical Models, Irwin Inc.
2. Christensen R. (1998) Analysis of Variance, Design and Regression, Chapman & Hall/CRC

Course Title	Advanced Quality Control Statistics			**Course Code**	ASH 32223		
				Pre-request	-		
Level	3	**Semester**	II	**Credits**	3	**Theory (hrs.)**	45
						Practical (hrs.)	-
						Independent Learning (hrs.)	105

Aim of the Course:

The aim of this course is to develop an understanding of advanced quality control in real data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Use advanced tools for statistical quality control and statistical process control.
- Analyze the process capability.
- Do the sampling plan.
- Use advanced joint Monitoring schemes

Course Content:

Introduction: Exploratory data analysis, Statistical process control, Control charts for variables, Control charts for attributes. Advanced control charting schemes. Process capability analysis. Design of experiments in quality technology. Factorial experiments. Response surface models. Fractional factorial designs. Taguchi's parameter design. Acceptance sampling.

Use of statistical software for advanced quality control statistics.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. D.C. Montgomery, Introduction to statistical quality control 5th edn. John Wiley and Sons, New York 2005.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Operational Research</td><td>Course Code</td><td colspan="3">ASH 32233</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

The aim of this course is to make use of survival analysis techniques when needed.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify time-to-event data.
- Define and identify types of censoring.
- Estimates of survival function, hazard function, and survival time using tables and graphs.
- Compare survival functions between groups using non-parametric techniques.
- Estimate hazard function and survival function using semi-parametric techniques.
- Model survival time with covariates using semi-parametric techniques.
- Compare survival functions between groups using parametric techniques.

Course Content:

Examples of survival data, Introduction to time to event data analysis, Concepts, and techniques used in the analysis of time to event data including censoring, hazard rates, estimation of survival curves, parametric and nonparametric models, regression techniques, and regression diagnostics. Kaplan- Meier estimation of survivor functions, Fitting the Proportional Hazards Regression Model, Fitting the Proportional Hazards Model with Tied Survival, Estimating the Survivorship Function of the Proportional Hazards. Interpretation and Use of the Covariate-Adusted Survivorship Function. The Weibull Regression Model is the use of statistical software for time-to-event data analysis.

Use of statistical software for time-to-event data analysis.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term)– 30%
- End Semester Examination – 70%

References:

1. Applied Survival Analysis: Regression Modeling of Time to Event Data (Wiley Series in Probability and Statistics) David W. Hosmer, Stanley Lemeshow , Susanne May
2. Survival Analysis John P. Klein, , Melvin L. Moeschberge

Course Title	Stochastic Process			**Course Code**	ASH 41212		
				Pre-request	-		
Level	4	**Semester**	I	**Credits**	2	**Theory (hrs.)**	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

The aim of this course is to develop an understanding of the stochastic Process.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Acquire knowledge of stochastic processes related to statistics
- Define basic concepts from the theory of Markov chains
- Describe the homogeneous Poisson process and its simple applications
- Learn the importance of the birth and death process

Course Content:

An introduction to stochastic processes. Stationary distributions. Markov chains. Homogeneous Poisson process, Birth-Death process, Queuing theory.
Use of statistical software for Stochastic Process.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Stochastic Processes, J. Medhi (1996)

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Statistical Simulation Techniques</td><td>Course Code</td><td colspan="3">ASH 41223</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

The aim of the course is to model and analyse a variety of random statistical phenomena.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Discuss the concepts and methods of statistical simulation analytics.
- Formulate and apply Monte Carlo simulation techniques
- Identify different types of models and simulations including discrete-event and continuous simulation.
- Apply and implement statistical models on a computer, and generate, interpret, and present results.

Course Content:

Introduction: Systems, Models, Simulation, and Monte Carlo Methods. Pseudo-random number generators; Statistical tests of Pseudo-random numbers.
Random variate generation-The inverse transform method, Acceptance-Rejection method,
Composition Method. Simulation of random vectors. Generation from Discrete and Continuous distributions; Transformation of random variables.

Monte Carlo integration: Variance reduction techniques.

Regenerative simulation: Point Estimators and Confidence Intervals.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

Reference:

1. Gamerman, D. and Lopes, H. (2006) Markov Chain Monte Carol: Stochastic Simulation for Bayesian Inferences.
2. Robert, C. P. and Casella, G. (2009) Introducing Monte Carol Methods with R. Springer.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Data Mining</td><td>Course Code</td><td colspan="3">ASH 41232</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

The aim of this course is to develop an understanding of data mining theories and applications in real-life data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Demonstrate the principles of data mining techniques and its applications
- Critically evaluate the different models of data mining with respect of their use, accuracy, and performance
- Employ appropriate data mining tools on large datasets to generate information
- Extract and analyze information from data with the use of statistical software.

Course Content:

An introduction to Data Mining, Statistical techniques, and tools such as Kernel methods for estimating the density and regression functions, Machine learning, Hidden Markov Chain, EM algorithm, Classification, Cluster analysis, and support vector machines for analyzing large data sets and for searching for unexpected relationships in the data, Model selection for searching through a large collection of potential local models that describe some aspect of the data in an easily understandable way.
Use of statistical software for Data Mining.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Data Mining Introductory and Advanced topics, M.H. Dunham (2003)
2. Predictive Data Mining, Weiss SM & Indurkhya N, Morgan Kaufmann (1997)
3. Principles of Data Mining, Hand DJ et al, MIT Press (2001)

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Seminar, Exposure Visits, and Report Writing</td><td>Course Code</td><td colspan="3">ASH 41242</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="4">Level</td><td rowspan="4">4</td><td rowspan="4">Semester</td><td rowspan="4">I</td><td rowspan="4">Credits</td><td rowspan="4">2</td><td>Theory (hrs.)</td><td>-</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Student Contact (hrs.)</td><td>60</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>40</td></tr>
</table>

Aim of the Course:

The aim of this course is to develop an understanding of the probability and applications of probability in real data and to develop the report-writing skills of students.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

Understand the probability theories and ideas apply the theories in real life and write a report individually.

Course Content:

Students will be requested to select a title from statistical research papers for this presentation. Before the presentation, their title should be approved by the department. During the semester students should make 10 minutes presentation and it will be evaluated for different aspects by a panel appointed by the head of the department.

Exposure visits will be arranged by the department covering the institutes such as the Department of Census and Statistics, various Research stations and farms, Stock markets, Meteorological stations, the Department of Tourism, etc. At the end of the visits, each student has to submit a report for each visit explaining the activities, collected data analysis and presentation, and the improvement plans for each organization.

Mode of Assessment and Weightage:

- Oral Presentation – 30%
- Final Reporting – 70%

Course Title	Industrial Training			**Course Code**	ASH 41252		
				Pre-request	-		
Level	4	**Semester**	I	**Credits**	2	**Theory (hrs.)**	-
						Practical (hrs.)	-
						Independent Learning (hrs.)	100

Aim of the Course:

The aim of this course is to develop the understanding the practical training in real life.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

Apply the theories and practical knowledge in life situations.

Course Content:

Students undergo 15 weeks of part-time training in any organizations or institutes approved by the department. These organizations or institutes should have some aspects of work where statistics should be used widely.

This is the credit to produce a model science graduate who is competent to work in the industrial sector and to meet the demand of the industrial sector for graduates with suitable knowledge in industrial activities. This training offers the opportunity for the students to apply their academic knowledge and generic skills in diverse fields in public and corporate sectors while earning academic credits. This training equips the undergraduates with knowledge, skills, and attitudes which will increase the employability of the graduates.

Evaluation of this training is based on three components:

- Evolution of the placement mentor for knowledge, skills acquisition, and attitude in the work environment – 20%
- Evaluation summary by the in-charge person in the organization/industry – 30%
- Final Reporting – 50%

Course Title	Research Project – Applied Statistics			**Course Code**	ASH 41266		
				Pre-request	-		
Level	4	**Semester**	I	**Credits**	6	**Student – Supervisor contact (hrs.)**	60
						Independent Learning (hrs.)	540

Aim of the Course:

To provide an opportunity for students to plan and execute a research project independently.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Search, analyze and summarize current literature relevant to a specific topic of his/her area of expertise.
- Rationalize the research gap for innovation.
- Design and implement a suitable experimental / theoretical procedure.
- Comprehend expertise on maintaining a lab logbook, data analysis and scientific report writing.
- Exposure for safe laboratory practices by handling high-end equipment.
- Communicate any findings and defend the work in a professional manner.

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and Weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Survival Analysis</td><td>Course Code</td><td colspan="3">ASH 42212</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

The aim of this course is to develop an understanding of survival analysis in real data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify time-to-event data. Define and identify types of censoring. Derive the algebraic relationship between a probability density function, cumulative distribution function, survival function, hazard function, and cumulative hazard function. Estimate survival function, hazard function, and survival time using non-parametric techniques.
- Summarize estimates of survival function, hazard function, and survival time using tables and graphs.
- Compare survival functions between groups using non-parametric techniques.
- Estimate hazard function and survival function using semi-parametric techniques.
- Model survival time with covariates using semi-parametric techniques. Assess the fit of a semi-parametric model. Estimate survival function, hazard function, and survival time using parametric techniques.
- Compare survival functions between groups using parametric techniques. Model survival data with covariates using parametric techniques.
- Compute power and sample size for survival analysis.

Course Content:

Examples of survival data, Introduction to time to event data analysis, Concepts, and techniques used in the analysis of time to event data including censoring, hazard rates, estimation of survival curves, parametric and nonparametric models, regression techniques, and regression diagnostics. Kaplan- Meier estimation of survivor functions, Fitting the Proportional Hazards Regression Model, Fitting the Proportional Hazards Model with Tied Survival, Estimating the Survivorship Function of the Proportional Hazards. Interpretation and Use of the Covariate-Adusted Survivorship Function, Confidence Interval Estimation of the Covariate-Ddjusted Survivorship Function. The Weibull Regression Model is the use of statistical software for time-to-event data analysis.

Use of statistical software for time-to-event data analysis.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term)– 30%
- End Semester Examination – 70%

Reference:

1. Applied Survival Analysis: Regression Modeling of Time to Event Data (Wiley Series in Probability and Statistics) David W. Hosmer, Stanley Lemeshow, Susanne May
2. Survival Analysis John P. Klein, Melvin L. Moeschberge

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Econometrics</td><td>Course Code</td><td colspan="4">ASH 42222</td></tr>
<tr><td>Pre-request</td><td colspan="4">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

The aim of this course is to develop an understanding of the econometric theory and its applications in real-life data.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify and apply a range of econometric models used for analyzing relationships between economic variables
- Critically analyze a wide range of the theoretical and practical issues associated with econometric models
- Evaluate the assumptions of the classical linear regression model and the ways they can be modified and with what effects.
- Demonstrate understanding of how software is used in econometric analysis.
- Explain simultaneous equations models in econometrics

Course Content:

Data types in econometric theory, Overview of econometric models, BLUE estimation for multiple linear regression model, Autocorrelation problem, Heteroscedasticity problem, Multicollinearity of explaining variables problem, Errors in variables, Introduction to simultaneous systems.

Use of statistical software for econometrics.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Econometric Analysis, 5th Edition, W.H. Greene
2. Basic Econometric, D.N. Gujarati
3. Introductory Econometric with Applications, 5th Edition, R. Ramanathan

Course Title	Binary Data and Categorical Data Analysis			Course Code	ASH 42233		
				Pre-request	-		
Level	4	Semester	II	Credits	3	Theory (hrs.)	45
						Practical (hrs.)	-
						Independent Learning (hrs.)	105

Aim of the Course:

Comparison of proportions and odds. Two-way contingency tables: Chi-squared test, Fisher's exact test. Three-way contingency tables: partial association, Cochran-Mantel-Haenszel methods. Generalized linear models, exponential families. Logistic regression for binary responses and Binomial counts and analysis. Loglinear models for Poisson counts, two and three-way tables.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Compute and evaluate measures of association between categorical variables.
- Make a comparison of proportions. Examine data using two and three-way contingency tables.
- Fit and interpret generalized linear models, analyze binomial counts, and interpret the results.

Course Content:

Binomial distribution. Odds ratio and relative risk. Testing two proportions, Logit and Probit models. Conditional logistic regression. Model diagnostics.
Introduction to categorical data analysis, Principles of likelihood-based inference, Distributions for contingency tables, Measures of association for 2x2 tables and testing independence in contingency tables, Three-way tables, Introduction to Log-linear models for contingency tables, and Model building, Logistic regression, Multinomial response models for nominal data, Multinomial response models for ordinal data, Poisson regression model.
Use of statistical software for binary data and categorical data analysis.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Agresti, Alan (2007), An Introduction to Categorical Data Analysis, second edition, John Wiley& Sons, Inc. (Main Text)
2. Hosmer, David W., Jr. and Lemeshow, Stanley (2000), Applied Logistic Regression, second edition, John Wiley& Sons, Inc.
3. Analysis of binary data (1970) David Roxbee Cox, E. J. Snell

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Time Series Analysis</td><td>Course Code</td><td colspan="3">ASH 42243</td></tr>
<tr><td></td><td colspan="3"></td><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

The aim of this course is to explain some basic knowledge of financial time series data. To explain simple models and methods for analysis of financial time series. To describe characteristics of financial markets, and to explain the proper use and limits of econometric methods in finance

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Learn some basic knowledge of financial time series data.
- To study simple models and methods for the analysis of financial time series.
- To describe characteristics of financial markets and to understand the proper use and limits of econometric methods in finance

Course Content:

Nonseasonal and seasonal ARIMA models, filtering techniques, heteroskedasticity in financial time series, ARCH and GARCH models, the concept of multivariate time series, co-integration modelling, Dickey-Fuller test.
Use of statistical software for advanced time series analysis.

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Peter J. Brockwell and Richard A. Davis, ‘Introduction to Time Series and Forecasting’, Springer-Verlag New York Heidelberg.
2. Rueuy S.Tsay, (2005), ‘Analysis of Financial Time Series’, (2nd Edition), Wiley Inter science.
3. Stephen A. DeLurgio, (1998), ‘Forecasting Principles and Applications’, McGraw Hill.
4. Walter Enders, ‘Applied Econometric Time Series’, John Willy

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Multivariate Data Analysis</td><td>Course Code</td><td colspan="3">ASH 42253</td></tr>
<tr><td>Pre-request</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

The aim of this course is to develop an understanding of multivariate data analysis.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the applications of multivariate normal distribution.
- Apply principal component techniques to reduce variable and data
- Use factor analysis techniques to identify inter-correlation variables for grouping.
- Explain the usage of discriminant analysis in real situations.
- Apply cluster analysis theories in real life.

Course Content:

Geometric concept of multivariate data, properties of multivariate normal distribution,
Principal component analysis,
Factor Analysis (i) Centroid Method, (ii) Principal Components Method, and (iii) Varimax Method of Factor Rotation
Discriminant Analysis: Steps of Two-group Discriminant Analysis, Direction for Multiple Discriminant Analysis.
Cluster Analysis: Concept of clustering, Similarities measures, Clustering techniques, Hierarchical clustering algorithm, P Mean clustering algorithm based on variables, Rank order clustering algorithm (ROC) for groupings based on attributes (Association/Similarities Coefficients), Mathematical model for clustering of objects into P groups based on attributes (Association/Similarities Coefficients). Canonical Correlation Analysis (CCA).
Multidimensional Scaling and Conjoint Analysis: Multidimensional scaling (MDS), Basics of MDS, Applications areas of MDS, Conjoint analysis, multi-factor evaluation approach for conjoint analysis, Two-factor evaluation approach for conjoint analysis.
Data Analysis: Real data sets are analyzed using SAS, SPSS, and Minitab

Mode of Assessment and Weightage:

- Continuous Assessments (Quizzes, Assignments, Mid Term) – 30%
- End Semester Examination – 70%

References:

1. Multivariate Statistics - A Practical Approach, Flury B and Riedwel H,l (1998)
2. Multivariate Statistical Inference & Applications, A.C. Rencher (1990)
3. Applied Multivariate Statistical Analysis, R.A. Johnson and D.W. Wichern (1982)

Botany

Course Title	Aquatic Ecology			**Course Code**	BTH 31252		
				Prerequest			
Level	3	**Semester**	I	**Credits**	2	**Theory (hr)**	22
						Practical (hr)	24
						Independent Learning (hr)	54

Aim of the Course:

To impart knowledge on the major elements of marine and freshwater habitats, the biology and their functions
To expose to various aquatic animals, algae, and macrophytes in freshwater and marine habitats of Sri Lanka.
To equip to identify and assess problems threatening aquatic ecosystems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Explain the major elements of aquatic habitats and aspects of the ecological functioning of freshwater and marine systems.
2. Explain methods and controversies regarding the exploitation of aquatic resources and environmental threats to aquatic systems.
3. Identify some of the more common aquatic species. Comprehend, summarize and critique primary scientific literature.

Course Content:

Water as the ideal medium for life, Types of fresh water and the origin of lake basins: Lentic and lotic water, Distribution of aquatic ecosystems in Sri Lanka: coastal ecosystem, inland water ecosystem and hydro-electric and irrigation schemes, Abiotic factors of the Aquatic ecosystems: Physical factors and chemical factors, Biotic component of the Aquatic ecosystem: Ecological classification; Taxonomic classification, Introduction to aquatic plants; microalgae, seaweeds, and vascular aquatic plants with an emphasis on their unique habitats; morphological and physiological adaptations to the aquatic environment; Primary Productivity, planktons-the power house of ocean food webs, adaptation of aquatic organisms, patterns of distribution and succession in rivers, lakes and wetlands; impacts on aquatic systems, Economically important aquatic organisms in Sri Lanka, Laboratories include use of field equipment, field research techniques, and identification of aquatic organisms, including protozoa, one required field trip off campus.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Dodds, Walter and Matt Whiles. (2010) Freshwater Ecology: Concepts& Environmental Applications of Limnology 2nd Ed., Academic Press.
2. Alice Outwater (1996) Water: A Natural History, Basic Books
3. Dodson, S. (2005) Introduction to Limnology, McGraw Hill Companies Inc. New York.

Course Title	Plant Pathology			**Course Code**	BTH 32213		
				Prerequest			
Level	3	**Semester**	II	**Credits**	3	**Theory (hr)**	30
						Practical (hr)	45
						Independent Learning (hr)	75

Aim of the Course:

1. To equip students with knowledge and skills
2. To develop and implement disease management strategies for crop plants.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Learn living, non-living and other causes of disease or disorder in plants (Etiology)
2. Understand mechanism of disease development i.e. processes of infection and colonization of the host by the pathogen. (Pathogenesis)
3. Comprehend the interaction between the causal agent and the diseased plants in relation to environmental conditions. (Epidemiology)
4. Develop management systems of the diseases and reduce losses caused by them. (Control/Management)

Course Content:

Review of major groups of plant pathogens; Disease development in plants: Plant resistance to infection; Introduction to disease triangle; Principles of crop loss assessment; Principles and strategies for designing disease management operations; Methods that reduce efficiency of inoculum; Disease transmission and vectors; Biological control strategies; Cultural control methods; Green house cultural control strategies; Field cropscontrol strategies; Introduction to molecular plant pathology.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Agrios, G.N. (1997). Plant Pathology. 7th Edition. Academic Press, NewYork.
2. Pandey B.P. (1994) A Textbook of plant. Pathology: pathogen and plantdisease.
3. D. Gareth Jones, (1987). Plant pathology: principles and practice Open University Press
4. Pathak, V.N; Khatri, N.K; Pathak, Manish. (2003). Fundamentals of plant pathology, Agrobios, Jodhpur

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Plant Physiology</td><td>Course Code</td><td colspan="3">BTH 32222</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>54</td></tr>
</table>

Aim of the Course:

To give in-depth knowledge of metabolism, physiology and structure of plants together with a better understanding of regulation of growth and development and influence of environment.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Analyze the importance of nutrient mineral elements for plant.
2. State the importance of photosynthesis, factors affecting photosynthesis, the photosynthetic pigment, and describe the biochemistry of photosynthesis
3. Define and understand biotic and abiotic stress, different types of stresses
4. List and describe the function of plant growth substances and hormone phototrophic transduction.
5. Comprehend the role of plant secondary metabolites.

Course Content:

Plant metabolism (catabolism and anabolism), plant nutrition; photosynthesis; different types of stress (heat, cold, oxidative, hypoxia, drought etc.) and plant responses; plant hormones and their effects on growth and development; secondary metabolism, secondary metabolites and importance; advanced topics such as photo-protection, cavitation and embolism etc. Laboratory exercises based on above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Lincoln Taiz and Eduardo Zeiger (2012) Plant Physiology 5th Edn. Sinauer Associates Inc.
2. I William G. Hopkins and Norman P. (2008) Introduction to Plant Physiology4th edition

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Analytical Techniques</td><td>Course Code</td><td colspan="3">BTH 32232</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>54</td></tr>
</table>

Aim of the Course:

To develop knowledge in different types of plant and soil analytical techniques
To make students familiarize with different apparatus used in plant analysis
To develop knowledge in identifying the features advantages and disadvantages of different methods

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Identify suitable analytical methods for a particular purpose
2. Use different techniques/apparatus to carry out experiments
3. Distinguish between advanced analytical techniques and their usage

Course Content:

Laboratory organization and safety; soil and plant sampling and processing, physical and chemical analysis, major equipment used, their operation and maintenance; Use of radioisotopes in biological research, Principles and techniques of Chromatography, Spectrophotometry and Electrophoresis, Laboratory exercises based on above topics.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Wilson, K. and Walker, J. M. (Eds.) (1994). Principles and techniques of practical biochemistry (4th edition). Cambridge University Press, UK.
2. Margaret E. Farago (Eds.) (2008) Plants and the Chemical Elements: Biochemistry, Uptake, Tolerance and Toxicity, https://www.wiley.com/enus/
3. Kurt Hostettmann et al., (Eds.) (2014) Handbook of Chemical and Biological Plant Analytical Methods, https://www.wiley.com/enus/

Course Title	Post-Harvest Technology of Fruits, Vegetables and Grains			Course Code	BTH 32242		
				Prerequest			
Level	3	Semester	II	Credits	2	Theory (hr)	20
						Practical (hr)	30
						Independent Learning (hr)	50

Aim of the Course:

To provide adequate knowledge and skills on post-harvest handling, processing and preservation of fruits, vegetables and grains.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Explain the causes of post harvest food losses and the prevention measures.
2. Carryout post harvest food lossassessment.
3. Explain the pre-harvest factors affecting the post harvest life and quality aspects.
4. Carryout fresh produce handling appropriately: maturity determination, harvesting, grading, packaging, treatment and storage.
5. Survey the storage practices in the area and recommend for storage techniques.
6. Explains various methods of food processing and preservation.
7. Carry out processing and preservation of vegetables and fruits.

Course Content:

Introduction to Postharvest Technology; Post harvest losses of agricultural products; Biological/physiological and environmental factors affecting shelf life; Environmental factors influencing Deterioration; Post harvest technology procedures; Supplements to temp. & humidity management; Maturation and Maturity Indices; Harvesting systems; Preparation for fresh market; Preparation for packing; Storage systems; Post harvest pests & diseases of selected commodities; Food processing background; Food preservation principles and processes of fruit, vegetable and grain/cereal products; Food packaging. Laboratory exercises and field/industrial visits based on above.

Mode of Assessment and Weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Narayanasamy, P. (2006) Postharvest pathogens and disease management 1st Edn.,Wiley-Interscience.
2. Kader, Adel A. (2002) Postharvest technology of horticultural crops, University of California Agriculture and Natural Resources.
3. Thompson, A.K. (2015) Fruit and vegetables; vol.1 : harvesting, handling and storage Wiley-Blackwell.,
4. Chakraverty, Amalendu; Singh, R. Paul. (2014) Postharvest technology and food process engineering, CRC press.

Course Title	Evolutionary Biology			**Course Code**	BTH 32262		
				Prerequest			
Level	3	**Semester**	II	**Credits**	2	**Theory (hr)**	30
						Practical (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide adequate knowledge on evolution of biology

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Discuss the evolutionary evidence.
2. Describes the continental drifts and the concepts of natural selection
3. Identify the contributors and explain about the Neo Darwinism
4. Explain the variations in plants and different types of speciations.
5. Explain the advantages and disadvantages of poly ploidy in plants

Course Content:

History of evolution; Continental drifts; Evolutionary evidences; Pre-Darwinian; Different people involve in the evolution: Lamarck, Darwin, Wallace, De-viris ; Artificial and natural selection of plants; Variation in plants; Mutation: How the mutation takes place, Different types of mutations advantages and disadvantages of mutations; Polyploidy; Hardy Weinburg theory; Gene flow; Speciation ;Natural selection; Co-evolution; Neo –Darwinism

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Ginsdasa Katupotha. L(1995) Evolution and the geological significance of the late Pleistocene fossil shell beds of the Southern coastal zone of Sri Lanka NARESA
2. Verma, P. S. and Agarwal, V. K. (1995) Cell bilology, genetics evolution and ecology
3. Martine Ingrouille, (1992) Diversity and evolution of land plants
4. Ronald Good (1997) Flowering plants and their evolution.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Environmental Microbiology</td><td>Course Code</td><td colspan="3">BTH 32272</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>16</td></tr>
<tr><td>Independent Learning (hr)</td><td>62</td></tr>
</table>

Aim of the Course:

To provide an overview of physiology and ecology of microbes in natural environments and their impact on human life
To provide insight into exploiting microbial activities to manage environmental health

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Describe/discuss microbial structures/functions and factors affecting microbial activities.
2. Relate/apply microbial ecological principles to solve environmental problems.
3. Describe/discuss/compare different microbial techniques used in pollution treatment.

Course Content:

Microbial physiology: Microbial cell structure and function, microbial metabolism, effect of environmental conditions on growth, microbial environments, microbial ecology: interactions, Liebig's law of the minimum and Shelford's law of tolerance, microbial strategies under stress. Waste treatment: Solid waste: composition, problems, treatment techniques, microbiology, and methods of composting. Liquid wastes: types of pollutants, sewage treatment process, fixed film systems, suspended cell systems, activated sludge process, modifications to remove N and P, aerobic and anaerobic digestion of sludge; tertiary treatment. Microbes and xenobiotics: recalcitrants, persistence and biomagnification, biodegradation. Bioremediation: environmental modification, inoculation, enzyme technology, soil bioremediation techniques, bioremediation of air pollutants. Novel methods of pollution control and microbes in mineral recovery. Toxigenic microorganisms (cyanobacteria and dinoflagellates), their occurrence in water bodies of Sri Lanka and strategies to minimize their proliferation. Laboratory exercises and field visits based on above.

Mode of Assessment and Weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. RM Atlas and R Bartha (2000) Microbial ecology: Fundamentals and applications, 4th Edn. Addison Wesley Longman, Inc.
2. I.L Pepper and CP Gerba. (2015) Environmental microbiology, Academic Press, USA.
3. S McEldowny, DJ. Hardman, S. Waite (1993) Pollution: Ecology and Biotreatment, Longman Scientific and Technical.
4. FB. Metting. Jr., Ed. (1993) Soil Microbial Ecology: Applications in Agricultural and Environmental Management, Marcel Decker, Inc.
5. GM Masters (1991) Introduction to environmental engineering and science Prentice –Hall International, Inc.
6. S.A. Kulasooriya (2016) Toxigenic freshwater cyanobacteria of Sri Lanka, Cey Jour. Sci.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Plant tissue Culture</td><td>Course Code</td><td colspan="4">BTH 41212</td></tr>
<tr><td>Prerequest</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>25</td></tr>
<tr><td>Practical (hr)</td><td>15</td></tr>
<tr><td>Independent Learning (hr)</td><td>60</td></tr>
</table>

Aim of the Course:

To provide knowledge and skills on techniques in plant tissue culture, in vitro conservation, protoplast culture and micropropagation.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Explain the concepts of plant tissue culture and transformation.
2. Demonstrate the basic and advanced tissue culture techniques.
3. Establish, maintain and subculture many types of plant tissue cultures (axenic shoot cultures, callus cultures, embryogenic callus cultures, cell suspension cultures), micropropagate their plants and most of all master aseptic technique to produce microbe/microorganisms-freecultures.
4. Demonstrate how to initiate and perform plant tissue culture research with a crop of choice.

Course Content:

Introduction: Definition and technology; Plant cell & tissue culture techniques: A brief description, role of plant hormones, aseptic techniques, potential applications of organ culture, meristem culture, anther/pollen culture, callus & suspension cultures and protoplast culture; Plant propagation; Regeneration through meristem and callus cultures; Somatic embryogenesis: production, preservation and use of somatic embryos as propagules; Artificial seeds and automation of somatic embryo production: Principles, technology of automation and the application; Embryo culture; Haploid plant production; Cryopreservation: Storage of germ plasm; Protoplast culture; Somatic hybridization; Induction & utilization of somatic variants; Secondary metabolite production through cell
cultures: Principles and the technology, pharmaceuticals, pigments, other natural products and beverage production; Commercialization of tissue culture technology: Concept of commercialization and the need, design of typical tissue culture laboratory and its management.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. M.K. Razdan. (1993) An Introduction to plant tissue culture, Intercept.
2. S. Narayanaswamy. (1994) Plant cell and tissue culture, Tata McGraw-Hill Education.
3. Giano, Robert N and Gray, Dennis J. (1999) Plant tissue culture concepts and laboratory exercises 2nd Edn., CRC Press.
4. Pareek, L.K. and Swarnkar, P.L. (2001).Trends in plant tissue culture and biotechnology, Agro Botanical Publishers
5. Smith, H.Roberta. (2012) Plant tissue culture: Techniques and experiments, Academic Press.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Bioinformatics</td><td>Course Code</td><td colspan="3">BTH 41222</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>16</td></tr>
<tr><td>Independent Learning (hr)</td><td>62</td></tr>
</table>

Aim of the Course:

To give students the knowledge of and the competence in use of bioinformatical methods central to conduction of molecular biological research projects.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Explain which type of data is available from the most common protein sequence and structure databases (UniProt, gene bank, Protein Data Bank, CATH).
2. Explain the theories underlying the most common methods for sequence searches and sequence alignments, and in particular explains the principle and main steps for pairwise and multiple sequence alignments;
3. Explain and is able to apply the main steps of dynamic programing for/to simple alignments of short sequences;
4. List methods to uncover structure-function relationship in proteins and explains their underlying principles;
5. Explain the principles of computational methods for the prediction of secondary structure elements from protein sequence, prediction and modeling of three-dimensional protein structures (homology modeling, threading and ab initio methods).
6. Select and apply the most appropriate bioinformatics sequence or structure database to retrieve or search data given a specific question in molecular biology;
7. Select and apply the most appropriate method for aligning sequences, visualizing and analyzing protein structures, predicting secondary structure elements and modeling protein structures from sequence.

Course Content:

Course Content:

Introduction: Definitions, need, development, potentials and applications, Genomics, Proteomics, pattern recognition and prediction, sequence-structure deficit; molecular biological information resources: Nucleic acid and protein sequence databases, specialize databases, links and integrated databases; Protein information resources: Secondary databases, composite protein sequence and pattern databases, protein structure databases; Bioinformatics resource providers and their functions: European Molecular Biology Network (EMBnet) and National Center for Biotechnology Information (NCBI), submission of DNA sequences to the data bases, their accuracy and use of databases; DNA information resources: DNA sequence analysis, cDNA and Expressed Sequence Tags (ESTs), Analysis and interpretation of ESTs, sequence editing, assembling, sequence alignment and data matrices, similarity searches on sequence databases using the data mining tool BLAST, analyses of sequence-structure-function-phylogenetic relationship of Query sequences, making evolutionary trees; Bioinformatics in pharmaceutical industry: Human genome project and medically relevant genes, identification of therapeutic and vaccine targets, structure-based drug design and drug discovery. Regulation of bioinformatics exchanges on endemic species.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Mount, David W. (2001) Bioinformatics: sequence and genome analysis 2ndEdn., Cold Spring Harbor Laboratory Press;.
2. Krane, Dan E; Raymer, Michael L. (2003) Fundamental concepts of Bioinformatics, San Francisco : Benjamin Cummings.
3. Lesk, Arthur M. (2006) Introduction to bioinformatics, Oxford University Press, Inc. New York, NY,USA
4. Kumar, Santosh. (2017) Crop breeding: bioinformatics and preparing for climate change 1st Edn. Apple Academic Press

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Enzymology</td><td>Course Code</td><td colspan="3">BTH 41232</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>16</td></tr>
<tr><td>Independent Learning (hr)</td><td>62</td></tr>
</table>

Aim of the Course:

To deliver fundamental knowledge on classification, structure, mechanism, and related application of enzymes. Basic concepts of enzymology including designing artificial enzymes will be introduced to students.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Classify enzymes from their E.C. numbers and structures
2. Comprehend structural enzyme-substrate relationship and binding equilibria
3. Interpret inhibition and activation mechanisms of enzymes
4. Learn components of artificial enzymes, requirements for their design
5. Discuss the application of enzymes in different fields.

Course Content:

Background on Enzymology; Chemical bonds/reactions and classification of enzymes; Structural components of enzymes; Enzyme-substrate equilibria; Effect of temperature pH etc. on enzyme activity, Kinetics of enzyme-substrate reactions; Chemical mechanisms in enzyme catalysis; Experimental measures of enzyme activity; Inhibitors: Reversible, tightly bound, time dependent; Enzyme reactions with multiple substrates; applications of enzymes, modeling enzymes and artificial enzyme synthesis.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. John R. Whitaker (1994) Principles of enzymology for the food sciences, CRC press.
2. Bisswanger, Hans (2012) Practical enzymology Wiley-VCH Verlag GmbH & Co KGaA
3. Devasena,T. (2010) Enzymology, Oxford University Press, India

<table>
<tr><td>Course Title</td><td colspan="3">Economic Botany</td><td>Course Code</td><td colspan="3">BTH 41242</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>16</td></tr>
<tr><td>Independent Learning (hr)</td><td>62</td></tr>
</table>

Aim of the Course:

To develop awareness on the diversity of the plant products and plants of economical importance
To develop scientific insights into the development of economic uses of plant products

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Appreciate the taxonomic diversity of important families of useful plants.
2. Describe/discuss the economic uses of plants in modern society.
3. Describe the botany and origin of important food, medicinal and economically important plants.
4. Identify/describe/discuss the impact of economical use of plants on environment.
5. Explain the scientific basis into the development of many plant products.

Course Content:

A brief botanical description of economically important plants of selected cereals, vegetables, fruits and nuts, spices and condiments, medicinal plants, fiber crops, forage crops, ornamental plants, invasive plants, weeds, beverages, industrial products and some processing techniques; Structure and properties of wood, factors affecting the strength of timber, timber processing technology, agents of destruction of wood and wood preservation; manufactured products of wood and their applications. Economic importance of conifers, algae and cyanobacteria. Laboratory exercises based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. S. L. Kochhar (2016) Economic Botany: A Comprehensive Study 5thEdition, Cambridge University Press
2. Simpson, B.B. Ogorzaly, M. C. (1995) Economic Botany: Plants in Our World. McGraw-Hill,Inc.
3. Samba Murthy, A.V.S.S. & Subrahmanayam, N.S. (1998). A Text Book of Economic Botany, Wiley Eastern Ltd.
4. Desch, H. E. & Dinwoodies, JM. (1998). Timber- structure, properties, conversion and use. Macmillan Press.
5. Tisseverasinghe, A.E.K. (1971). A manual of timber utilization for Ceylon. Forest Department, Sri Lanka.

Course Title	Science Research Methodology			**Course Code**	BTH 41252		
				Prerequest			
Level	4	**Semester**	I	**Credits**	2	**Theory (hr)**	30
						Practical (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To develop knowledge on basic concepts of research and its methodologies
To develop knowledge in identifying and defining appropriate research problems, formulating hypothesis, plan and conduct research and report and present research work.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Identify research problems, access and review literature, formulate hypothesis,
2. Adopt appropriate experimental designs.
3. Prepare research proposal and budget.
4. Critically evaluate data, analyze and interpret.
5. Write/present a report

Course Content:

Research design, Literature search and review, Scientific writing, Scientific presentation, Critical scientific review, Ethical issues

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

Creswell, J. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches Vol. 4, SAGE Publications.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Experimental Designs and Analysis</td><td>Course Code</td><td colspan="4">BTH 41262</td></tr>
<tr><td>Prerequest</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>16</td></tr>
<tr><td>Independent Learning (hr)</td><td>62</td></tr>
</table>

Aim of the Course:

1. To provide insight into the need for statistics.
2. To develop skills in scientific experimentation and analysis.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Apply appropriate experimental designs.
2. Derive valid results from the scientific experiments.
3. Apply statistical methods in analyzing data.
4. Present the results of the findings of an experiment in scientific manner and make conclusions based on the results

Course Content:

Principles of experimental designs, Completely Randomized Design, Randomized Complete Block Design, Latin Square Design, Mean separation procedures, Factorial experiments, Analysis of factorial experiments, Modifications to factorial experiments, Analysis of Covariance, Confounding in factorial experiments, Incomplete Block Designs.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Thattil R.O (1999)., Design and Analysis of Experiments., PGIA.
2. Cochran WG & Cox GM (1957)., Experimental Designs, John Wiley &Sons, Canada.
3. Murray R.S & Larry J.S (1999)., Statistics (Third Edition), McGraw-Hill, Singapore.

Course Title	Seminar – Botany			**Course Code**	BTH 41271		
				Prerequest			
Level	4	**Semester**	I	**Credits**	1	**Theory (hr)**	
						Practical (hr)	-
						Independent Learning (hr)	50

Aim of the Course:

1. To develop interest on current developments and applications of the subject area.
2. To develop skills self-learning and oral communication.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Keep track on current developments in the subject area
2. Gather knowledge/relevant data and organize.
3. Prepare audiovisual aids for presentations.
4. Convey a scientific message orally in an attractive and concise manner.

Course Content:

Awareness lectures and discussions on presentation skills.
An individual seminar should be presented on a topic, on an issue at the forefront, selected with the consent of the assigned supervisor.

Mode of Assessment and weightage:

- Oral Presentation – 100%

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Integrated Pest Management</td><td>Course Code</td><td colspan="3">BTH 41282</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>54</td></tr>
</table>

Aim of the Course:

To provide a wide knowledge of pest management

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. List different type of pest which affect the plants with examples and three components of the IPM.
2. Provide the reasons why pest management has shifted from routine pesticide application to IPM
3. Describe the evolution of IPM and the differences among the components.
4. Identify the principles behind the successful IPM program.
5. Discuss the strategies and tactics of IPM and the advantages and disadvantages of IPM.

Course Content:

Introduction; Definition of Pest and its biology; pest management and IPM; Pest management options (cultural, mechanical, biological, chemical); Ecological basics for pest management; Identifying the pest problems; Different type of pests and control measures with examples; Evolution of IPM; Three components of IPM; Principles of IPM program; Strategies and tactics of IPM; Advantages and disadvantages of IPM

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Dharam P Abrol Uma Shankar(2012) Integrated Pest Management: Principles and Practice CABI
2. Uma Shankar, Satya Priya and Deepak (2008) Vegetable pest management Guide for farmers International book distributing company.
3. Dhaliwal. G. S., Ramesh Arora (2001) Integrated pest management: Concepts and Approaches Kalyani publishers.
4. Mengech, Annalee (1995) Integrated pest management in the tropics: current status and future prospects. John Wiley and Sons.

Course Title	Industrial Training			**Course Code**	BTH 41292		
				Prerequest			
Level	4	**Semester**	I	**Credits**	2	**Theory (hr)**	
						Practical (hr)	-
						Independent Learning (hr)	200

Aim of the Course:

To expose students to real work of environment and gain knowledge and skills in work ethics, communication, management etc.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. apply subject knowledge and skills to real work situations.
2. work with responsibility, commitment and other good work habits.
3. to write reports on technical works/projects.
4. perform with self-confidence, strength, teamwork spirit, good communication skills etc.

Course Content:

Working in some established subject relevant industry, institute, enterprise etc. either state or private full time for four weeks either continuously or staggered during semester end vacation periods, on a programme agreed by the Department and the host institute with the supervision of a senior academic from the department and an executive of the host institute

Mode of Assessment and weightage:

log book - 20%
Progress reports - 20%
Presentation and viva – 20%
Final report - 20%

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Plant Breeding</td><td>Course Code</td><td colspan="3">BTH 42212</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>16</td></tr>
<tr><td>Independent Learning (hr)</td><td>62</td></tr>
</table>

Aim of the Course:

To provide adequate knowledge and skills on post-harvest handling, processing and preservation of fruits, vegetables and grains.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Formulate breeding strategies that would lead to an increase in productivity and profitability in agriculture and horticulture.
2. Discuss the use of plant breeding in developing sustainable agricultural production systems that satisfy the increasing demand for food, fiber and plant based industrial products.

Course Content:

Features of flowering plants and their products; variation and selection; origins of agriculture; Crop plants and their wild relatives, centers of origin and diversification of crop plants. Mating systems in crop plants; continuous versus discontinuous variation traits; heritability of economically important traits, genetics of self and cross-pollinated crops; breeding methods with self and cross-pollinated crops; design of field experiments; genetics of disease and insect pest resistance in crop plants; induced mutations and chromosome manipulation in crop improvement; genetic diversity in crops and gene banks; seed production industry; crop improvement through genetic engineering; general breeding problems associated with regional crops. Laboratory exercises based on the above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Gupta.S.K. (2008) Plant breeding: Theory and techniques, Agriobios, Jodhpur.
2. Acquaah, George. (2012) Principles of plant genetics and breeding (2ndedn.), John Wiley &Sons.
3. Sai Prasad, S.V. et. Al., (2016) Agri-facts: plant breeding: model papers, short notes, long answer, New Vishal Publication
4. Gupta, S.K. (2010) Practical plant breeding. Agribios, India.
5. Kumar Santosh. (2017) Crop breeding: bioinformatics and preparing for climate change, Apple Academic Press.

Course Title	Industrial and Food Microbiology			**Course Code**	BTH 42222		
				Prerequest			
Level	4	**Semester**	II	**Credits**	2	**Theory (hr)**	22
						Practical (hr)	16
						Independent Learning (hr)	62

Aim of the Course:

To provide an overview of biological basis and processes of fermentation technology used in obtaining microbial products in commercial scale.
To develop an in-depth knowledge of the microbiology of food, food-borne diseases, food spoilage and preservation

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Describe/discuss main steps and processes used in microbial products industry
2. Discuss microbiological principles behind different stages in fermentation industry
3. Explain microbial interactions in food, their significance and factors influencing their growth and survival.
4. Discuss the microbiology of different types of food commodities
5. Demonstrate skills of microbiological analysis of food.

Course Content:

Industrial microbiology: introduction and history, significance of microbes, categories of microbial products, industrially important microbes, growth & nutrition, growth kinetics, microbial metabolism & fermentation; Upstream Processing: strain suitability and techniques of selection, fermentation media, crude media, defined media, fermentation systems, design and control, solid substrate fermentation and methods; Downstream processing: unit operations, factors determining unit operation selection.
Food microbiology: Introduction, Food Spoilage and General Principles Underlying Spoilage, Intrinsic Parameters Extrinsic Parameters, implicit and processing factors; microbial spoilage of milk, meat, fish and plant products; sources of microorganisms in foods (contamination), factors influencing microbial growth, changes caused; principles and techniques of food preservation; Food Borne Infections/ Intoxications; Laboratory exercises and field/industrial visits based on above.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. WC. Frazier and DC. Westhoff (1988) Food Microbiology 4th Edn., McGraw-Hill Co.
2. MJ Waites et. al., (2004) Industrial Microbiology- An Introduction, Blacwell Science.
3. G. Reed, Ed., (1999) Industrial Microbiology 4th Edn. CBS India.
4. GJ. Banwart, (1987) Basic Food Microbiology CBS India.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Restoration Ecology</td><td>Course Code</td><td colspan="3">BTH 42232</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>54</td></tr>
</table>

Aim of the Course:

To impart knowledge on scientific principles and applications in the area of restoration ecology
To develop skills in retrieving information about restoration ecology critical analysis and evaluation and communicating with a variety of audiences in written and spoken forms

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Recognize local ecosystems and describe the theoretical aspects of restoring different types of ecosystems.
2. Apply content knowledge to real-world settings and contexts by developing and writing a restoration plan and preparation of a public presentation.
3. Recognize current issues in restoration ecology, and engage in research and critical analysis.
4. Demonstrate understanding of the practical aspects of restoring ecosystems, working with communities and producing sound restoration plans through engagement with the community partner.

Course Content:

Introduction to restoration ecology; ecosystem functioning, ecological relationships at various spatial scales as they apply to restoration, keystone species, invasive species management, reclamation of contaminated sites, restoration of various types of ecosystems (e.g. forest, degraded grasslands, wetland, riverine vegetation, coastal ecosystems), value of ecosystem services, financial and practical considerations in ecological restoration projects.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Andre F. Clewell, James Aronson (2013) Ecological Restoration, 2nd Edn: Principles, Values, and Structure of an Emerging Profession, Island Press.
2. Donald A. Falk, Margaret A. Palmer, Joy B. Zedler, Richard J. Hobbs. Eds. (2006) Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series) 1st Edn. Isand Press.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Biodiversity Conservation and Management</td><td>Course Code</td><td colspan="3">BTH 42242</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>54</td></tr>
</table>

Aim of the Course:

Develop knowledge on biodiversity conservation and management.
To enable them to critically address the issues related to biodiversity and the environment and socio economic impacts.
To provide students basic skills for goal oriented research in biodiversity conservation and management.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Understand key threats to biodiversity
2. Select appropriate techniques that can be used to achieve biodiversity conservation within reserves including control of pests of plants and animals, species translocations
3. Select techniques to conserve biodiversity outside reserves including retention of keystone structures, connectivity and corridors
4. Explain/describe key ecological concepts in ecosystem restoration
5. Identify key legislations relevant to biodiversity conservation
6. Critically analyse the fact that wildlife populations, man's actions and habitat are interconnected and dependent on each other.
7. Demonstrate the ability to apply concepts of experimental design and scientific method to solve management problems.

Course Content:

Introduction to biodiversity: global and national biodiversity estimates; Techniques of measuring biodiversity; Loss of biodiversity; Threats to biodiversity including invasive species; Biodiversity Conservation: ex situ and in situ conservation strategies; sustainable management of biodiversity; IUCN categories for the conservation status of taxa, Red data book; key legislations available to conserve and manage biodiversity; priorities in conservation; indigenous knowledge in biodiversity; international conventions on Biodiversity, International trade and CITES, Ecotourism,. Biological diversity conservation in Sri Lanka.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination –70%

References:

1. Braun, C. (2005) Techniques for Wildlife Investigations and Management,6th edn. Wildlife Society
2. Cauhley, G and Sinclair, R.E.A. (1994) Wildlife ecology and management. Blackwell Scientific Publications, Boston,MA.
3. Gaston, K. and Spicer, J. (2003) Biodiversity: an Introduction. Blackwell Science.
4. Gatson, J.G. and Spicer, J. I. (2004) Biodiversity: An introduction (2ndEdition), Blackwell Publishing, Oxford

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Research Project</td><td>Course Code</td><td colspan="3">BTH 42256</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Level</td><td rowspan="2">4</td><td rowspan="2">Semester</td><td rowspan="2">II</td><td rowspan="2">Credits</td><td rowspan="2">6</td><td>Student – Supervisor contact (hrs.)</td><td>60</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>540</td></tr>
</table>

Aim of the Course:

To provide an opportunity for students to plan and execute a research project independently.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Search, analyze and summarize current literature relevant to a specific topic of his/her area of expertise.
2. Rationalize the research gap for innovation.
3. Design and implement a suitable experimental / theoretical procedure.
4. Comprehend expertise on maintaining a lab logbook, data analysis and scientific report writing.
5. Exposure for safe laboratory practices by handling high-end equipment.
6. Communicate any findings and defend the work in a professional manner.

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor

Chemistry

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Mineralogy and Metallurgy</td><td>Course Code</td><td colspan="3">CHH 31211</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hrs.)</td><td>15</td></tr>
<tr><td>Practical (hrs.)</td><td></td></tr>
<tr><td>Independent Learning (hrs.)</td><td>35</td></tr>
</table>

Aim of the Course:

To give a broad-based knowledge of minerals and existence of mineral wealth in Sri Lanka.
To teach students about the ores and minerals of elements in relation to extraction from ores.
To introduce different extractive metallurgical processes and the role of thermodynamics in them.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Define and identify minerals.
- Distinguish and differentiate between the terms/substances: chemicals & minerals, rocks & minerals, and minerals & ores.
- Summarize the mineral properties that make them useful.
- Identify the properties used to identify minerals.
- Describe how the mineral properties (such as color, luster, streak, hardness, etc.) are used to identify a mineral and distinguish different minerals.
- Write a brief outline of the mineral wealth of Sri Lanka.
- Identify and list the appropriate ores for the extraction of certain (important) metallic elements.
- Explain reduction reactions that result in free metals.
- Recognize different reduction methods are used to extract different metals.
- Understand and describe the major steps involved in metal extraction (extraction metallurgy).
- Compare the different metallurgical processes in terms of advantages and disadvantages.
- Identify and describe some of the pyro and hydro-metallurgical processes.
- Explain, the different chemicals and physical methods available in ore preparation (concentration).
- Describe the different methods of metal extraction (based on their reactivity).
- Apply thermodynamic principles in extractive metallurgy.
- Use the Ellingham diagram to predict the feasibility of reduction of oxides by C/CO (and/or other reactive metals) and the temperature at which the anticipated reduction occurs.
- Appreciate the importance of purification of metals and describe different methods (distillation, electrolysis and zone refining) of metal purification

Course Content:

Mineralogy

Definition of terms, Mineral identification, Classification of minerals; Mineral resources of Sri Lanka: available minerals; their chemical compositions, uses and places of occurrence (in Sri Lanka).

Metallurgy

Metal ores, Chemistry of metal extraction, Basic principles of extractive metallurgy processes, Preparation of ore, Production of metals (methods of metal extraction): pyro-metallurgy (Application of thermodynamics in extraction metallurgy: Ellingham diagram), hydrometallurgy and electrometallurgy. Purification methods of metals

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Inorganic chemistry chap 20, 6th edn, Raymond Chang
2. Economic geology of Sri Lanka, 5th edn, MMJW Herath
3. Introduction to mineral sciences, Andrew Putnis

Course Title	Advanced Organic Chemistry I			**Course Code**	CHH 31222		
				Prerequest	-		
Level	3	**Semester**	I	**Credits**	2	**Theory (hrs.)**	30
						Practical (hrs.)	
						Independent Learning (hrs.)	70

Aim of the Course:

To provide advanced knowledge on organic synthesis and 2D NMR techniques

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Predict mechanistic pathway of organic reactions.
- Perform retrosynthetic analysis of organic compounds.
- Design the synthesis for one-group and two-group retrosynthetic analysis of various organic compounds
- Describe the basic concepts of 1D NMR experiment and 2D NMR experiments.
- Use 1D and 2D NMR data to assign the chemical shifts for a given structure.
- Elucidate structure based on information obtained from MS, IR, 1D and 2D NMR spectrum

Course Content:

Retro Synthetic Analysis

Basic principles, functional group inter –conversions, synthons and synthetic equivalents, C-X disconnections (one group and two groups), C-C disconnections (one group and two groups-1,2-1,3-, 1,4-, 1,5- and 1,6- difunctionalised compounds), disconnections of cyclic compounds (3-, 5- and 6-membered rings) and aromatic heterocycles

Advanced NMR spectroscopic techniques

Different types of 13C spectra, Decoupling and NOE; Spin echo pulse sequence, APT experiment, Polarization transfer, DEPT experiment, 2D-NMR source of the second dimension. COSY experiment, TOCSY and 1D-TOCSY experiments, NOE and NOESY experiments, HMBC (Heteronuclear correlation and indirect detection), HETCOR and HMQC experiments, Application of NMR in the student organic chemistry laboratory

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Take-home assignments, Essay type examination)– 30%
- End Semester Examination – 70%

References:

1. Advanced Organic Chemistry Carey and Sandburg, 3rd Edition
2. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes Page #358-395
3. Organic Chemistry by T.W. Graham Solomons Craig, B. Fryhle, 10th Edition
4. Some Modern Methods of Organic Synthesis, Carruthers, W., Cambridge University Press (1987).
5. Organic Synthesis: The Disconnection Approach, Warren, S., Wiley (2007)

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Chemical Thermodynamics</td><td>Course Code</td><td colspan="3">CHH 31232</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

Designed to provide the students with experience in applying thermodynamic principles to predict physical phenomena.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the Third Law of Thermodynamics and calculate third law entropies.
- Describe the background of chemical potential.
- Analyze thermodynamics of mixing.
- Predict thermodynamic parameters involved in activation of molecules

Course Content:

Third law, Absolute entropies, Thermodynamics of chemical reactions, Chemical potential, Gibbs- Duhem equation, Phase equilibria, Equilibrium constants, Mixtures, Activities, Partial molar quantities, Non equilibrium thermodynamics.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Introduction to Molecular Thermodynamics, Hanson, R.M. and Green, S. University Science Books, 2008
2. Physical Chemistry (P.W. Atkins)
3. Physical Chemistry (D. A. McQuarrie)

Course Title	Advanced Practical Organic Chemistry			Course Code	CHH 31242		
				Prerequest	-		
Level	3	Semester	I	Credits	2	Theory (hrs.)	-
						Practical (hrs.)	90
						Independent Learning (hrs.)	10

Aim of the Course:

Designed to provide advanced training in organic chemistry-related laboratory techniques, procedures instruments, data collection, analysis and presentation

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Tactically design multi-step organic synthesis.
- Determine the analytical techniques required to isolate natural products and elucidate their chemical structures
- Synthesize, purify and characterize different organic compounds.
- Communicate the results of scientific experiments in oral and written reports

Course Content:

Multi-step synthesis of organic compounds (aliphatic, aromatic, alicylic and heterocyclic compounds), extraction of natural products, interpretation of UV, IR, NMR (^{1}H-NMR, ^{13}C-NNR, 2D-NMR) and mass spectra and elucidation of the structure of heterocycles and natural products.

Mode of Assessment and weightage:

- Continuous Assessment (Practical examination, Individual Report, Logbook)– 50%
- End Semester Examination – 50%

References:

1. Techniques for Organic Chemistry, Fessenden, R. J. and Fessenden, J. S., Willard Grant Press (1984).
2. Vogel's Textbook of Practical Organic Chemistry, Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R., Dorling Kingsley (2008).
3. Experiments and Techniques in Organic Chemistry, Pasto, D., Johnson, C. and Miller, M., Prentice Hall (1991).
4. Handouts issued in the laboratory.

Course Title	Advanced Practical Inorganic Chemistry			**Course Code**	CHH 31252		
				Prerequest	-		
Level	3	**Semester**	I	**Credits**	2	**Theory (hrs.)**	-
						Practical (hrs.)	90
						Independent Learning (hrs.)	10

Aim of the Course:

Designed to provide advanced training in inorganic chemistry-related laboratory techniques, procedures, instruments, data collection, analysis and presentation

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the difference between qualitative and quantitative chemical analysis.
- Apply practical skills of inorganic and organometallic chemistry including those related to synthesis, reaction chemistry, and structure and bonding.
- Quantify ions by titrimetric and gravimetric analysis.
- Communicate the results of scientific experiments in oral reports, technical graphics, and written reports

Course Content:

Advanced titrimetric and gravimetric techniques, Qualitative analysis of inorganic mixtures containing rare cations and rare anions, Synthesis of metal complexes

Mode of Assessment and weightage:

- Continuous Assessment (Practical examination, Individual Report, Logbook)– 50%
- End Semester Examination – 50%

References:

1. Mendham, J., Denney, R. C., Barnes, J. D., and Thomas, M. J. K., Vogel's Textbook of Quantitative Analysis, Pearson Education, (2007) 3rd ed.
2. Skoog, D. A., Holler, F. J., and Nieman, T. A., Principles of Instrumental Analysis, Thomson, (2006) 5th ed.
3. Vogel’s Textbook of qualitative inorganic analysis
4. Vogel’s Textbook of quantitative chemical analysis
5. Principles of Instrumental Analysis, Skoog, D. A., Holler, F. J., and Nieman, T. A., Thomson, (2006) 5th ed.
6. Handouts issued in the laboratory

Course Title	Advanced Heterocyclic Chemistry			Course Code	CHH 32211		
				Prerequest	-		
Level	3	Semester	II	Credits	1	Theory (hrs.)	15
						Practical (hrs.)	
						Independent Learning (hrs.)	35

Aim of the Course:

To provide in advanced knowledge on reactions and synthesis of heterocyclic compounds.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the nomenclature of different heterocyclic compounds.
- Describe synthesis and reactivity of fused, six-membered and smaller heterocyclic compounds.
- Explain the biological important of heterocyclic compounds

Course Content:

Theories of aromaticity, criteria for aromaticity, homo-aromaticity, chemistry of non-benzenoid aromatic and non-aromatic systems.
Reactions and synthesis of heteroalicyclic compounds, benzothiophene, benzofuran, pyrones (α-and β-pyrones), benzoopyrones(chromone, coumarin and isocoumarin), pyrylium ion, benzopyrylium ion, quinolizinium ion, diazines (pyridazine, pyrimidine and pyrazine), 1,3- azoles (imidazole, thiazoloe and oxazole), 1,2-azoles (pyrazole, isothiazole and isoxazole), purines.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Comprehensive Heterocyclic Chemistry, Katritzky A.R., and Rees C.W., Pergamon Press (1996).
2. Heterocyclic Chemistry Gupta, R.R., Kumar M., and Gupta, V., Vo1.1-3, Springer Verlag (2008).

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Applications of Group Theory and Diffraction Methods</td><td>Course Code</td><td colspan="3">CHH 32222</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide e advanced knowledge on application of group theory in the prediction of molecular properties

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the symmetry elements and operations of molecules
- Determine the point groups of molecules
- Apply group theory for the study of molecular vibration (IR and Raman spectroscopies) and bonding in molecules.
- Explain the molecular bonding using group theory
- Gain knowledge in diffraction techniques for three-dimensional structural elucidation.

Course Content:

Applications of group theory

Introduction

basic terms, use of molecular symmetry

Molecular symmetry

Symmetry operation and elements: Identity, Proper rotation plane of symmetry, Inversion center, improper rotation. Effect of the various symmetry operation on a point, Multiplication of symmetry operation summery, Commuting symmetry operation.

Point group, Group properties, Finding the Point Group, Matrix for symmetry operation, Metrics representation of symmetry operation, construction of character table, properties of character table, reducible and irreducible representation, decomposing reducible representation, Reducible formula.

Application

Chirality Using Symmetry, Vibrational Spectroscopy Using Symmetry, Vibrational Spectroscopy Using Symmetry, Predicting the orbitals used in σ bonds (hybridization), Predicting molecular orbitals, constructing correlation diagram, Predicting polarity of molecules.

Diffraction Methods

Brief overview of solid-state chemistry including crystal systems and reciprocal lattices. Translational symmetry, Screw axes, glide planes, crystal classes and space groups. Theory of diffraction. X-ray crystallography, instrumentation, diffraction patterns, indexing, scattering and structure factors, intensity, phase problem, Fourier synthesis, electron density maps, Patterson and direct method. Case studies using crystal visualization software such as VESTA and Mercury. Neutron diffraction. Electron diffraction.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Clusters and colloids: from theory to applications. Schmid, G., John Wiley & Sons: 2008.
2. Energy landscapes: Applications to clusters, biomolecules and glasses. Wales, D., Cambridge University Press: 2003.
3. Molecular Symmetry & Group Theory (Alan Vincent)
4. Introductory Group Theory for Chemists (G. Davidson)
5. Physical Chemistry (P. W. Atkins)
6. Chemical Applications of Group Theory (F.A. Cotton).

Course Title	Statistical Thermodynamics			Course Code	CHH 32231		
				Prerequest	-		
Level	3	Semester	II	Credits	1	Theory (hrs.)	15
						Practical (hrs.)	
						Independent Learning (hrs.)	35

Aim of the Course:

To provide thorough knowledge in statistical thermodynamics

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- derive bulk thermodynamic properties from molecular properties.
- derive relevant thermodynamic parameters using different thermodynamic ensembles.
- Explain Maxwell's relationships, Maxwell – Boltzmann, Fermi – Dirac and Bohr's Einstein statistics Comparison and application spontaneity, equilibria-Temperature, pressure dependence of thermodynamic quantities

Course Content:

Statistical states, configuration and weights, axiom of equal probability of complexions, distribution of molecules / atoms in energy states, degeneracy, independent identical distinguishable particles. Sterling's Approximation, Boltzmann Distribution. Molecular partition function and interpretation, translational, vibrational, rotational, electronic and nuclear partition functions. Corrected Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Specific heats of solids, Einstein, Debye models. Specific heats of gases. Equilibrium constant, diatomic molecules. Ortho-para equilibrium. Canonical, microcanonical, and grand canonical ensembles.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Statistical mechanics (D.A. McQuarrie)
2. Physical Chemistry (P.W. Atkins)

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Advanced Environmental Chemistry and Chemical Ecology</td><td>Course Code</td><td colspan="4">CHH 32242</td></tr>
<tr><td>Prerequest</td><td colspan="4">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the scientific principles to understand, monitor, protect and improve the environment around us.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe the air, soil and water pollution by diffracting industry, pesticides and microorganism.
- Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil and waste management.
- Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil and waste management)
- Define different concepts of atmosphere, stratospheric and tropospheric chemistry, photochemical reaction, atmospheric aerosols.
- Express air, waste and soil pollution and their control.
- Develop methods and procedures to reduce the contaminants or the chemicals in the air, soil, and water.

Course Content:

Chemical Ecology

Introduction, What is chemical ecology, Importance of chemical communication for organism, Challenges for survival in natural environment, history of chemical ecology, Lesson of the Kaibab Deer, Chemical Cues, Semiochemicals, Pheromone, chirality in pheromones, Types of pheromones, The Chemistry of Defense, Chemical defense invertebrates, Chemical defense of vertebrates, Chemical defense of frogs, How these toxins works, Chemical defense of mammals, Recent methods of pest control, Analysis of chemical messengers, techniques involved in isolations, detection, analysis of these chemicals and bio - assay methods

Environmental Chemistry

Atmospheric chemistry

Physical characteristics of the atmosphere; temperature and pressure profiles. Chemistry of stratosphere; Chapman mechanism, polar ozone depletion. Chemistry of troposphere; one-box model, organic and inorganic pollutants, chemical and photochemical reactions, effect of air pollutants on health and ecosystem, control strategies. Sources and transformations of tropospheric and stratospheric aerosols and particulate matter.

Soil chemistry

Soil formation, soil minerals and organic matter, surface charges of soil clay particles, soil profile and texture, acidity, alkalinity and salinity of soil, cation exchange capacity (CEC) and base saturation, sodium absorption ratio (SAR), pollutants in soil; aluminum, lead, arsenic content in soils etc., Greenhouse effect.

Aquatic chemistry

Characterization of different water bodies based on physical, chemical, and biochemical properties of water in different conditions. Interactions of water and air, interactions of water and soil, chemical reactions in water, aquatic microbial chemistry, transformation of different elements, colloids and sedimentation, water quality parameters, water pollution and water quality assessments, water purification techniques.

Pollution and waste management

Waste and pollutants in atmosphere, hydrosphere and geosphere, treatment and disposal of waste and minimization of waste.

Field Visit and report writing

Field visit will be arranged by the department covering institutes such as Rubber Research Institute of Sri Lanka, Rice Research and Development Institute – RRDI, Coconut Research Institute of Sri Lanka etc.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Environmental Chemistry, Van-Loon G.W., and Duffy S.J., Oxford University Press (2005) 3rded.
2. Environmental Pollution Control Engineering, Rao C.S., New Age International Publishers, New Delhi, 2nd Edition (2006).
3. Environmental Chemistry, Sindhu P.S., New Age International Publishers (2002) 2nded.

Environmental Chemistry, De A.K., New Age International Publishers (2008) 6thed.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Conformational analysis</td><td>Course Code</td><td colspan="4">CHH 32251</td></tr>
<tr><td>Prerequest</td><td colspan="4">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hrs.)</td><td>15</td></tr>
<tr><td>Practical (hrs.)</td><td></td></tr>
<tr><td>Independent Learning (hrs.)</td><td>35</td></tr>
</table>

Aim of the Course:

To provide students the basic concepts of Stereochemistry and conformation analysis of organic molecules

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the conformational stabilities of organic molecules
- Estimate the relative reactivity and stability of an organic molecule based on chemical structure, including conformation and stereochemistry

Course Content:

conformations of chiral aldehydes(Crams model Felkin- Anh model) monocyclic, bicyclic (decalin) and polycyclic (perhydrophenanthrene and perhydroanthracene) compounds, effect of conformation on rearrangement reactions (Neighboring Group Participation, classical and non-classical ions etc.) stereoisomerism, stereo specific and stereo selective reactions, asymmetric syntheses using chiral auxiliaries, chiral reagents and chiral catalysts (sharp less asymmetric epoxidation, asymmetric hydroxylation, asymmetric hydrogenation etc.) geometrical isomerism, optical isomerism in achiral compounds (Spiro compounds, Biphenyls etc.) correlation of configuration and specification of configuration.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Advanced Organic Chemistry, Carey and Sandburg, 3rd Edition
2. Organic Chemistry, T.W. Graham solomons, Craig B. Fryhle, 10th Edition

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Advanced Practical Physical Chemistry</td><td>Course Code</td><td colspan="4">CHH 32262</td></tr>
<tr><td>Prerequest</td><td colspan="4">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>-</td></tr>
<tr><td>Practical (hrs.)</td><td>90</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>10</td></tr>
</table>

Aim of the Course:

Designed to provide advanced training in physical chemistry-related laboratory techniques, procedures instruments, data collection, analysis and presentation

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Act safely and responsibly in the laboratory
- Design experiments to solve scientific problems, perform experiments using established chemistry techniques, and analyze experimental data
- Formulate and solve problems in the laboratory
- Follow safety requirements and lab skills to perform physicochemical experiments
- Effectively communicate scientific discovery in professional fora through an oral presentation and written reports

Course Content:

Construction of phase diagrams, determination of equilibrium constant by distribution method, determination of transport number of ions, determination of molecular weight of polymers, determination of order, rate constant, activation energy and effects of catalysts on reactions using different kinetic methods experiments using advanced analytical techniques such as titration, conductometry, potentiometry, coulometry, voltammetry, colorimetry polarimetry refractometry and spectroscopy

Mode of Assessment and weightage:

- Continuous Assessment (Practical examination, Individual Report, Logbook)– 50%
- End Semester Examination – 50%

Reference:

1. Advanced practical physical chemistry. Yadav,J., Krishna Prakashan Media: 2006.
2. A textbook of physical chemistry. Adamson, A., Elsevier: 2012
3. Handouts issued in the laboratory.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Seminar and Essay Writing</td><td>Course Code</td><td colspan="3">CHH 41211</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hrs.)</td><td>-</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>50</td></tr>
</table>

Aim of the Course:

Intended to provide the opportunity for students to improve their presenting and writing skills.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Read and understand recent scientific publications.
- Critically evaluate the information in the publication.
- Extract and summarize the core discovery of publication.
- Present the information in a comprehensive and interesting approach to a distinct audience.
- Appropriately answer questions using the knowledge accumulated during the HD programme
- be aware on current developments in seminar topic.
- write a comprehensive summery report, explaining on a current development in seminar topic

Course Content:

An individual seminar should be presented on a topic assigned by the supervisor.

Mode of Assessment and weightage:

- Oral Presentation – 100%

References:

Supervisor will provide scientific publication

Course Title	Organo-transition Metal Chemistry			Course Code	CHH 41221		
				Prerequest	-		
Level	4	Semester	I	Credits	1	Theory (hrs.)	15
						Practical (hrs.)	-
						Independent Learning (hrs.)	35

Aim of the Course:

To provide advanced knowledge in structure, reactivity and reaction mechanisms of organometallic compounds

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe the structure and bonding in the main group and transition metal compounds.
- Explain the reactivity and reaction mechanism of various organometallic compounds.
- Identify the multicentre bonding in different organo-transition metal compounds.
- Apply the acquired knowledge to explain the applications including catalysis and biomedical applications

Course Content:

Overview of Organometallic Chemistry

Metal-ligand bonding, MO and bonding nature of important ligands, Dewar-Chatt-Duncanson model, metal-ligand reactivity patterns, Chemistry of ferrocene, Synthesis, structure and bonding.

Reactivity of metal-bound ligands

Oxidative addition, Reductive Elimination, Insertion, Association, dissociation, Elimination and oxidative coupling, Substitution reactions and kinetics of octahedral and square planar metal complexes, stereo chemical changes, isomerization, fluxional behaviour, electron transfer reactions.

Applications

Homogeneous and heterogeneous catalysis, applications in green chemistry, biomedical applications, energy-related materials.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. The Organometallic Chemistry of the Transition Metals, Crabtree, R. H., Wiley VCH, 6th Ed, (2014).
2. Inorganic Chemistry, Gary L. Miessler, Paul J. Fischer and Donal A. Tarr, 5th Ed. (2008).
3. Inorganic Chemistry, Atkins, Overton, Rourke, Weller and Armstrong, Shriver & Atkins 5th Ed, (2010).
4. Basic Organometallic Chemistry, Gupta B. D. and Elias A. J., 2nd Ed., University press (India) Pvt Ltd., (2013)

5. The Organometallic Chemistry of the Transition Metals, Crabtree, R. H., Wiley VCH, 6th Ed.,(2014).
6. Organotransition Chemistry, Hill A. F., The Royal Society of Chemistry, Cambridge, (2002)
7. Organometallics, Elschenbroich C. and Salzer, A.,2nd edition, Wiley VCH, (1992)

Course Title	Pericyclic Reactions and Organic Photochemistry			**Course Code**	CHH 41232		
				Prerequest	-		
Level	4	**Semester**	I	**Credits**	2	**Theory (hrs.)**	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide advanced knowledge on Pericyclic Reactions and their interaction with electromagnetic radiation

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Interpret the molecular orbital symmetry and possibility of thermally and photochemically pericyclic reactions.
- Describe the theory and application of photochemistry and photophysical principles of macromolecules.
- Use orbital description to classify different type of pericyclic reactions namely cycloaddition, sigmatropic reactions and electro cyclic reactions.
- Use selectivity theories in order predict the stereochemistry of the products of pericyclic reactions under thermal and photochemical conditions.
- Explain the different electronic excitation in organic molecules with a chromophore.
- Identify the different process available for electronically excited states of organic molecules.
- Describe the changes in the electronic distribution and structural changes in the excited state.
- Identify the possible reaction of carbonyl, alkenes, aromatic, diazo, and di-pi-methane compounds in the excited state and derive the mechanisms of such reactions.
- Use photo-removable groups in organic syntheses.
- Use of photochemical reactions in Industry
- Design photochemical sensors

Course Content:

Pericyclic Reactions

Frontier orbital description, classification of thermal and photochemical cycloadditions, Diels-Alder reaction, other thermal and photochemical cycloadditions, 1, 3-dipolar cycloadditions, 3,3-sigmatropic, 2,3-sigmatropic, 1,5-sigmatropic hydrogen shifts and electro cyclic, group transfer reactions, theories, prediction of the mode of reaction and the stereochemistry of products under thermal and photochemical conditions by applying the theories.

Organic Photochemistry

Selection rules for electronic excitation. Electronic states, Quantum yield, excitation sources, filters, fluorescence and phosphorescence. Photochemistry of carbonyl compounds, photochemical deconjugation, photochemical additions with and without sensitizer; Buchi-Paterno reaction. Photoisomerization of C=C, N=N, C=N compounds, photo stationary state, photochromism, photochemistry of aromatic compounds, Di-methane rearrangement, photo removable protecting groups in organic synthesis, resins containing light sensitive chromophores, industrial photochemical synthesis; Supra molecular chemistry: molecular recognition, information, complementarity, Entropic considerations and spontaneity; Spherical recognition, structural recognition, Molecular receptors for tetrahedral recognition: di-nuclear and poly nuclear metal-ion crystals, example for linear recognition; Supra molecular reactivity and catalysis; Transport processes and carrier design; Introduction to exoreceptors; Introduction to poly molecular assemblies, Molecular switches, supra molecular photochemistry, Molecular electronic devices.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Molecular Reactions and photochemistry., Depuy, C.H., and Chapman, O. L., Pearson Education, Limited, (1972).
2. Organic Photochemistry. A Comprehensive Treatment, Horsepool, W. H., Ellis Horwood, Chichester, U.K (1992).
3. Organotransition metal catalysis, S.P. Deraniyagala and M.D.P De Costa, Monograph Number 14, 2001,

Course Title	Advanced Organic Chemistry II			**Course Code**	CHH 41242		
				Prerequest	-		
Level	4	**Semester**	I	**Credits**	2	**Theory (hr)**	30
						Practical (hr)	-
						Independent Learning (hr)	70

Aim of the Course:

To provide an advanced knowledge in linear free energy relationships and the use of Hammett plots in predicting reaction rates/investigating reaction mechanisms and protecting groups in organic synthesis.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Strategically choose different methods to investigate the reaction mechanism
- Derive the Hammett equation, the Yukawa Tsuno Equation and Taft equation
- Analyze deviation from Hammett straight line plots; concave upwards and downwards curves.
- Discuss the role of reagents in organic synthesis.
- Explain the characteristics of protecting groups.
- Express the functional group protection using chemical reactions.
- Know the protection of important functional groups.
- Explain reaction conditions, product formation and mechanism of some

Course Content:

Modern Reagents and Protective Groups: Uses of enzymes, silicon reagents, palladium reagents, transition metal catalysts (in alkene metathesis) in organic synthesis, protection/de-protection of functional groups in organic synthesis and functional group compatibility. **Determining Reaction Mechanism:** Methods for investigating the reaction mechanism: kinetic methods, deuterium isotope effect, labeling methods, intermediates in reactions etc.
Hammett equation: Brief review of Hammett equation and its relationship: limitations of Hammett equation, deviations from Hammett equation and modifications of Hammett equation. Yukawa – Tsuno equation and its applications, Taft equation. Effect of conformation on reactivity and stability of compounds, Curtin- Hammett principle.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Advanced Organic Chemistry Carey and Sandburg, 3rd Edition
2. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes Page #358-395
3. Organic Chemistry by T.W. Graham Solomons Craig B. Fryhle, 10th Edition
4. Organotransition Metal Catalysis, S.P. Deraniyagala and M.D.P De Costa, Monograph Number 14, 2001.
5. Reaction mechanism in organic chemistry, S.M. Mukharjee and S.P. Singh, 3rd Ed.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Applied Natural Product Chemistry</td><td>Course Code</td><td colspan="3">CHH 41252</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the knowledge of chemical, biochemical and biological properties of drugs derived from natural sources and will equip the students with the pharmaceutical industry

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Discuss the history of drugs discovered from natural sources.
- Provide an overview of the field of natural product chemistry
- Categorize various types of natural products into classes.
- Explain how medicinal compounds are extracted from natural sources.
- Explain how natural products are screened to identify potential drug compounds
- Explain main steps of identification of natural product

Course Content:

What is Natural product (NP), primary and secondary metabolize, Introduction and brief history of herbal systems of medicine, Pharmaceuticals, cosmeceuticals, and lead compounds of natural origin, Importance of NP, Natural products with pharmaceutical value; anticancer, anti-tumer, anti-HIV, antioxidants and hyperglycemic activities etc., NP sourses, Discovery of NP 1. Identification 2. collection sample 3. prepararion of sample, 4. Extraction

4.1 types of extraction, 4.2 traditional and modern extraction techniques, 5. Isolation 6. Bioassays, 6.1 antibacterial assay, MIC and MLC, 6. 2 antifungal assay, antioxidant assay, etc., 7. class of NP e.g., terpen, terpenoids etc., essential oil, Industrial applications essential oils, 8. identification of natural products using of LC-MS, GC-MS, EAG, GC-EAG

Field Visit and report writing

Field visit will be arranged by the department covering institutes such as Rubber Research Institute of Sri Lanka, Rice Research and Development Institute – RRDI, Coconut Research Institute of Sri Lanka etc.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Textbook of Pharmacognosy (Trease and Evans)
2. Textbook of Pharmacognosy and Pharmacobiotechnology (J.E. Robbers, M.K. Speedie & V.E. Tyler)
3. Drugs of Natural Origin (G. Samuelsson).

Torsell, K.B.G., Natural Product Chemistry, Apotekasocieteten (1997).

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Quantum Chemistry</td><td>Course Code</td><td colspan="3">CHH 41262</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

Designed to provide an advanced knowledge in quantum mechanical description of atom and molecule

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Predict properties of non-interacting entities using quantum mechanics.
- Apply approximate methods to predict properties of complex systems.
- Apply quantum mechanics to multi-electron systems.
- Explain the theoretical foundation of electronic structure calculations using quantum chemistry

Course Content:

Exactly solvable problems, atomic units; Approximate methods, many electron systems, Born-Oppenheimer approximation, Pauli exclusion principle, spin and spatial orbitals, Hartree products, Slater determinant, configuration interaction, Hartree-Fock approximation, Coulomb and exchange integrals, Hartree-Fock equations, Bonding in polyatomic molecules, Orbital energies, Koopamann theorem, Brillouins theorem, Virial theorem, Hellmann- Feynman theorem. Introduction of a basis functions: Roothaan equations, orthogonalization of the basis, the self-consistency procedure, use of computational packages in semi-empirical and ab-initio calculations.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Quantum Chemistry, Levine, N.I., Prentice Hall (2008) 5th ed.
2. Molecular Quantum Mechanics, Atkins, P., and Friedman, R., Oxford University Press (2005) 4th ed.
3. Theory and application of quantum molecular dynamics. Zhang, J. Z. H., World Scientific: 1998.
4. Quantum chemistry (D.A. McQuarrie)

Course Title	Advanced Coordination Chemistry and Magneto Chemistry			Course Code	CHH 41272		
				Prerequest	-		
Level	4	Semester	I	Credits	2	Theory (hrs.)	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

Designed to provide advanced theoretical knowledge in coordination chemistry, applications of coordination compounds and the concepts and applications of magneto chemistry

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe the structure and bonding in the main group and transition metal compounds.
- Explain the reactivity and reaction mechanism of various main group and transition metal compounds
- Apply theoretical models to explain magnetism and other properties of transition-metal complexes

Course Content:

Advanced Coordination Chemistry

Bonding in complexes: Theories in coordination chemistry, type and description of bonding, diagrammatic representations. Electronic spectra of complexes: Introduction, spin multiplicity , weak and strong field approaches, spectroscopic terms, microstates, Ogrel diagrams for d1 to d9 complexes, type of transitions, selection rules and intensities, crystal field splitting energy, Recah parameters, spin-orbit coupling, Jahn-Teller effect, Angular Overlap Model (AOM) of d- orbitals, charge transfer spectra.

Magneto Chemistry

Introduction, magnetic susceptibility, measurement of susceptibility, corrected magnetic susceptibility, paramagnetism, Curie's law, Curie-Weiss law, trend of paramagnetic behaviour with energy separation, quenching of orbital contribution, spin-orbit coupling, temperature independent paramagnetism, applications of paramagnetic behaviour, diamagnetism, ferromagnetism, antiferromagnetism.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Inorganic and Organometallic Reaction Mechanisms (J.D. Atwood)
2. Inorganic reaction Mechanisms (M.L. Tobe)
3. Mechanisms of Inorganic Reactions (I. Basolo and R.G. Pearson)
4. Cluster Molecules of p-Block Elements (C.E. Housecroft)
5. Multiple Bonds Between Metal Atoms (F.A. Cotton and R.A. Walton)
6. Spectroscopy (D.R. Browning)
7. The Organometallic Chemistry of the Transition Metals (Robert H. Crabtree)
8. Concise Inorganic Chemistry (J.D. Lee)

Advanced Inorganic Chemistry (F.A. Cotton and R. Wilkinson).

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Research Project</td><td>Course Code</td><td colspan="3">CHH 41286</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="2">Level</td><td rowspan="2">4</td><td rowspan="2">Semester</td><td rowspan="2">I</td><td rowspan="2">Credits</td><td rowspan="2">6</td><td>Student – Supervisor contact (hrs.)</td><td>60</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>540</td></tr>
</table>

Aim of the Course:

To provide an opportunity for students to plan and execute a research project independently

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Search, analyze and summarize current literature relevant to a specific topic of his/her area of expertise.
- Rationalize the research gap for innovation.
- Design and implement a suitable experimental / theoretical procedure.
- Comprehend expertise on maintaining a lab logbook, data analysis, scientific report writing.
- Exposure for safe laboratory practices by handling high-end equipment and chemical reagents
- Effectively communicate any findings and defend the work in a professional manner

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by Supervisor

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Molecular Dynamics & Molecular Modelling</td><td>Course Code</td><td colspan="2">CHH 42212</td></tr>
<tr><td>Prerequest</td><td colspan="2">-</td></tr>
</table>

<table>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

Designed to provide deep knowledge on theoretical methods in molecular modeling and molecular dynamics.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the theoretical foundation of computational chemistry, with an emphasis on electronic structure calculations using quantum chemistry and classical molecular dynamics simulation techniques
- Use computational chemistry as a tool to effectively address the chemistry problem.
- Investigate the theoretical and practical challenges associated with computational modeling.
- Describe the aspects of molecular modelling and molecular dynamics.
- Construct the force field expression of total energy.
- Derive an expression for the free energy change of mixing.

Course Content:

Molecular Dynamics

Symmetry-adapted MO's using projection operators; Linear combination of atomic orbitals. Hükel molecular orbital calculations; Molecular Properties & Molecular Dynamics: The electric dipole, vector addition of dipole moments, induced dipole moment, Charge-charge interactions, charge- dipole interactions, dipole-dipole interactions, dipole-induced dipole interactions, induced dipole-induced dipole interactions, total attractive interactions, effect of rotation, Axilrod-Teller formula, Mie potential, Lennard-Jones potential, hydrogen bonding interactions, multipoles; Minimum energy structure of a molecule, methods to obtain minimum energy; Molecular dynamics simulation, modeling liquids and solvation;

Molecular Modelling

Energy minimization and related methods for exploring the potential energy surfaces, Non derivative minimization methods, derivative minimization methods, first order and second order minimization methods, selection of suitable minimization methods, calculation of thermodynamic properties, molecular dynamic simulation methods, Monte Carlo simulation methods.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Quantum chemistry (D.A. McQuarrie)
2. Molecular modeling: principles and applications (A.R. Leach) Concise Inorganic Chemistry (J.D. Lee)
3. Molecular Quantum Mechanics, Atkins, P., and Friedman, R., Oxford University Press (2005) 4th ed.
4. Theory and application of quantum molecular dynamics. Zhang, J. Z. H., World Scientific: 1998.

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Techniques in Analytical and Spectroscopic Methods</td><td>Course Code</td><td colspan="3">CHH 42222</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hrs.)</td><td>15</td></tr>
<tr><td>Practical (hrs.)</td><td></td></tr>
<tr><td>Independent Learning (hrs.)</td><td>35</td></tr>
</table>

Aim of the Course:

To provide well understanding on the principles and applications of advanced spectroscopic techniques and to elucidate the structure of inorganic compounds using advanced spectroscopic techniques.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the theoretical aspects of main analytical techniques and instruments used in chemistry
- Describe the theoretical aspects of main spectroscopic techniques used in the field of chemistry
- Tactically plan analytical campaigns to analyze different types of samples and research objectives
- Interpret different types of spectroscopic/analytical data to solve chemistry related problems
- Explain the basic principles of common types of multivariate spectral analysis.

Course Content:

Advanced Analytical Techniques:

A summary of the application of modern analytical techniques and their uses.

Determination of pKa values of chelating ligands, the study of stoichiometry and stability of various metal complexes at different pH values, use of coordination complexes in chelation therapy, principles of chelation therapy in medicine (metal transport, removal of metal ion overload).

Electroanalytical methods: Coulometry, electrogravimetry, amperometry, potentiometry, ion and molecular selective electrodes, carbon paste electrodes, conductometry. Conditional formation constants; Masking (Sequestration), - coefficients; Medicinal and industrial purposes; Metal ion speciation; Effect of sequestration on redox reactions, formal potential values, Eh and pE, environmental redox parameters; Kinetic Methods of analysis.

Advanced Spectroscopic Techniques:

Nuclear Magnetic Resonance Spectroscopy:

A brief overview of principles, comparative study of classical and quantum mechanical models, fundamentals of magnetic resonance, instrumentation - NMR magnets, probes, field sweep- and frequency sweep- continuous wave NMR spectra, 13C- NMR spectra, temperature dependent NMR spectra, advanced theories of NMR coupling constants, mechanism of coupling, chemical equivalence and magnetic equivalence, second-order spectra, multi-pulse methods in NMR, 2D NMR, dynamic NMR, multinuclear NMR spectroscopy and their uses in inorganic chemistry.

Electron Spin Resonance Spectroscopy (ESR):

Principles of ESR spectroscopy, nuclear hyperfine splitting, anisotropic effects, ESR

spectra of transition metal ion complexes, uses of ESR spectroscopy in chemistry.
Nuclear Quadrupole Resonance Spectroscopy (NQR):
Introduction and principles, energy quadrupole transitions, the effect of the magnetic field, the relationship between electric gradient and molecular structure, NQR spectra of transition metal ion complexes, use of NQR spectroscopy in chemistry
Mossbauer Spectroscopy (MBS):
Principles of Mossbauer Spectroscopy, interpretation of isomer shifts, quadrupole interactions, magnetic interactions, Mossbauer spectra of transition metal ion complexes, uses of MB spectroscopy in chemistry
Photo Electron Spectroscopy:
Principles, introduction to UV-PES and X-ray, Koopmans rule, photoelectron spectra of diatomic and simple polyatomic molecules Comparative study of molecular orbital energies obtained from PES and theoretical Quantum mechanical calculations, applications and limitations of UV-PES and X-PES
Microwave Spectroscopy:
Microwave spectroscopy of linear polyatomic molecules; Introduction to microwave spectra of symmetric top, spherical top, asymmetric top and molecules.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

4. Materials characterization: introduction to microscopic and spectroscopic methods. Leng, Y., John Wiley & Sons: 2009.
5. Physical Methods in Inorganic Chemistry, Russell S. Drago, 1st edition, ACS publications, 1966.
6. NMR Spectroscopy in Inorganic Chemistry (Oxford Chemistry Primers), Jonathan A. Iggo, 1st edition, Oxford Science Publications, 1999.
7. Understanding NMR Spectroscopy, James Keeler, 2nd edition, Wiley Pvt. Ltd, 2010
8. Principles and Applications of ESR Spectroscopy, Anders Lund, Masaru Shiotani, Shigetaka Shimada, 1st edition, Springer, 2011

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Topics in Physical Chemistry</td><td>Course Code</td><td colspan="3">CHH 42232</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td></td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide in depth theoretical knowledge in surface chemistry, chemical kinetics and electrochemistry.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain Maxwell's relationships, Maxwell – Boltzmann, Fermi – Dirac and Bohr's Einstein statistics Comparison and application spontaneity, equilibria-Temperature, pressure dependence of thermodynamic quantities
- Analyze and apply the principles of electrochemistry in real-world problems.
- Familiarize with the theories of reaction rate and their utilization.
- Describe the special nature and properties of surfaces, specific interactions between the surface and the environment, to derive mathematical relationships governing adsorption and surface catalysis

Course Content:

Advanced Surface Chemistry

Adsorption - physisorption and chemisorptions isotherms, factors affecting adsorption of gases on solids, catalysis, homogeneous and heterogeneous activity and selectivity, enzyme catalysis, colloidal state, distinction between true solutions, colloids and suspensions; lyophillic, lyophobic, multimolecular and macromolecular colloids, properties of colloids, Tyndal effect, Brownian movement, electrophoresis, coagulation, emulsions - type of emulsions.

Advanced Electro Chemistry:

Ion-solvent interaction, Structural treatment, Nature of Electrolytes, Debye – Huckel theory, electrode/electrolyte interface, electrocapillary phenomenon, models for the electrical double layer, kinetics of electrode reactions, Mass-transfer and electron-transfer reaction, Butler – volmer equation and Tafel plots.

Advanced Chemical Kinetics

Fundamental laws in Kinetics, collision theory and relaxation methods, chain reactions, explosions, oscillation, potential energy surface, transition state theory (TST) for ideal gas and relation between TST and collision theory, Eyring equation, thermodynamic treatment of TST, experimental methods in studying fast reactions

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Take-home assignments, Essay type examination)– 30%
- End Semester Examination – 70%

References:

1. Elements of Physical Chemistry, S. Glasstone and D. Lewis, Macmillan, 2nd Edition, 1995.
2. Physical Chemistry, P.W. Atkins, Oxford University Press, 5th edition, 1995.
3. Electrochemical methods: Fundamentals and applications (A.J. Bard, L.R. Faulkner)
4. Chemical kinetics (K.J. Laidler)

Course Title	Biochemistry and Molecular Biology			**Course Code**	CHH 42242		
				Prerequest	-		
Level	4	**Semester**	II	**Credits**	2	**Theory (hrs.)**	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

Designed to provide knowledge in the structure, properties, functions of important biomolecules and application of thermodynamic principles in biological systems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe types of molecular/ionic interactions important in biochemical systems.
- Describe types of reactions in biological systems.
- Explain structure-function relationship of biomolecules.
- Describe the use of properties of biomolecules in their identification

Course Content:

Introduction

Four major classes of biomolecules, monomers, polymers, macromolecules, Noncovalent Interactions in biomolecules

Aqueous solution

Properties of water, Structure and interaction of water, H-bonding in liquid water and ice, Acids, base and buffers, acid base theories, Strength of Acid and Base, Acid –Base dissociation constant K_a/K_b, Henderson-Hasselbalch equation, buffers, How buffer solution resists the pH change, buffer capacity, buffer range, preparation of buffer, Physiological (biological) Buffers

Biomolecules

Protein

amino acid, classification of amino acids, properties of Amino acids, stereochemistry of amino acids, Amino Acids as Acids and Bases, Titration Curves of Amino Acids, isoelectric point pI,

Peptides, oligopeptide, polypeptide, Biologically Active Peptides, subunit, simple proteins, conjugated proteins, prosthetic group

Protein structure, Primary, secondary structure (α-Helix, β-sheet, random coil), tertiary (fibrous proteins, globular proteins) and quaternary structure, Sickle cell anaemia, Ramachandran plot, protein structure analysis via Circular Dichroism, structure of α-Keratin and Collagen, domains and motifs of protein, Protein Denaturation and renaturation, Anfinsen’s Experiment, molecular chaperones, Protein-misfolding diseases, Prion Diseases, Proteins Separation and Purification, Main steps of protein separations, Electrophoresis, Estimating the molecular weight of a protein, Isoelectric focusing, Two-dimensional electrophoresis, Protein sequencing

Lipids

role of lipids, Fatty Acids (FA), Nomenclature fatty acids, Triacylglycerols, cis/trans FA, biological roles of Triacylglycerols, Significant Of Using Triacylglycerols As Stored Fuels, Structural Lipids in Membranes, Glycerophospholipids, Galactolipids and Sulfolipids,

Archaeal ether lipids, Sphingolipids, Subclasses Of Sphingolipids, steroids, sterols, working with lipids
Sugar and Carbohydrates
Mono/di/polysaccharides, Cyclic Structures of Monosaccharides, Reducing Agents, Blood Glucose Measurements, Disaccharides, Nonreducing sugar, Nomenclature of disaccharides, Polysaccharides, starch, Digestion of starch, Glycogen, Digestion of starch and glycogen, Dextrans, Polysaccharides: Homopolysaccharides, Cellulose, Chitin, Agar,
Nucleotides and Nucleic Acids
Structure of Nucleotides and Nucleic Acids, Phosphodiester Bonds, Why RNA is so fragile?, Representation of Nucleic acid, Nucleic Acid Structure, Watson-Crick model, DNA conformations, B-form, A- form, Z- form, palindrome, hairpin or cruciform structure, Triplex DNA structure, quadruplex
Messenger RNAs Code for Polypeptide Chains, RNAs 3D structure, Denaturing DNA and RNA structure, UV absorption of DNA, Melting point of DNA structure, DNA Hybrids, Nonenzymatic Transformations of DNA, DNA sequencing, Sanger method, Maxam and Gilbert Method,

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Biochemistry (C. K. Mathews & K. F. van Holde)
2. Biochemistry (D. Voet & J. G. Voet)
3. Fundamentals of biochemistry, J. L. Jain, Sunjay Jain and Nitin Jain, 6th edition, S. Chand and company Ltd., 2005.
4. Biochemistry, Berg, J. M., GattoJr.,G. J., Tymoczko, J. L. and Stryer, L. (8th Edition), 2015

Course Title	Bioinorganic Chemistry, Nuclear and Radio-Chemistry	Course Code	CHH 42251			
		Prerequest	-			
Level	4	Semester	II	Credits	1	Theory (hrs.) 15
						Practical (hrs.) -
						Independent Learning (hrs.) 35

Aim of the Course:

To give clear understanding of the basic principles of Bioinorganic Chemistry and Nuclear and Radio-Chemistry, thereby to provide the ability to describe the pharmacological properties of the inorganic compounds and to discuss selected examples to illustrate the applications of inorganic compounds in pharmaceutical industry.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe the role of metal ions in biological systems
- Explain correlation between structure and function of different metalloproteins including metalloenzymes
- Describe the applications of metal-based drugs (therapeutic and diagnostic agents) and their structure-activity relationships
- Explain the fundamental concepts of nuclear and radiochemistry
- Solve simple problems and calculations using the fundamentals of nuclear and radiochemistry
- Identify and define various types of nuclear changes or processes including fission, fusion and decay reactions.
- Utilize the principles of transition metal coordination complexes in understanding functions of biological systems.

Course Content:

Bioinorganic chemistry

The biological roles of metal ions: reaction pathways of metal enzymes, metal storage, Transport and biomineralizations. Dioxygen management; storage and transport of metal ions. Electron transfer in metabolic processes, metal-sulphur proteins, metals in medicine, Detoxification of toxic metal.

Nuclear and Radio Chemistry

Introduction, elementary particles, radioactive series, radioactive decay law, radioactive equilibrium law, kinetic isotopic effect, schilard-chalmer effect, radiation sources and measurement of radiation, alpha-, beta- and gamma- radiation, half-life, nuclear fission, nuclear fusion, neutron activation analysis, Radioactive dating

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Principles of Bioinorganic Chemistry. Lippard and Berg, University Science Books, 1994 (ISBN 978-0-935702-72-9).
2. Bioinorganic Chemistry. Bertini, Gray, Lippard and Valentine, University Science Books, 1998 (ISBN 81-7649-000-8).
3. Essentials of Nuclear Chemistry. Arnikar, H. J., New Age International, 2011. (ISBN 978-81-224-3203-9).
4. Radiochemistry and Nuclear Chemistry. Choppin, Lilijenzin, Rydberg, and Ekberg. Elsevier Inc, 2013. (ISBN 978-0-12-405897-2).
5. Element speciation in bioinorganic chemistry. Caroli, S., John Wiley & Sons: 1996; Vol. 178
6. Nuclear and Radiochemistry, Friendlander G, Kennedy G and Miller J. M. Wiley Interscience
7. Basic concept of Nuclear Chemistry, Overman R. T, Chapman & Hall.
8. An Introduction to Radiation Chemistry, Spinks J. W. T. and Woods R. J. Wiley
   Essentials of Nuclear Chemistry, Arnikar H. J., Wiley Eastern, Second Edition.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Chemical Synthesis of Secondary Metabolites and Therapeutic Agents</td><td>Course Code</td><td colspan="3">CHH 42262</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

Designed to provide advanced knowledge on synthesis and chemical modification of major classes of secondary which possess therapeutic value

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the chemistry of secondary metabolites and therapeutic agents.
- Predict different types of reagents and conditions that are used to synthesize of secondary metabolites.
- Describe the Nomenclature and stereochemistry of sterols
- Explain the rationale behind synthetic routes to triterpenoids, alkaloids, steroid and flavonoids.
- Analyze the synthetic route for terpenes, steroids, alkaloids and flavonoids.
- Describe the mode of action of therapeutic agents.

Course Content:

Terpenoids

General methods of determining structure, classification, structure elucidation and synthesis of different groups of terpenoids (monoterpenoids, sesquiterpenoids, diterpenoids, triterpenoids and polyterpenoids).

Steroids

Nomenclature, stereochemistry, synthesis of sterols (cholesterol, ergosterol), stigmasterol, bile acids and steroid hormones.

Carotenoids

Characterisation of carotenoids, synthesis of carotenes (α-,β- and y-carotenes), lycopene, xanthophylls and carotenoid acids.

Alkaloids

Definition, general methods of determining structure, classification, structure elucidation and synthesis of different groups of alkaloids (phenylethylamine, pyrrolidine, pyridine and piperidine, pyrrolidine-pyridine, quinoline, isoquinoline, phenanthrene, aporphine and indole groups)

Flavonoids

Nomenclature, properties, and synthesis of different groups of flavonoids (anthocyanins, flavones and isoflavones).

Therapeutic agents

Mechanism of therapeutic action, hematological agents, sulphonamides, vitamins, and antibiotics (chloramphenicol, penicillin, cephalosporin, tetracycline, ofloxan, bacitracin A)

Field Visit and report writing
Field visit will be arranged by the department covering institutes such as Rubber Research Institute of Sri Lanka, Rice Research and Development Institute – RRDI, Coconut Research Institute of Sri Lanka etc.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Functions of plant secondary metabolites and their exploitation in biotechnology. Wink, M., Taylor & Francis: 1999; Vol. 3
2. Organic Synthesis, Elsevier Inc, Michael. B. Smith, Third Edition, 2010

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Application of Biotechnology</td><td>Course Code</td><td colspan="3">CHH 42271</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hrs.)</td><td>15</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>35</td></tr>
</table>

Aim of the Course:

Designed to provide principles and applications of DNA science with special reference to recombinant DNA technology and the analysis of nucleic acids (DNA and RNA) and proteins.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Describe the foundations of biotechnology
- Demonstrate the steps of recombinant DNA technology and genetic engineering
- Manipulate DNA with restriction enzymes
- Construct recombinant vectors with novel properties
- Amplify DNA by polymerase chain reaction
- Identify a person based on DNA profile

Course Content:

DNA-Based Information Technology, DNA Cloning, Restriction Endonucleases and DNA Ligase, DNA digestion, vectors, Transformation, Bacteriophages λ, Bacterial Artificial Chromosomes, Expression of Cloned Genes, expression vectors, site directed mutagenesis, Tag protein, DNA amplification method PCR, Applications of genetic engineering, transgenic animals, transgenic plants, crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors, genetically.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions)– 30%
- End Semester Examination – 70%

References:

1. Introduction to Biotechnology (3rd Edition), Benjamin Cummings Publishing Company, 2012. ISBN: 9780321766113

Computer Science

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Mathematics for Computing and Mathematical Modelling</td><td>Course Code</td><td colspan="3">CSH 31213</td></tr>
<tr><td>Prerequisite</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To develop important components of set theory and mathematical solutions for real-world problems.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the concepts of sets, relations, and functions.
- Demonstrate the concepts of mathematical logic.
- Explain the theorems related to groups, subgroups, and cyclic group.
- Develop and solve the mathematical models.

Course Content:

- *Mathematics for Computing*:
  - ✓ Sets and relations, Cartesian products of sets, relations as subsets of Cartesian products, partitions, coverings, permutations, combinations, functions and mapping, relations and their properties including symmetry, transitivity, transitivity and functionality: logical operators, Venn diagrams;
  - ✓ Boolean algebra, truth tables, normal forms, prepositional connectives, tautologies and contradictions, simple prepositional calculus using natural deduction method, validity of arguments, rules of inference, conditional proof and method of reducio ad absurd, syntax and semantics first order predicate logic, symbols, terms, theorems, first order calculi: natural deduction, correctness and completeness.
  - ✓ Algebraic structures: general definition, types of algebramonoids, groups, rings and fields; vector spaces linear dependence and independence, inner product and norms orthogonality; working with algebra: homomorphism’ isomorphism’ quotient algebra' polynomials and their roots; elementary number theory,
  - ✓ Graphs: particular classes of graphs, graphs and associated relations, operations on graphs, graphs and associated matrices, graph algorithm.
  - ✓ Optimization: linear programming, dynamic programming constrained and unconstrained problems;
  - ✓ Queues: discrete and continuous time Markovchins, birth-death processes, classical querying system, M/M/m. M/G/1 variants, queue characteristic measures;
  - ✓ Decision Mathematics: decision Trees, Certain and uncertain decision making. Non-probabilistic and probabilistic decision problems, Posterior and pre posterior

analysis.

- *Mathematical Modelling:*
  - ✓ Introduction to Mathematical models, Modeling Methodology,
  - ✓ Modeling Skills: Listing factors; Making assumptions: Translating into mathematics; Dimensional analysis.
  - ✓ Optimization Models, Models using Difference Equations, Models using Differential equations, Empirical models.
  - ✓ Example of Models: Traffic lights; Price wars, Evacuation; Corridors and corners.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial) – 30%
- End Semester Examination – 70%

References:

1. Chetwynd& P. Diggle, *Discrete Mathematics*, Butterworth-Heinemann, 1995;
2. John B. Fraleigh, *A First Course in Abstract Algebra*, Person Education, Inc., 2003.
3. Hamdy a. Taha, *Operations Research: An Introduction, 9th edition*, Prentice Hall, 2010;
4. Edwards, D., & Hamson, M., *Guide to mathematical modelling*. Industrial Press, 2007.

Course Title	Software Project Analysis and Management			Course Code	CSH 31221		
				Prerequisite	CSM 31212		
Level	3	Semester	1	Credits	1	Theory (hr)	15
						Practical (hr)	-
						Independent Learning (hr)	35

Aim of the Course:

To provide student with an insight of software project management and system analysis.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the players in software development process and system analysis process.
- Identify functional, non-functional, system and user requirement.
- Analyse feasibility of a system using feasibility investigation.
- Capable to manage a project in terms of planning, scheduling, risk analyzing, resource allocation, cost and time management etc.
- Differentiate process and project management.
- Model processes in an system using modelling diagrams.

Course Content:

- *System Analysis:* Players in software project development, Feasibility study, Motivation for a system development process in terms of the Capability Maturity Model (CMM); PIECES framework for categorizing problems, opportunities, and directives; Computer-aided systems engineering (CASE), Application Development Environments (ADEs), Process and project management technology as automated tools for system development.
- *Requirement Discovery:* System requirements and requirements management; Fact-finding techniques and their characteristics.
- *Feasibility Analysis and the System Proposal:* Feasibility checkpoints in the systems life cycle; Types of feasibility; Cost-benefit analyses using time adjusted costs and benefits; System proposal reports for different audiences.
- *Project Management:* Project selection, Planning, Scheduling, Risk management, Project teams, Resource allocation, Effort estimation, Optimizing the network, Financial management, Project execution, Monitoring, Control and termination, Communication skills, Quality management, Configuration management (version control), Contract management and Human resource management.
- *Project and Process Management:* Causes of failed IT projects; Basic competencies required of project managers; Functions of project management; PERT and Gantt charts; Eight activities in project management; Joint project planning; Work breakdown structure to decompose a project into tasks; Estimate tasks' durations, and specify inter-task dependencies on a PERT chart; Project schedule with a Gantt chart; Critical path analysis.
- *Cost Management:* Investigation, problem analysis, requirements analysis, and decision analysis phases in terms of purpose, participants, inputs, outputs, techniques, and steps.

- *Process modelling:* Systems modelling-logical and physical system models; Process model using DFD; Context diagram; Synchronize data and process models using a CRUD matrix.; Mini project-feasibility checking, requirement gathering, process management.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Case studies) – 30%
- End Semester Examination – 70%

References:

1. Information Systems Project Management: A Process and Team Approach; Mark Fuller, Joe Valacich, and Joey George, Prentice Hall, 2007.
2. Systems Analysis and Design 7th Edition, Alan Dennis, Barbara Wixom, Roberta M. Roth.

Course Title	Operating Systems Theory and Shell Programming			Course Code	CSH 31232		
				Prerequisite	CSM 21221		
Level	3	Semester	1	Credits	2	Theory & Practical (hr)	30
						Independent Learning (hr)	70

Aim of the Course:

To provide students advance concepts of operating systems.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain advanced OS Concepts in terms of process management, memory management, data management and file system.
- Understand the process of paging: loading, linking and libraries;
- Explain processes, threads, resource allocation, scheduling and deadlock;
- Operating system as a virtual machine and as a resource manager
- Use Linux file system and commands
- Differentiate Unix, Linux and Android
- Demonstrate C programming and Shell commands for system programming

Course Content:

- *Advanced OS Concepts:*
  - ✓ Introduction, Distributed OS Techniques;
  - ✓ Naming, Inter-process communications and remote procedure calls
  - ✓ Data and process migration, transactions, file systems, Parallel OS Techniques;
  - ✓ Process management, scheduling, synchronization, Data management, caching, coherency, consistency, file systems, Load balancing,
  - ✓ Advanced OS Concerns;
  - ✓ Memory management, virtual memory, garbage collection, Fault-tolerance, reliability, replication, Protection, authentication, security, cryptography, I/O models, Performance, benchmarking, and monitoring, Client - Server Model.
  - ✓ Memory management: Paging page tables.
  - ✓ Memory Management: Swapping, paging, page tables, MMUs Page faults, associative page table, caches, page replacement algorithm, page fault handling, segmentation.
  - ✓ paging: loading, linking and libraries;
  - ✓ file systems, consistency, redundancy, concurrency, operating system security
  - ✓ Processes and threads, resource allocation, scheduling and deadlock;
  - ✓ Deadlock detection & recovery, prevention, 2 phase locking, Communication Dead-locks
- *Operating system as a virtual machine and as a resource manager;*
  - ✓ Virtualization, Real-time Operating Systems & Micro Kernels.
  - ✓ Virtualisation: VM ware, clouds as a service, virtual machine migration
  - ✓ Multi-processor OS, synchronization, scheduling, multicomputer hardware, Remote procedure call, multicomputer scheduling, distributed shared memory, load balancing.
- *File system in Linux*

- ✓ Unix file system as an example;
- ✓ user interfaces, standalone windows and network extended windows: distributed systems principles, Amoeba and Mach;
- ✓ current operating systems: Linux architecture and file systems in Linux;

- *System programming in the Unix environment:*
  - ✓ Review of C programming, shell command language, system calls for process management, file access, network system calls, RPC,
  - ✓ Threading: program development
  - ✓ Implementing/Modifying, System Calls, File systems, Device Drivers, Shells & Communication Abstractions (pipes etc.)
- *Case study: Unix, Linux and Android:*
  - ✓ Linux utility programs,
  - ✓ The Shell, kernel structure, process management system calls in Linux,
  - ✓ Memory management system calls in Linux,
  - ✓ File system calls in Linux,
  - ✓ Implementation of Linux file system

<u>Practical</u>

C Programming, Shell commands for system programming.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Quiz) – 30%
- End Semester Examination – 70%

References:

1. Tanenanbaum, A.S.; Modern Operating Systems (3rd Edition); Prentice Hall; 2001

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Compiler Design and Theory of Computation</td><td>Course Code</td><td colspan="3">CSH 31242</td></tr>
<tr><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide student in depth knowledge in compiler construction and Theory of Automata.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain compiler theory.
- Differentiate lexical and syntax analysis.
- Understand the concept of Finite state machines (DFA and NDFA), Regular Expressions, Regular Grammar, Regular languages, Context free grammars, Pumping lemma and Pushdown automata.
- Design Finite Automata from Regular Expression.
- Generate regular expression from Finite Automata.
- Convert DFA from NFA.

Course Content:

- *Compiler Theory:*
  - ✓ Contemporary techniques in implementation of programming language translators
  - ✓ Different methods in depth and techniques used to translate a programme written in a high-level language into a programme in low-level language which is more suited for machines.
- Lexical and syntax analysis using Flex and Bison as tools.
- *Compiler construction tools*: LEX and YACC.
- *Theory of Computation*:
  - ✓ Basic Terminologies of Theory of Computation
  - ✓ Chomsky Hierarchy in Theory of Computation
  - ✓ Application of Automata: Finite Automata, Push Down Automata (PDA), Turing Machine (TM)
  - ✓ Finite state machines: DFA, NDFA;
  - ✓ Regular Expressions, Regular Grammar
  - ✓ Regular languages, Context free grammars, Pumping lemma, Pushdown automata;
  - ✓ Computational complexity, P, NP, EXP classes;
  - ✓ Halting problem;
  - ✓ Lambda and Pi calculi.
  - ✓ Arden's Theorem in Theory of Computation
  - ✓ Designing Finite Automata from Regular Expression
  - ✓ Generating regular expression from Finite Automata
  - ✓ Designing Deterministic Finite Automata
  - ✓ Conversion from NFA to DFA

- ✓ Kleene's Theorem in theory of computation
- ✓ Mealy and Moore Machines in TOC

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Presentation, Quiz) – 30%
- End Semester Examination – 70%

References:

1. Introduction to Automata and Compiler Design Paperback, 2011, Ramaiah K, Prentice Hall India Learning Private Limited,

<table>
<tr><td>Course Title</td><td colspan="3">Group Software Project</td><td>Course Code</td><td colspan="3">CSH 31252</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequisite</td><td colspan="3">CSM 21221, CSH 31221</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td></td></tr>
<tr><td>Practical (hr)</td><td>30</td></tr>
<tr><td>Independent Learning (hr)</td><td>170</td></tr>
</table>

Aim of the Course:

This course is designed to enable students to apply the knowledge acquired through the modules in the Computer Science curricular. As such, the students should be able to demonstrate that they have grasped theoretical and practical aspects of modules in the Computer Science curricular and should produce a research-oriented software instead of a routine software application.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Demonstrate the theoretical and practical aspects of modules grasped in the Computer Science curricular.
- Produce a research-oriented software.

Course Content:

- Apply theoretical and practical aspects of Computer Science modules to develop a research-oriented software instead of a routine software application for a real-world problem.
- Work involves problem investigation, requirement analysis, planning, designing, implementation and evaluation.
- The use of programmes with at least one of the technical components applied in industrial development platform (Eg: Networking, Mobile, and IOT etc.) or emerging techniques and research components are essential.
- Students should work in teams of 2-3 members with a department advisor to analyze and solve typical scientific, commercial or real-world problems.
- The course unit is oriented around directed, self-paced learning, team working and researching, supported by weekly practical mentoring and discussions.
- Though it is designed as a group project, individual participation is also evaluated to ensure that each student has attempted to gather knowledge and skill in planning and developing a software solution and technical documentation.

Mode of Assessment and weightage:

- Progress management, individual contribution, software product and deployment with demonstration, written reports and oral presentation are evaluated and the marks will be allocated as follows:

1. Problem identification and investigation-5%
2. Project progress, involvement and individual contribution -5%
3. Complexity of technical platform and research components used-15%
4. Deployment of the software and demonstration-15%
5. Report Writing-30%
6. Final Presentation -25%
7. Innovation or Overall context the project-5%

Course Title	Formal Methods			Course Code	CSH 32212		
				Prerequisite	-		
Level	3	Semester	2	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	70

Aim of the Course:

To provide basic insights of formal methods in Computer Science.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand verification & specification problems.
- Differentiate prepositional, predicate and temporal.
- Apply models of computation.
- Explain predicates, pre and post conditions, Hoarer calculus, axiomatic semantics of programs, program development using Hoare/Dijkstra method
- Demonstrate verification methods.

Course Content:

- Deductive verification and model checking.
- Each style will be introduced in three ways: conceptual, theoretical, and practical, using particular tools.
- The course builds on skills in first-order logic and temporal logic and shows how these formalisms can be applied, and extended for the verification of software.
- Introduction to formal method, verification and specification problems.
- Models of computation: abstract machines, program semantics, approaches to define program semantics: operational approach, Demotional approach, axiomatic approach.
- Logic fundamentals: prepositional, predicate and temporal.
- Operational semantics: formalization of machine, status, programming language constructs as operators, program semantics as a function; the Vienna Definition Language.
- Predicates, pre and post conditions, Hoarer calculus, axiomatic semantics of programs, program development using Hoare/Dijkstra method, denotational semantics of different programming languages, data abstractions, equational classes, specification languages constructive specifications.
- Verification methods: program correctness, syntactic unit correctness.
- Proofs of partial correctness: Mathematics basis of the axiomatic approach,

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Formal Methods in Computer Science, Jiacun Wang, William Tepfenhart, 1st Edition.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Computer Architecture</td><td>Course Code</td><td colspan="3">CSH 32221</td></tr>
<tr><td>Prerequisite</td><td colspan="3">CSM 11211</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide advanced concepts in Computer system and architecture.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain Fetch-Execution cycle of a computer system.
- Understand performance metrics.
- Differentiate RISC vs CISC architectures.
- Explain Amdahl's law, Pipelining, Multiprocessor systems overview.
- Demonstrate Assembly Language Programming.
- Understand the advance concept in Heterogeneous and Quantum Architectures.

Course Content:

- Processor architectures range: processors on mobile phones, raspberry pi, multi-core based personal computers, servers, massive clusters hosting Google/Amazon virtualized services.
- Architectural features that are desirable to support such a range of domains, operating systems and applications.
- Memory organization: Addresses. Memory organization into bytes, words, longs. Memory-mapped i/o.
- Processor: Simple internal structure. Registers, program counter etc. Fetch-Execute cycle. Instructions: Instruction Set Architecture (ISA) – syntax and semantics. Addressing modes, Encoding and decoding.
- CPU Architecture, Performance metrics, MIPS, MFLOPS, Word length, Instruction set based classification of processors
- Basic hardware: Structure and operations of basic hardware devices from transistor to memory devices.
- Simple I/O: Handling simple devices: the interface and the peripheral Device registers and polling Interrupts and interrupts hardware, interrupt vectors.
- More complex devices: Programmable devices, Block-mode devices.
- DMA: system structure and operation.
- Magnetic and optical storage: Basic bit storage Tapes and disks: structure and operation of discs Organization of disc blocks into files.
- Memory management: Paging page tables MMUs Page faults associative page table caches.
- Performance enhancements: Pipelining, caches, memory.
- RISC vs CISC architectures, addressing modes, Control flow, Instruction set formats, superscalar architectures, VLIW multi-threaded and trace-based architectures.
- Basic non-pipelined CPU Architecture, accumulator, register, stack, memory/register, execute cycle,

- Amdahl's law, Pipelining, Multiprocessor systems overview
- Micro controllers: Role: low cost, low power, small size computer systems I/O systems: analogue and digital.
- Heterogeneous and Quantum Architectures

Practical

Assembly Language Programming.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Quiz, Presentation) – 30%
- End Semester Examination – 70%

References:

1. Advanced Computer Architecture: A Systems Design Approach 1st Edition, Richard Y. Kain

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Natural Language Processing</td><td>Course Code</td><td colspan="3">CSH 32233</td></tr>
<tr><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="2">Level</td><td rowspan="2">3</td><td rowspan="2">Semester</td><td rowspan="2">2</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td>Theory & Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide students Natural Language Processing skills and programming practices.

Intended Learning Outcomes:
On the successful completion of the course, students should be able to:

- Understand the concepts of NLP syntax, semantics, regular expression, words and transducers.
- Use N-gram models in NLP applications for evaluating language models.
- Explain HMM, CFG and PCFG.
- Demonstrate lexical analysis, syntactic parsing and semantic analysis in real world NLP applications.
- Apply BoW, TF-TDF techniques and extract key features from the text.
- Use word embedding models and stemming algorithms.
- Analyse sentiments from the text content.

Course Content:

- Introduction to NLP: NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Regular Expressions and Automata-finite state transducers. Words and Transducers-Tokenization, Stemming and Lemmatization, Spelling correction and minimum edit distance

- N-gram Language Models: The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models. Part Of Speech Tagging and Sequence Labelling. Hidden Markov Models (Forward and Viterbi algorithms and EM training), Lexical syntax, Maximum Entropy models, POS Tagging and Stop Words Removal, Text “Features” and TF-IDF Classification, Keyword Extraction, the “Words” in a “Text”-BoW Concept, Named Entity Recognition (NER)

- Syntactic parsing: Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs. Neural shift-reduce dependency parsing, Feature & Unification, Language and Complexity

- Semantic Analysis: The Representation of Meaning, Computational Semantics, Lexical semantics and word-sense disambiguation, Computational Lexical Semantics, Compositional semantics, Semantic Role Labelling and Semantic Parsing, Computational Discourse

- NLP Applications: Information Extraction (IE)-Named entity recognition and relation extraction. IE using sequence labelling. Machine Translation (MT)-Issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars. Question Answering and Summarization, Dialog and Conversational Agents, Word Embeddings, Sentiment Analysis, Topic Modelling, Text Summarization, Named Entity Recognition.

Practical

- Sphinx Python for document generation.
- Python programming using NLP libraries for Natural Language analysis.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Practical Assignments, Presentation, Mini project) – 30%
- End Semester Examination – 70%

References:

1. Speech and Language Processing (3rd ed. draft)
   Dan Jurafsky and James H. Martin, 2023.
2. Natural Language Understanding 2nd Edition, James Allen

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Distributed and Cloud Computing</td><td>Course Code</td><td colspan="4">CSH 32242</td></tr>
<tr><td>Prerequisite</td><td colspan="4">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide students in-depth knowledge and application aspects in Distributed and Cloud Computing.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the concept in distributed system such as Leader election, consensus, byzantine agreement, Lambort registers.
- Explain various of context of distributed system such as communication, concurrency, transaction, replication and security.
- Use cloud computing platform for storage and virtualization.
- Practice in cloud environments using AWS, Google cloud and Azure.

Course Content:

- *Distributed Systems*: Leader election, consensus, byzantine agreement, atomic commit, logical clocks, snapshots, broadcast variants, memory consistency models, Lamport registers, paxos, software transactional memory, CAP theorem and large-scale systems, Cassandra, Zookeeper, Spanner
- *Issues and techniques*: communications, distributed data, decentralized synchronization mechanisms, performance and modeling of distributed systems, naming context, location context,
- *Communication context*: RPC rendezvous, object-based paradigm,
- *Concurrency context*: explicit, implicit, sequential, quasi-sequential; shared memory approaches, message passing models, distributed algorithms, Distributed mutual exclusion, Byzantine generals' problem,
- *Transaction context*: serializability, commit protocols,
- *Replication context*: consistency problems, models of replicated data;
- *Security context*: authentication, programming language and systems support for distributed systems.
- *Cloud Computing*: Introduction to Cloud Computing, Cloud Computing Platforms, Parallel Programming in the Cloud, Distributed Storage Systems, Virtualization, Cloud Security, Multicore Operating Systems.

<u>Practical</u>

- Practical sessions in cloud environments using AWS, Google cloud and Azure.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Presentation, Quiz) – 30%
- End Semester Examination – 70%

References:

1. Distributed and Cloud Computing, Kai Hwang Geoffrey C. Fox Jack J. Dongarra, 2012.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Industrial Exposure Visits (Non-GPA)</td><td>Course Code</td><td colspan="3">CSH 32251</td></tr>
<tr><td>Prerequisite</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>50</td></tr>
</table>

Aim of the Course:

The aim of the visit is to provide students and academics a chance to meet eminent people from the IT industry and to know the philosophies to be a leading and successful establishment.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Apply the experience in career-oriented tasks and development.
- Succeed in industrial training, industrial career and project development.

Course Content:

- Each firm has a different perspective on the IT industry which will give students a clear picture about the industry.
- This experience will help to train the students in the right direction such that they will be successful in the industry.
- At the end of the industrial visit, there should be a report submission with a presentation (viva) to summarize the experience gained through the visit.
- The student's participation is compulsory.

Mode of Assessment and weightage:

- Report writing-60%
- Presentation and viva voce-40%

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Research Seminar and Report Writing</td><td>Course Code</td><td colspan="3">CSH 41211</td></tr>
<tr><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">1</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>50</td></tr>
</table>

Aim of the Course:

It aims to introduce students to research, communication, evaluation and presentation culture.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Continually enhance the quality of critical thinking, analysis, evaluation and presentation in research.
- Present or discuss the research conducted in myriad of fields within the domain of Computer Science.

Course Content:

- The research seminar course introduces students to research, communication, evaluation and presentation culture.
- The expectation of this course module is to continually enhance the quality (critical thinking, analysis, evaluation & presentation in research) of the students by presenting/discussing research conducted in myriad of fields within the domain of Computer Science.
- Student should select an emerging and trending research area in Computer Science for the seminar. However, the research topic for the seminar and final year thesis topic should not be the same.
- The scientific report writing should present a critical thinking, analysis, spot recent advances, evaluation of methods and discussion of the research from the existing survey conducted in the field of the emerging research area.
- They should find recent 5-10 research articles related to the area, and analyze them to deliver a clear home take message.
- Students should present a seminar from the selected research area. Seminar presentation and vice voce should be evaluated by a panel of three evaluators with minimum six questions.

Mode of Assessment and weightage:

- Report writing– 50%
- Presentation and viva voce – 50%

Course Title	Artificial Intelligence & Logic Programming			Course Code	CSH 41223		
				Prerequisite	-		
Level	4	Semester	1	Credits	3	Theory & Practical (hr)	45
						Independent Learning (hr)	105

Aim of the Course:

To provide students in-depth in Artificial Intelligence, Agents, Expert systems and Logic.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the AI domain and related fields of applications.
- Apply informed and un-informed searching strategies.
- Explain intelligent agents.
- Represent knowledge through learning and reasoning.
- Develop expert system using machine learning, knowledge base, rules and inference engine.
- Demonstrate logical reasoning using PROLOG programming.

Course Content:

- Intelligent Systems Philosophy of AI.
- Search (Heuristic/Adversarial/Informed/Uninformed Search, Tabu and A* search, Greedy and Hill-climbing).
- Game Playing.
- Knowledge Representation and Reasoning, Common KADs, Planning, Learning,
- First order logic, Logical reasoning systems, Uncertainty, Probabilistic Reasoning, Simple and complex Decisions, Learning.
- Intelligent Agents, Semantic Web, Emerging Trends.
- Expert systems: Characteristics and components of expert systems, Machine learning, Knowledge base and bank, Rule Knowledge, Inference engine, transit fare rule, Rule interpreter, Inference tree.
- Logic programming paradigm through PROLOG.
- Syntax and semantics of propositional and predicate logic, presents the syntax and semantics of PROLOG and explores in detail the procedural aspects of PROLOG using UNIFICATION and BACKTRACKING.
- Analyzes and optimizes the PROLOG search space in writing PROLOG program

Practical

PROLOG Programming

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Practical Assignments, Presentation, Mini-project) – 30%
- End Semester Examination – 70%

References:

1. Russell, S.J; Norvig, P.; Artificial Intelligence: A Modern Approach; Prentice-Hall; 1995.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Database Systems and Data Analytics</td><td>Course Code</td><td colspan="3">CSH 41233</td></tr>
<tr><td>Prerequisite</td><td colspan="3">CSM 31221</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide advance database concepts and data analytics experience**.**

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Process query and optimization.
- Differentiate serial schedules and serializability.
- Explain distributed DBMS.
- Demonstrate NoSQL database systems using MongoDB
- Understand Basic Data Mining Tasks in a data warehouse.
- Apply data mining techniques in practical scenario.
- Explain exploratory data analysis.

Course Content:

- Advanced database concepts:
  - ✓ File organization and indexing
  - ✓ Query processing and optimization- Query Execution Algorithms, Heuristics in Query execution, Cost estimation in Query execution, Semantic query optimization.
  - ✓ Transaction management
  - ✓ Transaction Processing Concepts, Transaction and System Concepts, Desirable Properties of a Transaction, Schedules and Recoverability,
  - ✓ Concurrency control and recovery techniques
  - ✓ Serializability of Schedules, Transaction Support in SQL, Recovery Techniques, Database Backup, Deadlocks.
  - ✓ Database security.
  - ✓ Database design concepts.
  - ✓ NoSQL database systems such as MongoDB
  - ✓ Introduction to Distributed DBMS, OO DBMS, ORDBMS.

- Data mining & Web Mining
  - ✓ Introduction to Data Mining-Knowledge discovery process and data mining techniques.
  - ✓ Basic Data Mining Tasks, Database / OLTP Systems, Data Warehousing, OLAP Systems,
  - ✓ Information Retrieval, Decision Support Systems, Dimensional Modeling
  - ✓ Web Content Mining, Web Structure Mining, Web Usage Mining.
  - ✓ Applications and Trends in Data Mining. Some practical assignments will be given for this course.
- Introduction to Big Data Analytics.
  - ✓ Data pre-processing,

- ✓ Exploratory data analysis,
- ✓ Statistical approaches for estimation and prediction.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Practical Assignments, Quiz) – 30%
- End Semester Examination – 70%

References:

1. Database system concepts, Silberschatz, 7th Edition.
2. Fundamentals of Database Systems, Elmasri and Navathe, 7th Edition.
3. Advanced Database Systems (Lecture Notes in Computer Science), Nabil R. Adam, Bharat K. Bhargava.
4. Advanced Database Technology and Design (Artech House Computer Library), Mario Piattini, 1st Edition. (2000).
5. Data Mining Introductory and Advanced topics, M.H. Dunham (2003).
6. Principles of Data Mining, Hand DJ et al, MIT Press (2001).

Course Title	High Performance Computing	Course Code	CSH 41242			
		Prerequisite	-			
Level	4	Semester	I	Credits	02	Theory & Practical (hr)	30
						Independent Learning (hr)	70

Aim of the Course:

To provide students advance knowledge and skills in parallel computing programming and architecture design.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Differentiate serial and parallel program paradigms.
- Familiarize with hardware and software for parallel computing.
- Understand parallel program design and principles for parallel algorithm design.
- Construct programs in parallel computing for complex problem.
- Understand shared memory and distributed memory in parallel computing architecture.
- Explain the underlying principle behind OpenMP, MPI and Pthreads.
- Develop programming construct for OpenMP, MPI and Pthreads.

Course Content:

- Advanced C programming for parallel computing.
- Serial and Parallel Programs.
- Basic Serial Performance.
- Optimization Guidelines.
- Hardware for Parallel Computing.
- Parallel Program Design and Principles of parallel algorithm design
  - ✓ decomposition techniques
  - ✓ mapping & scheduling computation
  - ✓ Templates
- Programming shared-address space systems: Cilk Plus, OpenMP, Pthreads
- Parallel computer architectures.
  - ✓ shared memory systems and cache coherence
  - ✓ distributed-memory systems
  - ✓ interconnection networks and routing
- Programming scalable systems.
  - ✓ message passing: MPI
  - ✓ global address space languages
- Analytical modeling of program performance
  - ✓ speedup, efficiency, scalability
  - ✓ cost optimality
  - ✓ isoefficiency
- Collective communication
- Synchronization
- Non-numerical algorithms: sorting, graphs

- Numerical algorithms: dense matrix algorithms, sparse matrix algorithms
- Performance measurement and analysis of parallel programs
- Problem solving on clusters using MapReduce
- Software for Parallel Computing: MPI, Pthreads, OpenMP;

Practical

- C programm for MPI, OpenMP, Pthreads
- Apache Hadoop, Rocky cluster manager.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Practical assignments, Presentation) – 30%
- End Semester Examination – 70%

References:

1. Hwang, K.; Briggs, F; Computer Architecture and Parallel Processing; McGraw-Hill; 1984.
2. Introduction to Parallel Computing: Roman Trobec, Boštjan Slivnik, Patricio Bulić, Borut Robič, 1st Edition (2018).

<table>
<tr><td>Course Title</td><td colspan="3">Information Theory, Coding and Cryptography</td><td>Course Code</td><td colspan="3">CSH 41253</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">03</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide students advance knowledge and skills in Cryptography and Information encryption.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Apply number theory to cryptography.
- Differentiate Public and private key concept in cryptography
- Understand DES and RSA, and their design protocols.
- Define digital signatures and identify potential applications.
- Apply public key cryptography.

Course Content:

- Quantifying information, entropy, Shannon's first theorem, Huffman code, q-ary codes in a Galois field, linear, codes, encoding and decoding, perfect codes, hamming code, cyclic codes.
- Computing the greatest common divisor efficient exponentiation mod n, primality testing and extracting square roots modulo a prime, factoring, application of number theory to cryptography, design of protocols, DES and RSA.
- Symmetric-key encryption: One time pad and stream ciphers, Block ciphers.
- Message integrity: Collision resistant hashing, Authenticated encryption: security against active attacks.
- Public key cryptography: Arithmetic modulo primes and finite cyclic groups, Cryptography using finite cyclic groups, ElGamal public key encryption, public key encryption using a trapdoor function.
- Digital signatures: definitions and applications.
- Protocols: Identification protocols, Authenticated key exchange and SSL/TLS session setup, Zero knowledge protocols, Cryptography in the age of quantum computers.
- The crypto wars: end-to-end encryption.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Presentation) – 30%
- End Semester Examination – 70%

References:

1. A Graduate Course in Applied Cryptography (V 0.5) by D. Boneh and V. Shoup.
2. Introduction to Modern Cryptography (2nd edition) by J. Katz and Y. Lindell.

Course Title	Computer Vision			Course Code	CSH 41262		
				Prerequisite	-		
Level	4	Semester	I	Credits	02	Theory & Practical (hr)	30
						Independent Learning (hr)	70

Aim of the Course:

To provide students detailed concise and insights in Computer Vision.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the concept of image formation, projective geometry and lighting
- Use camera models in 2D and 3D imaging views.
- Generate 3D images from 2D images.
- Apply object detection and tracking algorithms in real time applications.
- Explain deep learning techniques applied for vision applications.

Course Content:

- Introduction to Computer Vision.
- Human Visual System.
- Fundamentals of image formation, projective geometry, lighting.
- Camera Models: Camera imaging geometry, Camera calibration.
- Geometry of Multiple images: Single-view and multi-view geometry, Stereo Vision.
- 3D Computer Vision: Generating 3D images from 2D views.
- Model based vision; Appearance based vision.
- Motion and flow: stereo, motion estimation and tracking.
- Feature detection and matching techniques: corner & edge detection.
- Object Detection and Object Tracking.
- Image classification.
- Deep learning for computer vision.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Practical Assignments, Quiz) – 30%
- End Semester Examination – 70%

References:

1. Concise Computer Vision by Reinhard Klette.
2. Computer Vision: Algorithms and Applications, 1st Edition by Richard Szeliski.
3. Deep Learning, by Goodfellow, Bengio, and Courville.

Course Title	Research Project – Computer Science			Course Code	CSH 41276		
				Prerequisite	-		
Level	4	Semester	I	Credits	06	Student – Supervisor contact (hrs.)	60
						Independent Learning (hrs.)	540

Aim of the Course:

To provide students skills of solving problems in Computer Science research domain.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Provide the skills of scientific writing, critical analysis and thinking.
- Demonstrate data gathering, data analysis, implementation and evaluation using algorithm and models for problem solving.
- Present the insights and findings achieved throughout the research.

Course Content:

The research project covers the work throughout the 4th year and thesis should be submitted at the end of the 4th year. The thesis should consist of the following section:

- ✓ Introduction which outlines research problem.
- ✓ Literature review where an extensive analysis of existing literature should be analysed to highlight the research gaps.
- ✓ Methodology should outline the proposed solution in an algorithmic representation.
- ✓ Experimental validation of the proposed solution using appropriate data.
- ✓ Discussion and Conclusion.
- ✓ References.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">Computer Graphics and Graphics Programming</th><th>Course Code</th><th colspan="4">CSH 42222</th></tr>
<tr><th>Prerequisite</th><th colspan="4">-</th></tr>
<tr><td rowspan="2">Level</td><td rowspan="2">4</td><td rowspan="2">Semester</td><td rowspan="2">II</td><td rowspan="2">Credits</td><td rowspan="2">02</td><td>Theory & Practical (hr)</td><td>30</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide insights of computer graphics with a mathematical perspective and the basics of image processing that enables the analysis and the understanding of images by computers.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand graphics systems, Components of graphics systems, Display devices, processors, software standards.
- Explain 2D and 3D Transformations.
- Represent objects and modelling using rasterization of lines, circles and curves.
- Understand the applications of computer graphics, image representations, vector vs. raster graphics, colour models.
- Demonstrate GKS, ***PHIGS*** (application programming interface (API) and OpenGL for 2D and 3D graphics.
- Work with graphic representation, manipulation, and display of topological 2D and 3D objects using OpenGL.
- Explain Virtual/ Augmented Reality, Game programming and design and Game AI.

Course Content:

- Fundamentals of computer graphics with a mathematical perspective and the basics of image processing that enables the analysis and the understanding of images by computers.
- Overview of graphics systems, Components of graphics systems, Display devices, processors, software standards.
- Applications of computer graphics, image representations, vector vs. raster graphics, colour models.
- Introduction to GKS, PHIGS and OpenGL, Basic raster algorithms.
- Object Modelling and Representation: Rasterization of lines and circles, parametric forms of curves and surfaces, solid modelling with polygonal meshes.
- Mapping and Clipping: Window to viewport mapping, algorithms for clipping lines, and polygons.
- Basic rendering for visual realism: Visibility and occlusion (such as depth buffering, Painter's algorithm, and ray tracing), polygon filling, texture mapping, and shading models.
- Generation of output primitives, attributes (color, area filling, etc.), geometric transformations, Structure of graphics packages; 2-D viewing, structures /segments, hierarchical model, graphical user interfaces, interactive input methods, 3-D object representations and manipulations;
- 2D and 3D Transformations: Affine transformations in 2D and 3D, coordinate transformations, view plane and view volume, projections, viewing transformation.
- Polygon mesh, spline surfaces, super quadrics, fractal geometry, octrees, visualization

of 3-D, data sets, geometric transformations, 3-D viewing.
- Parallel and perspective projections, Visible surface identification methods, Illumination models and surface rendering.
- Constant intensity, Gouraud shading, Phong shading, ray tracing, radiosity, Color models; Basic concepts; RGB.
- Virtual/ Augmented Reality Environment Technology and Applications, Graphics Pipe Line in 3D Simulations, Scene Graphs, Shaders and Graphics Programming.
- Physical Realism in Graphical Simulations, Collision Detection.
- 3D User Interfaces and Interaction Design.
- Spatial Data Structures, Game Design, Game Programming, Game AI.

Graphic Programming Practical
- Graphic representation, manipulation, and display of topological 2D and 3D objects using OpenGL.
- Applications of software, hardware and mathematical tools to specific problems.

Mode of Assessment and weightage:
- Continuous Assessment (Written tests, Assignments, Practical Assignments, Presentation, Quiz) – 30%
- End Semester Examination – 70%

References:
1. Wright R. S. Jr., Sweet M. R.; OpenGL Super Bible, Waite Group; 1997.
2. Neider J. et al; Open GL Programming Guide Addison Wesley; 1993.

<table>
<tr><td>Course Title</td><td colspan="3" rowspan="2">New Paradigms in Computing</td><td>Course Code</td><td colspan="3">CSH 42233</td></tr>
<tr><td></td><td>Prerequisite</td><td colspan="3">CSM 31212</td></tr>
<tr><td rowspan="2">Level</td><td rowspan="2">4</td><td rowspan="2">Semester</td><td rowspan="2">II</td><td rowspan="2">Credits</td><td rowspan="2">03</td><td>Theory & Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide students advanced machine learning, neural network, fuzzy logic and deep learning insights to solve pattern recognition problems.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the learning paradigms in terms of supervised, unsupervised, semi-supervised and reinforcement learning.
- Apply machine learning algorithms for classification, clustering, regression in pattern recognition domain.
- Differentiate Artificial Neural Network, Convolutional Neural Network and Recurrent Neural Network.
- Understand the computing paradigms in ANN using neurons, connectivity, activation function, propagation rule, learning rules, pattern perceptron, multilayer perceptron and associative memory.
- Explain Hopfield neural networks and Self-organizing map (SOM).
- Apply fuzzy logic and reasoning in real world applications.
- Demonstrate deep learning models with classification problems.

Course Content:

- Advanced Machine Learning Algorithms for Pattern Recognition:
  - ✓ Baysian Network, KNN, Naïve Bays & Decision trees, Ensemble method, Guassian Mixture, Expectation Maximization (EM) etc.
  - ✓ Support Vector Machine (SVM), kernels and kernel optimization and Hidden Markov Model (HMM).

- Learning paradigms:
  - ✓ Supervised learning (generative and discriminative learning (GAN), parametric/non-parametric learning, neural networks, support vector machines);
  - ✓ Semi-supervised Learning.
  - ✓ Unsupervised Learning: Clustering, dimensionality reduction using PCA, kernel methods & Auto Encoder
  - ✓ Learning theory (bias/variance trade-offs);
  - ✓ Reinforcement learning and adaptive control.

- Artificial Neural Network:
  - ✓ Parallel and distributed processing, Neuron, Connectivity, Activation function, propagation rule, learning rules, pattern
  - ✓ Preparation, Perceptron, Multilayer perceptron, Associative memory,
  - ✓ Hopfield neural networks, Self-organizing map (SOM),
  - ✓ Adaptive Resonance theory, topologies, Training methods, supervised and unsupervised learning.

- Fuzzy Logic:
  - ✓ Fuzzy system models, Fuzziness and certainty, fuzzy sets, basic properties and characteristics, Domains,
  - ✓ Alpha- level sets and support sets, Linear representation,
  - ✓ Fuzzy set operators, Conventional (crisp) set operations, basic Zadeh type operations, intersection, union and complement of fuzzy sets, General algebraic operations, Fuzzy set hedges,
  - ✓ Fuzzy reasoning, linguistic variables,
  - ✓ Fuzzy models, Fuzzy systems and modeling, Design methodologies, modeling and utility software.

- Boltzmann Machine, Bayesian statistics, Fuzzy Logic vs Machine Learning
- Deep Learning-Convolutional neural network, Recurrent neural network

Practical

Python implementation for Machine learning algorithms, ANN and Deep Learning.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Practical Assignments, Mini projects, Presentation) – 30%
- End Semester Examination – 70%

References:

1. Russell, S.J; Norvig, P.; Artificial Intelligence: A Modern Approach; (2nd Edition), Pearson Education Inc., New Jersey, USA, 2003
2. Kevin Gurney, An introduction to neural networks, University of Sheffield, UCL Press Limited,1997.
3. Charu C. Aggarwal , Neural Networks and Deep Learning: A Textbook 1st ed. 2018 Edition.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Industrial Training</td><td>Course Code</td><td colspan="3">CSH 42212</td></tr>
<tr><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>200</td></tr>
</table>

Aim of the Course:

To provide students the much-needed industrial exposure, which is an essential part of education in order to meet Industrial standards.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Be a competent industrial candidate who can demonstrate both subject knowledge, technical skills along with all the soft skills capable for an industry career.

Course Content:

- The industry placement provides the much-needed industrial exposure for the students, which is an essential part of education in order to meet Industrial standards.
- The Industrial Training programme is scheduled at least for a period of minimum 4 months which improves their professionalism to make them ready for the industry.
- Students are placed in various sectors of the industry where they will be working as interns.
- The students are allowed to choose a list of interesting fields at the beginning of the programme, allowing them to work in their preferred area.
- The Internship programme produces quality graduates in the fields of Computer Science (CS).
- Students are expected to get trained under a software developer/engineer in an IT firm which deliver software products and services.
- Student should maintain a training journal/diary with all the weekly training records with mentor's signature.
- At the end of the training, a training report along with weekly progress diary should be submitted.
- A confidential evaluation form should be provided by the mentor/training manager to evaluate students' performance and activities in the industrial firm.
- Industrial training report and presentation should excel the detail description of the tasks, technologies, industrial platform the candidate has practiced, and the knowledge and skills the candidate has gained from the training. It also should express the advantages, opportunities and limitations of the training and future concerns.

Mode of Assessment and weightage:

The evaluation of this module shall be based on the following criteria:

1. Industrial placement with high software development profile and background-10%
2. Project involvement, position held & progress based on Industrial Training report, weekly diary and confidential mentor's feedback report-40%

3. Competency of the latest technology & Knowledge gained-10%
4. Number of projects involved & New techniques expertised-10%
5. Presentation skill-20%
6. Utilization of Opportunities & Challenges overcome -5%
7. Overall context & Importance of the work demonstrated -5%

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Scientific Computing</td><td>Course Code</td><td colspan="3">CSH 42242</td></tr>
<tr><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide students in-depth insights of Scientific Computing and practical experience in various domains.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand numerical computation for the mathematical, computational, physical sciences and Engineering problem.
- Demonstrate LU decomposition, interpolation and numerical differentiation, Euler, Runge_Kutta methods.
- Computation of Eigen values: Jacob's method, householders' method.
- Construct programming paradigms in MATLAB/Octave (Open Source) that use arithmetic and mathematical functions, input and output, selection and iteration statements., program decomposition, recursion, vectors and matrices.
- Use mathematical modelling for dynamical systems, linear systems, numerical differentiation and integration.

Course Content:

- Issues of numerical computation for the mathematical, computational, physical sciences and Engineering,
- Problems of accurately computing solutions in the presence of rounding errors,
- Computing discrete approximations of solution of linear simultaneous and nonlinear equations, Gaussian elimination.
- LU decomposition, interpolation and numerical differentiation: Newton-Coates, Romberg, Richardson, approximation of integrals,
- Solution of differential equations: Euler, Runge_Kutta methods,
- Computation of Eigen values: Jacob's method, householders' method.

Practical

- MATLAB programming: language specific capabilities, use of MATLAB for scientific visualization.
- MATLAB help system, data types and scalar variables, arithmetic and mathematical functions, input and output, selection and iteration statements.
- Functions: user defined functions, function files, passing information to and from functions, function design and program decomposition, recursion.
- Arrays: vectors, arrays and matrices, array addressing, vector, matrix and element-by-element operations.
- Graphics: 2-D and 3-D plotting.
- Mathematical modelling: dynamical systems, linear systems, numerical differentiation and integration.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Brian Hahn and Daniel Valentine, Essential MATLAB for Engineers and Scientists.

Mathematics

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Mathematical Methods</td><td>Course Code</td><td colspan="3">MTH 31213</td></tr>
<tr><td>Prerequest</td><td colspan="3">---</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide a solid foundation on Partial Differential Equations and solving techniques specially applications of known transformations

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Define special functions and use them to solve problems,
2. Evaluate elliptic integrals,
3. Explain the Partial Differential Equations (PDE) and their classifications,
4. Demonstrate different type of PDE's and their real-life application,
5. Find the Fourier/Laplace transforms and apply those transforms to real life problems,
6. Solve second order homogeneous and non-homogeneous PDEs including heat equations due to various boundary conditions using Fourier analysis.

Course Content:

Gamma and Beta functions;
Elliptic integrals;
Introduction to Partial Differential equations (PDE), Classification of PDE and their nature,
Laplace transforms; Fourier transforms, Fourier sine and cosine transforms; Fourier analysis; solving PDEs' using transformations and practical applications of transformations
PDE's; Variable separable methods, Heat equation and its applications, Solutions of linear PDE's with homogeneous and non-homogeneous boundary conditions; analytical solution of heat equation,

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Grewal BS, "Higher Engineering Mathematics", Khanna Publishers, 32nd Edition, 1995.
2. Boas ML, "Mathematical Methods in the Physical Sciences", John Wiley & Sons, 3rd Edition, 2006.
3. Riley KF, Hobson MP, Bence SJ, "Mathematical Methods for Physics and Engineering", Cambridge University Press, 3rd Edition, 2006

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Numerical Linear Algebra</td><td>Course Code</td><td colspan="3">MTH 31222</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To develop an understanding of direct methods of numerical linear algebra for solving linear systems and the eigenvalue problems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Apply a variety of numerical direct methods to the problems of finding solutions to large systems of linear equations;
2. Use different iterative methods for solving systems of linear equations and discuss the convergence of these methods;
3. State and apply House holder's method to reduce a square matrix to an upper Hessenberg matrix;
4. Apply some numerical methods to find eigenvalues for large matrices.

Course Content:

Direct methods for solving linear systems of equations: Elementary triangular matrices and Gauss elimination, elementary permutation matrices and pivoting, elementary Hermitian matrices and matrix factorization, iterative refinement.

Matrix analysis: canonical forms and positive definitive matrices, norms and spectral radius, condition of problems and scaling.

Norm reducing methods for linear systems: Iterative methods and error bounds, convergence results for special matrices, choice of relaxation parameter.

Similarity reduction for Eigen systems: Elementary Hermitian matrices and House holder's method, elementary triangular and permutation matrices, Eigen systems of Hessenberg and tri-diagonal matrices. Strum sequence, Hyman's method

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Gene H. Golub and Charles F. Van Loan, Matrix Computations, 4th Ed., Johns Hopkins University Press, 2013.
2. Lloyd N. Trefethen and David Bau III, Numerical Linear Algebra, SIAM, 1997.
3. James W. Demmel, Applied Numerical Linear Algebra, SIAM, 1997.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Multivariate Calculus</td><td>Course Code</td><td colspan="3">MTH 32212</td></tr>
<tr><td>Prerequest</td><td colspan="3">---</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">2</td><td>Theory (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

To give an introduction to elementary number theory.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Determine the continuity and differentiability of a function of several variable at a point in R^{n};
2. Derive the partial and total derivatives,
3. Use the partial derivatives to solve the problems,
4. Evaluate multiple integrals over various regions,
5. Use different techniques to evaluate multiple integrals.

Course Content:

Limits, repeated limits, continuity,

partial derivative and differentiation, directional derivatives, total derivative, Jacobian matrix, the chain rule, tangents and normals to implicitly defined hypersurfaces, extrema, Lagrange's multipliers, Parameterization theorem, plane transformations,

double integral, triple integral, Leibniz's rule

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Malik S. C. and Savita Arora, Mathematical Analysis, New Age International Limited, 2012.
2. Edwards, C.H. Jr., Advanced Calculus of Several Variables, Dover Publications 1994.
3. Edwards H.M., Advanced Calculus: a Differential Forms Approach, Birkhauser 1994.
4. Wendell Fleming, Functions of Several Variables (Second Ed.), Springer, 1991.

Course Title	Group Theory			**Course Code**	MTH 32223		
				Prerequest			
Level	3	**Semester**	2	**Credits**	3	**Theory (hr)**	45
						Practical (hr)	
						Independent Learning (hr)	105

Aim of the Course:

To develop some of the mathematics underlying the classification of finite groups and to develop some applications of Group Theory

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Develop and analyze the concepts of group action on a set;
2. Define the main concepts and theorems of group theory;
3. Apply these in the investigation of examples and problems;
4. Prove the basic and intermediate results in group theory including unseen material;
5. Prove Sylow's Theorems, and to use them and other techniques as a tool for analyzing the structure of a finite group of a given order.

Course Content:

Group action on a set: the notion of group action, orbits and stabilizer,

Series of groups: subnormal and normal series, Solvable groups, the Jordan-Holders theorem,

Sylow theorems: p-groups, the Sylow theorems, applications of Sylow theorems, applications to p-groups,

Free abelian groups: Free groups, Homomorphism of free groups.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Fraleigh. J.R., A First Course in Abstract Algebra, Addison-Wesley Publishing Company, (1999).
2. Rose.J. S., A Course in Group Theory, Cambridge University Press, (1978).
3. Scott. R., Group Theory, Prentice-Hall, (1964).

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Further Mathematical Modeling</td><td>Course Code</td><td colspan="3">MTH 41213</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide mathematical applications and solutions for real world problems.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Formulate the real world problems mathematically.
2. Construct the models which describe the real problems.
3. Identify the solution techniques and implement those techniques.
4. Discuss the advantages and disadvantages of modeling techniques

Course Content:

Introduction to Mathematical Models, Modeling process, Modeling in various fields, basic models for various fields, Simple models in Biology, growth models, population dynamics models, infected disease transmission models, Computational models and simulation techniques

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Keshet L.E., Mathematical Models in Biology, SIAM, 2005.
2. Othmer H.G., Adler F.R., Lewis MR, Dallon J.C., Case Studies in Mathematical Modeling – Ecology, Physiology, and Cell Biology, Prentice-Hall Inc, 1997.
3. Murray J.D., Mathematical Biology: I. An Introduction, 3rd Edition, Springer, 2001

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Numerical Solutions of Ordinary Differential Equations</td><td>Course Code</td><td colspan="3">MTH 41223</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide an introduction to computational methods for the approximate solution of ordinary differential equations.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Describe Euler Methods and use them to solve ordinary differential equations;
2. Describe the basic concepts of convergence and stability as related to Runge-Kutta and Linear Multi-step methods;
3. Derive order conditions for the methods, and use them to construct methods or determine the order of a given method;
4. Interpret linear and non-linear stability theory concepts for the methods.

Course Content:

Initial Value Problems,

Euler methods: Explicit and Implicit Euler methods, convergence, local and global truncation errors, order, error bounds.

Linear Multi-step methods: general methods, order and error constant, concept of consistency, stability and convergence of the methods, Schur's and Routh-Kurwitz criterion, derivation of methods.

Runge-Kutta methods: general methods, explicit and implicit methods, local and global truncation errors, order, order conditions, derivation of methods.

Stability of the methods: A-Stability, B-Stability and algebraic Stability

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Lambert J.D., Numerical Methods for Ordinary Differential system, John Wiley and Sons, Chichester 1991.
2. Butcher J.C., Numerical Analysis of ODEs, John Wiley and Sons, 1987.

Course Title	Further Topology			**Course Code**	MTH 41233		
				Prerequest			
Level	4	**Semester**	I	**Credits**	3	**Theory (hr)**	45
						Practical (hr)	
						Independent Learning (hr)	105

Aim of the Course:

To understand the advance concepts of topological spaces such as separation axioms, product and quotient spaces, nets and filters.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Describe the concepts connectedness and compactness.
2. Analysis the separation axioms and regular and normal spaces.
3. Explain and analysis the product and quotient spaces.
4. Analysis the nets and filters.
5. Describe the concept related to Homotopy & the Fundamental Group

Course Content:

Connectedness: properties of separated sets, connected and disconnected sets, path connectedness, local connectedness

Compactness: covering of a space, compact set, properties of compact sets and local compactness, countable compactness.

Separation axioms: T_0, T_1 and T_2 - spaces and their properties.

Regular and Normal spaces: T_3 and T_4 -spaces. Product spaces and Quotient spaces.

Nets: directed sets, convergence of a net in a topological space.

Filters: filter, discrete filter, co-finite filter, ultra filter and their properties.

Homotopy and the Fundamental Group: Homotopy of paths, the fundamental group of a space, covering spaces, computation of the fundamental group of the circle, Van-Kampen's theorem and applications.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Seymour Lipschutz, General Topology, McGraw-Hill Company, New York(2011).
2. Armstrong, M. A., Basic Topology, Springer International Ed.(2005).
3. Joshi, K.D., An introduction to general topology, Wiley Eastern Ltd. New Delhi (2002).
4. Munkres, J. R., Topology: A First Course, Prentice-Hall, (1975). , Pearson Education Inc.(2015)

Course Title	Research Project			**Course Code**	MTH 41246		
				Prerequest			
Level	4	**Semester**	I	**Credits**	6	**Student – Supervisor contact (hrs.)**	60
						Independent Learning (hrs.)	540

Aim of the Course:

To give students experience of Mathematics as it is pursued close to the frontiers of research, as an engaging, evolving activity in which students themselves can play a part.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Identify research-able problems and questions in a variety of fields;
2. Apply skills learned to undertake small-scale research projects;
3. Write clear and concise research reports;
4. Effectively present and defend research orally in front of professors and peers;
5. Objectively critique their own work and the work of their peers.

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Measure Theory</td><td>Course Code</td><td colspan="3">MTH 42213</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>135</td></tr>
</table>

Aim of the Course:

To introduce the concepts of *measure and integral with respect to a measure,* to show their basic properties, and to provide a basis for further studies in Analysis, Probability, and Dynamical Systems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Explain what Lebesgue measure is; what measurable sets and functions are;
2. Describe the construction of the Lebesgue integral and its relation to the Riemann integral;
3. Integrate a variety of different functions using the definition of the Lebesgue integral;
4. Interpret the basic convergence theorems of measure theory, the Fubini and Tonelli theorems; Lp spaces and some of their most important properties.

Course Content:

σ – algebras of sets; Additive set functions and measures; Lebesgue outer measure; Measurable sets and Lebesgue measure; Borel sets; Non-measurable sets; Measurable functions; Structure of measurable functions; Lebesgue integration; Fatou's lemma; Monotone convergence theorem; Dominated convergence theorem; Modes of convergence; Connection between Riemann and Lebesgue integrals. Lp spaces.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Stein, E. M. and Shakarchi R., Real Analysis – measure Theory, integration and Hilbert Spaces. (Princeton Lectures in Analysis III) Princeton University Press, 2005.
2. Bartle, R. G., The Elements of Integration and Lebesgue Measure, Wiley, 1995.
3. Royden. L. Real Analysis, Third edition, Macmillan Publishing Company, 1988.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Functional Analysis</td><td>Course Code</td><td colspan="3">MTH 42223</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

to provide students with a firm grounding in the theory and techniques of Functional Analysis and to offer students ample opportunity to build on their problem-solving ability in this subject.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Describe the notion of a norm and use the basic theory of normed linear spaces and operators acting on these spaces to solve simple problems;
2. Determine whether a function on a vector space defines a norm, establish whether such norms are complete and determine when norms are equivalent;
3. State and apply fundamental theorems of classical functional analysis, e.g. Hahn-Banach theorem, Baire's category theorem, Uniform boundedness principle, closed graph theorem, etc. to mathematical problems;
4. Develop and use the basic theory of Hilbert spaces and orthogonality; use the Gram-Schmidt process to produce orthonormal sequences and use these in problems
5. State and prove the Riesz representation theorem for Hilbert spaces

Course Content:

Normed linear Spaces and Banach spaces: Norms, Normed linear spaces, Banach spaces, Finite dimensional normed linear spaces, Riesz Lemma, schauder basis, Separable normed linear spaces; Linear operators and Bounded linear operators ;Linear functionals and Dual spaces: Linear functionals and Bounded linear functionals, Hahn-Banach theorems, Consequences of Hahn-Banachtheorem, Dual spaces; Fundamental Theorems for Normed and Banach spaces: Uniform Boundedness theorem, Open mapping theorem, Closed linear operators and Closed graph theorem and their applications; .Reflexive spaces; Inner product and Hilbert Spaces: Properties of inner product spaces, Orthonormal sets and sequences, Series related to Orthonormal sequences, Total Orthonormal sets and sequences. Representation of functionals on Hilbert spaces.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. D. Lax, Functional Analysis, Wiley lnterscience, New York, 2002.
2. W. Rudin, Functional Analysis, McGraw-Hill, 1991.
3. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, 1989.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Further Complex Analysis</td><td>Course Code</td><td colspan="3">MTH 42233</td></tr>
<tr><td>Prerequest</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To recognize the contribution and impact of complex analysis and special function in different areas of Science and to demonstrate an ability to initiate and sustain in-depth research relevant to complex analysis

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Apply appropriate theories, principles and concepts relevant to the functions of a complex variable and special functions;
2. Analyze accurate and efficient use of complex analysis techniques;
3. Study the important theorems in complex analysis;
4. Determine capacity for mathematical reasoning through analyzing, proving and explaining concepts from complex analysis.

Course Content:

Elementary properties and examples of analytic functions, Fourier integral transforms, conformal mapping, Möbius transformation, the identity theorem, Montel's theorem, logarithms and argument principle, Riemann mapping theorem, Weierstrass factorization theorem, special factorization, harmonic functions, entire functions, singular integrals, Poisson integrals and Dirichlet's problem, Hardy spaces, The maximum modulus principle; The Schwarz lemma, The phragmen-Lindelof method, An interpolation theorem, A converse of the maximum modulus theorem.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Rudin, W., Real and Complex Analysis, third Edition McGraw Hill, 1987.
2. Conway J. B., Functions of one complex variable, Narosa Publising House, 1980.
3. Ahlfors L. V., Comples Analysis, Third edition, McGraw Hill, 1979.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">Financial Mathematics</td><td>Course Code</td><td colspan="4">MTH 42243</td></tr>
<tr><td>Prerequest</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">2</td><td rowspan="3">Credits</td><td rowspan="3">3</td><td>Theory (hr)</td><td>45</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide good understand of Finance and Finance related models

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. Identify the time value concept.
2. Identify pricing techniques and apply those to value the future cash flows.
3. Construct the cash flows related to real project.
4. Value the projects and price those projects.

Course Content:

Interest rate, Simple and Compound interest rate, Time value of Money, Present value, Future value, Discounting, Compounding, Effective rate of return (EAR), Basic annuity valuation, Annuity immediate, Annuity due, Perpetuity, Discounted cash flow analysis, NPV, Bond valuation, Loan repayment methods, Internal rate of return (IRR), interest rate on fund, Introduction to corporate finance and related applications, Corporate Securities as contingent claims on total firm value, The corporate firms, Goals of the corporate firm, Financial Markets, varying interest rate valuation, Annuity valuation, Amortization and sinking fund, Internal rate of return and its applications, Bond valuation and analysis, stock valuation, foreign currency rate, interest rate modeling, term and risk structure of interest rate, holding rate.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Kellison SG, “The Theory of Interest”, 2nd Edition, McGraw-Hill, 1991.
2. Ross SA, Westerfield RW, Jordan BD, “Fundamentals of Corporate Finance”, 8th Edition, McGraw-Hill, 2008.
3. Bodie Z, Kane A, Marcus AJ, “Investments”, 8th Edition, McGraw-Hill, 2009

Course Title	Optimization			**Course Code**	MTH 42253		
				Prerequest			
Level	4	**Semester**	2	**Credits**	3	**Theory (hr)**	45
						Practical (hr)	
						Independent Learning (hr)	105

Aim of the Course:

To provide solid foundation of Optimization techniques

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

1. explain why and how optimization problem exist in real life.
2. Identify and formulate the optimization problems.
3. Apply the different optimization schemes to solve problems.

Course Content:

Formulate the optimization problems, Unconstrained and constrained optimization of functions of single and many variables and applications, Lagrangian optimization, The Hessian of a function; Positive and negative, semi-definite and definite matrices; Coercive functions and global minimizers; Iterative methods, Convexity and the arithmetic-geometric mean inequality. an introduction to geometric programming; Unconstrained geometric programming. Least square optimization, Network models.

Mode of Assessment and weightage:

- Continuous Assessment (Written tests, Assignments, Tutorial Assignments, Oral Presentation etc.) – 30%
- End Semester Examination – 70%

References:

1. Boyd S. and Vandenberghe, Convex Optimization, Cambridge University Press, 2004.
2. Murty K.G., Optimization for Decision Making: Linear and quadratic Models, Springer, 2010.
3. Helmke U. and Moore J.B, Optimization and Dynamical systems, springer 1996.

Physics

Course Title	Mathematical Methods in Physics			Course Code	PHH 31212		
				Prerequest	-		
Level	3	Semester	I	Credits	02	Theory (hrs.)	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide the necessary Mathematics knowledge to understand and solve the Physics problems.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- identifying mathematical tools best suit for physical problems.
- defining and calculating the gradient, divergence and curl of a vector field.
- calculating line, surface and volume integrals and appreciate the significance of the flux across a surface.
- determining eigenvalue and eigenvector and solving PDE using three different methods (separation of variables, series solution, and Fourier transform).
- developing mathematical methods to describe physical phenomena.

Course Content:

Introduction: Cartesian, cylindrical and spherical coordinate systems and transformation equations, determinants and matrices; **Vector analysis**: basic properties, differential operators and vector integration theorems; **Eigenvalue**: Introduction to Eigenvalue equations, Matrix and Hermitian Eigenvalues; **Differential equations**: First and second order equations with series solutions and with other forms of solutions; **Partial differential equations**: First and Second order equations, separation of variables; **Complex functions**; Legendre, Bessel, Hermite, Gamma and Special functions; **Fourier series**: general properties and applications; **Integral transforms**: properties of Fourier transforms, properties of Laplace transforms, convolution theorems for Fourier and Laplace transforms, Inverse Laplace theorem, Calculus of variations, Tensors.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. George Brown Arfken, Hans-Jurgen Weber, Frank E. Harris, Mathematical Methods for Physicists: A Comprehensive Guide,(2013), Elsevier publishers, UK.
2. Tai. L Chow, Mathematical method for Physicists: A concise introduction.
3. Boas, Mary L., Mathematical Methods in the Physical Sciences, (John Wiley and sons.

Course Title	Advanced Solid State Physics			**Course Code**	PHH 31223		
				Prerequest	-		
Level	3	**Semester**	I	**Credits**	03	**Theory (hrs.)**	45
						Practical (hrs.)	-
						Independent Learning (hrs.)	105

Aim of the Course:

To provide the knowledge about the structure and thermal, electrical and magnetic properties of solid materials.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- have the ability to classify solids according to their structures and their electrical, thermal and mechanical properties
- demonstrate an understanding of the underlying relationships between the macroscopic properties of a solid and the characteristics of the individual atoms which comprise it.
- be able to solve introductory problems involving in the concepts learnt and begin to understand how physicists use them to study solids, build devices, tailor properties of materials, build new materials and study their emergent properties
- be able to develop problem-solving skills (including numeracy), for both well-defined and open-ended problems, analyze problems in solid state physics.

Course Content:

Crystal structure: Review of crystal structure and common examples of crystal structure, crystal symmetry and point group, reciprocal lattice , laue condition, Bragg condition, X-ray Crystal diffraction, experimental crystal diffraction method-rotating crystal method, powder method, etc; **Lattice vibrations**: Vibrations of monatomic and diatomic lattices, Brilloun Zones, acoustic and optical modes, quantization of lattice vibrations, Lattice heat capacity- the Einstein model and Debby model, density of modes; **Free electron gas**: Fundamental properties of the free electron gas, the Fermi wave vector, energy levels and density of orbital in one and three dimensions, thermal properties of the free electron gas, the Fermi-Drake distribution electronic heat capacity; **Magnetic properties of solids:** Diamagnetism, atomic magnetic moments, Para magnetism, Curies law, Ferro magnetism Curie- Weiss law Antiferro magnetism; **Crystal binding:** Crystals of inert gases, repulsive interaction, cohesive energy, Ionic and covalent crystals; **Energy bands:** Electrons in free atoms and solids, the energy gap, Bloch functions, wave equation of electron in a periodic potential; **Semiconductors:** Intrinsic and extrinsic behaviour, the energy gap, the p-n junction donor and acceptor states, free electron density in a semiconductor.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. Charles Kittle, Introduction to Solid State Physics, John Wiley & Sons.
2. Blakemore, J.S., Solid State Physics, Cambridge University Press, (2^{nd} ed.).
3. Ashcroft, Neil, W., Mermin, N., David, Solid State Physics, Thomson Brooks.
4. M Ali Omar, Elementary Solid State Physics by, Addison-Wesley, Longman.

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Classical Mechanics</td><td>Course Code</td><td colspan="3">PHH 31232</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the knowledge about the conservation laws of motion and mechanics of system of particles and bodies.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- demonstrate knowledge and understanding of the concepts in classical mechanics:
- demonstrate knowledge and understanding of the conservation laws and symmetries in physical systems
- demonstrate knowledge and understanding of the motion of particle and systems of particles in three dimensions
- demonstrate knowledge and understanding of the Lagrangian and Hamiltonian formalisms
- demonstrate knowledge and understanding of the central Force systems and motion
- develop problem solving skills in classical mechanics using Lagrangian and Hamiltonian formalisms

Course Content:

The Lagrangian formulation: mechanics of a system of particle, centre of mass, Conservation Laws of angular momentum and energy of a system of particles, Constrains, Equation of constrains, degrees of freedom, generalized coordinates, displacements, velocity and force in generalized coordinates, virtual work, D'Alembert's principle of virtual work, Lagrange's equations, Lagrange's equation for a conservative system, Lagrange's equation from Hamilton's principle, generalized momentum, conservation of energy, Hamilton's formulation of mechanics, simple applications of Lagrangian formulation; **The Hamiltonian formulation**: the Hamiltonian of a dynamical system, Hamilton's canonical equations, Hamilton's canonical equations from variation principle, Canonical transformations, Poisson Brackets; **Central force motion**: energy of a particle in central force motion, effective potential energy, variation of effective potential energy, differential form of equation of orbit motion under inverse square force, equations of orbits with inverse square law, classification of orbits.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. Tai L. Chow, Classical Mechanics, John Willey & sons, Inc, Singapore.
2. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, Pearson Education (3rd ed.)

Course Title	Advanced Physics Laboratory I			Course Code	PHH 31242		
				Prerequest	-		
Level	1	Semester	I	Credits	02	Theory (hrs.)	-
						Practical (hrs.)	90
						Independent Learning (hrs.)	10

Aim of the Course:

This course is aimed to provide opportunity for students to engage in laboratory work in observing and experiencing physical phenomena in Optics, quantum physics and electronics

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- advanced experimental techniques through laboratory work.
- designing and planning of laboratory experiments.
- writing comprehensive laboratory reports.
- presenting results based on the analysis of experimental data.

Course Content:

Modern Physics: Characterization and properties of X-rays, Zeeman effect experiment, Frank Hertz Experiment, Millikan Oil drop experiment, Fine beam tube experiments; **Optics & wave:** Michelson & Fabry Perot Interferometer, experiments with laser source, Micro wave experiments; **Electronics**: Construction of two stage amplifier, Construction of Wein Bridge oscillator, Analogue computer, Combinational logic experiments, Sequential Logic experiments, Construction of Function Generator.

Mode of Assessment and weightage:

- Continuous Assessment (laboratory Reports) – 50%
- End Semester Examination – 50%

References:

1. Worsnof, B. L and Flint, H. J. (1965), Advanced Practical Physics for Students, Jerrold & Sons Ltd.
2. Whittle, R. M. and Yarwood, J. (1973), Experimental Physics for Students.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Advanced Optics</td><td>Course Code</td><td colspan="3">PHH 32213</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">03</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide the wide knowledge about the properties of laser, operation of laser and optical fibres

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- understand the mechanism and operation of various types of Lasers
- important applications of lasers
- understand the basic principle and characteristics of Fibre optical waveguide and their uses.
- understand the operation and the use of display devices and photo detectors

Course Content:

Light: nature of light, wave nature of light, plane waves, propagation of light in unbounded media, Light sources; **Lasers:** Properties-monochromaticity, coherence, directionality, brightness, polarization, tunability; **Lasers Mechanisms**: emission and absorption of radiation, Einstein relations, population inversion, optical feedback, threshold conditions, Laser losses, line shape function, pumping threshold conditions; **Laser Operations**: Laser models, classes of Laser, Single mode operation, Frequency stabilization , Mode Locking, Q-switching, safety measures. **Laser Types:** Ruby laser, gas laser, semiconductor laser, Quantum well laser, dye laser, and polymer laser. **Applications of Lasers:** Measurement of distance, Holography, Laser induced nuclear fusion, etc.; **Fibre optical waveguides**: basic characteristics of the optical fibre, total internal reflection, numerical aperture, pulse dispersion, losses mechanisms, ray path and pulse dispersion in planer dielectric waveguides, transit time calculations, pulse dispersion in graded index fibre, material dispersion, modes in planner waveguides, TE and TM modes, propagation characteristics of a step index fibre and graded index fibres, fibre jointing, Fibre optical communication systems, Modulation schemes; **Display devices**: luminescence, photoluminescence, cathode-luminescence, electro-luminescence, injection Luminescence and the light emitting diode, plasma displays, liquid crystal displays; **Photo detectors**: thermal detectors, photon devices, Detector performance parameters.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. Eugene, Hecht, Optics, New York Addison Wesley, (3rd ed.).
2. R. Allen Shotwell, An Introduction to Fibre Optics, New Delhi Prentice Hall of India.
3. Akhmanov, S.A., Nikitin, S.YU., Physical Optics, , Oxford Clarendon press (1st ed).
4. Laser Physics and Applications: Group VIII, Volume 1: Laser Physics and Applications. Sub volume B: Laser Systems. Part 1, Edited by G. Herziger, H. Weber, R. Poprawe, Published by Springer, ISBN 978-3-540-26033-2 Springer Berlin Heidelberg New York.

Course Title	Advanced Quantum Mechanics I			Course Code	PHH 32222		
				Prerequest	-		
Level	3	Semester	II	Credits	02	Theory (hrs.)	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide the deep knowledge about the quantum mechanics and related applications

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- understand the formalism and 'language' of quantum mechanics.
- understand the central concepts and principles of quantum mechanics: the Schrödinger equation, the wave function and its physical interpretation, stationary and non-stationary states, time evolution and expectation values.
- interpret and discuss physical phenomena in light of the uncertainty relation.
- apply the technique of separation of variables to solve problems in more than one dimension and to understand the role of degeneracy in the occurrence of electron shell structure in atoms.

Course Content:

Introduction: Failure of classical Physics and birth of Quantum Mechanics, review of basics in Quantum Mechanics, Schrödinger equation (time independent and time dependent) & Applications, Problems related to Degenerate case, one dimensional Harmonic oscillation, Mathematical properties of waves functions and Eigen functions; **Operators Formalism**: Linear Hermitian operator, the angular momentum operators, Operator approach to determine Eigen values, expectation values.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. B.H. Bransden, C.J. Joachain, Quantum Mechanics, Prentice Hall, London.
2. P. M. Mathews, A Textbook of Quantum Mechanics, New Delhi Tata McGraw Hill.
3. Davies, Paul C. W. Betts, David S., Quantum Mechanics, New York Chapman & Hall (2nd ed.).

Course Title	Advanced Electronics I			**Course Code**	PHH 32232		
				Prerequest	PHM 31212		
Level	3	**Semester**	II	**Credits**	02	**Theory (hrs.)**	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide the wide knowledge about the anolog electronics

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Understand the function of solid-state electronics including diodes, MOSFET, BJT, and operational amplifier.
- analyze analog electronic circuits using discrete components.
- Explain the electronic systems for physical problems.

Course Content:

Introduction: Review of characteristics, biasing and operation of BJT and single stage BJT amplifier, different types of BJT amplifier, analysis of small signal models for BJT amplifier, Review of characteristics, Biasing and operation of JFET and MOSFET, FET amplifiers, logic switches, **Stability and Compensation of amplifier** : General concepts, Beta Stability circuit analysis, Leakage currents, Temperature sensitivity; **Feedback amplifier**: The fundamental feedback equation, Positive and Negative feedback, Feedback Amplifier: **Special amplifiers**: Differential Amplifier, Complementary symmetry, Darlington pair, Push-pull output, voltage amplifiers and DC amplifiers; **Operational amplifier:** The inverting and non-inverting amplifier, flower, current source and other basic operational amplifier circuits, Active filters, comparator; characteristics of the non-ideal operational amplifiers, Frequency compensation, Slew rate; **Analogue computers**: Simulators and damped harmonic Oscillators.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. Horowitz and Hill, The art of Electronics, Cambridge University Press (2nd ed.).
2. William H. Gothman, Digital Electronics, PHI Learning (2nd ed.).
3. James J. Brophy, Basic Electronics for Scientists, McGraw Hill Publishing (5th ed.).
4. Jacob Millman, Integrated Electronics: Analog and Digital circuits systems, Tata McGraw Hill.

Course Title	Ceramics			Course Code	PHH 32241		
				Prerequest	-		
Level	3	Semester	II	Credits	01	Theory (hrs.)	15
						Practical (hrs.)	-
						Independent Learning (hrs.)	35

Aim of the Course:

To provide the knowledge about the ceramic materials and properties

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- various types of ceramics presence
- physical properties of ceramics
- common preparation techniques and property testing

Course Content:

Ceramics: Old and new ceramics, Oxide and non-oxide ceramics, Piezo electric ceramics, Bio ceramics, Electronic and electro-optic ceramics; **Properties:** Mechanical, Thermal, electrical, magnetic and optical behavior**; Preparation:** Powder processing, sintering, techniques for forming and densifying ceramics, microstructure of Ceramics, toughening of ceramics, ceramic composites.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. M.W. Barsoum, Fundamentals of ceramics (2003), Taylor & Francis, New York.
2. Robert H. Heimann, Classical and advanced ceramics, WILEY VCH, Verlarch Gmbh & Co.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Physics Laboratory II</td><td>Course Code</td><td colspan="3">PHH 32252</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hrs.)</td><td>-</td></tr>
<tr><td>Practical (hrs.)</td><td>90</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>10</td></tr>
</table>

Aim of the Course:

This course is aimed to provide opportunity for students to engage in laboratory work in observing and experiencing physical phenomena electronics

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- advanced experimental techniques through laboratory work.
- designing and planning of laboratory experiments.
- writing comprehensive laboratory reports.
- presenting results based on the analysis of experimental data.

Course Content:

Polymer Physics: Electropolymerization, Cyclic Voltammetry experiments, Electro Quartz Crystal experiments, UV-Visible absorption spectroscopy, A.C. impedance analyzer. **Crystal Physics**: Crystal diffraction by X-ray Diffractometer; Hall Effect experiment.

Mode of Assessment and weightage:

- Continuous Assessment (laboratory Reports) – 50%
- End Semester Examination – 50%

References:

- Worsnof, B. L and Flint, H. J. (1965), Advanced Practical Physics for Students, Jerrold & Sons Ltd.
- Whittle, R. M. and Yarwood, J. (1973), Experimental Physics for Students.

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Quantum Mechanics II</td><td>Course Code</td><td colspan="3">PHH 41212</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3">PHH 32222</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the knowledge about quantum mechanics and related systems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- independently solve the Schrödinger equation for simple one-dimensional systems -- the ones explicitly taught (e.g. square well, harmonic oscillator, potential barrier), as well as similar, new ones.
- relate the matrix formalism to the use of basis states, and solve simple problems in that formalism.
- Explain the concepts of spin and angular momentum, as well as their quantization- and addition rules. Explain the Zeeman affect and spin orbit coupling.

Course Content:

Application of Schrödinger equation to three dimensional problems: particle confined to a box, Schrödinger equation to Spherical polar coordinates and solving central field problems, Spherical harmonic oscillators, Schrödinger equation to many particle system, Hydrogen like atoms and radial equations, Quantum numbers and Degeneracy; **Matrix Formalism** :Matrix formulation of Quantum Mechanics, Perturbation Theory (Time independent & time dependent), Perturbation Theory(Degenerate case), Identical particles and Pauli exclusion Principle and parity.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- David S. Saxon, Elementary Quantum Mechanics, New York McGraw Hill.
- Steven Weinberg, Lectures on Quantum Mechanics (2013), Cambridge university press.
- L. D. Landau, L. M. Lifshitz, Quantum Mechanics: Non-Relativistic Theory- Volume 1, 2 and 3(3rd ed.).

Course Title	Advanced Electronics II			Course Code	PHH 41222		
				Prerequest	PHH 32232		
Level	4	Semester	I	Credits	02	Theory (hrs.)	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide the wide knowledge about the digital electronics

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- explain use of the different representations of digital circuits: truth tables, circuit diagrams and logical word descriptions.
- Explain ways of transmitting and storing data, especially the concepts of computer buses and addressing and multiplexing/de-multiplexing.
- understand the different requirements for transmitting data using parallel and serial interfaces.
- Explain the operation of simple sequential circuits, including flip-flops, counters and registers.

Course Content:

Development of digital electronics: Digital and analogue method, Number systems, Binary arithmetic in computers, Conversion Algorithms; **Boolean Algebra**: Development of Boolean algebra, Law of Boolean algebra, Boolean expressions and Logic diagrams, Universal building blocks, Negative logic; **Logic Hardware**:, The diode as a DC switch & an AC switch, The bipolar transistor as a DC switch, & a AC switch, The field effect transistor as a switch, Logic specifications, Logic families, Logic packages; **Combinational Logic**: Introduction, Minterms, Truth tables and maps, SOP & POS map reduction, Hybrid function, Multiple output minimization, Variable mapping, Tabular minimization; **Sequential circuits**: Introduction, Flip-Flops, Ripple counters, Type T design, Type D design, Type JK design, Asynchronous sequential circuits; **Digital integrated circuits**: MSI and LSI, Logic gates, Multiplexers, Demultiplexers, Decoders and Code converters. Arithmetic functions, Flip-Flops, Shift resistors, Counters, Optoelectronic display devices; **Memory circuits and systems:** Introduction, ROM, RAMs, Dynamic random-access memories; **The digital computer**: The computer age and system, Computer instructions, Processing instructions, the NC6801 microcomputer; **Analogue/Digital conversion**: Analogue meets digital, Digital to analogue conversion, Analogue to Digital conversion, Converters specifications.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- Horowitz and Hill, The art of Electronics, Cambridge University Press (2nd ed.).
- William H. Gothman, Digital Electronics, PHI Learning (2nd ed.).
- James J. Brophy, Basic Electronics for Scientists, McGraw Hill Publishing (5th ed.).
- Jacob Millman, Integrated Electronics: Analog and Digital circuits systems, Tata McGraw Hill, New Delhi.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Nuclear Physics</td><td>Course Code</td><td colspan="3">PHH 41232</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the knowledge about the nuclear structure, binding energies and nuclear reactions

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- describe the properties and structure of stable nuclei;
- understand the properties of the nuclear force properties;
- understand the quantum model of the nucleus;
- understand the shell model and be able to explain radioactive processes including beta decay and its properties
- understand the mechanism of nuclear reaction and products of the reaction
- know about the various types of nuclear reactors and their operations.

Course Content:

Review of basics in Nuclear Physics: Proton-Electron model, some notable failure of the model, Chadwick's experiment; **Nuclear Structure & properties**: nuclear size, Coulomb energy difference between mirror nuclei, analysis of the electromagnetic radius using Quantum Mechanics, mass of nuclei, nuclear binding energy, separation energy systematic, abundance systematic of stable nuclides, nuclear magnetic moments, nuclear angular momentum, coupling of nucleon state and nuclear levels, nuclear Quadruple moment, methods for measuring magnetic moments, Hyperfine structure, Zeeman effect, Paschen–Back effect; **Nuclear models**: Introduction, Liquid Drop model, Evaluation of Asymmetry coefficient,, Mass parabolas and the stability of nuclei against β decay and electron capture, the stability of the nuclei, The energy released in a α-particle decay, Shell model, Nuclear Isomers, Collective model; **Nuclear Reaction**: Reaction mechanism, compound nucleus, kinematic and cross section, Energy levels of product nucleus, Conservation of iso – spin, Nuclear Reactors, Fission Reactors, Artificial Isotopes, Biological effect of Radioactive particles.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- W.E. Burcham, M. Jobes, Nuclear and Particle Physics, Longman, London.
- Bernard L. Cohen, Concepts of Nuclear Physics, Tata McGrawHill, New Delhi.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Electromagnetic Theory and Waves</td><td>Course Code</td><td colspan="3">PHH 41243</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">03</td><td>Theory (hrs.)</td><td>45</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>105</td></tr>
</table>

Aim of the Course:

To provide the wide knowledge about the electromagnetism, electromagnetic waves, wave motion and applications

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- describe all the fundamental aspects of electromagnetism;
- explain many aspects of the interaction of electromagnetic radiation with matter;
- recast the electric and magnetic fields in terms of scalar and vector potentials and to recast Maxwell’s equations in terms of these potentials.
- solve problems requiring application of Maxwell's equations to a variety of situations
- understand the concept of an electromagnetic gauge, in particular to understand the use and importance of the Coulomb and Lorentz gauges. To be able to perform simple gauge transformations.
- analyze the propagation of plane waves in lossless and lossy dielectric and conducting media.
- understand and analysis the transmission lines.
- analyze and design rectangular waveguides and understand the propagation of electromagnetic waves, including propagation in dielectric waveguides and optical fibers.

Course Content:

Electrostatics: Poisson’s equation, Laplace’s equation, Electric multipoles, Electrostatic energy, Energy in the presence of dielectrics; **Magnetism**: Current density, Equation of continuity, Bound charge current density, Force between two circuits, Ampere’s Law, Relation between electric field and vector potential, Magnetization current densities, Ampere’s Law for H-field, Energy of magnetic field, Maxwell’s equations in free space, Integral form of Maxwell’s equation, Maxwell’s equations in medium, Gauge transformations; **Electromagnetic waves**: Electromagnetic waves in free space, Plane Electronic waves in free space, Pointing theorem, Electromagnetic waves in conducting medium, Skin depth, Electromagnetic waves in dielectrics, Electromagnetic waves in ionised gases. Reflection and Refraction of plane waves, Energy relations; **Transmissions Lines**: lossless transmission lines, practical transmission lines (parallel wire, coaxial cable and parallel strip), reflections, impedance matching, lossy lines; **Metallic waveguides**: parallel plate waveguides, rectangular waveguides, cavities.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- Grant I S, Phillips W R, Electromagnetism, John Wiley & sons, (7^{th} ed.).
- Paul, Corson. Dale R, W.H., Electromagnetism, Freeman and company.
- Powell, R.G; G.E. Drabble, Electromagnetism, London Macmillan.
- Franklin, Jerrold, Classical Electromagnetism, New Delhi Pearson Education

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Advanced Statistical Physics</td><td>Course Code</td><td colspan="3">PHH 41252</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the knowledge about the statistical distributions and systems

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- identifying and describing the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential, Free energies, partition functions.
- using the statistical physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems.
- applying the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.
- analyzing phase equilibrium condition and identify types of phase transitions of physical systems.
- making connections between applications of general statistical theory in various branches of physics.

Course Content:

Introduction: statistical methods, Random walk - Binomial distribution and general discussions, statistical formulation of the mechanical problem, interaction between macroscopic systems; **Statistical thermodynamics**: Irreversibility and the attainment of equilibrium, thermal interaction and general interaction between macroscopic systems, macroscopic parameters and their measurements, **Basic methods and results of statistical mechanics**: ensembles representation for various situations, approximation methods, generalizations and alternative approaches; **Simple applications of statistical mechanics:** general method of approach, ideal monatomic gas, the equipartition theorem, paramagnetism, kinetic theory of dilute gases in equilibrium; **Equilibrium between phases or chemical species**: general conditions, equilibrium between phases, system with several components and chemical equilibrium; **Quantum Statistics of ideal gases**: Maxwell-Boltzman, Bose-Einstein and Fermi – Dirac statistics, ideal gas in the classical limit, conduction in metals.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- Federick Rief, Fundamentals of Statistical and Thermal Physics, McGraw Hill.
- Huang, Kerson, Statistical Mechanics, John Wiley and Sons, New York.

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2" colspan="3">Field Visit and Presentation</td><td>Course Code</td><td colspan="3">PHH 41261</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hrs.)</td><td></td></tr>
<tr><td>Field visit (hrs.)</td><td>30</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide the knowledge about the operation of industries related to the energy supply and physics related fields

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Identify the principles of the industry equipment
- Explain the technical background of the industry
- Write a detailed reports based on the field visits

Course Content:

Industrial visit to the different types of industries and power generation plants.

Mode of Assessment and weightage:

- Oral Presentation – 30%
- Report writing – 70%

Course Title	Astrophysics II			Course Code	PHH 41271		
				Prerequest	-		
Level	4	Semester	I	Credits	01	Theory (hrs.)	15
						Practical (hrs.)	-
						Independent Learning (hrs.)	45

Aim of the Course:

To provide the knowledge about the advanced astrophysics and universe

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Solve astronomy-related problems using quantitative methods
- explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories
- explain the evolution of the expanding Universe using concepts of the Big Bang and observational evidence

Course Content:

Basic Theoretical ideas and observational data on star formation; Nucleosynthesis inside stars; end states of stellar evolution, a brief discussion on extragalactic astronomy, the space time dynamics of the universe; thermal history of the universe. High-energy Astrophysics.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

1. Choudhuri, A.R. (2010). Astrophysics for Physicists, Cambridge Press.
2. Carroll, B.W. & Ostlie D.A. (2007) An Introduction to Modern Astrophysics, 2nd edition, Addison Wesley.
3. Kippenhahn, R. & Weigert A. (1990) Stellar Structure & Evolution, SpringerVerlag, Berlin

Course Title	Advanced Physics Laboratory III			**Course Code**	PHH 41282		
				Prerequest	-		
Level	4	**Semester**	I	**Credits**	02	**Theory (hrs.)**	**-**
						Practical (hrs.)	**90**
						Independent Learning (hrs.)	**10**

Aim of the Course:

This course is aimed to provide opportunity for students to engage in laboratory work in observing and experiencing physical phenomena

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Advanced experimental techniques through laboratory work.
- Designing and planning of laboratory experiments.
- writing comprehensive laboratory reports.
- presenting results based on the analysis of experimental data.

Course Content:

Designing electronic circuits including logic gates, bridges and power supplies. Hands on training on Autolab, Characterization of solar cells, ionic conductivities of different types of gel polymer electrolytes

Mode of Assessment and weightage:

- Continuous Assessment (laboratory Reports) – 50%
- End Semester Examination – 50%

References:

- Worsnof, B. L and Flint, H. J. (1965), Advanced Practical Physics for Students, Jerrold & Sons Ltd.
- Whittle, R. M. and Yarwood, J. (1973), Experimental Physics for Students.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Polymer Physics</td><td>Course Code</td><td colspan="3">PHH 42212</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">4</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hrs.)</td><td>30</td></tr>
<tr><td>Practical (hrs.)</td><td>-</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>70</td></tr>
</table>

Aim of the Course:

To provide the knowledge about the types, fabrication and characterizations of polymers

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the history, chemical nature and structures of synthetic polymers
- Understand common techniques used in polymer characterization
- Explain Mechanical. optical, electrical and thermal properties of polymers
- Explain the conduction mechanism in conjugated polymers and their uses
- synthesis and characterization of conjugated polymers.

Course Content:

Introduction: Polymers, a brief history of synthetic polymers, chemical nature of polymers, properties and applications, polymer processing; **Techniques studying Polymers:** Differential Scanning Calorimetry (DSC) and Differential Thermal Analysis (DTA), Density Measurements, Light Scattering, X-ray scattering, Infrared and Raman spectroscopy, NMR technique, Optical and electron microscopy; **Classification of Polymers**: Thermoplastic versus thermoset polymers, amorphous versus crystalline polymers; **polymers structures**: Determination of molar mass and determination, the shape of polymer molecules, evidence for ordered structures in solid polymers; **Morphology**: crystallinity, orientation; **Mechanical Properties**: strength, modulus, elongation, hardness; **Thermal Properties** : Glass transition temperature, 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, piezoelectric. **Special Polymers**: Blends, Copolymers, liquid crystal polymers; **Conjugated polymers:** A brief overview, charge transport and electrical conductivity, optical properties, synthesis and characterization (Electropolymerization, Eelectro Quartz Crystal Microbalance (EQCM), etc), applications.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- Young, R.J, Lovell, P.A., Introduction to Polymers, London Chapman & Hall (2nd ed.).
- Bower, David I., An introduction to polymers physics, New York Cambridge University Press.
- Cowie, J.M.G., Polymer chemistry and physics of modern materials, London Chapman & Hall (2nd ed.).

Course Title	Advanced Nanoscience and Nanotechnology			Course Code	PHH 42222		
				Prerequest	-		
Level	4	Semester	II	Credits	02	Theory (hrs.)	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide the knowledge about the advanced nanomaterial synthesis and characterizations and related devices

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the nanomaterials presence in different forms and their uses
- Explain the types, properties and applications of carbon nanotubes
- Understand the experimental techniques in thin film preparations
- Explain the characterization techniques used in nanotechnology.
- Explain some specific applications of nano technology

Course Content:

Introduction : Timeline and Milestones, characterization and manipulation of extremely small objects, dimensionality, nanoscale objects, microscale objects, size effects of properties observed in thin films, **Nanomaterials:** overview of different nanomaterials, semiconductor quantum dots and nanowires, potential uses of nanomaterials, preparation of nanomaterials ("Top-Down" and "Bottom-Up" approaches); **Carbon Nanotubes:** Overview of carbon nanotubes, Single-walled carbon nanotubes and multiwalled carbon nanotubes, Structure-property relationships, Physical properties, Applications; **Thin Film Growth Techniques:** Conventional microfabrication including thin film deposition, lithography, chemical etching and electrodeposition; **Nanocharacterization**: Scanning Electron Microscopy, Atomic Force Microscopy, Transmission Electron Microscopy, etc.; **Applications**: Micro and Nano technology including Microelectronics, Microfluidics, Micro Electro Mechanical Systems (MEMS) and Molecular Electronics.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- Frank Owens and Charles Poole, The Physics and Chemistry of Nanosolids (2008), John Willey.
- George hanson, Fundamentals of nanoelectronics (2008), Pearson.

Course Title	Superconductivity and Application			**Course Code**	PHH 42232		
				Prerequest	-		
Level	4	**Semester**	II	**Credits**	02	**Theory (hrs.)**	**30**
						Practical (hrs.)	**-**
						Independent Learning (hrs.)	**70**

Aim of the Course:

To provide the knowledge about the principle of superconductor and applications

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- describe the characteristics of different classes of superconducting materials-
- describe different theories of superconductivity and their ranges of validity-
- in detail describe the difference between good conductors, perfect conductors and superconductors-
- apply London theory, modified London theory and Ginzburg-Landau theory for superconductivity for both derivations and numerical calculations-
- explain type-I and type-II superconductivity based on thermodynamic calculations of the Gibbs free energy for a superconductor-
- discuss vortices and their properties in a superconductor both quantitatively and qualitatively, especially concerning energy losses in superconducting wires- apply Bean critical state model.

Course Content:

Superconductivity: transition temperature, Meissner effect, Magnetic susceptibility, London's equations , Critical magnetic field of superconductor, differences in free energy and entropy between superconductor, electronic and lattice specific heats; **Classification of Superconductors**: type I and type II superconductors, lower and upper critical fields of type II superconductors, magnetization of type II superconductors; **BCS Theory**: Cooper pairs, Quantum interference in superconductors, Phase difference of a electron pair wave in applied magnetic field, flux quantization, Josepson effect, DC and AC Josepson effect, coupling energy, Ginsburg and Landaus theory, wave function as an order parameter, quantum mechanical current density, penetration depth and critical field from Ginsburg Landau theory; **High temperature superconductors:** synthetic ceramic compound superconductors, preparation of high temperature superconductors, applicants of superconductors.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- Gianfranco Vidali, Superconductivity: The next Revolution, Cambridge University Press.
- A.C. Rose Innes and E.H. Rhoderick, Introduction to superconductivity, Pergamon Press, Oxford.
- D. R. Tilley, J. Tilley, Superfludity and Superconductivity, IOP publishers, London.
- Michael Tinkham, Introduction to Superconductivity (1996), Dover paperpack. High Temperature
- Gerald Burns, Superconductivity: An Introduction.

Course Title	Particle Physics			Course Code	PHH 42242		
				Prerequest	-		
Level	4	Semester	II	Credits	02	Theory (hrs.)	30
						Practical (hrs.)	-
						Independent Learning (hrs.)	70

Aim of the Course:

To provide the knowledge about the elementary particles, interactions, particle accelerators and detectors

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Explain the elementary particles and their classifications and features
- Explain the various types of particle accelerator and their operational mechanism
- Understand the Quarks models for particle formation and particle detectors
- Explain the operational principles of particle accelerators and detectors

Course Content:

Elementary particles: Introduction, particles and anti-particles, pion, muon, neutrinos, strange particles; **Classification of particles:** baryons, mesons, leptons, quark model; **Particle accelerator mechanics**: the linear accelerator, the Cyclotron, the Synchrocyclotron, the Betatron, electron synchrotron, Intersecting beam accelerators; **conservation laws**: Energy, and momentum, angular momentum, Isospin, strangeness, parity, charge conjugation; **Passage of charged particle through matter**: Path length and range of electrons, Čerenkov radiation, Interaction of uncharged particles with matter, the energy loss inside a material in the passage of electron; **Collisions of particles**: Calculation of threshold energies in centre of mass and laboratory frames, production of additional particle; **Quarks theory and QCD**: strong interactions, the constituent of hadrons, Quark construction of mesons, strange particles and strangeness, Quark structure of Baryons, the glue-particles Gluons; **Particle detectors**: The bubble chamber, Stream chamber, Spark chamber, Scintillation counters, Čerenkov counters.

Mode of Assessment and weightage:

- Continuous Assessment (MCQ, Short answer questions, Home take Assignments, closed book essay type examination) – 30%
- End Semester Examination – 70%

References:

- C.D. Coughlan, and J.E.Dodd, The idea of Particle Physics.
- Martin R. and Shaw, Particle Physics, John Wiley & Sons.
- Burcham, W.E., Jobes, M., Nuclear and particle physics, Longman, London.

<table>
<tr><td>Course Title</td><td colspan="3">Research Project - Physics</td><td>Course Code</td><td colspan="3">PHH 42256</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="2">Level</td><td rowspan="2">4</td><td rowspan="2">Semester</td><td rowspan="2">II</td><td rowspan="2">Credits</td><td rowspan="2">06</td><td>Student – Supervisor contact (hrs.)</td><td>60</td></tr>
<tr><td>Independent Learning (hrs.)</td><td>540</td></tr>
</table>

Aim of the Course:

To provide an opportunity for students to plan and execute a research project independently.

Intended Learning Outcomes:

On the successful completion of the course, students should be able to:

- Search, analyze and summarize current literature relevant to a specific topic of his/her area of expertise.
- Rationalize the research gap for innovation.
- Design and implement a suitable experimental / theoretical procedure.
- Comprehend expertise on maintaining a lab logbook, data analysis and scientific report writing.
- Exposure for safe laboratory practices by handling high-end equipment.
- Communicate any findings and defend the work in a professional manner.

Course Content:

An individual research project will be carried out under the supervision of a senior academic staff member of the unit or in collaboration with other units (or with co-supervision on the case of industry-based project) and a dissertation should be submitted based on the work carried out in that research project.

Mode of Assessment and weightage:

- Oral Presentation - 30%
- Dissertation – 70 %

References:

Will be recommended by the Supervisor