Faculty of Applied Sciences
South Eastern University of Sri Lanka

Bachelor of Science (General)

Details of Course Contents

Faculty of Applied Sciences
South Eastern University of Sri Lanka
Sammanthurai
Sri Lanka

DETAILED SYLLABI OF BIOLOGY

LEVEL I

BLM 11012: PRINCIPALS OF BIOLOGY

Course Code Course Title Credits Compulsory/optional Prequisites	**BLM 11012** Principles of Biology 2 Credits Compulsory Advanced Level Biology
Aims	1. To develop an understanding of basic concepts and principles in Biology 2. To enhance an interest and develop an appreciation of the nature and diversity of organisms 3. To create an awareness of the application of biological knowledge to modern society 4. To develop an ability to make informed evaluations about contemporary biological issues.
Time allocation	22 hours lectures and 24 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Relate the basic principles of Biology to living organisms. 2. Identify and justify the cell as a unit of life. 3. Demonstrate the fundamental principles of Mendelian genetics. 4. Explain and interpret the molecular basis for heredity. 5. Demonstrate proper use of the standard tools of biological scientists and the use of metric measurements.
Course Content	Organization of living systems, energy transfer, continuity of life, biodiversity, and classification of living things: structure and functions of cells and cellular organelles; cellular processes; general biochemistry; DNA structure and function; heredity; evolution; animal development; classification; and introductions to viruses, prokaryotes, Protista, and Fungi.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. R. Brooker, E. Widmaier, L. Graham and P. Stiling. Principles of Biology (2nd Edition) (2017), McGraw-Hill Education.
2. Laboratory Manual for Principles of Biology I (3rd edition) (2208) by William C. Burnett, Michael B. Beach, and Mark T. Sugalski, Tavenner Publishing Company, Anderson, Sc

BLM 11022: BIOLOGICAL CHEMISTRY

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 11022** Biological Chemistry 2 Credits Compulsory Advanced Level Biology
Aims	To develop an understanding on chemical processes in living things and energy flow at the cellular level.
Time allocation	23 hours lectures and 21 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. discuss chemistry behind biological processes 2. describe chemical reactions and structures of biomolecules essential to life on Earth 3. show competence in extensive hands-on exposure to basic instrumentation and techniques and the information derived from them.
Course Content	Essential principles of biochemistry; the structure and characterization of biological macromolecules, the energetics and thermodynamics of coupled biological reactions, and enzymology; membranes and nucleic acids; cellular mechanisms of energy transduction; integration and control of cell metabolism; important metabolic pathways their cellular compartmentalization, integration and control.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Bugg, T. (2009). Introduction to enzymes and Coenzyme Chemistry (2nd edition). Blackwell Publishing Ltd.
2. Cox, M. and Nelson, D.L. (2008). Lehninger Principles of Biochemistry , Amazon, UK.

BLM 12032: FUNDAMENTALS OF ECOLOGY

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 12032** Fundamentals of Ecology 2 Credits Compulsory BLM 11012
Aims	1. To instill the importance of ecology to contemporary society 2. To develop understanding on vital ecological services provided by various ecosystems 3. To enhance the awareness of the effects of biotic-abiotic interactions and how they shape organism adaptation and distribution, 4. To develop an ability to understand population growth patterns in contrasting environments
Time allocation	23 hours lectures and 21 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Describe how organisms are (or are not) adapted to their abiotic environment 2. Describe the principal processes involved in population growth 3. Explain the key ecological interactions of competition, predation and parasitism 4. Relate population-level ecological processes to community or ecosystem-level processes 5. Explain how ecological principles relate to selected areas of applied ecology 6. Present and interpret ecological data accurately and clearly
Course Content	Introduction to Ecology: Climate, terrestrial biomes, aquatic biomes; Functional Ecology: biotic and abiotic factors; Behavioural Ecology; Population Biology: Life tables and Demography; Population growth and dynamics: competition, facilitation, predation and herbivory; Interactions; Population Regulation; Species Diversity and Richness; Food webs and chemical cycles; Global climate change.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. M. Molles and A. Sher (2019) Ecology: Concepts and Applications, 8th Edition, McGraw Hill
2. J. L. Chapman, M. J. Reiss (1999) Ecology: Principles and Applications, Cambridge University Press.
3. EP Odum and Gary W Barrett (2005) Fundamentals of ecology, Thomson Brooks/Cole

BLM 12042: FUNDAMENTALS OF MICROBIOLOGY

Course Code Course Title Credits Compulsory/optional Prerequisites	BLM 12042 Fundamentals of Microbiology 2 Credits Compulsory BLM 11012, BLM11022
Aims	1. Introduce basic principles in Microbiology 2. Expose students to applications and importance of microorganisms in industries related to food, water, human health and agriculture. 3. Gather skills in basic laboratory techniques in Microbiology
Time allocation	22 hours lectures and 24 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Describe/discuss role of microbes in health, food, environment, industry etc. 2. Demonstrate knowledge in microbial structure, physiology, reproduction and ecology. 3. Demonstrate skills in basic microbial and microscopic techniques
Course Content	Biology of microorganisms: special emphasis on bacteria; Cellular structure, physiology, genetics, and interactions with higher forms of life; Emphasis on fundamental life processes, including a brief introduction to epidemiology and immunology; microbiological equipment and safety procedures; aseptic techniques: culturing, isolation, purification, characterization and identification of microorganisms; estimation of growth and populations of microbes.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Tortora, G.J. Funke, B.R. and Case, C.I. (2014). Microbiology — An Introduction (9th Edn.) Publisher: Pearson.
2. Keya Sen and Nicholas J. Ashbolt (2011). Environmental Microbiology: current technology and water applications, Horizon Scientific Press.
3. T.M. Schmidt and M. Schaechter (2012). Topics in Ecological and Environmental Microbiology, Academic Press
4. S. P. Hardy (2002). Human Microbiology, Taylor and Francis Inc. USA.
5. Michael T. Madigan, John M. Martinko, David Stahl and David P. Clark . (2010) Brock Biology of Microorganisms (13th Edition). Benjamin Cummings.

LEVEL II

BLM 21012: FORM AND FUNCTIONS OF ORGANISMS

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 21012** Form and Functions of organisms 2 Credits Compulsory BLM 11012, BLM11022
Aims	1. To introduce some structures and their functions in animals and plants and their physiological mechanisms 2. To develop the knowledge on fundamental aspects of functions in plants and animals as a basis of understanding their basic physiological aspects of nutrition, transport, respiration, transpiration and growth and development 3. To provide exposure to current research trends in the field of Plant and animal physiology.
Time allocation	22 hours lectures and 24 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Recognize the importance of plant and animal physiology 2. Describe plant and animal physiology by elaborating on the concepts and principles of basic topics 3. Demonstrate knowledge and experience related to plant and animal physiological aspects 4. Report the current research trends in the field of plant and animal physiology
Course Content	This basic course focus on multicellular animals and vascular plants: different organism levels; structure and function of animal organ and organ systems: circulation, respiration, nervous systems, endocrine systems, excretion, nutrition, and developmental biology. Structure and function of plants: cell walls, anatomy, photosynthesis, water relations, mineral nutrition, growth and flowering.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Taiz, L. and Zeiger, E. (2002). Plant Physiology. The Benjamin Cummings Publishing Company, Inc. California.
2. Öpik, H., Rolfe, S.A., Willis, A.J. (2005). The Physiology of Flowering Plants. Cambridge University Press.

BLM 21021: ECOSYSTEMS OF SRI LANKA: ECOLOGY, CONSERVATION AND MANAGEMENT

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 21021** Ecosystems of Sri Lanka: Ecology, Conservation and Management 1 Credit Compulsory BLM 12032
Aims	1. To develop understanding on the main ecosystems of Sri Lanka and their ecology and distribution 2. To develop awareness on the threats to natural ecosystems 3. To introduce measures to conserve, manage and restore natural ecosystems
Time allocation	13 hours lectures and 06 hours of laboratory work/field visit
Learning outcome	On successful completion of the course the students will be able to; 1. Describe the physical/climatic variations of the island. 2. Classify/Identify ecosystem types. 3. Describe/map their distribution. 4. Describe/compare environmental features of/among different ecosystems. 5. Describe/compare structure and composition of/among ecosystems. 6. Discuss importance/significance of different ecosystems 7. Discuss threats on ecosystems. 8. Describe/discuss conservation measures.natural and degraded habitats.
Course Content	Floristic zones of Sri Lanka: geology, climate, soil geography; Ecosystem types: forests, grasslands, marine, maritime and aquatic, their distribution: extent, structure, biodiversity, special features, dynamics; Factors responsible for degradation of natural ecosystems; Conservation, management and restoration of natural ecosystems.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Whitmore, T.C. 1990. An introduction to tropical rainforests. Oxford University Press, Oxford, UK.
2. Anon. 2000. Natural Resources of Sri Lanka. The National Science Foundation, Sri Lanka.

BLM 21031: FIELD ECOLOGY

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 21031** Field Ecology 1 Credits Compulsory BLM 12032
Aims	1. To introduce methods of describing vegetation 2. To introduce sampling methods to quantify, analyze and interpret ecological parameters 3. To develop skills of ecological experimentation and communication of scientific results in written and oral format.
Time allocation	10 hours lectures and 15 hours of field/laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Formulate ecological hypotheses 2. Design and implement field experiments 3. Apply statistics properly for a given hypothesis and data set 4. Collect and interpret data and present ecological findings
Course Content	Introduction; methods of describing vegetation: species lists, life forms, Humboldt's classification, Raunkiaer's classification; structure of vegetation: profile diagrams, visual estimation of abundance (British system, Braun- Blanquet system and Domin's scale) and quantitative measures of abundance (density, cover, basal area, yield, performance, frequency) advantages and disadvantages; sampling vegetation: single plot and multiple plot method, random, systematic and partial random sampling systems, plotless sampling, transects: line, belt and gradsects; density and volume of phytoplankton and benthic algae, vegetation mapping; Field and laboratory work covering above techniques, data analyzing and reporting/presenting.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Practical Field Ecology: A Project Guide C. Philip Wheater, James R. Bell, Penny A. Cook wiley.
2. Vegetation Description and Data Analysis: A Practical Approach, 2nd Edition Martin Kent ISBN: 978-0-471-49093-7 November 2011, Wiley-Blackwell.
3. How to be a Quantitative Ecologist: The 'A to R' of Green Mathematics and Statistics Jason Matthiopoulos ISBN: 978-0-470-69978-2.
4. Experimental Plant Ecology: P. Kapur and S. R. Govil (2004). CBS Publishers, India.
5. Ecological Census Techniques: A Handbook (1996), William J Sutherland. Cambridge University Press, London.

BLM 22043: MOLECULAR GENETICS AND BIOTECHNOLOGY

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 22043** Molecular Genetics and Biotechnology 3 Credits Optional BLM 11012, BLM 11022, BLM 21012
Aims	1. To introduce basic principles in Molecular Biology 2. To develop understanding on the anatomy and functions of the genome and the methods used to study genomes including molecular techniques, DNA sequencing 3. To introduce methods of identifying genes 4. To introduce basic skills of practical aspects of Genetics and Molecular Biology
Time allocation	32 hours lectures and 24 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Explain the basic concepts of Genetics and Molecular Biology 2. Discuss the function of the gene and mechanism of protein synthesis 3. Explain the methods involved in recombinant DNA technology
Course Content	Concept of the gene, transcription, translation, regulation of gene expression and replication; Organization of nuclear structure and function; protein synthesis and interactions; protein structure; call cycle and cancer; acterial virus (bacteriophage) molecular genetics; eukaryotic chromosome structure; applications of molecular genetics; methods of identifying genomes and studying genome functions; General techniques used in Molecular Biology: cloning and DNA sequencing; molecular markers: RAPD, RFLP, SCAR, microsatellites etc.; Applications in agriculture, medicine and industries.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Benjamin A Pierce (2007). *Genetics, A conceptual approach*. W. H. Freeman publishers
2. Robert F. Weaver (2002). *Molecular Biology*. McGraw-Hill.

BLM 22052 ANIMAL BEHAVIOUR

Course Code Course Title Credits Compulsory/optional Prerequisites	BLM 22052 Animal Behaviour 2 Credits Optional BLM 11012
Aims	1. To introduce the foundations and to develop understanding of methodological principles and empirical basis for behaviour studies; 2. To develop a synoptic view of animal behaviour with an introduction to ethology, behavioural ecology and applied animal behaviour. 3. To develop skills in evaluating the questions in animal behavior
Time allocation	23 hours lectures and 21 hours of practical work
Learning outcome	On successful completion of the course the students will be able to; 1. Demonstrate the contribution of scientists towards advancement in Animal Behaviour 2. Apply the knowledge to develop the skills in education psychology 3. Explain the feeding, reproductive and parental care, and territorial behavior of animals 4. Apply the knowledge to increase the animal welfare especially in animal based industries. 5. Critically analyze and interpret data from studies of animal behaviour and relate findings to theoretical principles
Course Content	History of animal behavior; Proximate and ultimate causes of behavior; The concepts of classical ethology and current approaches to study of behavior; Perception and sensory filters; Brain organization and behavior; Hormones and behavior; Movement; Biological rhythm; Biological clocks; Introduction to learning; simple learning; Associative learning; Complex learning and memory; Introduction to behavioural Ecology; Ecology of habitat selection; Ecology of feeding; Ecology of Antipredator behavior; Ecology of Reproduction; Parent offspring interaction; Ecology of Social organization; Complex type of communication and Language in primates; Applied Animal Behaviour: Applications in agricultural, veterinary, animal welfare and conservation; Measuring behaviour: Insect grooming behaviour; Handedness and eyedness in human; Associative learning in fish; Learning in Human; Habitat selection; Movement; Factor affecting distress call in chicks; Mini Project.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Alcock, J.,(2005) Animal Behavoiur: An evolutionary Approach, 8th Edn., Sinauer Associates Inc. publishers, Sunderland. Massachusetts
2. Krebs, J.R. & Davies, N.B. (1993) An Introduction to Behavioural Ecology, 3rd Edn., Blackwell Scientific Publications.
3. McFarland, D., (1985), Animal Behaviour, Psychology, Ethology and Evolution, English language Book Society/ Longman.
4. Neilson, C. (1995) Animal Evolution Interrelationships of the Living Phyla. Oxford University Press.
5. Ridley, M. (1995) Animal behaviour: an introduction to behavioural mechanisms, development and ecology. 2nd Edn., Blackwell.

LEVEL III

BLM 31013: HORTICULTURE

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 31013** Horticulture 3 Credits Optional Level I and II courses
Aims	1. To introduce basic principles in Horticulture 2. To develop the practical skills to grow, manage and design experiments and trials with horticultural plants 3. To introduce physiological and biochemical characters of nutrients and phytochemicals in horticultural products.
Time allocation	38 hours lectures and 21 hours of field/laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Demonstrate knowledge and skills in application of horticultural principles to the successful growth and production of horticultural plants and sustainable production of fruit, vegetable, and ornamental crops. 2. Recognize ethical practices in horticultural applications and synthesis & integration of information to solve horticultural problems. 3. Make presentations (oral/poster) to deliver knowledge and techniques to stake holders.
Course Content	Introduction to principles of Horticulture; cropping systems, crop rotation, cropping calendar, economic importance; Essentials in nursery managemet: Soil management - garden soil, physical and chemical properties of soil, organic matter, compost, maintenance of soil condition; Cultural practices; Water management - water quality, irrigation, mulching, Nursery structures- protected cultivation (greenhouses), environment controls, pest and disease control; Hydroponic Culture; Growing Media and Media Mixes ; Loam–based and non-loam based media, heat and chemical treatment of growing media, container-growing; Use of Manures and Fertilizers in Horticultural Crop Production; Organic Farming; environment factors in vegetable and fruit production: selection of site; Growth control in horticultural crops: Physical control- pruning and training; biological control- graft combination; chemical control- use of plant growth substances; Plant Propagation; Pest control: Traditional methods and Integrated pest management; Commercial horticulturE: Horticultural production systems, orcharding, vegetable farming, floriculture; Ornamental Gardening; Landscape Horticulture; Amenity Horticulture: trees, shrubs, turf culture; Policies and supportive services in order to enhance fruit and vegetable production and marketing.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. H. Edward Reiley and Carroll Shry (2000), Introductory Horticulture, 6th Edn., Delmar Cengage Learning.
2. C R Adams and M P Early (2008) Principles of Horticulture, 5th Edn., Butterworth-Heinemann.
3. Carroll Shry and Edward Reiley, (2010) Laboratory Manual for Shry/Reiley's 8th Edn., Delmar Cengage Learning.
4. Jack Ingels (2000) Ornamental Horticulture: Science, Operations & Management, 3rd Edn., Delmar Thomson Learning

BLM 31022: APPLIED ENTOMOLOGY

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 31022** Applied Entomology 2 Credits Optional BLM 11012, BLM 12032
Aims	1. To develop basic knowledge and skills in Entomology 2. To develop knowledge and skills in identification of economically important insects 3. To make awareness the basic methods involved in integrated pest management
Time allocation	22 hours lectures and 24 hours of laboratory work
Learning outcome	On successful completion of the course students should be able to demonstrate knowledge of/skills in; 1. Morphological features, structure and function of the exoskeleton, feeding habits, internal anatomy, structural and functional adaptations of insects. 2. Insect identification characteristics and features of economically important orders. 3. Concepts, basics and methods of integrated pest management and their advantages and disadvantages. 4. Economically important insects, natural enemies and their impact on integrated pest management.
Course Content	Introduction to Entomology, External morphology of insects, Stucture and function of exoskeleton, feeding habits and mouth parts of insects. Characteristics of insects in economically important orders, internal anatomy and physiology. current approach for entomological problems, insecticides and their target sites, development of insecticide resistance; Introduction, and definitions for integrated pest management (IPM), Concepts of IPM and advantages, Economically important insect, Basics of IPM for Vegetable and other crops relevant to the region , Natural enemies, Insect pest management Natural enemies impact of IPM.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. PJ. Gullan and PS. Cranston (2010) The Insects: An Outline of Entomology, Wiley-Blackwell.
2. AS. Packard, (1898)A text book of Entomology, including the anatomy, physiology, embryology and metamorphoses of insects for use in agricultural and technical schools and colleges as well as by the working entomologist, Macmillan.
3. OW Richards and, R. G. Davies (1997) Imm's General text book of Entomology. Volume 1: Structure, Physiology and Development Volume 2: Classification and Biology, Springer.
4. Ed. B. Radcliffe et al., Eds. (2009)Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies Cambridge University Press.
5. RA. Cloyd et al., (2009) IPM for Gardeners: A Guide to Integrated Pest Management Timber Press
6. RF. Norris et al., (2002) Concepts in Integrated Pest Management Prentice Hall.
7. DP. Abrol and U Shankar (2012) Integrated Pest Management: Principles and Practice

BLM 32032 AQUACULTURE

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 32032** Aquaculture 2 Credits Optional BLM 11012, BLM 12032
Aims	1. To introduce the principles and concepts in practice of aquaculture. 2. To introduce the species and types of cultures. 3. To develop knowledge on overall scientific, social, economical and commercial aspects in aquaculture.
Time allocation	22 hours lectures and 24 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to: 1. Demonstrate a sound knowledge on principles of aquaculture, aquaculture systems, breeding, feeding and diseases of cultured fish. 2. Identify common edible fin fish and shellfish species used in tropical freshwater, brackishwater and marine aquaculture and common tropical freshwater and brackishwater ornamental fish species. 3. Demonstrate skills in applying the knowledge gained in practicing aquaculture
Course Content	Principles and types of Aquaculture, desirable features of potential species for aquaculture, site selection for land based and water based aquaculture, site selection, pond construction, effluent water treatment, increasing production, food and feeding; biology and culture of selected species freshwater edible fin fish culture, ornamental fish culture with compatible aquarium plants, brackish water shrimp culture and fin fish culture, mariculture of edible fin fish and molluscs. Breeding of selected species of edible and ornamental fin fish and shrimp, provision of food for different developmental stages of shrimp and for some selected fin fish species; Common viral, bacterial, fungal and parasitic diseases of fin fish and shrimp recorded in tropical aquaculture.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. Axelord, H.R. (1989) Handbook of Fish Diseases, TFH Publishers, Oxford.
2. Bardach, J.E. et.al. (1972) Aquaculture : The farming and husbandry of freshwater and marine organisms. John Wiley & Sons, New York.
3. Beveridge, M.C.M. (1987) Cage Aquaculture. Blackwell Science, Oxford.
4. Bromage, N.R. and Roberts, R.J.(1995) Broodstock Management and Egg and Larval Quality . Blackwell Science, Oxford.
5. Lightner, D.V. (1996) A Handbook of Pathology and diagnostic procedure for diseases of penaeid shrimp. The World Aquaculture Society, Louisiana.
6. Mills, D. (1988). Popular guide to tropical aquarium fishes. Salamander Books Limited, London.
7. Pillay, T.V.R. (1990) Aquaculture: Principles and Practice. Fishing New Books, Oxford.
8. Shepherd, C.J. and Bromage, N.R. (1992) Intensive Fish Farming . Blackwell Science, Oxford.

BLM 32042: APPLIED PARASITOLOGY

Course Code Course Title Credits Compulsory/optional Prerequisites	**BLM 32042** Applied Parasitology 2 Credits Optional BLM 11012
Aims	1. To introduce the basic concepts of parasitology; 2. To introduce the knowledge of host-parasite relationships 3. To develop knowledge on epidemiology, transmission, control and treatment of parasitic diseases.
Time allocation	23 hours lectures and 21 hours of laboratory work
Learning outcome	On successful completion of the course the students will be able to; 1. Demonstrate a broad understanding of the central facts and the experimental basis of modern Parasitology 2. Solve problems of a numerical or logical nature in the context of this understanding 3. Demonstrate practical skills in fundamental Parasitological techniques
Course Content	Types of parasites, nature of parasitism, advantages and disadvantages of parasitism. Life cycle of some common parasites of man and animals, epidemiology of some tropical parasites; modes of infection, adaptations; life cycle; Mode of transmission; symptoms and pathogenic conditions; control measures; epidemiology of parasitic diseases with special reference to Sri Lanka; Drug resistance; Zoonoses; emerging infectious diseases; Evolution of parasitism; diagnostic techniques of parasitic diseases.
Assessment criteria Continuous assessment End-semester examination	 30% 70%

Recommended texts:

1. W.C. Marquardt, R.S. Demaree and R.B. (2000) Grieve Parasitology and Vector Biology..
2. L.H. Ash and T.C. Orihel (2007) Atlas of Human Parasitology, 5th Edn., American Society for Clinical Pathology

DETAILED SYLLABI OF MATHEMATICS I

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Set Theory</td><td>Course Code</td><td colspan="3">MTM 11012</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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></td></tr>
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Aim:

To develop basic aspects of the set theory and related topics.

Intended Learning Outcomes:

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

1. Demonstrate knowledge of the concepts of mathematical logic;
2. Explain methods of proofs which are fundamental in various parts of mathematics.
3. Explain the concept of sets, relations and functions.
4. Apply these concepts to given problems in a proper manner.

Course content:

- Propositional calculus: Notation, Connectives, Truth tables, Equivalence, Arguments, Quantifiers, Implications.
- Predicate Calculus.
- Method of Proof: Direct proof, Proof by contrapositive, Proof bycontradiction, Mathematical induction.
- Set theory: Sets, Operation on sets, Laws connecting these operators, Ordered pairs and Cartesian Products;
- Relations: Relations, Equivalence relations, Order relations, Maximum and minimal of ordered sets, Zorn's Lemma;
- Functions: Injection, Surjection, Bijection, Invertible and composite functions.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1)-Closed book exam – 7.5%
Assessemnt-2 (ILO-2) -Closed book exam – 7.5%
Assessment-3 (ILO-3)-Closed book exam – 7.5%
Assessemnt-4 (ILO-4) -Closed book exam – 7.5%

- End Semester Examination(ILO 1-4) –70%

Closed book exam - 2 Hours

References:

1. Elliott Mendelson, *Introduction to Mathematical Logic*, Chapman & Hall/CRC, 1997;
2. Chetwynd& P. Diggle, *Discrete Mathematics*, Butterworth-Heinemann, 1995;
3. S. Lipschutz& M. L. Lipson, *Theory and Problems of Discrete Mathematics*, Tata McGraw-Hill Publishing Company Limited,1999.
4. R. S. Aggarwal, *A text book on Modern Algebra*, S. Chand & Company Ltd, 1973.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Vector Algebra and Geometry</td><td>Course Code</td><td colspan="3">MTM 11022</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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></td></tr>
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Aims:

To provide students with the opportunity to understand the basic concepts of vector algebra and to build the confidence and skills to apply these concepts in geometrical problems..

Intended Learning Outcomes:

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

1. Define the basic terms related to vector algebra;
2. Evaluate vector operations and interpret them geometrically;
3. List the properties of vector operations;
4. Find the reciprocal set of given vectors;
5. Apply vector operations to solve vector equations.
6. Use section formula to solve geometrical problems;
7. Find the direction cosines and direction ratios of a line;
8. Derive and interpret various types of equations (parametric, non-parametric, Cartesian, symmetric) of a straight line;
9. Solve problems related to straight lines by vector methods;
10. Derive and interpret various types of equations (parametric, non-parametric, polar form, Cartesian) of a plane;
11. Solve problems related to planes by vector methods.

Course content:

- Introduction to vectors: Vectors as directed line segments, Types of vectors.
- Basic vector operations: Vector addition, Multiplication of a vector by a scalar.
- Vectors in Euclidean space, Linear combination of vectors
- Vector products of two vectors: Scalar product, Vector product, Geometrical interpretations.
- Vector products of three vectors: Scalar triple product, Vector triple product, Geometrical interpretations.
- Reciprocal set of vectors.
- Application: Solution to vector Equations.
- Lines in space: Section formula, Collinear vectors, Direction cosines and direction ratios, Equation of a line: Parametric, Cartesian, Symmetric, Non-parametric forms, Angle between two lines, Intersection of two lines, Skew lines, Shortest distance between two lines;
- Planes: Coplanar vectors, Equation of a plane: Parametric, Cartesian, Normal forms, Line of intersection of two planes, Angle between two planes, Point of intersect of a line and a plane, Angle between a line and a plane, Distance of a point from a plane.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam – 7.5%
Assessemnt-2 (ILO-3,ILO-4) -Closed book exam – 7.5%
Assessment-3 (ILO-6, ILO-7, ILO-8) -Closed book exam – 7.5%
Assessemnt-4 (ILO-9,ILO-10, ILO-11) -Closed book exam – 7.5%

- End Semester Examination(ILO 1-11) –70%

Closed book exam - 2 Hours

References:

1. Shanti Narayan and Mittal P.K.,*A Textbook of Vector analysis*, S. Chand & Company Ltd, 2007;
2. Murray R. Spiegel, *Schaum's outlines –Vector Analysis*, McGraw-Hill, 2005;
3. M.D. Raisinghania, *Vector Analysis*, S. Chand & Company Ltd, 1997.

<table>
<tr><td>Course Title</td><td colspan="3">Number Theory</td><td>Course Code</td><td colspan="3">MTM 12031</td></tr>
<tr><td></td><td colspan="3"></td><td>Prerequisites</td><td colspan="3">MTM 11012</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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>15</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aim:

To give an introduction to elementary number theory.

Intended Learning Outcomes:

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

1. Explain the concept of numbers and their properties;
2. Describe and use the Euclidean algorithm and to explain how to solve linear Diophantine equations;
3. Discuss linear congruenceand apply the Chinese remainder theorem to solve problems;
4. Apply the fundamental theorem of arithmetic and to solve systems of linear congruence.

Course content:

- Numbers, Rational and Irrationals,
- Divisibility and Primes, Greatest common divisor, Least common multiple, Euclid's algorithm
- Linear Diophantine equations in two variables,
- Modular arithmetic: Linear congruence, Chinese remainder Theorem.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam – 15%
Assessemnt-2 (ILO-3,ILO-4) -Closed book exam - 15%

- End Semester Examination(ILO 1-4) –70%

Closed book exam - 1 Hour

References:

1. James E. Pommersheim, Tim K. Marks and Erica L. Flapan, *Number Theory*, John Wiley & Sons, Inc, 2010;
2. George E. Andrews, *Number Theory*, Dover Publication, Inc., New York, 1971.

Course Title	Group Theory I			Course Code	MTM 12041		
				Prerequisites	MTM 11012		
Year	1	Semester	2	Credits	1	Theory (hr)	15
						Practical (hr)	
						Independent Learning (hr)	

Aim:

To develop some of the mathematics underlying the classification of finite groups.

Intended Learning Outcomes:

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

1. Recognize the fundamental properties of groups and subgroups;
2. Demonstrate knowledge of subgroups, cyclic groups and permutation groups;
3. Derive and apply theorems related to groups, subgroups, cyclic group and permutations.

Course content:

- Binary operations, Groups, Order of a group,
- Subgroups, Cyclic groups,
- Permutation groups, Even and odd permutations.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam – 15%
Assessemnt-2 (ILO-2,ILO-3) -Closed book exam - 15%

- End Semester Examination(ILO 1-3) –70%

Closed book exam - 1 Hour

References:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, Person Education, Inc., 2003.
2. Thomas A. Whitelaw,*Introduction to Abstract Algebra*, Springer, 1990.
3. I.N. Herstein, *Topics in Algebra*, Wiley & Sons, Inc., 1975.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Real Analysis</td><td>Course Code</td><td colspan="3">MTM 12052</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 11012</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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></td></tr>
</table>

Aim:

To provide an introduction to Real Analysis, which isconcerned with the study of the real number system, limiting processes, continuous functions, differentiable functions and their properties.

Intended Learning Outcomes:

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

1. State clearly the key definitions and theorems of real number system;
2. Derive and apply the key theorems related to sequences of real numbers;
3. Apply tests to determine the convergence or divergence of a sequence.
4. Determine the continuity and differentiability of a function at a point and on a set;
5. Apply properties of continuous functions and differentiable functions to solve simple problems;
6. Derive and apply principal theorems to solve simple unseen problems.

Course content:

- Real numbers: The algebraic and order properties, Absolute value and the real line, Completeness property, Applications of the supremum property.
- Sequence of real numbers: Sequences and their limits, Convergent sequences, Subsequence and the Bolzano-Weierstrass Theorem, The Cauchy criterion.
- Limits: Limits of function, Limit theorems, some extensions of the limit concepts.
- Continuous Functions: Continuous functions, Combination of continuous functions, Continuous functions on intervals, Uniform continuous.
- Differentiation: The derivative, Mean value theorem, L' Hospital rule, Taylors Theorem, maximum and minimum of functions.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam – 7.5%
Assessemnt-2 (ILO-2,ILO-3) -Closed book exam – 7.5%
Assessment-3 (ILO-4, ILO-5) -Closed book exam – 7.5%
Assessemnt-4 (ILO-5,ILO-6) -Closed book exam – 7.5%

- End Semester Examination(ILO 1-6) –70%

Closed book exam - 2 Hours

References:

1. Robert G. Bartle and Donald R. Sherbert, *Introduction to Real Analysis*, John Wiley & Sons, Inc., 2011;
2. Charles G. Denlinger, *Elements of Real Analysis*, Jones and Bardtt Publishers, LLC, 2011.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Mathematical Modeling</td><td>Course Code</td><td colspan="3">MTM 21012</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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></td></tr>
</table>

Aim:

To educate in the theoretical and practical aspects of mathematical problem solvingand mathematical model development.

Intended Learning Outcomes:

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

1. Explain how the general principles arise in the context of Mathematical Modeling.
2. Analyze some existing mathematical models and construct meaningful models of simple mechanical, financial, physical and biological system.
3. Formulate, solve and interpret real world problems.

Course content:

- Modeling methodology: Introduction, Definitions and terminology
- Modeling skills: Listing factors, making assumptions, formulating models.
- Modeling using difference equations for mechanical, financial, physical and biological system.
- Modeling using differential equations for mechanical, financial, physical and biological system.
- Case studies and presentation of models.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam (5%)
Assessemnt-2 (ILO-2) –Open book exam (5%)
Assessment-3 (ILO-3) - Assignment (5%)
Assessment-4 (ILO-2, ILO-3) - Report writing and presentation (15%)

- End Semester Examination ILO 1 - 3) –70%

Closed book exam - 2 Hours

References:

1. Frank R. Giordano, William P. Fox, Steven B. Horton and Maurice D. Weir, *A First Course in Mathematical Modeling,*Brooks/Cole, Cengage Learning, 2009;
2. Dilwyn Edwards and Mike Hamson, *Guide 2 Mathematical Modelling*, Palgrave, 2007.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Vector Space and Matrices</td><td>Course Code</td><td colspan="3">MTM 21022</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 12041</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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></td></tr>
</table>

Aims:

To familiarize students with matrices and develop facility with matrix multiplication, row operations, determinants, and applications including the solution of linear equations; to introduce vector spaces which provide natural context/language for describing linear phenomena.

Intended Learning Outcomes:

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

1. Carry out the basic operations of matrix algebra.
2. Use row operations and column operations to reduce a matrix to echelon form.
3. Discuss the consistency of a linear system and find the full set of solutions, if it exists.
4. Determine whether a specified set of vectors forms a vector space.
5. Determine whether a set of vectors is linearly independent.
6. Find bases and dimension for a vector space.

Course content:

- Types of matrices, Matrix operations, Row operation and Column operation, Transpose of a matrix, Properties of matrices, Determinants, Adjoin of a matrix, General solution of system of linear equations.
- Vector spaces, Subspaces, Spanning set, Direct sum, Linear independence and linear dependence, Maximal independent set, Bases and dimension.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -10%
Assessment-3 (ILO-5, ILO-6) - Open book exam – 10%

- End Semester Examination(ILO 1 - 6) –70%

Closed book exam - 2 Hours

References:

1. Paul R. Halmos, *Finite Dimensional Vector Spaces*, Martino Fine Books, Mansfield Centre, 2012;
2. Robert M. Thrall and Leonard Tornheim, *Vector spaces and Matrices*, Dover Publications, INC., New York, 2011;
3. Shanti Narayan, P.K. Mittal , *A Textbook of Matrices*, , S Chand & Co Ltd, New Delhi., 2010;

Carl Meyer, *Matrix Analysis and Applied Linear Algebra, Volume 1*, Society for Industrial and Applied Mathematics, 2000.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Elementary Differential Equations</td><td>Course Code</td><td colspan="3">MTM 22031</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aim:

To provide students with the opportunity to acquire the basic knowledge of differential equations as well as various elementary techniques involved in their solutions.

Intended Learning Outcomes:

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

1. Define basic terms related to differential equations (DE);
2. Form a DE by eliminating arbitrary constants;
3. Solve a given first order DE by an appropriate technique;
4. Solve a DE that model a variety of real world problems and explain the phenomenon of the resonance;
5. Solve a DE by Picard's iterative method.

Course content:

- Introduction to differential equations: Basic definitions, Classification of differential equations, Formation of ordinary differential equations, Solutions of a differential equation.
- First order first degree ordinary differential equations: Existence and uniqueness of solutions, Variable Separable equations, Homogeneous equations, Exact equations, Linear equations, Bernoulli's equation, Ricatti's equation, Clairaut's equation, Substitution methods.
- Applications.
- Approximation Method: Picard's method.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam – 15%
Assessemnt-2 (ILO-3,ILO-4) -Closed book exam - 15%

- End Semester Examination(ILO 1-5) –70%

Closed book exam - 1 Hour

References:

1. Raisinghaniya M. D., *Ordinary and Partial Differential Equations*, S. Chand and company Ltd. New Delhi., 2008;
2. Zafar Ahsan, *Differential Equations and Their Applications,* PHI Learning Pvt. Ltd., 2004;
3. Dennis G. Zill, *A First Course in Differential Equations with Applications*, PWS Publishers., Boston, 1986.

Course Title	Group Theory II			Course Code	MTM 22041		
				Prerequisites	MTM 12041		
Year	2	Semester	2	Credits	1	Theory (hr)	15
						Practical (hr)	
						Independent Learning (hr)	

Aim:

To give a coherent treatment of basic theories and problems from group theory.

Intended Learning Outcomes:

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

1. Investigate properties of groups;
2. Apply these properties to solve problems in algebra.

Course content:

- Normal subgroups; Quotient groups; Subgroups of a quotient group.
- Homomorphism; Fundamental theorem of homomorphism.
- Center of a group: Commutator, Commutator subgroup, Centralizer, Normalizer.
- Automorphism.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1) -Closed book exam- 15%
Assessemnt-2 (ILO-2) -Closed book exam -15%

- End Semester Examination(ILO 1 - 2) –70%

Closed book exam - 1 Hour

References:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, Person Education, Inc. 2003;
2. S. Lipschutz& M. L. Lipson, *Theory and Problems of Discrete Mathematics*, Tata McGraw-Hill Publishing Company Limited, 1999;
3. R. S. Aggarwal, *A Text Book on Modern Algebra*, S. Chand & Company Ltd, 1996.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Metric Spaces</td><td>Course Code</td><td colspan="3">MTM 22051</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 12052</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aims:

To introduce metric spaces; to show how continuity may be utilized within this context to provide generalizations of familiar results and to show how the greater generality leads to new results.

Intended Learning Outcomes:

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

1. Explain metric spaces with examples and recognize basic properties of metric space;
2. Demonstrate an understanding of notions such as openness, closeness, continuity, limits, completeness, equivalence of metrics as applied in the context of general and specific metric spaces.
3. Drive and apply elementary theorems involving the concepts of metric space, subspace and bases.

Course content:

- Metric spaces, open spheres and closed spheres, Equivalent metrics.
- Interior points, closed sets, Limit points, closure of a set, Boundary points, Distance between sets and Diameter of a set.
- Subspace of a metric space, Bases.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 15%
Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -15%

- End Semester Examination(ILO 1 – 3) –70%

Closed book exam - 1 Hour

References:

1. Wilson A. Sutherland, *Introduction to Metric and Topological Spaces*, Oxford University Press, 2009;
2. Pawan K. Jain and Khalil Ahmad, *Metric Spaces*, Alpha ScienceInternational Ltd., 2004.

Course Title	Integral Transforms			Course Code	MTM 22062		
				Prerequisites	MTM 21011		
Year	2	Semester	2	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aim:

To encourage a view of Integral transforms as a way of thinking and as tools for problems in many branches of Mathematics.

Intended Learning Outcomes:

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

1. Define the Laplace transforms;
2. Evaluate Laplace transforms of functions, if they exist, by definition;
3. Find the inverse Laplace transforms using the properties and techniques;
4. Apply the method of Laplace transforms to evaluate some definite integrals, to solve ordinary and partial differential equations.
5. Express a given function as a Fourier, Fourier sine/cosine integrals and hence evaluate some definite integrations.
6. Find the Fourier, Fourier sine/cosine transforms and corresponding inverse transforms.
7. Express a given function as a Fourier series, half-range Fourier sine/cosine series and use them to evaluate some convergent series.
8. Apply the appropriate methods of Fourier transforms to solve boundary value problems.

Course content:

- Laplace Transforms: Laplace transforms of elementary functions, Basic properties.
- Inverse Laplace Transforms, Convolution Theorem, Use of special functions, Partial fraction method, Heaviside's expansion method.
- Applications: Evaluation of certain integrals, Applications in ordinary differential equations, Mechanics and in partial differential equations.
- Fourier integral representation, The (Complex) Fourier transforms, Infinite Fourier sine/cosine transforms and their inverse formulae.
- Fourier series, Finite Fourier sine/cosine transforms, Inverse formulae using Fourier series.

Solution of boundary value problems using Fourier transforms.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 7.5%
Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -7.5%
Assessment-1 (ILO-5, ILO-6) -Closed book exam- 7.5%
Assessemnt-2 (ILO-7, ILO-8) -Closed book exam -7.5%

- End Semester Examination(ILO 1 - 8) –70%

Closed book exam - 2 Hours

References:

1. Murray R. Spiegel, *Schaum's outlines – Laplace Transforms*, McGraw–Hill, 2005;
2. Larry C. Andrews and Bhimsen K. Shivamoggi, *Integral Transforms for Engineers*, Prentice–Hall, 1999;
3. Raisinghania M. D., *Laplace and Fourier Transforms*, S. Chand & Company Ltd, 1995.
4. Murray R. Spiegel, *Schaum's outlines – Fourier Analysis with Application to Boundary Value Problems*, McGraw–Hill, 2005;

Course Title	Partial Differential Equations			Course Code	MTM 31012		
				Prerequisites	MTM 21011		
Year	3	Semester	1	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aims:

To provide basic knowledge in the theory of partial differential equations and use it to solve boundary value problems those arise in the field of mathematical physics.

Intended Learning Outcomes:

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

1. Define basic terms related to partial differential equations (PDE).
2. Classifya PDEs as per linear, semi-linear, quasi-linear and non-linear.
3. Form a PDE by eliminating arbitrary constants or arbitrary functions.
4. Solve a first order linear PDEs by Lagrange's method.
5. Solve first order non-linear PDEs by Charpit's method.
6. Solve second order linear PDEs with constant coefficients.
7. Apply the method of separation of variables to solve Heat, Wave and Laplace equations.

Course content:

- Introduction: Basic definitions, Classification of equations, Classification of solutions, Formation of partial differential equations.
- First order partial differential equations: Linear Equations, Characteristics, Lagrange's equations, Non-linear equations: Charpit's method, Characteristic strips.
- Second order equations: Semi-linear equations: Classification, Canonical forms, Linear Equations with constant coefficients: Homogeneous and non-homogeneous equations; Method of separation of variables: Heat equation, Wave equation and Laplace equation. Boundary value problems, use of Fourier series.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-2, ILO-3) -Closed book exam- 10%
Assessemnt-2 (ILO-4, ILO-5) -Closed book exam -10%
Assessment-3 (ILO-6, ILO-7) - Open book exam – 10%

- End Semester Examination(ILO 1 - 7) –70%

Closed book exam - 2 Hours

References:

1. Raisinghaniya M. D., *Ordinary and Partial Differential Equations*, S. Chand and company Ltd. New Delhi.,2008;
2. Amarnath T, *An Elementary course in Partial Differential equations*, Narosa Publishing House, New Delhi., 2005;
3. K. Sankara Rao, Introduction to Partial Differential Equations, Prentice Hall of India Private Limited, New Delhi, 1997.

Course Title	Linear Algebra			Course Code	MTM 31022		
				Prerequisites	MTM 21032		
Year	3	Semester	1	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aims:

To improve the basic ideas and techniques of linear algebra and help the students to develop the ability of solving problems; to develop the ability to abstract and critical reasoning by studying logical proofs.

Intended Learning Outcomes:

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

1. Find the raw space, column space and null space of a matrix
2. Explainthe concept of dimension of sub space and the rank and nullity of a matrix and to explain the relationship of these concept to associated systems of linear equations.
3. Find the change of basis matrix with respect to two of a vector space.
4. Explain the notion of a linear transformation and its matrix.
5. Find the eigenvalue and eigenvectors of a square matrix using the characteristic polynomial.
6. Diagonalize a matrix when it is possible.
7. Recognize and invert orthogonal matrices.
8. Find the orthogonal diagonalization of symmetric matrices.

Course content:

- Finite dimensional space; Dimension theorem for vector spaces; Linear transformations; Range of linear mapping; Kernal of linear mapping; Singular and non-singular mappings; Dimension theorem for linear mapping.
- Diagonalizable linear operators; Singular and non- singular linear operators; Eigenvalues and Eigenvectors of linear operator; Eigenvalues and Eigenvectors of matrix; Minimum polynomial of matrix; Cayley-Hamilton theorem.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2, ILO-3) -Closed book exam- 10%
Assessemnt-2 (ILO-4, ILO-5) -Closed book exam -10%
Assessment-3 (ILO-6, ILO-7, ILO-8) - Open book exam – 10%

- End Semester Examination(ILO 1 - 8) –70%

Closed book exam - 2 Hours

References:

1. David. C. Lay, *Linear Algebra and Its Applications*, Pearson Education, 2010;
2. Fraleigh Beauregard, *Linear Algebra,* Addison Wesley Publishing Company, 1995.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Riemann Integrals and Infinite Series</td><td>Course Code</td><td colspan="3">MTM 31031</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 12052</td></tr>
<tr><td rowspan="3">Year</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>15</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aim :

To provide basic aspects of the Riemann integrations and infinite series.

Intended Learning Outcomes:

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

1. Demonstrate knowledge of the basic concepts of Riemann integration.
2. Appraise integrals of real valued function on intervals
3. Employ the techniques of testing the behavior of infinite series with regard to convergence

Course content:

- The Riemann integral, Integrability of certain classes of functions, Fundamental theorem of calculus, Improper integrals;
- Infinite Series: Positive term series, Comparison test, Cauchy's root test, D'Alembert's ratio test.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 15%
Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -15%

- End Semester Examination(ILO 1 - 3) –70%
- Closed book exam - 1 Hour

References:

1. S. C. Malik and Savita Arora, *Mathematical Analysis*, New Age International Limited, 2012;
2. Pawan K. Jain and Shiv K. Kaushik, *An Introduction to Real Analysis*, S. Chand & Company Ltd, 2000.

Course Title	Function of Several Variables			**Course Code**	MTM 32041		
				Prerequisites	MTM 12052		
Year	3	**Semester**	2	**Credits**	1	**Theory (hr)**	15
						Practical (hr)	
						Independent Learning (hr)	

Aim:

To give a coherent treatment of basic theories and problems solving techniques from multivariate calculus.

Intended Learning Outcomes:

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

1. Describe the ideas and concepts for functions of a single variable to functions of several variables
2. Explain the concepts of limits, continuity, partial derivatives and extrema for functions of several variables
3. Compute double integrals

Course content:

- Limits and continuity of functions from R^2 to R^2.
- Partial derivatives, Differential, Sufficient condition for differentiability.
- Tangent plane, Maxima and minima (including Lagrange multipliers).
- Double integrals.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 15%
Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -15%

- End Semester Examination(ILO 1 - 3) –70%

Closed book exam - 1 Hour

References:

1. S. C. Malik and Savita Arora, *Mathematical Analysis*, New Age International Limited, 2012;
2. C.H. Edwards, Jr., Advanced Calculus of Several Variables, Dover Publications 1994;
3. H.M. Edwards, Advanced Calculus: a Differential Forms Approach, Birkhauser 1994;
4. Wendell Fleming, Functions of Several Variables (Second Ed.), Springer, 1991.

Course Title	Complex Analysis			Course Code	MTM 32052		
				Prerequisites	MTM 12052		
Year	3	Semester	2	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aims:

To extend the idea developed in real analysis to complex analysis; to understand the basic theory of complex analysis and apply the methods to solve problems in physics and engineering.

Intended Learning Outcomes:

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

1. Explain the idea of convergence and continuity in the complex plane;
2. Describe path and contour integral, cauchy's theorem and integral formula;
3. Develop power series and Laurent series expansions of complex-valued functions;
4. Explain the meaning of Residue, and to evaluate integrals using residue theorem;
5. Evaluate some standard integrals using contour integration.

Course content:

- The complex field; Riemann sphere; Topology of the complex plane.
- Analytic functions; Cauchy-Riemann equations.
- Cauchy theorem; Cauchy's integral formulae.
- Taylor series; Laurent's series.
- Residue theorem; Evaluation of real-valued integrals by means of residues.
- Conformal mappings.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -10%
Assessment-3 (ILO-4, ILO-5) - Open book exam – 10%

- End Semester Examination(ILO 1 - 5) –70%
  Closed book exam - 2 Hours

References:

1. Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, and Dennis Spellman, Schaum's Outlines: *Complex Variables*, McGraw-Hill, 2nd ed., 2009;
2. James W. Brown and R.V. Churchill, *Complex Variables and Applications*, McGraw-Hill, 8th ed., 2009;
3. Dennis G Zill and Patrick D Shanahan, A *First Course in Complex Analysis with Application*, Jones and Bartlett Publishers, 2006.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Ring Theory</td><td>Course Code</td><td colspan="3">MTM 32061</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 12041, MTM 22041</td></tr>
<tr><td rowspan="3">Year</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>15</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aim:

To develop basic aspects of the theory of rings.

Intended Learning Outcomes:

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

1. Explore the basic concepts of rings which are fundamental for further studies in the theory of rings;
2. Write precise and accurate mathematical definitions of objects in ring theory;
3. Investigate the structure and detect properties of explicit rings.

Course content:

- Rings, Examples of rings, Integral domains; Ideals; Quotient rings; Quotient fields; Euclidean rings; Gaussian integers; Polynomial rings; Factorization of polynomials; Irreducible polynomials; Einstein's irreducibility criterion.

Assessment Strategy:

- Continuous Assessment – 30%

Assessment-1 (ILO-1, ILO-2) -Closed book exam- 15%
Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -15%

- End Semester Examination(ILO 1 - 3) –70%

Closed book exam - 1 Hour

References:

1. S. Lipchitz & M. L. Lipson, *Theory and Problems of Discrete Mathematics*, Tata McGraw-Hill Publishing Company Limited, 1999;
2. R. S. Aggarwal, *A Text Book on Modern Algebra*, S. Chand & Company Ltd, 1996.

DETAILED SYLLABI OF APPLIED STATISTICS

Level 1, Semester I

<table>
<tr><td rowspan="2">Course Title (1)</td><td colspan="3" rowspan="2">Introduction to Statistics and Probability</td><td>Course Code</td><td colspan="3">ASM 11012</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hr)</td><td>23</td></tr>
<tr><td>Practical (hr)</td><td>21</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in Statistics for the use of explantory data analysis and Probability for the use of explantory data analysis so that they will be able to apply those techniques successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Compute descriptive statistics and interpret
- Diagrammatic representation of data and interpret
- Identify most appropraite method for summarising a data set to highlight important features of data
- Carry out explanrory data analysis of a given set of data and interpret
- Use Minitab Software for explantory data analysis and interpret the output
- Motivate students for an intrinsic interest in statistiacl thinking
- Apply basic theory of probability to a practicle problem
- Use Minitab Software for explantory data analysis and interpret the output
- Motivate students for an intrinsic interest in statistiacl thinking

Course Capsule:

Statistics: Introduction of Statistics, Collection of Data (primary and secondary), Concept of Descrptive & Inferential Statistics, Data Classification (quantitative & qualitative), Exploring Univariate Data: Measure of Central Tendency (AM, GM, HM, TM, median, and mode), Measures of Dispersion (range, variance, sd, qquartiles, deciles and percentiles) for ungrouped and grouped data, Measure of Relative Dispersion (CV), Measure of Shapes (skewness and kurtosis), Visual Representation of Data (Stem &Leaf display, Box and Whisher plots)

Probability: Introduction of Probability, Elements of Probability (experiments, events, sample space, and type of events), Basic Axioms of Probability, Types of Probability (marginal, conditionl & joint using 2-way frequency tables), Mutiplication Theorm, Bayes' theorem.

Software: Introduction of Statistical software for explantory data analysis

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid Term) – 40%
- End Semester Examination – 60%

References:

1. Jim Pitman., **Probability**, Springer, ISBN: 3-540-97974-3
2. Murray R.S & Larry J.S., **Statistics** (Third Edition), McGraw-Hill, Singapore (SPI 519.5) ISBN 0-07-043510-3
3. Moore David S., **The Basic Practice of Statistics**., W.H Freeman & Company, USA. (519.5) ISBN 0-534-35778-4

4. Jim Pitman., **Probability**, Springer, ISBN: 3-540-97974-3
5. Murray R.S & Larry J.S., **Statistics** (Third Edition), McGraw-Hill, Singapore (SPI 519.5) ISBN 0-07-043510-3
6. Moore David S., **The Basic Practice of Statistics**., W.H Freeman & Company, USA. (519.5) ISBN 0-534-35778-4

<table>
<tr><td rowspan="2">Course Title (2)</td><td colspan="3" rowspan="2">Index Number</td><td>Course Code</td><td colspan="3">ASM 11021</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>10</td></tr>
<tr><td>Practical (hr)</td><td>15</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the use of index numbers so that they will be able to apply them successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Describe the property of index numbers
- Explain the methods of estimating index numbers
- Interpret the results
- Describe the importance of index numbers

Course Capsule:

Index numbers: Introduction, Price Relatives, Quantity Relatives and Value Relatives. Link and Chain Relatives, Cost of living Index Numbers, Methods of construction of Index Numbers, Quantity Index Numbers, Tests for Index numbers.

Mode of Assessment:

- Continuous Assessment (quizzes,assignments, mid-term,) – 40%
- End Semester Examination – 60%

References:

1. A *Basic Course in Statistics*, G.M.Clarke and D. Cooke.
2. Statistical methods, J.Medhi.
3. A Basic Course in Statistics, G.M.Clarke, and D.Cooke
4. Business *Statistics J.S. Chandan, Jagjit Singh and K.K. Khanna.*

Level I, Semester II

<table>
<tr><td rowspan="2">Course Title (3)</td><td colspan="3" rowspan="2">Probabilty Distribution</td><td>Course Code</td><td colspan="3">ASM 12032</td></tr>
<tr><td>Prerequest</td><td colspan="3">ASM 11021</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hr)</td><td>23</td></tr>
<tr><td>Practical (hr)</td><td>21</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in properties of discrete and continous random variables so that they will be able to apply those successfully in the field of Applied Sciences.

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

- Identify the difference between discrete and continours random varaibles.
- Compute df and cdf for both discrete and continuous random variables
- Compute the expected value, variance, and higher-order moments of both types of random variables
- Explain the momevment of a random variables using probbilities
- Explain the association between two random variables
- Describe the shapes of those commonly used probability distributions.
- Recall key properties of normal distribution and other distributions
- Apply those distributions for practicle problems
- Identify the correct probability distribution for a real practicle problem
- Compute probabilities of a given event under those distributions
- Approximate Binomial probabilities using Normal distribution incorporting a continuity orrection.

Course Capsule:

Random Variables (discrete and continuous), Properties of RVs (probability density function, cumulative distribution, expected values, variance); Moments and Moment Generating function of RVs and their use, Order Statistics, Standarizing Variables, Introdution to Bi-Variate Random Variables and their Properties (PDF, Covariance and Correlations).
Discrete Probability Distributions (Bernoulli, Binomial, Poisson and Uniform) and their applications, Continuous Probability Distributions (Uniform and Normal) and their applications, Central Limit Theorm, Approximation to Binomial using Poisson, Binomial using Normal, and Poisson using normal. Intrdiction to Studnet's t, F and Chi-square Distribution .

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid-term) – 40%
- End Semester Examination – 60%

References:

1. Jim Pitman., **Probability**, Springer, ISBN: 3-540-97974-3
2. John J, Schiller S& Srinivasan R.A.,**Schaum's Outline of Probability and Statistics**, 4th Edition, ISBN 978-0-07-179557-9
3. Robert D Mason, Douglas A Lind and William G Marchal, **Statistical Techniques in Business & Economics**, ISBN 0-07-118383-3
4. Jim Pitman., **Probability**, Springer, ISBN: 3-540-97974-3
5. John J, Schiller S&Srinivasan R A., **Schaum's Outline of Probability and Statistics**, 4th Edition, ISBN 978-0-07-179557-9
6. Lipschutz.S, (2000), **Probability**., McGraw-Hill, ISBN 0-07-135203-1.

<table>
<tr><td rowspan="2">Course Title (4)</td><td colspan="3" rowspan="2">Basic Data Analysis for Research</td><td>Course Code</td><td colspan="3">ASM 12041</td></tr>
<tr><td>Prerequest</td><td colspan="3">ASM 11011, ASM 11021, ASM 12032</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students basic statistical methodologies to analyse given set of data and derive statistical inferences so that they will be able to apply them successfully in the field of Applied Sciences.

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

- Compute descriptive statistics and interpret
- Explain the association between two continous variables
- Explain the association between two factors having different levels
- Derive a simple linear model to find the association between two qunatitative variables
- Validate the model and interpret the results
- Analysis data from a CRD and interpret results
- Use Minitab Software for data analysis

Course Capsule:

Correlation Analysis, Simple Linear Regression analysis and its inferences, Analysis of 2-way Contingency Tables, Introduction of Complete randomized Design (CRD) and Analysis of CRD using Analysis of Variance (ANOVA).

Mode of Assessment:

- Continuous Assessment (quizzes, assignments and practicles) – 40%
- End Semester Examination – 60%

References:

1. Murray R.S & Larry J.S., **Statistics** (Third Edition), McGraw-Hill, Singapore (SPI 519.5) ISBN 0-07-043510-3
2. Moore David S. (1994)., **The Basic Practice of Statistics**., W.H Freeman & Company, USA. (519.5) ISBN 0-534-35778-4
3. Cochran WG & Cox GM (1957)., **Experimental Designs**, John Wiley & Sons, Canada (COC 519.5) ISBN 9971-51-311-0

Level 2, Semester I

<table>
<tr><td rowspan="2">Course Title
(2)</td><td colspan="3" rowspan="2">Theory of Statistics</td><td>Course Code</td><td colspan="3">ASM 21012</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">I</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>-</td></tr>
</table>

Aim of the Course:

To provide students with the knowledge to carry out inferential statistics point estimation and interval estimation and obtain inferences from those so that they will be able to apply those techniques successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Decide sample size for some surveys
- Identify and describe the desiarble properties of point estimator
- Compute confidence intervals for different parameters and interpret
- Test hypothesis for different parameters and interpret
- Use hypothesis test for different parameters and simple sizes
- Conduct hypothesis tests for variety of applications

Course Capsule:

Point Estimation: Properties of point estimators, Unbiasedness, Consistency, Efficiency, Relative efficiency, Sufficiency, Factorization theorem, Rao-Blackwell theorem, Uniformly Minimum Variance Unbiased Estimators (UMVUE), Cramer Rao inequality, Method of Moments, Maximum likelihood estimator.

Interval Estimation: Constructing confidence interval for difference between two population parameters: means, proportions and ratio between two variances under different assumptions.

Sample Size Estimation: Determination of sample size for the (i) mean and (ii) proportions

Hypothesis Testing: Test of population parameters in two populations under various assumptions; Tests on independent and paired samples, Neyman Pearson Lemma. Uniformly Most Powerful tests, Likelihood Ratio tests.

Use of **Statistical Software**: Illustration of all applications using SPSS and MINITAB

Mode of Assessment:

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

References:

1. Canavos G.C. Applied Probability and Statistical **M**ethods, Little, Brown & Company.
2. Freund J.E. Mathematical Statistics, Prentice Hall
3. Hogg R.V. & Craig A.T., Introduction to Mathematical Statistics, Prentice Hall
4. Canavos G.C. Applied Probability and Statistical **M**ethods, Little, Brown & Company.
5. Freund J.E. Mathematical Statistics, Prentice Hall
6. Hogg R.V. & Craig A.T., Introduction to Mathematical Statistics, Prentice Hall

<table>
<tr><td rowspan="2">Course Title (5)</td><td colspan="3" rowspan="2">Introduction to Categorical Data Analysis</td><td>Course Code</td><td colspan="3">ASM 21021</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with basic understanding of analysing association between two categorical variables so that they will be able to apply those models successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Find the association between two categorical variables
- Interpret the results of 2-way tables
- Derive inferences from 2-way tables
- Analyse survey data using 2-way tables

Course Capsule:

Introduction to 2x2 contingency tables, Concept of odd ratios and its interpretations, testing independence in a 2x2 table and testing independecne of I x J tables using Goodness of fit tests, Interpretaion of results using percentages, maximum likelihood theory for 2-D tables, Introdution of multiway tables and interpretaion of such results, Introduction the concept of log linear models for higher order contingenmcy tables

Mode of Assessment:

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

References:

1. Agresti, Alan (2007), **An Introduction to Categorical Data Analysis**, ISBN
2. Fienberg. Stephen (1978), **The Analysis of Cross-Classified Categorical Data**, The Massachusetts Institute of Technology, London.
3. Mckay, D., Schofield,N. and Whiteley, P. (1983), **Data Analysis and the Social Sciences**, Frances Printer, London

<table>
<tr><td rowspan="2">Course Title (1)</td><td colspan="3" rowspan="2">SPSS laboratory</td><td>Course Code</td><td colspan="3">ASM 21031</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic knowledge of data managments in SPSS for data analysis so that they will be able to analyze data using SPSS softwae and interpret results successfully in the field of Applied sciences.

Intended Learning Outcomes:

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

- Carry out data managment using SPSS
- Use, understand and write programme in SPSS to solve statistical problems.
- Present the results obtain to convince the clients
- Write reports on the above statistical analyses

Course Capsule:

SPSS: Data Managment in SPSS, The Data View Spreadsheet, Variable View Spreadsheet, Generating Variables, Data Entry, Storing and Retrieving Data View, Running Statistical Procedures, Constructing Graphical Displays, The Output View, The Chart Editor, Progamming in SPSS, Descriptive Analysis. Inferential Analysis, Statistical analysis for quality control.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Presentations) – 50%
- End Semester Examination – 50%

References:

1. SPSS Manual

Course Title (4)	Applied Regression Analysis			**Course Code**	ASM 22042		
				Prerequest	-		
Year	2	**Semester**	II	**Credits**	02	Theory (hr)	30
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

To provide students with the basic concepts and theory of simple linear regression models so that they will be able to apply those models successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Find a relationship between two variables and interpret
- Develop simple linear regression models
- Validate the model developed and use the model for prediction
- Calculate and interpret confidence intervals for the parameters of the regression models.
- Recognize some potential problems if regression analysis is used incorrectly.
- Develop multiple linear regression models
- Validate the model developed and use the model for prediction of multiple regression
- Calculate and interpret confidence intervals for the parameters of the multiple regression models.
- Recognize some potential problems if multiple regression analysis is used incorrectly.

Course Capsule:

Concept of modelling, Significance of correlation, Theory of Simple Linear Regression (introdution, properties of estimators, hypothesis tests, ANOVA, prediction, model diagnostics, influential points), Matrix approach to simple regression.
Theory of multiple Linear Regression (introdution, properties of estimators, hypothesis tests, ANOVA, prediction, model diagnostics, influential points), Matrix approach to Multiple Linear Regression, Matrix approach to multiple regression.
Illustartion of above techniques using statistical software

Mode of Assessment:

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

References:

1. Draper R and Smith H,. **Applied Regression Analysis**, ISBN: 978-0-471-17082-2
2. Golberg M A & Cho H A, **Introdution to Regression Analysis**, ISBN 1462-2068

<table>
<tr><td rowspan="2">Course Title (3)</td><td colspan="3" rowspan="2">Statistical Quality Control</td><td>Course Code</td><td colspan="3">ASM 22052</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>-</td></tr>
</table>

Aim of the Course:

To provide students with basic statistical quality control techniques successfully for producing affordable products that meet customer and consumer expectations in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Explain the concepts of quality, quality improvement, and aspects of quality control
- **Become familiar with statistical quality control methods**
- Monitor and improve the quality of products resulting from industrial processes after statistical analysis
- Detect whether the process has changed in a way that will affect product quality
- Use Statistical software to analysis SQC data

Course Capsule:

- Introduction to Quality Control and Six Sigma Concept,
- Expletory Data Analysis
- Statistical Process control
- Control charts for variables
- Control charts for attributes
- Advanced control charting schemes
- Process capability analysis
- Operating characteristics curves
- Sampling plans (AOQL and LTPD plans).
- Use of statistical software (Minitab, and SPSS) for the analysis of quality control statistics**.**
- Miscellaneous topics

Mode of Assessment:

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

References:

1. Douglas C Montgomery, **Introduction to Statistical Quality Control** (**6th Edition),** ISBN 0470169923

2. John T Burr. **Elemenatry Statistical Quality Control**, ISBN-10: 0824790529

<table>
<tr><td rowspan="2">Course Title (1)</td><td colspan="3" rowspan="2">MINITAB laboratory</td><td>Course Code</td><td colspan="3">ASM 21061</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic knowledge of data managments in MINITAB for data analysis so that they will be able to analyze data using MINITAB softwae and interpret results successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Carry out data managment using MINITAB
- Use, understand and write programme in MINITAB to solve statistical problems.
- Present the results obtain to convince the clients
- Write reports on the above statistical analyses
- Carry out data managment using Minitab
- Develop simple and multiple linear regression using Minitab and interpret resulst
- Analyse 2-way and muti-way contingency tables using Minitab and interpret
- Present the results obtain to convince the clients
- Write reports on the above statistical analyses

Course Capsule:

MINITAB: Introduction, Data window, Managing data, Copying and pasting data, Generating pattered data, Opening, Saving and printing files, Working with database and special text files, Manipulating and calculating data, Manipulating cells, Rows and columns, Changing column data types and formats, Subsetting and splitting data, Stacking columns or rows, Recording data, Data analysis and quality tools, Descriptive statistics.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Presentations) – 50%
- End Semester Examination – 50%

References:

2. MINITAB Manual

Level 3, Semester I

<table>
<tr><td rowspan="2">Course Title (2)</td><td colspan="3" rowspan="2">Sampling Techniques</td><td>Course Code</td><td colspan="3">ASM 31012</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</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 (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students statistical concepts and techniques in sampling unit, sampling plan, sample size, execution, and estimation so that students will be able to apply those techniques successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Recognize the various aspects required in design a survey
- Design suitable sampling technique for a particular survey
- Compute the sample size for a given survey
- Analyze a survey data using statistical softwares
- Interpret the results and derive inferences from surveys
- Prepare questionnaire for the surveys

Course Capsule:

Principal steps in a Sampling survey, Probability sampling, Simple random sampling, Sampling distribution for sample means & proportions. Estimating population mean, variance, standard deviation, proportion, total, ratio and sample size. Systematic sampling. Questionaire Design,
Stratified random sampling: Proportional & optimum allocation. Comparison of simple random sampling mean & stratified random sampling mean, Ratio estimates, Introduction to cluster sampling.
Use of statistical softwares **for sampling techniques**.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid term exam) – 30%
- End Semester Examination – 70%

References:

1. Cocharn, W C (1977)**. Sampling Techniques,** ISBN-10: 047116240X

Sukhatme, P V, Sukhatme S V and Ashok C. **Sampling Theory of Surveys with Applications, 3rd Edition**

<table>
<tr><td rowspan="2">Course Title (4)</td><td colspan="3" rowspan="2">Experimental Designs</td><td>Course Code</td><td colspan="3">ASM 31022</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</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 (hr)</td><td>30</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with knowledge in designing experiments under specific environment and analyze such data so that students will be able to apply those techniques successfully in the field of Applied Sciences

Intended Learning Outcomes:

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

- Recognize suitability of different types of designs
- Recomend a suiatble design based on the situation
- Apply statistical methods in analyzing data from such experimental designs,
- Drive statistical inferences from the results of such experimental designs
- Present the results of the findings in scientific manner and make conclusions based on the results

Course Capsule:

Basic Statistical Concepts in Experimental Designs, Experiments with single factor (CRD), Pairwise Comparison Method (LSD method, Duncan's multiple range method, Tuckey's method, Bon-ferroni method, Scheffe's method), RCBD, Latin Square Design, Concept of Covariate and ANCOVA,

Illustration of statistical software for experimental design.

Mode of Assessment:

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

References:

1. Douglas G Montogomery (2009) **Design and Analysis of Experiments**. ISBN-10: 0470398825
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, ISBN 9971-51-311-0

<table>
<tr><td rowspan="2">Course Title (1)</td><td colspan="3" rowspan="2">SAS Laboratory</td><td>Course Code</td><td colspan="3">ASM 31031</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credit</td><td rowspan="3">1</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

Understand how to use the EViews and SAS programming language to analyze and interpret data more effectively. Learn how to identify statistical techniques and apply data analysis in real-life.

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

Carry out data managment using SAS Develop simple and multiple linear regression using SAS and interpret resulst Analyse qualitative and quantitative data using SAS and interpret Present the results obtain to convince the clients Write reports on the above statistical analyses

Course Capsule:

SAS: Introduction to SAS, Reading raw data and creating SAS data sets via data lines, in-file, input and set statements, Creating new variables, Programming techniques: conditional execution, looping, arrays, macro programming, Combining data files: Appending and Merging data files, Formatting for presenting results and as a data analysis tool, Enhancing Output using ODS, Character data calculations, Writing Output, Statistical Modeling and Statistical Graphics in SAS, Using SAS procedures for statistical data analysis.

Mode of Assessment:

Continuous Assessment (Quizzes, Assignments, Mid Term) –50% End Semester Examination – 50%

References:

1. SAS Manuals (SAS Base and SAS STAT)

Semester II

Course Title (3)	Non-Parametric **Methods in** Data Analysis			**Course Code**	ASM 32041		
				Prerequest	-		
Year	3	**Semester**	II	**Credits**	1	**Theory (hr)**	15
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

To provide students with the basic ideas, applicability, and analysis of data using non parametric methods so that they will be able to apply those techniques successfully in the field of Applied Sciences.

Intended Learning Outcomes:

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

- Choose and apply the appropriate non parametric statistical test based on the situation
- Analysis such data
- Interpret results
- Use statistical software for data analysis

Course Capsule:

Introduction to non parametric, The one-sample sign test , The one-sample Wilcoxson test , The Mann-Whitney test, The Kruskal-Wallis test , Rank correlation (Spearman's ρ and Kendall's τ, Cochran's test for related observations, Mood's median test , The Friedman test ,The runs test , Squared ranks test for variances

Illustration of statistical software for nonparametric data analysis.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid term exam) – 30%
- End Semester Examination – 70%

References:

1. Gibbons J.D. & Chakrabortic, **Nonparametric Statistical Inference**. ISBN 978-3-642-04897-5
2. Conover, W. J. 1999. **Practical Nonparametric Statistics**, 3rd edition. New York, New York: John Wiley & Sons,
3. Sprent, P., and N. C. Smeeton. 2001. **Applied Nonparametric Statistical Methods**, 3rd edition. Boca Raton, Florida: Chapman & Hall/CRC, ISBN 978-1-4398-9401-9

<table>
<tr><td rowspan="2">Course Title (5)</td><td colspan="3" rowspan="2">Time Series Analysis</td><td>Course Code</td><td colspan="3">ASM 32052</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credit</td><td rowspan="3">2</td><td>Theory (hr)</td><td>20</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic knowledge of time series data analysis so that they will be able to apply those techniques successfully in the field of Applied Sciences.

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

To familiarize the students with ideas, techniques and uses of time series analysis Use a trend equation to forecast future time periods and to develop seasonally adjusted forecasts Identify the correct method of smoothing techniques for time series forecasting Validate forecasting models Determine and interpret a set of seasonal indexes To familiarize the students with time series analysis using statistical software. Know the properties of time series using ACF Develop ARMA model for time series data Understand the concept of ARIMA models Recommend with care for decision making To familiarize the students with time series analysis using statistical software.

Course Capsule:

Introduction to Time Series, Objectives of time series analysis, Componenets of a time series, Traditional method of time series analysis: Estimation of trend, seasonal variation, Smoothing techniques, forecasting. Stationary time series, Properties of stationary time series and conditions for series to be stationary, transformations, Autocorrelation function (ACF), Introdution of AR, MA and ARMA models and their properties, Use of PACF of such models, Introduction to ARIMA models. Use of statistical software for time series analysis.

Mode of Assessment:

Continuous Assessment (Quizzes, Assignments, Mid term exam) – 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. Box and Jenkins, (1976). 'Time Series Analysis', John Willy
3. Stephen A. DeLurgio, (1998), 'Forecasting Principles and Applications', McGraw Hill.
4. C. Chatfield, 2nd Edition, (1980), 'Analysis of Time Series', Chapman-Hall.

<table>
<tr><td rowspan="2">Course Title (1)</td><td colspan="3" rowspan="2">EViews Laboratory</td><td>Course Code</td><td colspan="3">ASM 32061</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">3</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credit</td><td rowspan="3">1</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

Understand how to use the EViews and SAS programming language to analyze and interpret data more effectively. Learn how to identify statistical techniques and apply data analysis in real-life.

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

Known various data mnagment methods in EViews with confidence Use Eviews using our software Fit a regerssion model and Use Eviews with confidence Fit a time series model and Use Eviews with confidence Write reports on the above statistical analyses

Course Capsule:

EViews: Introduction to EViews, Creating a Workfile and Importing data, Verifying the Data, Examining the Data, Generating new variables, Graphical presentation using EViews, Time series analysis using Eviews, Regression Analysis using EViews, Hypothesis Testing: One sample, two independent samples and dependent samples, ANOVA using EViews, Write report based on output.

Mode of Assessment:

Continuous Assessment (Quizzes, Assignments, Mid Term) –50% End Semester Examination – 50%

References:

1. EViews Manuals
2. SAS Manuals (SAS Base and SAS STAT)

DETAIL SYLLABUS OF CHEMISTRY

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">General and Inorganic Chemistry</td><td>Course Code</td><td colspan="3">CHM 11012</td></tr>
<tr><td>Prerequest</td><td colspan="3">None</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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 give the basic knowledge of a branch of Chemistry that connects to the knowledge known previously (in G.C.E. A/L) and that has relevance to what they would study in subsequently
- To give an overview of the basic trends in Inorganic Chemistry.
- To provide an understanding of physical quantities their measurements, SI units and unit conversions.

Intended Learning Outcomes:

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

- Use scientific methods for measuring physical quantities, perform unit conversions and use SI units appropriately.
- Appreciate the scientific discoveries that made possible the present knowledge.
- Acquire numeracy skills and perform simple calculations based on the theory learnt.
- Make deductions based on the results of such calculations.
- Solve integrated problems
- Identify types of chemical bonds.
- Know theories of chemical bonding and the forces that influence molecular shapes.
- Understand theories of chemical bonding and determine the molecular geometry of molecules using VSEPR theory.
- Determine the electron configurations of atoms, and

- Use periodic trends to make predictions about atomic properties.

Course Capsule / Details:

Basics

Units (SI), dimensions of simple physical quantities; stoichiometric calculations.

Atomic Structure

Electro-magnetic spectrum, cathode rays, mass spectrometry, waves and particle nature of matter, Heisenberg uncertainty principle, de Broglie equation, atomic spectra, quantization, electron configuration, Aufbau principle, Hund's rule, Pauli exclusion principle.

Chemical Bonding

Valence, shapes of atomic bonding: ionic bond, covalent bond and metallic bond; theory of bonding: VSEPR, valence bond (VB) (molecular geometry), molecular orbital (MO) theories; MO energy level diagram: homo nuclear diatomic molecules (H_2, N_2 and O_2); electron deficient compounds, non-valence cohesive forces, electro-negativity, resonance, dipole moments.

Properties of Elements

Periodic classification of elements, vertical, horizontal and diagonal relationships in the periodic table, trends in the physical and chemical properties of the s, p and d block elements.

Mode of Assessment:

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

References:

1. Inorganic Chemistry-D.F. Shriver, P.W. Atkins, C.H. Langford
2. Principles of General Chemistry- B. Averill and P. Eldredge
3. Inorganic Chemistry- C. E. Housecroft and A. G. Sharpe
4. Concise Inorganic Chemistry- J.D. Lee

CHM 11021 Practical Chemistry – I

The list of practicals scheduled would be given at the chemistry lab on day one. It will be basically a bunch of qualitative and quantitative chemical analyses on inorganic chemistry.

CHM 12032 Essentials of Organic Chemistry*

IUPAC Nomenclature, Valence bond and Molecular orbital concepts, Resonance, Reaction intermediates, Transition states, Reaction rates and equilibria, Polar effects, Acidity and basicity, Types of reagents, Principles of organic qualitative analysis. Conformations of ethane, propane, butane, cycloalkane and substituted cycloalkanes., strain in alkanes and cycloalkanes.Isomers (constitutional isomers, conformers, stereoisomers), Newman projection, anti/gauche, achiral molecules, chiral molecules, stereogeniccentres, enantiomers, diastereoisomers, test for chirality (optical activity), nomenclature of enantiomers, Cahn-Ingold-Prelog convention, optical activity, racemisation (racemates), separation of enantiomers (resolution), chromatography, Fisher projection, molecules with two (or more) stereogenic centres, diastereotopic compounds (diastereomers) meso compounds, Fisher projection of compounds with more than one stereogenic centre, chirality without stereogenic centres: allenes, biphenyls. enantiotopic groups, enantiotopic faces, chemical reactions, substitution reactions, Organic chemistry Practicals (Systematic Analysis of Functional Group Analysis)

Course Title	Chemical Kinetics & Thermodynamics			**Course Code**	CHM 12041		
				Prerequest	None		
Year	1	**Semester**	2	**Credits**	1	**Theory (hr)**	15
						Practical (hr)	00
						Independent Learning (hr)	35

1. To decide whether a chemical reaction will occur independently.
2. To evaluate the rate of a chemical reaction, in the event of a spontaneous reaction.
3. To use first and second laws of Thermodynamics, appropriately and solve problems.
4. To derive essential mathematical relationships in classical Thermodynamics,
5. To apply essential mathematical relationships to chemical and physical problems, including chemical reactions
6. To understand the rate of chemical reactions and factors that affect the rate of reaction
7. To evaluate physical and chemical systems to determine how to control these systems.

Aim(s) of the Course:

Intended Learning Outcomes:

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

- Decide whether a chemical reaction will occur spontaneously or not.
- Estimate the rate at which a spontaneous reaction will occur.
- Express law of conservation of energy.
- Understand the laws of thermodynamics and identify the functions they introduce (enthalpy, entropy, Gibbs free energy, etc).
- To use first and second laws of Thermodynamics, appropriately and solve problems.
- Understand and perform calculations with the thermodynamic functions, enthalpy, entropy, free energy.
- Apply basic thermodynamic principles to study chemical / physical processes, like heat energy and work.
- Derive essential mathematical relationships in classical Thermodynamics.
- Understand the rate of chemical reactions and factors that affect the rate of reaction.
- Use principles of chemical kinetics to determine rates of reaction.
- Understand the influence of concentration, temperature and reaction time on rates of reaction.
- Propose reaction mechanisms for complicated reactions

Course Capsule/Details:

<u>Chemical Kinetics</u>

Rates of reactions, Rate equations, Factors influencing the rate, Order of reactions: Zeroth (0^{th}), First (1^{st}) & Second (2^{nd}) order, Determination of order of reactions, Effect of temperature on reaction rates, Arrhenius Equation, Enzyme kinetics, Effects of catalyst, Reaction mechanism, Molecularity, Steady state treatment.

<u>Thermodynamics</u> (TD)

Extensive and intensive properties, TD functions and the law of TD, TD description of systems. Review of basic TD principles and terminology; Zeroth law; first law; work of free expansion against constant pressure and reversible isothermal expansion, isochoric and isobaric heat capacities, variation of free energy and enthalpy with temperature, adiabatic processes. Second law; entropy changes, free energy functions,

Maxwell relations, open systems, Clapeyron equation, Clausius-Clapeyron equation.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%

The assessment methods may include one or more of the following: examinations, quizzes, and /or homework assignments

- End Semester Examination – 70%

References:

1. Physical Chemistry, D.J. Shaw and H. E. Avery.

2. Physical Chemistry, P.W (1990), Oxford University Press, Oxford

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Electrochemistry</td><td>Course Code</td><td colspan="3">CHM 21011</td></tr>
<tr><td>Prerequest</td><td colspan="3">--</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td>00</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

- To demonstrate an understanding of electrochemistry and the method used to study the response of an electrochemical cell and its applications.

Intended Learning Outcomes:

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

- Understand the basic principles of conductance, conductivity, mobility of ions, etc.
- Classify solutions as strong electrolytes, weak electrolytes and non-electrolytes.
- Apply the Kohlraush law and calculate molar conductivity values.
- Classify the electrodes and apply Nernst equation to calculate the electrode potentials.
- Understand the construction and operation of galvanic and electrolytic electrochemical cells.
- Determine standard and non-standard cell potentials.
- Write half reactions and combine to make full (cell) reactions.
- Explain the applications of conductivity and potential.

Course Capsule/Details:

Electrochemistry

Conductometry: electronic and electrolytic conduction. Conductivity of electrolytes, transport numbers, mobilities of ions, conductometric titrations.

Potentiometry: galvanic cells, relation of e.m.f. to concentration, thermodynamic information from e.m.f. data, potentiometric titrations.

Teaching Strategies:

- Lectures / Power point presentation
- Active Learning / reading
- Discussions

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70 %

References:

1. Physical Chemistry, P.W (1990), Oxford University Press, Oxford

CHM 21021 Organic Spectroscopy*

NMR : Nature of Nucleus, NMR spectrometer, Old continuous wave experiment, New pulse experiment, Fourier transformation, Proton NMR Spectroscopy, Chemical shifts, Magnetic anisotropy, Spin-spin splitting, ^{13}C NMR spectroscopy, Theory and application of infra-red (IR), ultra-violet (UV) and spectral analysis.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Analytical Chemistry</td><td>Course Code</td><td colspan="3">CHM 21032</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 11012 General Chemistry
CHM 11021 Practical Chemistry
CHM 12041 Chemical Kinetics & Chem TD</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td>30</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

1. To provide a rigorous background in analytical chemistry.
2. To develop an appreciation of the difficult task of judging the accuracy and precision of experimental data and to show how these judgments can be sharpened by the application of statistical methods.
3. To introduce the student too wide range of techniques of modern analytical chemistry.
4. To teach the laboratory skills that will give students competence in their ability to obtain high-quality analytical data.
5. To provide hands-on opportunities to develop and apply this knowledge.

Intended Learning Outcomes:

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

1. Develop the knowledge and comprehension of the core concepts of Analytical Chemistry.
2. Perform accurate and precise analysis in the field of analytical chemistry.

3. Keep records of all performed analysis in the manner which is required in modern analytical laboratory.
4. Do statistical analysis and evaluate repeatability of obtained results.
5. Perform quantitative and qualitative analysis of known standards as well as unknown samples.
6. Identify, properly use, and care for equipment and supplies used in analytical laboratory.
7. Identify the requirements for adequate protection of personnel form solvents and materials used in the analysis.
8. Understand safety, transfer and measurement of chemicals, filtration, solution preparation, mass percent determination, titrations, redox reactions, enthalpy of reactions, spectrochemical analysis, and gas stoichiometry applications in an undergraduate laboratory.
9. Carry out independent experimental work in a laboratory setting while investigating a research problem and utilize appropriate instrumentation and techniques to accomplish this.
10. Communicate the results of the work in the form of a clearly written lab report.

Course Capsule/Details:

Analytical Chemistry

An Introduction to Analytical Chemistry;

Basic Tools and Operations, Data Handling and Spreadsheets in Analytical Chemistry

Stoichiometric Calculations, General Concepts of Chemical Equilibrium

Electrolyte Effects: Activity or Concentration,

Acid-Base Equilibria and Titrations, Complex Formation Titration, Gravimetric Analysis and Precipitation

Chemistry Lab

Qualitative Chemical Analyses

Volumetry: Precipitation titrations; Gravimetry, Separation techniques (solvent extraction and ion exchange), spectrophotometric determination of metal ions: Beer- Lambert Law, colorimetriy, UV-Vis spectrophotometry

Analysis of simple salts and mixtures (test for cations and Anions).

Quantitative Chemical Analyses: Titrimetry

Volumetry: Acid-Base titrations, Redox titrations, Precipitation titrations; Gravimetry, Separation techniques (solvent extraction and ion exchange), spectrophotometric determination of metal ions: Beer- Lambert Law, colorimetry,

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Lab reports) – 30%
- End Semester Examination – 70%

References:

1. A text book of Macro and Semi-micro Qualitative Analysis. Vogel, A.I., Logman, London. 1973
2. Analytical Chemistry, Gary D. Christian, 6th edition, John Wiley Publishers, 2003

<table>
<tr><td rowspan="2">Course Title</td><td colspan="4" rowspan="2">Introduction to Quantum Chemistry and Surface Chemistry</td><td>Course Code</td><td colspan="3">CHM 22041</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 11012 General chemistry
CHM 12041 Principles of Chemical Thermodynamics</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td>0</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

1. To introduce the concept of quantum mechanics ; describe the mathematical model of atoms and calculate the energy levels
2. To provide basic knowledge of surface chemistry from a physical-chemical perspective.

Intended Learning Outcomes:

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

- Give reasons for the failure of classical physics
- Write the Schrodinger equation and understand its terms
- Interpret (and normalize) a wave-function, calculate a probability using a wave-function, calculate and interpret an expectation value, utilize and interpret the Heisenberg Uncertainty Principle.
- Apply the essential mathematical relationships to understand quantum mechanical models such as Particle in a Box.
- Employ quantum mechanical principals and models to interpret topics in the hydrogen atom, poly-electronic atoms, and bonding.
- Define and explain surface and interfacial phenomena.
- Define the terms and explain the temperature dependence of surface tension, viscosity, vapor pressure, normal boiling point, capillary action; and be able to organize a set of compounds in increasing order for most of these properties
- Explain the sorption process and interpret adsorption from absorption.
- Distinguish between physisorption and chemisorption processes.

- Identify different adsorption isotherms, such as Langmuir, Freundlich and Gibbs adsorption isotherms.
- List out some applications of surface chemistry in industry.

Course Capsule/Details:

Quantum Chemistry

The failures of classical physics, the dynamics of microscopic systems Introduction, The Schrödinger equation, interpretation of the wave function, operators, Eigen values and Eigen functions, quantum mechanical models, particle in a box system, quantized energy levels and degeneracy, probability functions, normalization, postulates in quantum mechanics, expectation values, solution of the Schrodinger equation for H and H-like atoms

Surface Chemistry

Description of various interfaces, surface tension, viscosity, vapor pressure, normal boiling point, capillary action, physisorption, chemisorption, Langmuir (Freundlich) adsorption isotherm, Gibbs adsorption isotherm; some applications of surface chemistry in industry.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70%

References:

1. Introduction to Quantum Mechanisms, 3rd Edn
   P.T. Mathews; Tata McGraw Hill (1974)
2. A textbook of quantum mechanics
   P.T. Mathews ; Tata McGraw Hill (1976)
3. Introduction to colloid and surface chemistry
   Shaw, J. Duncan; Butterworth, London (1980)

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Co-ordination Chemistry</td><td>Course Code</td><td colspan="3">CHM 21051</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 11012 General and Inorganic Chemistry</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td>00</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

1. To understand the key features of coordination compounds.

2. To be able to use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds.

3. To be able to describe the shapes and structures of coordination complexes with coordination numbers ranging from 4 to 12.

4. To be able to describe the stability of metal complexes by the use of formation constants and to calculate thermodynamic parameters from them.

5. To be able to recognize the types of isomers in coordination compounds.

6. To be able to name coordination compounds and to be able to draw the structure based on its name.

7. To become familiar with some applications of coordination compounds.

Intended Learning Outcomes:

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

- Be able to name and classify simple inorganic compounds.
- Describe the bonding and properties of transition metal coordination compounds.
- Describe the structures and stereochemistry of transition metal complexes.
- Describe and explain the bonding in d-metal complexes using crystal field and ligand field theories and the 18 electron rule.
- Describe various metal-ligand interactions in terms of sigma- and pi-bonding interactions.
- Explain the stability of d-metal complexes, their reactivity, and the mechanisms of ligand substitution reactions.

Course Capsule/Details:

Electron configurations of transition metals; oxidation state formalism

Introduction (Werner theory), Coordination numbers, classification of ligands, nomenclature of coordination compounds, stabilities and stability constant, reaction mechanisms, isomerism, reduction potentials in the presence of ligands.

Co-ordination bond theories: VB, CFT and MO. Magneto-chemistry, application of theories in the interpretation of spectra of d^1 and d^9 complexes.

Mode of Assessment:

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

References:

1. An introduction to transition metal chemistry. Orgel, L. E., (1966), Methuen, London

CHM 22062 Organic Synthesis and Reaction Mechanisms*

<table>
<tr><td rowspan="2">Course Title</td><td colspan="4" rowspan="2">Mineralogy and Metallurgy</td><td>Course Code</td><td colspan="3">CHM 22071</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 11012 General Chemistry
CHM 12041 Principles of Chemical Thermodynamics</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>15</td></tr>
<tr><td>Practical (hr)</td><td>--</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

OBJECTIVES

· To k*now the ores and minerals of elements*

· To L*earn the purification methods of ores*

· To u*nderstand the different metallurgical processes*

· To k*now the importance of purification of metals*

· To g*ain knowledge about the mineral wealth of Sri Lanka*

Intended Learning Outcomes:

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

1. Define mineral resources.
2. Define a mineral.
3. Give examples of mineral resources and products that contain them.

4. List the most abundant elements in Earth's crust and describe how these relate to the most abundant minerals in the context of resource availability.

5. Summarize the mineral properties that make them useful.
6. Differentiate between rocks and minerals.
7. Name the three main rock families and describe the processes that form them.
8. Cite examples of mineral resources, the products that contain them, and the mineral properties that cause these resources to be used in these products.
9. Describe how elemental abundance relates to mineral abundance and hence to resource availability.
10. Recognize the mineral wealth of Sri Lanka and the geographical regions where they occur.
11. Describe the basic principles and chemistry of extractive metallurgical processes

Course Capsule/Details:

Mineralogy: Definition of terms, Classifications of minerals, Mineral resources of Sri Lanka, Chemical compositions, Uses and Places of occurrence of minerals.

Metallurgy: Basic principles of extractive metallurgy processes: pyro-metallurgy (Application of thermodynamics in extraction metallurgy: Ellingham diagram), hydrometallurgy and electrometallurgy.

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid Term) – 50%
- End Semester Examination – 50%

References:

1. Inorganic Chemistry (Chap 20), 6th Edn; Raymond Chang.
2. Economic Geology of Sri Lanka (5th Ed) MMJW Herath
3. Introduction to Mineral Sciences, Andrew Putnis

<table>
<tr><td rowspan="2">Course Title</td><td colspan="4" rowspan="2">Introduction to Solid State chemistry and Organometallic Chemistry</td><td>Course Code</td><td colspan="3">CHM 31012</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 11012 General & Inorganic Chemistry
CHM 21041 Coordination Chemistry</td></tr>
<tr><td rowspan="3">Year</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>00</td></tr>
<tr><td>Independent Learning (hr)</td><td>70</td></tr>
</table>

Aim of the Course:

- To understand the basic structure of crystalline solids and their basic components.
- To investigate the properties organometallic compound and their applications

Intended Learning Outcomes:

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

- identify a unit cell in a symmetrical pattern
- know that there are 7 possible unit cell shapes.
- define cubic, tetragonal, orthorhombic and hexagonal unit cell shapes
- recognize the crystal defects
- learn about the common organometallic reactions and to be able to draw reasonable reaction mechanisms.
- learn about the applications of organometallic chemistry, including catalytic reactions for organic synthesis and polymerization.
- identify the basic concept, terms, and important events in the development of organometallic chemistry.
- learn methods, including spectroscopy techniques, used to determine the structure of organometallic complexes and to probe reaction mechanism.
- learn about cutting-edge single-molecule tools to study organometallic reactions.

- develop the skill to critically read primary literature, and to interpret experimental observations.
- develop an appreciation for the scope, diversity, and application of organometallic Chemistry.
- explain and give examples for the (ten) fundamental organometallic reactions
- account for general catalysis principles such as ligand activation.
- account for the mechanism for some commonly used catalytic processes in organometallic chemistry
- give examples to catalytic reactions related to homogeneous fuel production (liquid or gaseous fuels), chemical production from non-fossil fuel resources, and capturing emissions.

Course Capsule/Details:

Introduction to solid-state chemistry:

Crystallography: Crystal structures, unit cell, crystal systems, crystal plane and Miller indices.

Crystal Structure Analysis: Diffraction techniques, XRD, Bragg's equation.

Crystal defects.

Organometallic Chemistry:

Electron configurations of transition metals; Oxidation state formalism.

Metal carbonyls; metal cyanides, metal nitriles, metal olefin complexes, metal complexes with aromatic rings.

Structural features of silica; discrete anions; infinite chains; sheets (2-dimensional networks); 3-dimensional networks and their applications.

Mode of Assessment:

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

References:

1. Solid state chemistry and its applications.
   Anthony R. West.; John Wiley & Sons (1984)
2. An introduction to transition metal chemistry.
   Orgel, L. E., Methuen, London (1966),
3. Solid state chemistry: An introduction (2nd Ed),
   Smart, Lesley, Moore, Elaine; Chapman Hall (2004)

CHM 31021 Bioorganic Molecules*

Carbohydrates: aldose, ketose, pentose and hexose, D vs L Structures of Sugars, structure of epimers / epimerization, Fischer – Kiliani synthesis, formation of cyclic hemiacetal, anomers / anomeric carbon / mutarotation, Haworth projection formula / chair conformational formula, the ring size of pyranose vs furanose, glycosidic bond [with O and N], reducing sugars, structure of disaccharides, structure of polysaccharides.

Amino acids and Protein: Structures and names of amino acids, Peptide Bond Formation, Amino acid analysis of peptides, Separation and Analysis using pI values, Electrophoresis and Ion Exchange Chromatography, Chemical synthesis of poly Peptides, Cyclic peptides and its application.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Industrial Chemistry</td><td>Course Code</td><td colspan="3">CHM 31031</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 22071 – Mineralogy and Metallurgy</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">3</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>15</td></tr>
<tr><td>*Industrial visit (hr)</td><td>..</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

- To provide a knowledge about the insight of an industrial process
- To understand the role chemistry in industrial processes

Intended Learning Outcomes:

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

- Understand, what is an industrial process is and why the chemical industry is important?
- Estimate the necessary factors needed to establish an industry.
- Evaluate the different processes involved in different stages in a production

Course Capsule/Details:

1. The chemical industry
    a. Why is the chemical industry important
    b. The stages in producing a new product
    c. The economics of production
    d. Cash flow in the production cycle
    e. Running a chemical plant
    f. Designing a chemical plant
    g. Energy and mass balances
    h. Continuous and batch process

2. Chemical processes

    a. Industrial Revolution
    b. Chemical industry; Examples of modern chemical manufacture
    c. Manufacture of sulphuric acid
        i. The Haber process for the manufacture of ammonia
        ii. The manufacture of nitric acid
    d. The chlor-alkali industry
        i. What is the chlor-alkali industry?
        ii. The production of chlorine and sodium hydroxide
        iii. The ammonia-soda (Solvay) process

3. Various Industries based on Sri Lanka:

   Mineral based (e.g: P, apatite, lime, cement, etc) Metal processing, Dyeing industry, Rubber & Rubber based products, Paper industry, etc.

   Note:- ALL OF THESE MAY NOT BE TAUGHT, in one same semester

Mode of Assessment:

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

References:

1. An Introduction to Industrial Chemistry
   Heaton, C.A (ed), Blackie, Glasgow (1984)
2. The Chemical Industry
   Heaton, C.A (ed), Blackie, Glasgow (1986)
3. Advanced Chemistry : Physical and Industrial
   Philip Matthews, Cambridge University Press (2003)

Note : -

~Industrial visit will be arranged, subject to availability of resources (and time, without interfering other subjects)

CHM 31041 Practical Chemistry II*

The list of practicals schedule would be given at the chemistry lab on day one. It will be basically a bunch of Physical chemistry practicals.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Analytical Techniques in Chemistry</td><td>Course Code</td><td colspan="3">CHM 32051</td></tr>
<tr><td>Pre-request</td><td colspan="3">CHM 21011 Analytical Chem,
CHM 21021 Org Spectroscopy</td></tr>
<tr><td rowspan="3">Year</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>15</td></tr>
<tr><td>Practical (hr)</td><td>00</td></tr>
<tr><td>Independent Learning (hr)</td><td>35</td></tr>
</table>

Aim of the Course:

To introduce some hi-tech analytical instruments and their working principles

Intended Learning Outcomes:

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

- Recognize the accurate and precise measurement techniques.
- Judge the numerical criteria of selecting an analytical method.
- Recognize the uses/applications of AAS & AES, Fluorescence & Molecular luminance Spectroscopy.
- Principles and applications of various chromatographic techniques (TLC, GC, HPLC, etc.)

Course Capsule/Details:

Types of analytical methods, Numerical criteria of selecting an analytical method, Spectroscopic methods of analysis- Atomic Absorption and emission, Fluorescence and Molecular luminance spectroscopy, Chromatography-Thin layer Column, Gas chromatography and HPLC,

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments,) – 30%
- End Semester Examination – 70%

References:

1. Instrumental methods of Chemical Analysis
   OUSL, Open University of Sri Lanka (2002)

CHM 32061 Chemistry of Natural Products*

Introduction to Natural Products Chemistry, primary and secondary metabolism, Three Principal Groups of Secondary Metabolites, Isolation techniques, The building blocks Secondary metabolites, important reactions frequently encountered in biosynthesis, Biosynthesis Pathways: Mevalonate pathway, Terpene and Terpenoid, Natural Products, Acetate pathway: Fatty Acid Biosynthesis, Polyketides Biosynthesis, the shikimic acid pathway: flavonoids, alkaloids, coumarins,

<table>
<tr><td rowspan="2">Course Title</td><td colspan="4" rowspan="2">Environmental Chemistry</td><td>Course Code</td><td colspan="3">CHM 32072</td></tr>
<tr><td>Prerequest</td><td colspan="3">CHM 22071 Mineral & Metallurgy
CHM 31021 Industrial chemistry</td></tr>
<tr><td rowspan="3">Year</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>15</td></tr>
<tr><td>Field Visit
and / or
Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>40</td></tr>
</table>

Aim of the Course:

3. To provide the students with an understanding of the chemical and physical processes those occur amongst the environments of Earth.
4. To guide the students towards an appreciation of how fragile these systems are and what we can or cannot do to avoid severe negative impacts.
5. To give the real environment exposure (field trips) and hands on training on analyzing certain environmental parameters

Intended Learning Outcomes:

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

1. Describe how wastes are created during the different stages of product creation (chemical and physical processes) and use.
2. Discuss how waste products are/can be managed.
3. Summarize the effects of mining on land use and what can be done to minimize negative effects.
4. Identify how air, water, and land can potentially be polluted by mining and associated activities.
5. Understand modern agricultural practices involving the use of synthetic and natural products in food production and resource conservation.
6. Describe the process of using nonrenewable energy sources and their impact on the environment.
7. Describe the process of using renewable energy sources such as wind, solar, and geothermal and their impact on the environment.

Course Capsule/Details:

CHM 32072 ENVIRONMENTAL CHEMISTRY

Syllabus: Please note that this is tentative and, while efforts are made to 'stay to schedule', the lecturer in charge retains the right to alter this schedule during the term to adapt to student progress, natural and man-made disruptive events, and the-like.

Overview:

The course will begin with a description of the environments of Earth for that is where the chemistry we consider occurs. Environmental chemistry differs from "test tube" chemistry. That is, we need to consider extremely heterogeneous mixtures, quite unlike the well-defined recipes of laboratory chemistry.
'Atmospheric' chemistry will be covered as it applies to both the outside and the inside (buildings) world. This then includes such topics as the ozone layer, global warming, radioactivity and the generation of acid rain, photochemical smog and other topics.
Much of the course will be devoted to aquatic chemistry, and geochemical cycles, which include; C, N, S, P, Hg, As, CO_2/O_2 and others.
If time permits, "Fossil Fuel" and Nuclear Energies as well as emerging alternate energy sources (hydrogen, hybrid, solar, geothermal) will be reviewed.

Field Trips**:** At least one visit to a local area of environmentally interested site, is included. Here, the student will gain a much better feel for environmental chemistry in action and how it really applies to our everyday lives.

Practicals**:** Some laboratory practicals designed to analyse certain environmental parameters ways by which to do "test-tube" chemistry (and instruments, wherever available and appropriate) yet use / produce environmentally safe reagents / products, will be covered.

Course detail: CHM 32072 Environmental Chemistry

Introduction to the course.
The start of global environmental awareness. Beginning of description of "environments*" (*geosphere, hydrosphere, and atmosphere, *et cetera*).

Atmospheric Chemistry:

Review of atmospheric layering and major processes, air *per se*, electromagnetic radiation.
Ozone issues: Electromagnetic radiation and the formation of ozone (photochemical rate equations), free energy, catalytic decomposition reactions (hydroxyl, nitrous oxide, chlorine radicals, CFCs, HCFCs, etc.) and the ozone hole.

Tropospheric chemistry:

Smog, photochemical smog, volatile organic compounds (VOCs), the internal combustion engine; Rain and acid rain. NOx and SOx species, Controls of NOx and SOx; Atmospheric particulates, urban and indoor air quality.

"Greenhouse effect" and Global Warming
The concept of Earth as a 'greenhouse'; sources and sinks, alternative storage / disposal technologies.

Cont. Assessment #1

Aquatic Chemistry ('hydrosphere'):

Water, Speciation of dissolved species, residence times ($\tau = [x]/(dx/dt)$), dissociation of Bronsted-Lowry acids (mono-/di-/tri-protic) and calculation of constants, alkalinity.
Organic matter in water (fulvic and humic acids, chelation theory, source and sinks of metals), and
Metals: Hydration (aquo complexes), iron speciation (return to pH and redox concepts), additional metal-humic discussion, mercury and arsenic methylation, man introduced ligands and influence on natural metal cycling.

Cont. Assessment #2

Biogeochemical cycles Abiotic vs. biotic "worlds", photosynthesis / respiration, carbon, nitrogen, sulfur, oxygen, water and 'other' cycles.

Energy; Fossil fuels, nuclear, solar, wind, alternate.

Chemistry of waste,
Industrial effluents – solid, liquid, gaseous wastes; noise pollution
Role of Industry, Mineral extraction sites and Metallurgical processes
Role of Agriculture - Agrochemicals
Clinical & Domestic wastes
Waste (water) treatment and recycle, analytical parameters (BOD, COD, TSS, TP, TN, DO, pH etc.).
Solid waste management

Cont. Assessment #3

FIELD TRIP and/or Practicals
Areas close to Sammanthurai, Kalmunai, Addalachenai/Akkaraipattu or Ampara Municipal SWM Centre / Query site
Practical Details – Listed along with (other) practicals, separate.

Cont. Assessment #4 – Report(s) – Field / practical

Mode of Assessment:

- Continuous Assessment – 30%

- End Semester Examination – 70%

The Continuous assessment methods may include one or more of the following:

Examinations, quizzes, homework assignments, small group problem solving, oral presentations, Laboratory write-ups or Field visit reports.

The End Semester Examination is a written paper with essay questions

References:

1. Ian Williams (2001). Environmental Chemistry, A modular Approach. John Wiley & Sons, Ltd., Chichester, England

2. G. W. van Loon and S. J. Duffy (2000). Environmental Chemistry; a global perspective. Oxford University Press, Oxford. 492pp.

3. Fifield, F. W. and Haines, P.J. Environmental Analytical Chemistry. Blackwell Science, Oxford, 490 pp.

4. Wagner, R.E. *et al*., Editors (1996) Guide to Environmental Analytical Methods, 3rd. Ed., Genium Publishing Corp., Schenectady. >100pp.

5. Howard, A.G. (1998) Aquatic Environmental Chemistry. Oxford Science, Oxford. 90pp.

6. Samir K Banerji (1993). Environmental Chemistry, Prentice-Hall of India Private Limited, New Delhi

7. Garrels, R.M. and Christ, C.L. (1965) Solutions, Minerals, and Equilibria. Freeman, Cooper & Co., San Francisco. 450pp.

DETAIL SYLLABUS OF COMPUTER SCIENCE

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">System Fundamentals & Digital Organization</td><td>Course Code</td><td colspan="3">CSM 11011</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in Computer System and Logical Organization

Intended Learning Outcomes:

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

- Explain the fundamental parts and peripheral of the computer systems.
- Describe the basics of software, hardware and network devices and its functions.
- Explain the Von Neumann Architecture of Computer, factors affecting the computer performance
- Compare the memory hierarchy and usage, and Describe Gates and Circuits
- Solve Boolean expression using Boolean Algebra and Karnaugh maps (K-maps)

Course Capsule:

Introduction to Computer, Computer Peripherals, The Von Neumann Architecture of Computer, Computer Performance, Memory Hierarchy, Moor's Law, Software and Hardware, Number Systems, Conversion Among Bases, Logic Gates and Circuits, Boolean Algebra & Circuit Simplification: DeMorgan's Theorem, Canonical Expression, Karnaugh maps (K-maps) etc.,

Mode of Assessment:

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

References:

1. The Essential of Computer Organization & Architecture", By: Linda Null & Julia Lobur (2015)
2. "Computer Architecture", 5th Edition, By: John Hennessy & David Patterson (2016)

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Fundamentals of Programming and Programming Language</td><td>Course Code</td><td colspan="3">CSM 11022</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">01</td><td rowspan="3">Semester</td><td rowspan="3">01</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>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in programming and programming languages

Intended Learning Outcomes:

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

- Identify and describe uses of primitive date types.
- Design, implement, test, and debug a program that uses each of the following fundamental programming constructs: basic computation simple I/O, standard conditional and iterative structures, the definition of functions and parameter passing.
- Write a program that uses file I/O to provide persistence across multiple executions.
- Choose appropriate conditional and iteration constructs for a given programming task.
- Describe the concept of recursion and giving examples of its use.
- Identify the base case and general case of a recursively-defined problem
- Discuss the importance of algorithms in the problem-solving process.
- Use a programming language to implement, test, and debug algorithms for solving simple problems.
- Implement a divide-and-conquer algorithm for solving a problem.
- Apply the technique of decomposition to break a program into small pieces.

Course Capsule:

Fundamentals of Programming

Basic syntax and semantics of a higher-level language

- Variables and primitive data types (e.g., numbers, characters, Booleans)
- Expressions and assignments
- Simple I/O including files I/O
- Conditional and iterative controls structures

- Functions and parameter passing
- The concept of recursion

Algorithms and design

- The concept and properties of algorithms
- The role of algorithm in the problem-solving process
- Problem-solving strategies
- Fundamental design concepts and principles

Programming Languages

- Object oriented programming fundamentals
- PL/Fundamental programming
- Event-Driven and Reactive Programming
- Basic Type Systems
- Program Representation
- Language Translation and Execution
- Syntax Analysis
- Compiler Semantic Analysis
- Code Generation
- Runtime Systems

Mode Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid-term) – 30%
- End Semester Examination-70%

References:

- Java: The Complete Reference™, Eight edition by Herbert Schildt, Tata McGraw-Hill Edition 2011
- Computer Program Design by Elizabeth A Dickson, Tata McGraw-Hill Edition 2002

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Object Oriented Programming, Analysis & Design</td><td>Course Code</td><td colspan="3">CSM 12032</td></tr>
<tr><td>Prerequest</td><td colspan="3">CSM 11022</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">01</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>-</td></tr>
</table>

Aim of the course:

To provide student with the basic concepts in Object oriented programming and design

Intended Learning Outcomes:

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

- Use sub classing to design simple class hierarchies that allow code to be reused for distinct subclasses.
- Correctly reason about control flow in a program using dynamic dispatch.
- Explain the relationship between object-oriented inheritance (code-sharing and overriding) and sub typing (the idea of subtype being usable in a context that expects the super type).
- Use multiple encapsulation mechanisms, such as function closures, object-oriented interfaces, and support for abstract data types, in multiple programming languages

Course Capsule:

- Object-oriented design
  Decomposition into objects carrying state and having behavior
  Class-hierarchy design for modelling
- Definition of classes: fields, methods, and constructors
- Subclasses, inheritance, and method overriding
- Dynamic dispatch: Definition of method –call
- Sub typing
  Subtype polymorphism; implicitly up casts in the types languages
  Notion of behavioral replacement: subtype acting like super types
  Relationship between subtype and inheritance
- Object-Oriented idioms for encapsulation
  Privacy and visibility of class members
  Interfaces revealing only method signatures

  - Abstraction base class
  - Using collection classes, iterations, and other common library components
- Overview of Design Paradigms

- Structured design (top-down functional decomposition).
- Object-Oriented analysis and design ,
- Event driven design,
- Component-level design
- Data-structured centered,
- Aspect oriented,
- Function oriented,
- Services oriented,
- Divide and conquer (architectural design and detailed design).
- Separation of concerns
- Information holding
- Coupling and cohesion,
- Re-use of standard structures
- Appropriate models of software designs, including structure and behavior.
- Relationship between requirements and designs:
- Refactoring designs and the use of design patterns
- The use of components, in the design: components and pattern, components and objects, (for example build a GUI using a standard widget set).

Mode of Assessments:

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

Reference:

Ref1: System Analysis and Design Methods by Jeffrey L. Whitten, Lonnie D. Bentley 7th Edition. ISBN 0-07-058224-6, Tata McGraw-Hill, 2007.
Ref2: Teach Yourself UML in 24 Hours, Joseph Schmuller, 3rd Edition, ISBN 81-297-0609-1, Pearson Education, 2004
Ref3: http://en.wikipedia.org/wiki/Software_development_process
Ref4: http://en.wikipedia.org/wiki/Rational_Unified_Process
Ref5: http://eml-diagrams.org/profile-diagrams.html

Supplementary Reading

Ref5: UML 2 Bible, Tom Pender, Wiley Publishing ,Wiley Publishing Inc., 2003
Ref6: “UML User Guide”, Grady Booch, James Rumbaugh, Ivar Jacobson, Addison Wesley, 2002.
Ref7: Visual Modelling with Rational Rose 2002 and UML By Terry Quatrani Foreword by Grady Booch, 2002
Ref8: The Rational Unified Process: An Introduction, Philippe Kruchten, 3rd Edition, Addison-Wesley Professional, 2003

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Object Oriented Programming Laboratory</td><td>Course Code</td><td colspan="3">CSM12041</td></tr>
<tr><td>Prerequest</td><td colspan="3">CSM 11022, CSM 11022</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td></td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide student with the basic skills in Object oriented programming

Intended Learning Outcomes:

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

- Able to understand the concept of objects and definition of classes: fields, methods, and constructors in object oriented programming.
- Implement the object oriented programming concepts: encapsulation, inheritance and polymorphism.
- Use sub classing to design simple class hierarchies that allow code to be reused for distinct subclasses.
- Learn and distinguish access modifiers.
- Demonstrate special functions abstract class and abstract methods.
- Able to handle super and this keywords.

Course Capsule:

Introduction to Object Oriented Programming (Class, Object, Method), Constructors, Method Overloading, Inheritance, This and Super Keywords, Method Overriding, Encapsulation, Polymorphism, Access Modifiers, Abstract class, UML diagrams.

Mode of Assessment:

Continuous Assessment (Quizzes, Assignments, Presentations) – 50%
End Semester Examination – 50%

References:

1. Java The Complete Reference", 11th Edition By: Herbert Schildt
2. Head First Java'' , 2nd Edition, By: Bert Bates and Kathy Sierra

Course Title	Algorithm and complexity			Course Code	CSM 21012		
				Prerequest	-		
Level	02	Semester	I	Credits	02	Theory (hr)	30
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

To provide students with conventional and advance Algorithms and Complexity

Intended learning Outcomes:

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

- Explain what is meant by “best”, “average”, and “worst” case behavior of an algorithm
- Determine informally the time and space complexity of simple algorithms
- Understand the informally definition of Big O
- Give examples that illustrate time-space trade-offs of algorithm
- Use the big O notation formally to give average case bounds on time complexity of algorithms
- Use a greedy approach to solve an appropriate problem
- Use a divide and conquer algorithm to solve an appropriate problem
- Use recursive backtracking to solve a problem
- Use dynamic programming to solve an appropriate problem
- Implement basic numerical algorithms
- Be able to implement common quadratic and 0(N log N) sorting algorithms
- Be able to implement a string- matching algorithm

Course Capsule:

Basic Analysis

- Difference among best, average and worst-case behaviors of an algorithm.
- Asymptotic analysis of upper and average complexity bounds
- Big O notation: formation definition
- Complexity classes, such as constant, logarithmic, linear, quadratic and exponential
- Empirical measurement of performance
- Time and space trade-offs in algorithms

Algorithm Strategies

- Brute-force algorithms
- Greedy algorithms
- Divide-and-conquer (cross-reference SDF/Algorithm and Design /Problem-solving strategies)
- Recurve backtracking
- Dynamic Programming

Fundamental Date structures and Algorithms

- Simple numerical algorithms, such as computing the average of a list of numbers, finding the min, max and mode in a list, approximating the square roots of a number, or greatest common divisor
- Sequential and binary algorithms
- Worst case quadratic sorting algorithm (selection, insertion)

- Worst or average case 0 (N log N) sorting algorithm (quicksort, heapsort, mergesort)
- Hash table, including strategies for avoiding and resolving collisions
- Binary search trees: Common operations on binary search trees such as select min, max, insert, delete iterate over tree
- Graphs and graph algorithms: Representation of graphs (e.g., Adjacency list, adjacency matrix), Depth- and breadth- first traversals

Advance Data Structures, Algorithms, and Analysis

- Balanced trees (e.g. AVL trees, red-black trees, splay trees)
- Graph (topological Sort)
- Advance data structures (B-trees, tries, heaps)
- Liner Programming (duality, simplex method, interior point algorithms)
- Approximation algorithms

Mode of assessment:

- Continuous Assessment (Quizzes, assignments, practices Mid-term,) -30%
- End Semester Examination-70%

References:

Ref 1: Data Structure and Algorithm in Java by Adam Drozdek, Thomson learning, 2nd Edition, 2006 ISBN: 81-315-0107-8

Ref 2: Data Structure and Algorithm in java by the Robert Lafore, GC Join for Techmedia, 2nd edition, ISBN: 817635-186-5

Course Title	Operating Systems			Course Code	CSM 21021		
				Prerequest	-		
Level	2	Semester	I	Credits	01	Theory (hr)	15
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

- The course provide an understanding of entire process within Operating Systems. It covers overview of Operating Systems, Operating System principles, concurrency, scheduling and dispatch, memory management, security and protection, virtual machines, device management and file systems.

Intended Learning Outcomes:

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

- Understand the knowledge of Operating System principles, concurrency, scheduling and dispatch, memory management.
- Understand the knowledge of Operating System security and protection,
- Understand the knowledge of Operating System virtual machines, device management and file systems,
- Understand the knowledge of internal structure of modern operating system.
- Learn various facilities provided by the operating system to the user.

Course Capsule:

Overview of Operating Systems

- Role and purpose of the operating system
- Functionality of a typical operating system
- Mechanisms to support client-server models, hand-held devices
- Design issues (efficiency, robustness, flexibility, portability, security, compatibility)
- Influences of security, networking, multimedia, windows

Operating System Principles

- Structuring methods (monolithic, layered, modular, micro-kernel models)
- Abstractions, processes, and resources
- Concepts of application program interfaces (APIs)
- Application needs and the evolution of hardware/software techniques
- Device organization
- Interrupts: methods and implementations
- Concept of user/system state and protection, transition to kernel mode

Concurrency

- States and state diagrams
- Structures (ready list, process control blocks, and so forth)
- Dispatching and context switching
- The role of interrupts
- Managing atomic access to OS objects
- Implementing synchronization primitives
- Multiprocessor issues (spin-locks, re-entrancy)

Scheduling and Dispatch

- Pre-emptive and non-pre-emptive scheduling
- Schedulers and policies
- Processes and threads
- Deadlines and real-time issues

Memory Management

- Review of physical memory and memory management hardware
- Working sets and thrashing

Caching

Security and Protection

- Overview of system security
- Policy/mechanism separation
- Security methods and devices
- Protection, access control, and authentication
- Backups

Mode of Assessment:

- Continuous Assessment (written test, Assignments, Tutorials) - 30%
- End Semester Examination – 70%

References:

- Andrew S. Tanenbaum (2007),"**Modern Operating Systems**", 3rd Edition
- William Stallings (2011), "**Operating Systems: Internals and Design Principles**", 7th Edition

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Advanced Algorithm Laboratory</td><td>Course Code</td><td colspan="3">CSM 21031</td></tr>
<tr><td>Prerequisite</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">02</td><td rowspan="3">Semester</td><td rowspan="3">1</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td></td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning(hr)</td><td>-</td></tr>
</table>

Aim of the course:

To provide skill of Advanced Algorithms and their implementation using Java program

Intended Learning Outcomes:

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

- Understand the concept of Data Structures: Arrays, Linked Lists, Stack and Queue.
- Implement the basic operations to the above data structures.
- Understand and distinguish different sorting algorithms along with their implementation in Java
- Understand and implement tree and graph data structures.

Course Capsules:

Implementation of Basic and ADT data Structures
Arrays
Linked Lists
Stack
Queue
Implementation of Sorting Algorithms
Selection Sort
Insertion Sort
Bubble Sort
Quick Sort
Merge Sort
Implementation of Advanced data structures
Tree
Graph Data Structures

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Presentation) - 50%
- End Semester Examination – 50%

References:

Data Structures and Algorithms in Java, by Waite, Mitchell and Robert Lafore. Techmedia (1999)

Head First Java, by Sierra, Kathy and Bates, 2nd edition, Shroff Publishers & Distributors Pvt.Ltd (2005)

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Internet Programming & Web Services</td><td>Course Code</td><td colspan="3">CSM 22042</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">2</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>-</td></tr>
</table>

Aim of the Course:

- The course is designed to provide the knowledge of web application development techniques; client-side (HTML, JavaScript, CSS) and server-side programming (PHP, MySQL database connection)
- Improving students' skills and project-based experience needed for web design and development careers using a variety of strategies and tools.

Intended Learning Outcomes:

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

- Write server-side scripts to communicate with a web server.
- Demonstrate the fundamental Web Application Architecture including Web Services.
- Explain the Web Services Technology stack and how each component relates to the other.
- Build, compose, document, publish and consume Web Services.
- Explain the basic security issues and implementation issues in Web Services
- Improving students' skills and project-based experience needed for web design and development careers using a variety of strategies and tools. Further it intends to make students aware on World Wide Web (WWW), HTML editors for website development.

Course Capsule:

Web Technologies

- HTTP protocol
- Presentation abstractions
- Web-markup and display languages
- Client-side programming
- Server-side programming
- Web services Web servers
- Emerging technologies
- Standards & standards bodies

Information Architecture

- Hypertext/hypermedia
- Effective communication
- Interfaces
- Navigation schemes
- Media types
- Web design process

- User modeling and user-driven design
- Web design patterns

Web Development

- Web interfaces
- Web site implementation and integration
- Database integration

Vulnerabilities

- Client Security
- Cookies and web beacons
- Phishing
- Transaction security – certificates and secure connections
- Spyware & Viruses

Introduction to web services

- SOAP WSDL UDDI-Why Web Services are important?
- The evolution of web applications Not just another distributed computing platform:
- Web services and enterprises.

XML Fundamentals

- XML: The Lingua Franca of web services-
- XML Documents-XML namespaces Explicit and Default namespaces, Inheriting namespaces, And not inheriting namespaces, Attributes and namespaces
- XML Schema XML schema and namespaces, A first schema, Implementing XML schema types, The any Element, Inheritance, Substitution groups, Global and local type declarations, Managing Schemas, Schemas and instance documents, XML schema best practices
- Processing XML SAX: Simple API for XML, DOM: Document object Model, XSLT, XPATH

Mode of Assessment:

- Continuous Assessment (written test, Assignments, Tutorials) - 30%
- End Semester Examination – 70%

References:

- **Developing Enterprise Web Services** - An Architect's Guide – Sandeep Chatterjee, James Webber, Pearson Education– Second Indian Reprint 2005.
- **Understanding SOA with Web Services**, Eric Newcomer, Greg Lomow, Pearson Education, First Indian Reprint 2005.
- Benoit Marchal (1999/2001). **XML by Example** (1st or 2nd Edition). Que Publishers.
- Vikram Vaswani (2002**). XML and PHP**. Pearson Education Asia.
- James Fuller et. al. (2003). Professional PHP Web Services. Wrox Press (Indian Edition: Shroff Publishers)

Course Title	Networking and Communication			Course Code	CSM 22052		
				Prerequest	-		
Level	2	Semester	II	Credits	02	Theory (hr)	30
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

- The course is designed to provide knowledge in conceptual and technological aspects behind Computer networking. The major areas include data communication, computer networks, LAN architectures, structure of Internet, Routing, IP(Internet Protocol) multicasting, IP support protocols, application layer protocols, network management, wireless LANs (Land Area Networks).
- To understand fundamental principles of Networking.
- To develop a working knowledge of the networking environments and to use this knowledge to explore various applications.
- To familiarize students with networking environmental issues and challenges.

Intended Learning Outcomes:

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

- Student should have the knowledge in basic technologies of Computer networks and communications.
- Student will learn various routing technologies.
- Student will learn various switching technologies.

Course Capsule:

Introduction

- Organization of the Internet (Internet Service Providers, Content Providers)
- Switching techniques (Circuit, packet)
- Physical pieces of a network (hosts, routers, switches, ISPs, wireless, LAN, access point, firewalls)
- Layering principles (encapsulation, multiplexing)
- Roles of the different layers (application, transport, network, data link, physical)

Networked Applications

- Naming and address schemes (DNS, IP addresses, Uniform Resource Identifiers, etc.)
- Distributed applications (client/server, peer-to-peer, cloud, etc.)
- HTTP as an application layer protocol
- Multiplexing with TCP and UDP
- Socket APIs

Reliable Data Delivery

- Error control,
- Flow control ,
- TCP

Routing and Forwarding

- Routing versus forwarding
- Static routing
- Internet Protocol (IP)
- Scalability issues (hierarchical addressing)

Local Area Networks

- Multiple Access Problem
- Local Area Networks
- Ethernet
- Switching

Mobility

- Principles of cellular networks
- 802.11 networks
- Issues in supporting mobile nodes (home agents)

Mode of Assessment:

- Continuous Assessment (written test, Assignments, Tutorials) - 30%
- End Semester Examination – 70%

References:

- **Computer Networks**, Author: Tanenbaum A S, Prentice-Hall
- **Data and Computer Communication**, Author: Stallings
- **Data communication and Networking** Author: Behrouz A. Forouzan
- Todd Lammle (2011), "**CCNA Cisco Certified Network Associate Study Guide**", 7th Edition, ISBN-10: 0470901071
- Gil Held (2000), "**Cisco Router Performance Field Guide**",ISBN :81-76-56-887-2

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Internet Programming Laboratory</td><td>Course Code</td><td colspan="3">CSM 22061</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">02</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3"></td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the course:

To provide understanding in the implementation of web applications and internet technologies.

Intended Learning Outcomes:

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

- Learn the concepts used in internet programming.
- Write well-structured, easily maintained, standards-compliant, accessible HTML code to create simple web pages.
- Write well-structured CSS code to present HTML pages in different ways.
- Use JavaScript to add dynamic content to pages and apply client-side logics.
- Use PHP language for server side scripting.
- Using database technologies to store persistent data for a web application and data processing with MySQL database.

Course Capsule:

- **Elements of HTML using it to add content to the web page.**
  - learn to read, write and identify HTML tags in a page
  - HTML Tables
  - Input audio, video elements
  - Frames
- **CSS's role in creating user interfaces**.
  - The basic CSS concepts: selectors, CSS properties, CSS code structure, CSS declarations, CSS unit types etc.
- **Techniques and concepts on JavaScript**.
  - Insert JavaScript code into pages
  - JavaScript constructs: variables, arrays, functions, loops, conditional statements, objects
  - Processing HTML forms
- **PHP for server side scripting**
  - Variables, numbers and strings
  - Calculations with PHP
  - Using Arrays
  - Control Structures and Loops
  - Built-in functions

- Handling Forms
- **MySQL Database**
  - Create database and connect application programme
  - Entity Framework and Stored procedure

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Mid-term) - 50%
- End Semester Examination – 50%

References:

1. Practical PHP: The Definitive Guide to Programming PHP,Paul Hudson, 1 edition (October 28, 2013); Tuxradar.com (2014, updated continuously)
2. Learning JavaScript Design Patterns: A JavaScript and jQuery Developer's Guide, Addy Osmani, O'Reilly Media; 1 edition (August 27, 2012); eBook (2017)

Course Title	System Analysis, Design and Engineering			Course Code	CSM 31012		
				Prerequest	-		
Level	3	Semester	I	Credits	02	Theory (hr)	30
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

- Understand fundamental principles of Software Analysis, Design and Engineering
- provides a broad understanding of the software engineering process, concepts, the Systematic development and management of software projects.

- This course covers the modules of software design process models; requirements engineering; design principles; coding practices; testing strategies; software maintenance and evolution; software project management and fundamentals of software quality assurance

Intended Learning Outcomes:

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

- describe fundamental concepts and trends that provide the context of Systems Analysis and Design methods and to apply the techniques practically to analyze and design an information system,
- Describe software Design concepts and apply them to solve problems and prepare Object Oriented Analysis and Design documents for a given problem using Unified Modelling Language.
- Learn how to analyze and evaluate system demands.
- Study system design, project planning, system maintenance and testing.
- Learn different programming paradigms.
- Explain different stages of object oriented analysis; compare different models of analysis and design; and to carry out UML modeling

Course Capsule:

Software Processes

- Systems level considerations, i.e., the interaction of software with its intended environment
- Introduction to software process models (e.g., waterfall, incremental, agile)
- Phases of software life-cycles
- Applying software process models

Requirements Engineering

- Properties of requirements including consistency, validity, completeness, and feasibility
- Describing functional requirements using, for example, use cases or users stories
- Software requirements elicitation
- Non-functional requirements and their relationship to software quality
- Describing system data using, for example, class diagrams or entity-relationship diagrams

- Evaluation and use of requirements specifications

Software Construction

- Coding practices: techniques, idioms/patterns, mechanisms for building quality programs
    - Defensive coding practices
    - Secure coding practices
    - sing exception handling mechanisms to make programs more robust, fault-tolerant

  Coding standards

Software Verification and Validation

- Verification and validation concepts
- Inspections, reviews, audits
- Testing types, including HCI, usability, reliability, security, conformance to specification
- Testing fundamentals

  Unit, integration, validation, and system testing

  Test plan creation and test case generation

  Black-box and white-box testing techniques

- Defect tracking

Object-Oriented Analysis:

- Use-Case modeling, Class modeling, Dynamic modeling.

Object-Oriented Design:

- Sequence diagram, Collaboration diagram and detailed class diagram, Implementation, integration and maintenance, Introduction to Computer assisted software engineering (CASE).

Mode of Assessment:

- Continuous Assessment (written test, Assignments, Tutorials) - 30%
- End Semester Examination – 70%

References:

- Roger Pressman, **Software Engineering: A Practitioner's Approach**, 5th edition,
- Laboratory work: Computer programming on workstations.
- Sara Baase, Allen Van Gelder (2003), **Computer Algorithms. Introduction to Design and Analysis**. Third Edition, ISBN 81-7808-171-7
- **Object Oriented Modeling and Design**, Author: Raumbugh
- Ali Bahrami, "**Object Oriented Systems Development**", Tata McGraw-Hill.

Course Title	Database Management System			Course Code	CSM 31022		
				Prerequest	CSM 21021		
Level	3	Semester	I	Credits	02	Theory (hr)	30
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

- The course aims to provide a knowledge in advanced database concepts such as access control, transaction processing, indexing, mapping objects to relational database and managing big data.
- The topics are access control, transaction management, serializability, transaction management in SQL (Structured Query Language), indexing using SQL, stored procedure triggers and NoSQL
- Introduces the components of a database system and major DBMS functions. Data modelling, Relational database design, Query languages (SQL) are covered in the course.

Intended Learning Outcomes:

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

- Understand the role of a database system and the functions of a database administrator,
- Understand the three-schema architecture for databases and thus the difference between conceptual, external and physical schemas,
- Understand the database application development process, Understand SQL as a data definition language, data manipulation language and access control language and Understand how to develop a database application.
- Understand the concepts of normalization
- Gain the basic knowledge in relational databases and their design principles.

Course Capsule:

Information Management Concepts

- Information management applications
- Declarative and navigational queries, use of links
- Analysis and indexing
- Quality issues: Reliability, scalability, efficiency, and effectiveness

Database Systems

- Approaches to and evolution of database systems
- Components of database systems
- Design of core DBMS functions (e.g., query mechanisms, transaction management, buffer management, access methods)
- Database architecture and data independence
- Use of a declarative query language
- Systems supporting structured and/or stream content
- Approaches for managing large volumes of data (e.g., MySQL database systems, use of MapReduce).

Data Modelling

- Conceptual models (e.g., entity-relationship, UML diagrams)
- Spreadsheet models
- Relational data models
- Object-oriented models
- Semi-structured data model (expressed using DTD or XML Schema, for example)

Relational Databases

- Mapping conceptual schema to a relational schema
- Entity and referential integrity
- Relational algebra and relational calculus
- Relational Database design
- Functional dependency
- Decomposition of a schema; lossless-join and dependency-preservation properties of a decomposition

Normalization

- Candidate keys, super keys, and closure of a set of attributes
- Normal forms (BCNF)
- Multi-valued dependency (2NF)
- Join dependency (PJNF, 3NF)
- Representation theory

Query Languages

- Overview of database languages
- SQL (data definition, query formulation, update sublanguage, constraints, integrity)
- Selections
- Projections
- Select-project-join
- Aggregates and group-by

Query Optimization:

- Query Execution Algorithms, Heuristics in Query Execution, Cost Estimation in Query Execution, Semantic Query Optimization.

Database Transactions and Recovery Procedures:

- Transaction Processing Concepts, Transaction and System Concepts, Desirable Properties of a Transaction, Schedules and Recoverability, Serialisability of Schedules, Transaction Support in SQL, Recovery Techniques, Database Backup.

Concurrency control:

- Locking techniques for Concurrency Control, Concurrency Control Techniques, and Granularity of Data Items.

Database Security:

- Access Privileges, Multilevel Security, And Statistical Database Security.

Mode of Assessment:

- Continuous Assessment (written test, Assignments, Tutorials) - 30%
- End Semester Examination – 70%

References:

- **Database system concepts** 5th edition by Silberschatz
- Elmasri and Navathe**, Fundamentals of Database Systems**
- **Advanced Database Systems** (Lecture Notes in Computer Science) by: Nabil R. Adam, Bharat K. Bhargava
- **Advanced Database Technology and Design** (Artech House Computer Library) by: Mario Piattini

Course Title	Software Project Management			**Course Code**	CSM 32042		
				Prerequest	CSM 31012		
Level	03	**Semester**	II	**Credits**	02	**Theory (hr)**	30
						Practical (hr)	-
						Independent Learning (hr)	-

Aim of the Course:

To provide Student with conventional and advance Software Project Management

Intended Learning Outcomes:

On the successful Completion of the Course, students should be able to:

- Apply a conflict resolution strategy in a team setting.
- Use an as hoc method to establish software development effort (e.g., time) and compare to actual effort required. time) and compare to actual effort required.
- Describe the impact of risk in a software development life cycle and different categories of risk in software systems.
- Create a team by identifying appropriate roles to team members.
- Access and provide feedback to teams and individuals on their performance in a team setting
- Prepare a project plan for a software project that includes estimates of size and effort, a schedule, resource allocation, configuration control, change management plan and project risk identification and management project.
- Describe the impact of risk tolerance on the software development process.
- Conduct a cost/benefit analysis for a risk mitigation approach
- Identify and analyze some of the risk for an entire system that arise from aspects other than the software.

Course capsule:

Team participation (5 hours)

- Team processing including responsibility for tasks, meeting structure and work schedule
- Role and responsibilities in a software team
- Team conflict resolution
- Risk associated with virtual teams (communication, perception, structure)

Effort estimation (at personal level) (2 hours)

Risk (5 hours)

- The role of risk in the life cycle
- Risk categories including security, safety ,market, financial, technology people, quantity structure and process

Team management

- Team organization and decision making
- Role Identification and assignment

- Individual and team performance assessment

Project management

- Scheduling and tracking
- Project management tools
- Cost/benefit analysis

Software measurement and estimation techniques (2 hours)
Software quality assurance and the role management (2 hours)
Risk (2 hours)

- Risk identification and management
- Risk analysis and evaluation
- Risk tolerance (E.g., risk –adverse, risk neutral, risk seeking)
- Risk planning

System-wide approach to risk including hazards associated with tool (1 hour)

Mode of assessment:

- Continuous Assessment (Quizzes, assignments, practices Mid-term,) -30%
- End Semester Examination-70%

References:

Ref1: Data Structure and Algorithm in Java by Adam Drozdek, Thomson learning, 2nd Edithon,2006 ISBN: 81-315-0107-8

Ref2: Data Structure and Algorithm in java by the Robert Lafore, GC Join for Techmedia, 2nd edition, ISBN: 817635-186-5

CSM 32051 Introduction to Image Processing*

CSM 32061 Image Processing Laboratory*

DETAIL SYLLABUS OF EARTH SCIENCE

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Introduction to Earth Science</td><td>Course Code</td><td colspan="3">ESM 11012</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</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>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in Earth Science and interior of the Earth

Intended Learning Outcomes:

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

- Explain the nature and interactions between atmosphere, hydrosphere, biosphere and lithosphere
- Describe how the Universe, Solar system and the earth were evolved
- Compare the compositional and structural difference within the layers of the concentric Earth
- Explain how the super continent of Pangea was broken, continents and oceans were developed, and earthquakes and volcanoes are operated
- Distinguish processes in geological and human time scales

Course Capsule:

Earth as a system, Origin of the Universe, Solar system and the Earth, Structure and composition of the Earth, Subdivisions in earth science, Geological material and processes, Continental drift, sea floor spreading and plate tectonic theory, Sea floor and continental topography, Geological time scale, Introduction to Earth's internal processes; earthquakes, volcanism, plutonism, deformation, etc.,

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Field Report) – 30%
- End Semester Examination – 70%

References:

7. Blue Planet : An Introduction to Earth System Science - 2nd ed., by Brian J. Skinner, Stephen C. Porter and Daniel B. Botkin
8. Applications and Investigations in Earth Science - 6th ed., by Tarbuck, Lutgens, Pinzke and Tasa
9. Earth - 07 ed., by James F. Luhr
10. Introduction to Field Geology, by Mary Lou Bevier
11. Earth Materials: Introduction to Mineralogy and Petrology, by Cornelis Klein (Author), Anthony Philpotts
12. Geology and the Environment, by Pipkin Trent

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Earth Surface Processes I</td><td>Course Code</td><td colspan="3">ESM 11021</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">1</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in Earth surface processes

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

- Distinguish Exogenic process from endogenic process
- Understand the weathering, erosion and mass movement processes
- Estimate the weathering and erosion rates
- Know the types of mass movements
- Understand the formation process of soil profile
- Characterize the different horizons in the soil profile

Course Capsule:

Exogenic versus endogenic processes, Physical and chemical weathering processes, Erosion, Quantification of weathering and erosion rates, Mass movement and Soil forming process

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Field Report) – 30%
- End Semester Examination – 70%

References:

1. Earth Resources and the Environment (4th Ed.), by James R. Craig , David J. Vaughan , Brian J. Skinner
2. The Origin of Clay Minerals in Soils and Weathered Rocks by Bruce Velde and Alain Meunier
3. Weathering and Erosion (Earth and Space Science), by Torrey Maloof
4. Our Geologic Environment by Kehew
5. Dangerous Earth, by Murck and Skinner

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Introduction to Mapping and Remote Sensing</td><td>Course Code</td><td colspan="3">ESM 12032</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">1</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>15</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with conventional and advanced tools of remotely collected data

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

- Trace geographical locations in the field
- Interpret and explain relationships between relief, soil type, drainage pattern, land use cover, underlying geology and geological structures
- Deduce the extension of subsurface geology
- Predict hazard zones

Course Capsule:

Mapping concepts, Interpreting topographic maps for relief, drainage pattern and land use, Interpreting aerial photographs and satellite imagery for land use, land pattern analysis, geological and structural analysis, Analyzing geological maps to interpret subsurface geology, Terrain analysis, Studying hazard maps

Mode of Assessment:

- Continuous Assessment (Quizzes, Practicals, Assignments, Field Report,) – 30%
- End Semester Examination – 70%

References:

1. Basic Geological Mapping, by Richard J. Lisle and Peter Brabham
2. Basics of Geological Remote Sensing: An Introduction to Applications of Remote Sensing in Geological Mapping by Christopher Legg
3. An Introduction to Geological Structures and Maps, Eighth Ed., by George M Bennison and Paul A Olver
4. Applied Subsurface Geological Mapping with Structural Methods (2nd Edition), by Daniel J. Tearpock and Richard E. Bischke

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Earth Surface Processes II</td><td>Course Code</td><td colspan="3">ESM 12041</td></tr>
<tr><td>Prerequest</td><td colspan="3">-</td></tr>
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<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in Earth surface processes

Intended Learning Outcomes:

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

- Understand the depositional and erosional actions of river, glacier, wind and ocean current
- Identify different landforms in different geologic environments
- Apply geomorphological concepts in understanding landscape development
- Identify the limits of ground water
- Understand the subsurface properties including porosity, permeability and hydraulic conductivity
- Know types of aquifers
- Understand the process of ground water movement

Course Capsule:

Actions of rivers, glaciers, wind and waves, Formation of landforms, Occurrence and movement of groundwater

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Field Report) – 30%
- End Semester Examination – 70%

References:

1. Key Concepts in Geomorphology, by Paul R. Bierman and David R. Montgomery
2. Earth Resources and the Environment (4th Ed.), by James R. Craig , David J. Vaughan , Brian J. Skinner
3. Global Geomorphology (1st Ed.), by Michael A. Summerfield
4. Our Geologic Environment by Kehew
5. Dangerous Earth, by Murck and Skinner
6. Principles of Hydrology (4th Ed.) by Roy C. Robinson Ward, R.C. Ward, M. Robinson

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Tectonics and Field Geology</td><td>Course Code</td><td colspan="3">ESM 21012</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM 12041</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">I</td><td rowspan="3">Credits</td><td rowspan="3">02</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in Tectonics and Field Geology

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

- Explain how geological structurers are developed in crystalline rocks
- Identify rock types/geological features/ geological structurers in the field
- Measure strike and dip of geological structures/features
- Develop a geological map along a road
- Interpret the geological evolution of an area

Course Capsule:

Different types of deformation and tectonic events, Introduction to geological structures/features in crystalline rocks (folds, faults, joints, foliations, lineations, compositional layers, rock contacts, etc.), Measuring of strike and dip of geological structurers / features in the field, Interpretation of geological structurers, Geological road mapping

Mode of Assessment:

- Continuous Assessment (Quizzes, Practicals, Assignments, Field Report) – 30%
- End Semester Examination – 70%

References:

7. Tectonics, by Eldridge M. Moores and Robert J. Twiss
8. Tectonic Geomorphology, by Douglas W. Burbank and Robert S. Anderson3.
9. PlateTectonics: A Very Short Introduction, by Peter Molnar
10. Global Tectonics, by Philip Kearey and Keith A. Klepeis
11. Geological Field Techniques, by Angela L. Coe
12. Guide To Field Geology, by S.M. Mathur
13. Structural Geology, by Haakon Fossen

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Geochemistry</td><td>Course Code</td><td colspan="3">ESM 21022</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM 12041</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">2</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>0</td></tr>
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</table>

Aim of the Course:

To provide students with basic concepts in geochemistry

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

- Demonstrate an understanding of basic principles of geochemistry and their applications to geological studies
- Describe element distribution in major rocks
- Apply the principles of isotopes to dating of rocks

Course Capsule:

Introduction to geochemistry, Differentiation of and cosmic abundance of elements, Chemical behavior of different classes of elements, Trace element, Chemistry of igneous, metamorphic and sedimentary rocks, Radioactive isotope geochemistry, Stable isotope geochemistry, Introduction to geochronology

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Field Report) – 30%
- End Semester Examination – 70%

References:

5. Geochemistry, by William M. White
6. Geochemistry: Pathways and Processes, by Harry Y. McSween and Steven M. Richardson
7. Introduction to Geochemistry: Principles and Applications, by Kula C. Misra
8. Geochemistry: An Introduction, by Francis Albarède
9. Principles of Environmental Geochemistry, by Nelson Eby

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Crystallography and Mineralogy</td><td>Course Code</td><td colspan="3">ESM 22032</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM 12041</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">I</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>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in crystallography and mineralogy

Intended Learning Outcomes:

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

- Define a mineral correctly and to classify minerals based on chemical and structural characteristics
- Apply crystallographic concepts in identifying minerals
- Use physical properties to identify minerals
- Decide the economic potential of a mineral based on mineralogical concepts

Course Capsule:

Space lattice, Crystallographic symmetry, Forms and habits, Classes and systems, Millar indices, Twinning of crystals, Chemistry and structure of minerals, Industrial and rock-forming minerals, Physical properties of minerals, Classification of minerals, Silicate mineral group

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70%

References:

1. Crystallography and Crystal Structure by Arora G.D.
2. An Introduction to Crystallography by Phillips F.C.
3. Essentials of Crystallography by Duncan McKie and Christine McKie
4. Introduction to Mineral Science by Andrew Putins
5. Manual of Mineralogy by Klein Hurburt
6. Minerals, Rocks and Fossils by Bishop H.C.
7. Economic Minerals by U. Prasad
8. Economic Minerals of Sri Lanka by Herath

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Petrology</td><td>Course Code</td><td colspan="3">ESM 22042</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM 12041, ESM 22032</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">2</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>0</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with comprehensive introduction to igneous, sedimentary, and metamorphic rocks.

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

- Identify the major minerals that make up igneous, sedimentary and metamorphic rocks.
- Identify the textures and structures found in igneous, sedimentary and metamorphic rocks
- Explain the origin of each of the different types of igneous sedimentary and metamorphic rocks.
- Explain where igneous sedimentary and metamorphic rocks are formed on the earth.

Course Capsule:

Physical properties of magma, Igneous environments, Minerals and textures of igneous rocks, Chemical constituents of igneous rocks, Mineral classification of igneous rocks (IUGS), Origin of sedimentary rocks, Different types of sedimentary rocks, Textural and mineralogical classification of sedimentary rocks, Depositional basins and lithification, Introduction to metamorphic rocks, Metamorphic facies, Metamorphic minerals, Metamorphic textures and structures, Metamorphic recrystallization, Common Metamorphic rock types

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70%

References:

1. Petrology: Igneous, Sedimentary, and Metamorphic, by Harvey Blatt and Robert Tracy
2. Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks, by Loren A. Raymond
3. Petrology: Principles and Practice, by Gautam Sen
4. The Illustrated Encyclopedia of Rocks of the World: A Practical Guide To Over 150 Igneous, Metamorphic And Sedimentary, by John Farndon

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Practical in Crystallography, Mineralogy and Petrology</td><td>Course Code</td><td colspan="3">ESM 22051</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 22032, ESM 22042</td></tr>
<tr><td rowspan="3">Level</td><td rowspan="3">2</td><td rowspan="3">Semester</td><td rowspan="3">II</td><td rowspan="3">Credits</td><td rowspan="3">01</td><td>Theory (hr)</td><td>-</td></tr>
<tr><td>Practical (hr)</td><td>45</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with practical skills in identifying crystals, minerals and rocks

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

- Identify the system and class of a crystal based on its symmetry
- Name a crystal of a given class and find the miller index of a given face
- Recognize the most important rock forming and industrial minerals from their physical properties
- Recognize the most important rocks from their mineralogical and textural characteristics

Course Capsule:

Practical study on crystallography: determination of symmetry, recognizing the crystal system and class, assigning miller indices to crystal faces, recognizing different types of twinning; Practical study on most important rock forming minerals and industrial minerals : testing of physical properties of minerals and identification, Practical study on common rock types: identifying minerals and textures, naming the rocks

Mode of Assessment:

- Continuous Assessment (Practical)) – 50%
- End Semester Practical Examination – 50%

References:

1. Introduction to Mineralogy and Petrology, by S. K. Haldar
2. Mineralogy (3rd Edition), by Dexter Perkins
3. Introduction to Optical Mineralogy and Petrography - The Practical Methods of Identifying Minerals in Thin Section, by M. G Edwards
4. Earth Materials: Introduction to Mineralogy and Petrology, by Cornelis Klein and Anthony Philpotts

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Soil Mechanics and Hydrology</td><td>Course Code</td><td colspan="3">ESM 31012</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM12041</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 (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in soil science and hydrology

Intended Learning Outcomes:

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

- Explain how soil is formed and degraded
- Apply basic tests to characterize a soil
- Explain the presence and distribution of water in different terrestrial environments
- Measure and modal hydrological parameters

Course Capsule:

Soil formation, Soil composition, Soil profiles, Physical properties of soil, Soil chemistry, soil water movement, Chemical composition of soil, Soil degradation, Introduction to hydrological cycle and water balance, Basic processes of the hydrological cycle, Hydrological parameters (precipitation, evapotranspiration, infiltration, groundwater flow, surface runoff and streamflow, etc.), Measuring, estimating and modelling of hydrological parameters, Sources of stream flow, Characterization of streams, Hydrographs, Rating curves

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70%

References:

1. Soil Science and Management, by Edward Plaster
2. Elements of the Nature and Properties of Soils (3rd Edition), by Nyle C. Brady and Ray R. Weil
3. Soil Science Simplified, by Neal Eash and Cary J. Green
4. Introduction to Hydrology (5th Edition), by Gary L. Lewis Warren Viessman Jr.
5. Environmental Hydrology, Second Ed., by Andy D. Ward and Stanley W. Trimble
6. Hydrology for Engineers, Geologists, and Environmental Professionals, Second Edition: An Integrated Treatment, by Sergio E Serrano Ph.D.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Geophysics</td><td>Course Code</td><td colspan="3">ESM 31022</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM12041</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 (hr)</td><td>25</td></tr>
<tr><td>Practical (hr)</td><td>15</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with the basic concepts in geophysics

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

- Explain how physical properties of rocks and minerals are connected to geophysical information.
- Apply geophysical methods to geology related problems, including natural hazards, resource exploration and management, and environmental issues.
- Explain the benefits and limitations of using geophysics in a project

Course Capsule:

Introduction to geophysics, Physical properties of rocks and minerals, Seismology (Seismic waves, Earthquake seismology), Seismic imaging (reflection, refraction, etc.), The seismometer, Earth gravity, Mass distribution and relation to gravity, Gravity anomalies, The gravimeter, Introduction to ground penetrating radar and electrical methods, Geophysical application and their limitations

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments, Field work) – 30%
- End Semester Examination – 70%

References:

1. Fundamentals of Geophysics, by William Lowrie
2. Principles of Geophysics, by Norman Sleep and Kazuya Fujita
3. Whole Earth Geophysics: An Introductory Textbook for Geologists and Geophysicists, by Robert J. Lillie
4. Solved Problems in Geophysics, by Elisa Buforn and Carmen Pro
5. Applied Geophysics for Geologists and Engineers (Pergamon international library of science, technology, engineering, by Donald Harrison Griffiths and Roy Favell King

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Geology of Sri Lanka</td><td>Course Code</td><td colspan="3">ESM 31031</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 21012, ESM 22042</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">01</td><td>Theory (hr)</td><td>15</td></tr>
<tr><td>Practical (hr)</td><td>-</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with comprehensive knowledge in geology of Sri Lanka

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

- Explain the geological evolution of Sri Lanka
- Identify different rock types and structures found in Sri Lankan terrain
- Recognize mineral deposits in Sri Lanka
- Apply the acquired knowledge for geological mapping

Course Capsule:

Geological and Tectonic Evolution of Sri Lanka, Crystalline metamorphic terrain and major subdivisions, Cooling history and exhumation of metamorphic rocks, Metamorphic conditions, Geochronology of the crystalline terrain, Deformational events and structures in the crystalline terrain, Development of faulted basins, Jurassic sedimentary rocks, Miocene beds, Quaternary formations

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70%

References:

1. Physical Geology: The Science of Earth, by Charles Fletcher
2. Cooray, P.G., 1984, An introduction to the geology of Sri Lanka (Ceylon)
3. Kröner, A., Cooray, P.G., and Vitanage, P.W., 1991, Lithotectonic subdivision of the Precambrian basement in Sri Lanka
4. Cooray, P.G., 1994, The Precambrian of Sri Lanka: a historical review, Precambrian Research

<table>
<tr><td rowspan="2">Course Title</td><td></td><td colspan="3" rowspan="2">Oceanography</td><td>Course Code</td><td colspan="3">ESM 32042</td></tr>
<tr><td></td><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM 12041</td></tr>
<tr><td rowspan="3">Level</td><td></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 (hr)</td><td>30</td></tr>
<tr><td></td><td>Practical (hr)</td><td>0</td></tr>
<tr><td></td><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with basic concepts in oceanography

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

- Demonstrate a comprehensive understanding of all the branches of Oceanography
- Explain surface and deep ocean circulation and their driving mechanisms
- Explain the composition of sea water and its properties as well as an understanding of the chemical cycles in the ocean and their evolution
- Demonstrate an understanding of mechanisms generating ocean bathymetry and sedimentation

Course Capsule:

Introduction to physical, biological, chemical and geological oceanography, Ocean morphology, Marine stratigraphy, Ocean curst, Ocean circulation, Sea level history and seismic stratigraphy, Continental shelf and continental margin, Ocean sediments, microfossils and mineral resources

Mode of Assessment:

- Continuous Assessment (Quizzes, Assignments) – 30%
- End Semester Examination – 70%

References:

1. Oceanography: An Invitation to Marine Science, by Tom S. Garrison
2. Essentials of Oceanography (11th Edition), by Alan P. Trujillo and Harold V. Thurman
3. Invitation to Oceanography, by Paul R. Pinet
4. Ocean Studies: Introduction to Oceanography, by Joseph M. Moran
5. Essentials of Oceanography, by Tom S. Garrison

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Environmental Geochemistry</td><td>Course Code</td><td colspan="3">ESM 32052</td></tr>
<tr><td>Prerequest</td><td colspan="3">ESM 11012, ESM 11021, ESM 12041, ESM 21022</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 (hr)</td><td>22</td></tr>
<tr><td>Practical (hr)</td><td>24</td></tr>
<tr><td>Independent Learning (hr)</td><td>-</td></tr>
</table>

Aim of the Course:

To provide students with comprehensive introduction on environmental geochemistry

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
- Examine and decide the suitability of water for different applications
- Recognize the sources of water and air pollution and assess the impact of the pollutants on decline of environmental quality

Course Capsule:

Biogeochemical cycles, Physical and chemical properties of water, 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:

- Continuous Assessment (Quizzes, Practical, Assignments,) – 30%
- End Semester Examination – 70%

References:

1. Principles of Environmental Geochemistry, by Nelson Eby
2. An Introduction to Environmental Chemistry, by Julian E. Andrews and Peter Brimblecombe
3. Groundwater Geochemistry: A Practical Guide to Modeling of Natural and Contaminated Aquatic Systems, by Broder J. Merkel and Britta Planer-Friedrich
4. Chemical Fundamentals of Geology and Environmental Geoscience, by Robin Gill

DETAIL SYLLABUS OF MATHEMATICS II

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Vector Calculus</td><td>Course Code</td><td colspan="3">MTM 11512</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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></td></tr>
</table>

Aims:

To extend the fundermantal concept of infiniticimal calculus from the view point of vector valued functions of many variables and to explore the knowledge in applications by providing some of their many and varied applications.

Intended Learning Outcomes:

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

1. Differntiate vector valued functions and apply results to find arc length, tangents and normals to curves.
2. Calculate gradient, divergent and curl of a vector functions.
3. Apply knowledge of the gradient, divergent and curl of a vector function to describe physical phenominan.
4. Find arc length, area element and volume element in an orthogonal coordinate system, specially for cylindrical polar coordinates and spherical polar coordinates.
5. Evaluate gradient, divergent and curl in an orthogonal coordinate system.
6. Evaluate line integral and discuss their path independence.
7. Solve physical problems by evaluating line integrals.
8. Evaluate surface integral and use it to find a flux of a vector field and to find the syrface area.
9. Compute volume integrals and use it to find a volume enclosed by a surface.
10. Use integral theorems related to line, surface and volume integrals to solve problems.

Course content:

- Differentiation and integration of vector functions;
- Space curves; Tangent and normal; Scalar and vector fields; Directional derivative;
- Gradient vector; Divergence; Curl; Vector identities; Scalar potential of conservative fields;
- Orthogonal curvilinear coordinates: Coordinate surfaces, Coordinate curves and related unit vectors; Elements of arc length; Area and volume; Cylindrical polar coordinates; Spherical polar coordinates and others.
- Line integrals; Path independence.
- Surface integrals; Green's theorem in the plane.
- Volume integrals; Divergence theorem; The Curl and Stoke's theorem.
- Vector potential; Irrotational and solenoidal vector fields; Laplace's equation and its simple solutions.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2, ILO-3) -Closed book exam- 7.5%
  Assessemnt-2 (ILO-4, ILO-5) -Closed book exam -7.5%
  Assessment-1 (ILO-6, ILO-7) -Closed book exam- 7.5%
  Assessemnt-2 (ILO-8, ILO-9, ILO-10) -Closed book exam -7.5%
- End Semester Examination(ILO 1 - 5) –70%
  Closed book exam - 2 Hours

References:

1. Murray R. Spiegel, *Vector Analysis, 2nd edition*, McGraw-Hill, 2009;
2. Shanti Narayan, Text book of vector calculus, S. Chand & Company Ltd., 2003;
3. M.D. Raisinghaniya, *Vector Analysis*, S. Chand & Company Ltd.,1997.

Course Title	Numerical Analysis I			Course Code	MTM 11521		
				Prerequisites			
Year	1	Semester	1	Credits	1	Theory (hr)	15
						Practical (hr)	
						Independent Learning (hr)	

Aim of the Course:

To solve algebraic and transcendental equations.

Intended Learning Outcomes:

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

1. Represent the numbers used in text, computer arithmetic;
2. Solve an algebraic or transcendental equation using appropriate numerical methods;
3. Solve a linear difference equations using numerical methods.

Course content:

- Number system and Errors.
- Solution of equations in one variable: Bisection method, Fixed-Point iteration, Method of False position, Newton–Raphson Method.
- Collocation polynomials, Factorial polynomials, Osculating polynomials, Taylor polynomials.
- Linear difference equations of first and second order.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1) -Closed book exam -10%
  Assessemnt-2 (ILO-2) – Open book exam -10%
  Assessment-3 (ILO-3) - Assignment -10%
- End Semester Examination –70%
  Closed book exam - 1 Hour

References:

1. Richard L. Burden and J. Douglas Faires, *Numerical Analysis*, PWS Publishing Company, 1993.
2. Curtis F. Gerald and Patrick O. Wheatley,*Applied Numerical Analysis*, Pearson Education, Inc. 2004.
3. Francis Scheid, *Numerical Analysis*, Tata McGraw-Hill Publishing Company Ltd., 2004.

Course Title	Differential Geometry			Course Code	MTM 12542		
				Prerequisites	MTM 11022		
Year	1	Semester	2	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aim:

To describe how techniques from advanced calculus and vector algebra may be used to give meaning to the concept of "shape" for curves and surfaces in space.

Intended Learning Outcomes:

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

1. Define the basic terms related to differential geometry of the space curves.
2. Find the fundamental triad of lines (tangent, principal normal and bi-normal) and planes (osculating, normal and rectifying).
3. Derive and use expressions to compute the curvature and torsion of a space.
4. State Serret-Frenet formulae for a space curve and use them to compute the curvature, torsion and the fundamental triads of lines and planes.
5. Derive equations for osculating circles, involutes and evolutes of a space curve.
6. Describe the properties of helices.
7. Define the basic terms related to surfaces in the study of differential geometry.
8. Describe coordinate patches of surfaces and regular surfaces.
9. Find and explain envelopes, edge of regressions and developable surfaces.
10. Derive the expressions for edge of regressions of osculating, polar and rectifying developable.
11. Compute the first and second fundamental forms of a surface.
12. Compute various types of curvatures associated to a surface.
13. Describe the concept of ruled surfaces.

Course Capsule/Details:

- Introduction, Parameterized curves, Arc-length, Re-parameterization of a curve;
- Tangent, Principal normal and bi-normal lines, Osculating plane, Normal plane and rectifying plane;
- Curvature and torsion, Serret-Frenet formulae;
- Osculating circle,
- Involutes and evolutes,
- Helices.
- Parameterized surfaces (patches), Regular surfaces.
- Tangent plane, Surface normal,
- curves on a surface: envelopes, edge of regressions, Developable surfaces;
- The first and the second Fundamental forms, Asymptotic curves, Principal curvatures, Mean and Gaussian curvatures, Skew surfaces, Minimal surfaces, Lines of curvature and, Ruled surfaces.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2, ILO-3) -Closed book exam- 7.5%
  Assessemnt-2 (ILO-4, ILO-5, ILO-6) -Closed book exam -7.5%
  Assessment-3 (ILO-7, ILO-8, ILO-9) -Closed book exam- 7.5%

Assessemnt-4 (ILO-10, ILO-11, ILO-12, ILO-13) -Closed book exam -7.5%

- End Semester Examination(ILO 1 - 13) –70%
  Closed book exam - 2 Hours

References:

1. Somasundaram D, *Differential Geometry A First Course*, Narosa Publishing House, 2005;
2. Shanti Narayan (Revised by P.K.Mittal), *A text book of vector calculus*, S. Chand & Company Ltd, 2003;
3. John Oprea, *Differential Geometry and its Applications***,** Prentice Hall, 1997**.**

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Numerical Analysis II</td><td>Course Code</td><td colspan="3">MTM 12531</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 11521</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">1</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>15</td></tr>
<tr><td>Practical (hr)</td><td></td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aim:

To calculate derivatives and integrals and to perform an error analysis for various numerical methods.

Intended Learning Outcomes:

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

1. Approximate a function using an appropriate numerical method.
2. Solve the differential equations using an appropriate numerical method.

Course content:

- Interpolation: Lagrange interpolation, forward and backward difference methods, Errors in interpolation, Extrapolation, Inverse interpolation.
- Numerical methods of solving differential equations: Euler methods, Linear multi-step methods, Taylor method, Runge -Kutta method.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1) -Closed book exam -10%
  Assessemnt-2 (ILO-2) – Open book exam -10%
  Assessment-3 (ILO-1,ILO-2) - Assignment -10%
- End Semester Examination –70%
  Closed book exam - 1 Hour

References:

1. Richard L. Burden and J. Douglas Faires, *Numerical Analysis*, PWS Publishing Company, 1993.
2. Curtis F. Gerald and Patrick O. Wheatley,*Applied Numerical Analysis*, Pearson Education, Inc. 2004.
3. Francis Scheid, *Numerical Analysis*, Tata McGraw-Hill Publishing Company Ltd., 2004.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Linear programming I</td><td>Course Code</td><td colspan="3">MTM 21512</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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></td></tr>
</table>

Aim:

To provide understanding how linear programming is used to find the best or optimal solution to a problem that requires a decision or set of decisions about how best to use a set of limited resources to achieve a state goal of objectives.

Intended Learning Outcomes:

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

1. Formulate linear programming problems from contextual problems;
2. Identify feasible regions for linear programming problems;
3. Find solutions to linear programming problems using graphical means;
4. Apply the simplex method using variables (slack, surplus, artificial);
5. Interpret the solutions of dual and primal problems.

Course content:

- Linear inequalities; Geometric approach; Feasible solution; Graphical method;
- Simplex method: Theory and computational procedure; Efficient computational techniques; primal dual relationship, unboundedness, degeneracy, big-M method, Duality theory; Revised simplex method, Sensitive analysis.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -10%
  Assessment-3 (ILO-4, ILO-5) - Open book exam – 10%
- End Semester Examination(ILO 1 - 5) –70%
  Closed book exam - 2 Hours

References:

1. Hamdy a. Taha, *Operations Research: An Introduction, 9th edition*, Prentice Hall, 2010;
2. Saul I. Gass, *Linear programming methods and Applications,Fifth Edition*, Dover Publications, 2010;
3. Robert J. Vanderbei, *Linear programming Foundations and Extensions, 2nd Edition*, Springer, 2010.

Course Title	Numerical Analysis III			Course Code	MTM 21522		
				Prerequisites	MTM 11521, MTM 12531		
Year	2	Semester	1	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aim:

To give students a solid foundation in the theory and techniques of numerical analysis and skills in solving mathematical problems numerically.

Intended Learning Outcomes:

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

1. Study the knowledge of fundamental material in numerical methods;
2. Solve system of linear equations;
3. Use algorithms and theorems to find numerical solutions and bounds on their error to numerical differentiation and numerical integration.
4. Identify and use proper numerical methods to solve boundary value problems.

Course content:

- Numerical methods of solving system of linear equations: Gaussian elimination and backward substitution, Iterative methods; Jacobi and Gauss - Seidal methods and their convergence;
- Numerical Differentiation and Integration: Differentiation formulae for equidistant nodes, Some important approximate quadrature formulae, Newton cotes formulae, Trapezoidal, Simpson and Romberg integration, Error estimates;
- Boundary value problems of ordinary differential equations: The linear shooting method, Finite difference method, Collocation method, Finite element method;
- Numerical solutions of partial differential equations.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -10%
  Assessment-3 (ILO-3, ILO-4) - Open book exam – 10%
- End Semester Examination(ILO 1 - 4) –70%
  Closed book exam - 2 Hours

References:

1. R. Gupta**,** *Golden Maths Series Numerical Analysis*, Laxmi publications (p) ltd, 2011;
2. Devi Prasad, *Introduction to Numerical Analysis,* Narosa Publishing House, 2005.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Mathematical Software (MATLAB)</td><td>Course Code</td><td colspan="3">MTM 22531</td></tr>
<tr><td>Prerequisites</td><td colspan="3">-</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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>30</td></tr>
<tr><td>Independent Learning (hr)</td><td></td></tr>
</table>

Aims:

To introduce the students to MATLAB and to give a solid foundation in basic graphical and programming essentials.

Intended Learning Outcomes:

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

1. Start and quit MATLAB software.
2. Identify and describe the MATLAB desktop: Command window, command history, workspace and current folder.
3. Use MATLAB as a tool for calculations.
4. Work with matrices and vectors.
5. Use built in functions, commands etc.
6. Explain and create scripts and functions.
7. Plot a given set of data and edit the plot.
8. Write MATLAB programs using the variables properly, applying relational and logical operations, using conditionals and loops.

Course content:

- Getting started with MATLAB, MATLAB windows, Arithmetic with MATLAB, Some elementary build-in functions, variables;
- Matrices with MATLAB: Creating matrices, Adding and deleting elements, Some build-in functions, Matrix operations;
- MATLAB Files: M–files, Script files, function files;
- Graphics: Two dimensional plots, Editing plots, Basic plotting functions, Three dimensional plots;
- Programming: Relational and logical operations, Flow controls: if, elseif, else; switch and case; for; while.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Practical exam- 10%
  Assessemnt-2 (ILO-3, ILO-4) -Practical exam -10%
  Assessment-3 (ILO-5, ILO-6) -Practical exam(open) – 10%
- End Semester Examination(ILO 1 - 8) –70%- 2 Hours

References:

1. Amos Gilat, *MATLAB An Introduction With Applications*, John Wiley and Sons, Inc., 2005;
2. Help menu of the software;
3. Online resources.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Tensor Calculus</td><td>Course Code</td><td colspan="3">MTM 22542</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 12542</td></tr>
<tr><td rowspan="3">Year</td><td rowspan="3">2</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></td></tr>
</table>

Aim:

To acquire knowledge of the theory and techniques used in tensors

Intended Learning Outcomes:

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

1. Demonstrate knowledge in basic concepts of tensor calculus required for further studies in general relativity;
2. Explain different types of tensors;
3. Apply the properties of different kind of tensors to solve physical and mathematical problems.

Course content:

Spaces of N-dimensions, Coordinate transformation, Summation convention, Contravariant, covariant and mixed tensors, Kronecker delta, Scalar or invariant, Tensor field, Fundamental operators with tensor, Symmetric and skew symmetric tensors, Metric tensor and conjugate metric tensor, Associated tensor, Christoffel's symbols, Transformation laws of Christoffel's symbols, Geodesics, Covariant derivative, Tensor form of a gradient, divergent and curl, Intrinsic or absolute derivative, Relative and absolute tensors.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1) -Closed book exam- 10%
  Assessemnt-2 (ILO-2) -Closed book exam -10%
  Assessment-3 (ILO-3) - Open book exam – 10%
- End Semester Examination(ILO 1 - 3) –70%
  Closed book exam - 2 Hours

References:

1. U. C. De Absos Ali Shaikh JoydeepSengupta, *Tensor Calculus*, Narosa Publishing House 2004;
2. James G. Simmonds, *A Brief on Tensor Analysis*, Springer-Verlag, 1994.

Course Title	Graph Theory			Course Code	MTM 22552		
				Prerequisites	-		
Year	2	Semester	2	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aims:

To provide a thorough introduction to the subject of graph theory and to make aware of advanced methods from structural graph theory.

Intended Learning Outcomes:

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

1. Define the terms related to graph theory
2. Compute basic numerical quantities associated to graph theory.
3. Explain the fundamental results describing the behavior of graph properties.
4. Prove elementary results in graph theory.
5. Use presented graph theory methods in other areas of mathematics.
6. Apply basic graph decomposition techniques.

Course content:

Introduction of Graphs, Representing Graphs, Graphs Isomorphism, Types of Graphs, Union, Complement and product of Graphs, Connectivity, Eulerian Graphs, Hamiltonian Graphs, Weighted Graphs and their Applications, The Chinese Postman problem and the Travelling Salesman problem, Introduction to trees, Applications of trees, Tree Traversals, Spanning Trees, Minimum Weighted Spanning Trees, Planar Graphs, Euler's Formula, Dual Graphs, Coloring Graphs, Map Coloring, Edge Coloring.

Time table Scheduling, Directed Graphs, Isomorphism of Digraphs and other Properties, Application of Directed Graphs and Tournaments, Line Graph, Line graphs and Traversability, Cut points, Bridges and Blocks, Hall's Marriage Theorem, Transversal Theory, Applications of Hall's Theorem, Manger's Theorem, Network Flows, Factorization, Introduction to Matroids, Examples of Matroids, Steiner systems, Application of steiner Triple systems, Partitions, Infinite graphs.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -10%
  Assessment-3 (ILO-5, ILO-6) - Open book exam – 10%
- End Semester Examination(ILO 1 - 6) –70%
  Closed book exam - 2 Hours

References:

1. R.Balakrishnan, K.Ranganathan, *A Text book of Graph Theory*, Springer, 2012;
2. Jonathan L. Gross, Jay Yellen, *Graph Theory and Its Applications*,Chapman and Hall/CRC; 2005;
3. Douglas B.West,*Introduction to Graph Theory*, Pearson, 2000.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Linear Programming II</td><td>Course Code</td><td colspan="3">MTM 31512</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 21512</td></tr>
<tr><td rowspan="3">Year</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></td></tr>
</table>

Aims:

To get idea about to solve any decision making problem in real life using well organized dicision making and modeling of deterministic and probabilistic system; to have an undestanding

Intended Learning Outcomes:

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

1. Solve special Linear Programming problem: transportation and networking problem.
2. Solve the problems dealing with repair and maintenance, scheduling and sequencing control of project etc.
3. Allocate recourse to various operations, logistic, movement of personal etc.
4. Make a optimum schedule for any kind of project by using project scheduling models.

Course content:

- Transportation, Assignment and Transshipment problems: formulating transportation problems, finding basic solutions, simplex method for transportation problems, Assignment problems, Hungarian Algorithm, transshipment problems.
- Network: Introduction, Maximum flow, shortest path; Project and scheduling using Critical Path Method (CPM) and Project Evaluation review Techniques (PERT).

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -10%
  Assessment-3 (ILO-2, ILO-3, ILO 4) - Open book exam – 10%
- End Semester Examination(ILO 1 - 6) –70%
  Closed book exam - 2 Hours

References:

- Hamdy a. Taha, *Operations Research: An Introduction, 9th edition*, Prentice Hall, 2010;
- Saul I. Gass, *Linear programming methods and Applications,Fifth Edition*, Dover Publications, 2010;
- Wayne L Winston, *Introduction to Mathematical Programming*, Thomson Learning; 4th edition 2002.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Ordinary Differential Equations</td><td>Course Code</td><td colspan="3">MTM 31522</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 21011</td></tr>
<tr><td rowspan="3">Year</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></td></tr>
</table>

Aim:

To facilitate the students with the basic knowledge of differential equations as well as various techniques involved in their solution.

Intended Learning Outcomes:

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

1. Recall the techniques of solving various types of second and/or higher order linear differential equations (DE) and hence solve them.
2. Solve systems of linear DEs in two or three variables.
3. Find a fundamental set of solutions of a system of linear DEs by eigenvalue method and hence find the exponential of the coefficient matrix.
4. Sketch phase portrait of the autonomous system and discuss the stability of the solutions.

Course content:

- Higher order linear differential equations; Equations with constant coefficients; Wronskian, *D* operators, Undetermined coefficients, Variation of parameters.
- System of Linear Differential Equations: *D* operator method.
- Equations with variable coefficients: The Cauchy–Euler equation, Frobenius series solution,
- Total differential equations, Simultaneous total differential equations.
- System of Linear Differential Equations: Eigenvector method, Fundamental matrix solution, exponential matrix.
- Non-linear autonomous systems, Phase plane, Phase portraits of linear systems, stability.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -10%
  Assessment-3 (ILO-3, ILO-4) - Open book exam – 10%
- End Semester Examination(ILO 1 - 4) –70%
  Closed book exam - 2 Hours

References:

1. Raisinghaniya M. D., *Ordinary and Partial Differential Equations*, S. Chand and company Ltd. New Delhi., 2008;
2. Dennis G. Zill, *A First Course in Differential Equations with Applications*, PWS Publishers., Boston, 1986;
3. H.T.H. Piaggio, *Differential Equations*, G.Bell and Sons Ltd., 1949.

Course Title	Topology			Course Code	MTM 31531		
				Prerequisites	MTM 22051		
Year	3	Semester	2	Credits	1	Theory (hr)	15
						Practical (hr)	
						Independent Learning (hr)	

Aims:

To understand the main concepts of topological spaces and to describe the continuous functions and homeomorphisms.

Intended Learning Outcomes:

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

1. Demonstrate knowledge of topological structure and define topology and its constructions
2. Distinguish open and closed subsets and construct closure, interior and boundary points.
3. Construct subspaces, bases, continuity and homeomorphisms.

Course Capsule/Details:

- Definition and some examples, Coaser and finer topology
- Neighborhoods and spaces;
- Closure, Interior and Boundary points;
- Subspaces;
- Bases and sub-bases for topology;
- Continuity and homeomorphism.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 15%
  Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -15%
- End Semester Examination(ILO 1 - 3) –70%
  Closed book exam - 1 Hour

References:

1. Seymour Lipschutz ,*General Topology*, McGraw-Hill Company, New York., 2011;
2. Munkres, J. R., *Topology*, J. R. Prentice-Hall of India Ltd., New Delhi., 2000;
3. Bert Mendelson, *Introduction to Topology*, Dover Publications Inc., 1990.

<table>
<tr><td rowspan="2">Course Title</td><td colspan="3" rowspan="2">Fluid Dynamics</td><td>Course Code</td><td colspan="3">MTM 32542</td></tr>
<tr><td>Prerequisites</td><td colspan="3">MTM 11512</td></tr>
<tr><td rowspan="3">Year</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></td></tr>
</table>

Aims:

- To learn the most basic notions of continuous mechanics and fluid dynamics of an inviscid fluid.

Intended Learning Outcomes:

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

1. Use the basic mathematical tools for the description of motions of a continuous medium;
2. Formulate the governing equations of fluid dynamics;
3. Solve these equations in simple cases;
4. Explain rational ideas about various fluid flows around us;
5. Identify and explain interesting applications of fluid dynamics.

Course content:

Ideal fluid, Equilibrium of a fluid, Kinematics of flow fluids, Continuity equation of motion, Circulations, Euler's equation for fluid motion, Bernoulli's equation, Bara-tropic fluid, Helmholtz equation for velocity vector, Kelvin's circulation theorem, Expanding bubbles, Irrotational motion, Velocity potential, Two-dimensional motion and stream function, Complex potential, Sources, Sinks, Doublets, Vortices, Milne-Thomson theorem, Flow past a cylinder, Flow past a sphere.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-3, ILO-4) -Closed book exam -10%
  Assessment-3 (ILO-4, ILO-5) - Open book exam – 10%
- End Semester Examination(ILO 1 - 5) –70%
  Closed book exam - 2 Hours

References:

1. Peter S. Bernard, *Fluid Dynamics*, Cambridge university press, 2015;
2. M.D. Raisinghania, *Fluid Dynamics - 5th edition*, S Chand & Co Ltd., 2003;
3. G. K. Batchlor, *An Introduction to Fluid Dynamics*, Cambridge university press, 1967.

Course Title	Classical Mechanics			Course Code	MTM 32552		
				Prerequisites	MTM 11022, MTM 21011		
Year	3	Semester	2	Credits	2	Theory (hr)	30
						Practical (hr)	
						Independent Learning (hr)	

Aims:

To familiarize with the basic laws and methods of classical mechanics; to develop their skills in the application of these laws to specific mechanical problems; to give theoretical knowledge in formulating, applying and analyzing mathematical models for physical situations.

Intended Learning Outcomes:

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

1. Explain and discuss the central concepts of classical mechanics, including force, energy, work, momentum, moments of inertia, torque and angular momentum;
2. Study the kinematical and dynamical theory of a particle and a rigid body (as a rotating frame;
3. Apply these results to seen and unseen physical situations by using them to set up a mathematical model and to find quantitative solutions;
4. Solve dynamical problems involving classical particles by using the Lagrangian formulation.

Course content:

Kinematical Motion of a Rigid Body: Definitions of kinematical motion of a rigid body, transition and rotation motion, infinitesimal displacement of a rigid body, rotating frame of reference (non-inertial frame), **motion of a particle near the Earth surface**: Equation of Motion of a Rigid Body: Equation of motion of a system of particles, moment of inertia, product of inertia, Euler's equations, Torque free motion of a rigid body, the invariable line and plane, the motion of a symmetrical rigid body, Eulerian angle, the motion of a Heavy symmetrical top with one point fixed, the condition for precession without nutation; **Lagrange's Equation of Motion:** Virtual displacement, work, D'Alembert's principle, generalized force, Lagrange's equation, the motion of symmetrical top under the action of gravity.

Assessment Strategy:

- Continuous Assessment – 30%
  Assessment-1 (ILO-1, ILO-2) -Closed book exam- 10%
  Assessemnt-2 (ILO-2, ILO-3) -Closed book exam -10%
  Assessment-3 (ILO-3, ILO-4) - Open book exam – 10%
- End Semester Examination(ILO 1 - 4) –70%
  Closed book exam - 2 Hours

References:

1. Herbert Goldstein, *Classical Mechanics*, Charles P Poole and John Safto Doling Kindsesly (India) Pvt. Ltd., 2008;
2. Gupta, Kumar, Sharma, *Classical Mechanics*, 1998;
3. V. B. Bhutia, *Classical Mechanics*, Narosa Publishing House, 1997.

DETAIL SYLLABUS OF PHYSICS

PHM 11012 General Physics

Intended Learning Outcomes:

- Define nature of forces.
- Demonstrate knowledge of Newton's Laws of Motion and apply them to simple physical systems.
- Define and describe inertial frames and inertial forces, and solve numerical problems.
- Demonstrate knowledge of the Law of Conservation of Energy, Conservation of Momentum and apply it to simple mechanical systems.
- Demonstrate knowledge of Rotational dynamics and Fluid mechanics, and apply them to simple physical systems.
- Define and describe Simple Harmonic Vibrations and solve numerical problems in vibrations.
- Describe progress waves and wave equation and demonstrate their applications in problem solving.
- Describe the characteristics and properties of waves.
- Describe how standing waves occur and describe the Doppler effect and demonstrate problem solving skills.

Course Capsule:

Fundamental Forces of Nature: Gravitational, Electromagnetic, Weak and Nuclear Forces. *Inertia and Motion:* Principle of inertia, Newton's Laws, Inertial mass and gravitational mass, Inertial frames, Galilean Transformation, Accelerating frames.
Inertial Force: Centrifugal and Coriolis force, Accelerating frames and gravity, Principle of Equivalence, Weightlessness. *Energy and Momentum:* Work and energy, Conservation of energy, Conservation of force, Linear momentum, Conservation of linear momentum, Force due to loss of momentum. *Rotational Dynamics:* Angular momentum, Torque, Moment of inertia, Conservation of angular momentum, Precession, Gyroscopes, Rolling bodies. *Fluid Mechanics:* Streamline flow, Bernorlli's theorem and it's applications, Airlift and drag.
Simple Harmonic Vibrations: Composition of simple harmonic vibration (a) at right angles; (b) in the same straight line, same period, using same amplitude phase diagram (c) in the same straight line, different periods. *Waves:* Types of waves, transverse and longitudinal waves, progressive wave, *wave* equation in a specific media (e.g. stretched string), superposition and interference of waves, Sound waves, Electromagnetic waves.

References:

- Newtonian mechanics : AP French (I,II,III)

- Physics for Scientists and Engineers, R.A. Serway, 9th Edition, (2013), Elsevier, USA.
- Fundamentals of Physics, Volumes 1 & 2 (2013), by D. Halliday, R. Resnick, J. Walker, John Wiley & Sons, New York.

PHM 11021 Physics in Biology and Medicine

Intended Learning Outcomes:

- Explain how forces acting on and in human body during bending, lifting, falling, etc and demonstrate simple physics models for such activities.
- Quantitatively determine forces acting on and in human body during the processes using these models and suggests some precautions for such activities in day to day life.
- Solve numerical problems based on the models for such activities.
- Describe the source of energy production of the body, thermal equilibrium, conservation of energy, exchange of energy during work done, etc.
- Explain mechanics of the cardiovascular system and of blood flow and pressure by the heart.
- Describe how Physics used for medical diagnostics purposes.
- Demonstrate the functions of some important medical instruments' and diagnostic applications.

Course Capsule:

Forces on and in the Human Body: Bending, lifting and falling; static and dynamic forces. *Energy, work and power of the body:* Conservation of energy in the body; Energy changes in the body; Work and power; Heat losses from the body. *Physics of the Cardiovascular system:* The heart and circulatory system; Work done by the heart; Blood pressure and blood flow; Cardiovascular instrumentation. *Feedback and Control system:* Simple feedback control system; examples relating to the body. *Physics of diagnostic Techniques:* X-rays, Nuclear radiation, Ultra sonic scanning, Magnetic Resonance Imaging, etc., Laser in medicine, Radiation therapy and radiation protection.

References:

- **Physics With Illustrative Examples From Medicine and Biology: Statistical Physics by**
- **G. B. Benedek, F.M.H. Villars, Springer Science & Business Media (2000).**
- Jean A. Pope, Medical Physics.
- J.R. Cameron , J.G. Skofronsick, Medical Physics.

PHM 12032 Thermal and Environmental Physics

Intended Learning Outcomes:

- Define and describe different types of thermodynamics processes.
- State and describe thermodynamics laws and demonstrate related applications and solve numeral problems.
- Describe function of a heat engine.
- Define entropy and apply various thermals system and conditions.
- Describe kinetic theory of gases.
- Describe physical environment
- Understand the atmospheric compositions and profile and use thermodynamic theories to the atmosphere
- perform calculations within the selected environmental topics.

Course Capsule:

Thermodynamic systems, State of a system, state variables, equation of state, thermodynamic equilibrium, zeroth law of thermodynamics. *Thermodynamic processes:* adiabatic, Reversible and non-reversible, isothermal, isobaric, isochoric; isobaric volume expansively, isothermal compressibility. Fundamental concepts, Equations of states, First law of Thermodynamics, heat, work, internal energy, applications of First Law; Entropy and the Second Law of thermodynamics, Carnot cycle, Combined first and second laws, General thermodynamic functions, Phase transformation, Thermoelectricity.
Introduction: The environment, *Physical environment:* Lithosphere, Hydrosphere, Atmosphere, Energy and radiation. The solar system, the Earth's and its rotation, Earth's crust and Geomagnetism. The Hydrosphere, The hydrological cycle, Properties of water. *The Atmosphere:* Principal layers, troposphere, stratosphere, mesosphere, thermosphere, exosphere, Magnetosphere; The chemical composition of the Earth's atmosphere; the Ideal gas model (the parcel view), exponential variation of pressure with height, Temperature structure and lapse rate. Measuring the water content of the atmosphere, humidity; cloud formation, Growth of water droplets in clouds, Rain and thunderstorms.

References:

- Basic Thermodynamics, By Evelyn Guha, 4th Edition (Narosa Publication)
- Thermodynamics An Engineering Aproach, By Yunus A. Cengel Michael A.Boles, 4th Edition(McGRAW-HILL International)
- Environment and Pollution, R.S. Ambasht & P.K.Ambasht, 4th Edition(CBS Publishers)

PHM 12041 Introductory Nonoscience and Technology

Intended Learning Outcomes:

At the end of the course students should be able to have a clear understanding and an appreciation of nanomaterials and their fabrication and applications in materials science, electronics, medicine and environment.

Course Capsule:

Introduction and Historical aspects of Nanotechnology, Overview of different nanomaterials available, Special properties of Nano materials, Top down and bottom up fabrication methods**,** Carbon Nanotubes, Graphene; Atomic Force Microscope (AFM) and SEM for nanomaterial characterization (very briefly). Potential uses of nanomaterials in electronics, robotics, computers, sensors in textiles, sports equipment, mobile electronic devices, vehicles and transportation. Medical applications of nanomaterials, Nanotechnology for a Sustainable Environment.

References:

- Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, B. Raj, B.B. Rath, J. Murday, Springer (2013).
- The Physics and Chemistry of Nanosolids, Frank Owens and C. Poole, John Wiley, 2008.
- Nano-The essentials, T. Pradeep, McGraw Hill, 2008.

PHM 21011 Electromagnetism

Intended Learning Outcomes:

- Clearly describe and apply Coulomb's law and Gauss's law in Electrostatics.
- Obtain a relation between electric potential and electric field, apply it to different charged conductors and use to determine the capacitance of the various shapes of capacitors.
- Solve various numerical problems based on these laws
- Describe various magnetic properties of matters and define magnetic susceptibility, Permeability and hysteresis.
- Clearly explain Electromagnetic laws, Biot-Savart Law, Helmholts coil, Amperes circuital theorem and its applications.
- Solve various numerical problems on Electromagnetic applications.
- Describe electromagnetic induction and define self and mutual inductance.

Solve various numerical problems on electromagnetic induction applications

Course Capsule:

Electrostatics: Review of basic concepts of electrostatics, Coulomb's Law, Electric flux and Gauss's Law, Potential difference, Equipotential surfaces, Charge distribution on conductors, point discharge, Particle precipitators, Metellic capacitors, Dielectrics, Electric susceptibility, Permitivity.
Magnetism: Origin of dia-, para- and ferro-magnetism, magnetic susceptibility, Permeability and hysteresis, magnetic circuits and recording devices. *Electromagnetics:* Biot-Savart Law, Helmholts coil, Amperes circuital theorem and their applications, Laws of electromagnetic induction, Self and mutual inductance. Electromagnetic waves.

References:

- Grant I S, Phillips W R, Electromagnetism, John Wiley & sons, (7th ed.).
- Powell, R.G; G.E. Drabble, Electromagnetism, London Macmillan.
- Electromagnetic Fields and Waves: Including Electric Circuits, by P. Lorrain and F. L. Freeman (1988).

PHM 21022 Quantum and Atomic Physics

Intended Learning Outcomes:

- Understand the concept of blackbody radiation, Photoelectric effect, Compton effect Planck's hypothesis, and Einstein's quantum explanation.
- Explain why light can be consider to be small packets of energy
- Describe evidence for the particle nature of light and wave properties of matter
- Understand how to use the wave function and Schroedinger's equation to account for the tunneling of a particle through a barrier
- Recognize the relation between the magnetic dipole moment of an atom, and its angular momentum quantum number
- Explain atomic orbital and spin angular momentum, atomic spectra and electron spin.

Course Capsule:

Birth of Quantum Theory: Failure of classical physics and the birth of quantum Physics: Black body radiation and the Planck's hypothesis of quantization of radiation, the photoelectric effect, Einstein's quantum explanation, Compton effect, the dual nature of electromagnetic radiation. Matter waves and De Broglie's hypothesis, Davission-Germer experiment, the Millikan's oil drop experiment and particle nature of electron, wave-particle duality of matter, the uncertainty principle.
Quantum Mechanics: The Heisenberg's Uncertainty Principle, probability amplitude and wave function, Scrödinger's equation, interpretation of wave function, probability density, expectation value, momentum and energy, time-independent Scrödinger's equationand it's solutions in some

simple cases: The free particle, 1-D potential well and energy quantization, 1-D potential step and potential barrier; reflection and transmission coefficients, tunnelling.
Atomic Physics: Atomic spectra: Thomson's and Rutherford's model of atom; Bohr theory of hydrogen atom, quantization of momentum and energy, excitation and ionization energies, hydrogen-like atoms, Frank-Hertz experiment, x-rays and their origin X-ray spectra, Moseley's Law. *Application of Scrödinger's equation to hydrogen atom:* Introduction to 3-D Scrödinger's equation and out line of the solution in spherical polar coordinates, spherical harmonics, wave functions, energy levels, quantum numbers *n, l,* and *m,* probability density, selection rules, comparison with Bhor theory and Rhdberg's formula, spectroscopic notation. *Angular Momentum:* Orbital, spin and total; L-S coupling and j-j coupling, selection rules. Effect of external magnetic field: normal and anomalous Zeeman effect, Zeeman pattern of hydrogen and sodium D-lines.

References:

- Modern Physics, Kenneth Krane, 2nd Edition
- Fundamentals of Modern Physics, Robert Martin Eisberg
- Atomic and Nuclear Physics, John Yarwood

PHM 21031 General Physics Laboratory - I

Intended Learning Outcomes:

- Arrange experimental set up and perform the experiments covering the areas on electromagnetism and quantum and atomic physics and collect data, record data, and analyse and interpret observations thereby comprehend the behavior of physical systems according to the laws of Physics.
- Demonstrate the ability for team work with peers while experimenting in the laboratory.
- Analyze data with error estimation and interpret the results in the context of the aim of the experimental investigation.
- Develop the scientific writing skills to write lab reports.

Course Capsule:

Experiments based on Electromagnetism (PHM 21011) and Quantum and Atomic Physics (PHM 21022).

References:

- Laboratory Handouts

PHM 22042 Oscillations and AC Theory

Intended Learning Outcomes:

- Analyze several examples of oscillators,
- Understands free vibrations, damping vibrations and forced vibrations and derive relevant equations, and Solve numerical problems in Oscillation.
- Calculate energy of oscillation and define Q-factor.
- Describe forced oscillation and power absorption.
- Analyze D.C. circuit with elements of capacitor, inductor and resistor, and define transients currents.
- Understand alternative current (A.C.) and analyze different A.C. circuits

Course Capsule:

Oscillatory motion: Harmonic oscillators, Solution of harmonic oscillator equation, light damping, critical and heavy damping, energy loss per cycle, Q-factor. *Forced Vibrations:* undamped oscillator with harmonic force, forced oscillations with damping, transient phenomena, power absorption by a driven oscillator, resonance (electrical, optical nuclear). *Coupled oscillators*: two coupled oscillators, normal modes, resonance.
Review of D.C. circuits: circuits theorems, D.C. transients in C-R and L-R and circuits. *A.C. generation:* variation of voltage and current with time, amplitude, frequency, period, phase difference, peak value, rms value, average value. AC through resistor, inductor and capacitor, impedance and phase difference; series L-R and C-R circuits, impedance, admittance and phase diagram. *Use of complex numbers in ac circuit analysis:* complex impedance, C-R, L-R and L-C circuits, RC filters – low pass. High pass and band pass; *series L-C-R (acceptor) circuits:* resonance, power dissipation, power factor, Q-factor, band width, AM radio receiver. Parallel LC (rejecter) circuit and generation of em waves; *Transformers:* coupling coefficient, impedance matching; A*.C. measurements:* A.C. Bridges, bridge circuits to measure L, C and frequency. Single phase and three phase systems.

References:

- Vibrations and Waves by A.P. French
- Vibrations and Waves by W. Gough
- Electricity and Magnetism: J. Yarwood

PHM 22052 Electronics

Intended Learning Outcomes:

- Describe the electrical conduction mechanism in semiconductors.
- Demonstrate knowledge in solid state diodes and applications: Rectifier, solar cell, LED, etc
- Describe the operation and function of MOSFET and BJT.
- Analyze and design amplifier electronic circuits using MOSFET and BJT.
- Explain the frequency response of the amplifier
- Describe feedback concept in amplifier circuits and advantages
- Demonstrate knowledge in operational amplifier and its applications
- Make use of the different representations of digital circuits: truth tables, circuit diagrams and logical world descriptions
- Explaining the operation of simple sequential circuits, including flip-flops, countersand registers.

Course Capsule:

Introduction to semiconductors: Intrinsic semiconductors, Positive hole concept, n-type and p-type semiconductors (extrinsic), electric conductivity and mobility.
Junction diodes: p-n junction, Diode characteristics, Rectifier circuits, Voltage multiplier circuits, other diodes: Zener diode and Zener regulator; light emitting diode (LED), photodiode, etc.
Transistor: Introduction to BJT and FET; Transistor action; d.c. characteristics; Basic BJT amplifier circuits – common base, common emitter and emitter follower; Transistor as a switch,
Feedback: Basic idea of feedback, effect of negative feedback on band width, on input and output impedance, on frequency dependent gain, and on distortion; Positive feedback and oscillators.
Operational Amplifiers: Inverting and non-inverting amplifiers, Op-amp based electronic ammeters and voltmeters, Analogue differentiators and integrators.
Digital Electronics: Basic logic concepts, Truth tables, Basic logic gates, Combinational logic circuits, Construction of full adder, Addition and Subtraction, Flip-Flop as a memory element.

References:

- Horowitz and Hill, The Art of Electronics, Cambridge University Press (2nd ed.).
- William H. Gothman, Digital Electronics, PHI Learning (2nd ed.).

PHM 22061 Electronic Laboatory I

Intended Learning Outcomes:

- Design simple analog and digital electronics circuits
- Explain the actions and functions of various types of simple electronics circuits
- Develop problem solving skills related to electronics circuitry.

Course Capsule:

Experiments based on PHM 22042 and PHM 22052.

References:

- Handouts

PHM 31012 Physical Optics and Optical Instruments

Intended Learning Outcomes:

- Define and understand the phenomena of interference, diffraction and polarization of light.
- Explain the experimental observations of interference and diffraction of light, and hence identify the conditions required to observe such wave behavior of light.
- Distinguish the formation of different types of interference and diffraction fringes.
- Apply the established theoretical concepts of wave optics in optical instrumentation, spectroscopy, holography, digital devices and fiber optics.
- Develop problem solving skills on interference and diffraction of light
- Describe how laser light differs from ordinary light.

Course Capsule:

Introduction: Nature of light, electromagnetic wave spectrum, Equation of progressive wave. *Interference:* Superposition of two sinusoidal waves, conditions necessary to observe interference of light, coherence and incoherence, division of wave-front and division of amplitude to obtain mutually coherent beams for interference. *Two beam interference by division of wave-front:* Young's double slit Experiment, Fresnel's biprism, Lloyd's mirror; *two beam interference by division of amplitude:* fringes of equal inclination and equal thickness, Michelson Interferometer, Newton's Rings, Wedge films, *Diffraction:* Introduction, Fraunhofer and fresnel diffraction, Huygens' principle, Fraunhofer diffraction by a single and double slit. *Polarization and scattering of light:* Polarisation by (a) crystal (b) reflection (c) Double reflection (d) scattering (of air molecules, colloidal particles), scattering and the colours in the sky.
Review of Fraunhofer diffraction, Fraunhofer diffraction by circular aperture, multiple slit diffraction, diffraction grating. *Resolving power of optical instruments:* The optical image and

diffraction, Rayleigh criterion for resolution of optical image, resolving power optical imaging - human eye, telescope, microscope; chromatic resolving power of prism spectrometer; Multiple beam interference and chromatic resolving power of grating and Fabry-Perot Interferometer. *Lasers:* principle of lasers, time and space coherence, gas and solid lasers, applications of lasers

References:

- Fundamentals of Optics, Francis A. Jenkins & Harvey E. White, Mc Graw-Hill International Editions
- Geometrical and Physical Optics , 3rd Edition, R.S. Longhurst, Orient Longman Publication
- A textbook of Optics, N. Subrahmanyam, S.Chand & Company Ltd

PHM 31022 Solid State Physics

Intended Learning Outcomes:

- Describe basic crystallographic definitions and their uses crystal studies
- Explain the laws in crystal diffractions and methods used in determining crystal structures.
- have the ability to classify solids according to their structures and their electrical, thermal and mechanical properties.
- Describe quantum mechanical free electron theory and properties of metals; failure of free electron model.
- Understand the band theory of solids and distinguish conductors, insulators and semiconductors.
- Understand the basic theory of Semiconductor Physics.
- Demonstrate the importance of understanding the nature of materials, their characterization and how it might be applied to real world situations.
- Develop problem solving skills related to Physics of materials.

Course Capsule:

Crystal structure: Chemical bonding in solids, the crystalline state, crystal symmetry and Bravais lattices, unit cell, basis and crystal structure, packing fraction; Indices of direction, crystal planes and Miller indices, reciprocal lattice. *Crystal diffraction:* Bragg's diffraction law, experimental methods in x-ray diffraction – rotating crystal method, Laue method and powder method; outline of electron and neutron diffraction.
Metals: Quantum mechanical free electron theory and properties of metals; failure of free electron model and the band theory of solids, conductors, insulators and semiconductors. *Semiconductor Physics:* The charge carriers, the concept of holes, intrinsic and extrinsic semiconductors, electrical conductivity of a semiconductor, the density of states, carrier concentration and Fermi energy level, Hall effect.

References:

- Charles Kittle, Introduction to Solid State Physics, John Wiley & Sons.
- Blakemore, J.S., Solid State Physics , Cambridge University Press,(2nd ed.).
- Ashcroft, Neil, W., Mermin, N., David, Solid State Physics, Thomson Brooks.

PHM 31031General Physics Laboratory II

Intended Learning Outcomes:

- Understand the interference and diffraction phenomena of light through their observations,
- Understand the nature of laser light and its applications
- Understand the nature of different materials by experiments on their physical properties
- Demonstrate problem solving skills related to optics and solid state materials, particularly on semiconductors based on experimental measurements of important parameters.

Course Capsule:

Experiments based on PHM 31012 and PHM 31022

References:

- Handouts

PHM 32041Statistical Physics

Intended Learning Outcomes:

- Distinguish between microscopic and macroscopic states of thermodynamic systems.
- Derive expressions for variations of microscopic properties of macroscopic thermodynamic systems
- Derive expressions for partition functions in order to derive thermodynamic state functions
- Understand the difference between statistical treatments for classical and quantum systems and hence apply Fermi-Dirac and Bose-Einstein statistics for fermions and bosons respectively.

Course Capsule:

Introduction, Energy states and energy levels, macrostates and microstates. Thermodynamic probability, Maxwell-Boltzmann Statistics, Fermi-Dirac Statistics, Bose-Einstein Statistics, Statistical interpretation of Entropy. Distribution functions and Comparison of them for indistinguishable particles; The Partition function; and some selected topics in statistical physics.

References:

- Statistical Physics(Introductory Course), Daniel J. Amit & Yosef Vebin, World scientific publishing
- Fundamentals of Statistical and Thermal Physics, F. Reif, McGraw-Hill/ Levant Book Publishers (1967).
- Introduction to Statistical Physics, Kerson Huang, CRC press, London.

PHM 32051 Special Theory of Relativity

Intended Learning Outcomes:

- Understand that simultaneity is relative to the observer.
- Demonstrate that the Lorentz transformations account for time dilation and length contraction.
- Explain how to relate the velocity of a particle in different Lorentz frames.
- Understands how the Lorentz transformation accounts for the ability of muons, created at the top of the atmosphere, are able to penetrate to the surface of the Earth
- Understand and use the relativistic relation between mass, energy and momentum, and its agreement with Newtonian physics at non-relativistic speeds.

Course Capsule:

Introduction: Review of the Galilean transformation and electromagnetic theory; the Michelson-Morley experiment, Einstein's postulates, the Lorentz Transformation; Simultaneity, time dilation and length contraction and the velocity transformations. Relativistic mechanics, transformation of momentum and energy, relativistic Doppler effect and space-time diagram and experimental verifications of the theory.

References:

- Introductory Special Relativity, WGV. Rosser, Taylor & Francis Publication
- Principles of Modern Physics, Ajay.K. Saxena, Narosa Publishing House
- **Introduction to Special Relativity, by Resnick, Wiley India Pvt. Limited (2007)**

PHM 32061 Nuclear Physics

Intended Learning Outcomes:

- Describe the atomic nuclei, binding energy and stability of various nuclei
- Distinguish between the three types of rays given off by radioactive nuclei
- Interpret the symbols used to label the isotopes of an element
- Explain the concept of half-life

- Distinguish between nuclear fission and nuclear fusion
- Describe the nature of neutrons in causing and sustaining nuclear fission
- Describe the equivalence of mass and energy
- Describe the advantages and problems associated with nuclear power
- Describe the advantages and problems associated with nuclear power.

Course Capsule:
Distribution of Nuclear matter: Rutherford's experiment of α – particle scattering; other experimental

References:
- Introductory Nuclear Physics, Kenneth S. Krane, John Wiley & Sons, Inc.
- Atomic and Nuclear Physics, John Yarwood, University Tutorial Press Ltd.
- Atomic and Nuclear Physics, N.Subrahmaniyan, S.Chand & Co Ltd.

PHM 32071 General Physics Laboratory III

Intended Learning Outcomes:

- Carry out experiments to demonstrate the advanced Physics.
- Explore the Physics based industries.

Course Capsule:

Experiments based on Advanced Physics and Industrial (Physics based) visits (4 days)

References:***

***** The details will be updated.