K.R. MANGALAM UNIVERSITY
THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Bachelors of Science (Hons) Mathematics

B.Sc. (Hons.) Mathematics

Programme Code: 11

2020-23

Approved in the 23rd Meeting of Academic Council Held on 23 June 2020

Member Secretary

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

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PREAMBLE

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The K. R. Mangalam University visualizes all its programmes in the best interest of their students and in this endeavour; it offers a new vision to all its Under-Graduate courses. It imbibes a combination of Learning Outcome-based Curriculum Framework (LOCF) and Choice Based Credit System (CBCS) for all its Undergraduate programmes. The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The CBCS provides an opportunity for the students to choose courses from the presecribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. The Undergraduate Programmes will prepare the students for both, academia and employability. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to emotional stability, well-being, critical thinking and also skills for employability.

The new curriculum of B.Sc. (Hons.) Mathematics offer courses keeping in view of the wide applications of Mathematics in science, engineering, social science, business and a host of other areas. All the courses are having defined objectives and learning outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of mathematics and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offer ample skills to pursue research such as a career in the field of mathematics and allied areas. The K. R. Mangalam University hopes the LOCF approach of the programme B.Sc. (Hons) Mathematics will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

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1.Introduction

The K.R. Mangalam Group has made a name for itself in the field of education. Over a period of time, the various educational entities of the group have converged into a fully functional corporate academy. Resources at KRM have been continuously upgraded to optimize opportunities for the students. Our students are groomed in a truly inter-disciplinary environment wherein they develop integrative skills through interaction with students from engineering, management, journalism and media study streams.

The K.R. Mangalam story goes back to the chain of schools that offered an alternative option of world-class education, pitching itself against the established elite schools, which had enjoyed a position of monopoly till then. Having blazed a new trail in school education, the focus of the group was aimed at higher education. With the mushrooming of institutions of Higher Education in the National Capital Region, the university considered it very important that students take informed decisions and pursue career objectives in an institution, where the concept of education has evolved as a natural process.

K.R. Mangalam University was founded in the year 2013 by Mangalam Edu Gate, a company incorporated under Section 25 of the Companies Act, 1956.

K. R. Mangalam University is unique because of its

i. Enduring legacy of providing education to high achievers who demonstrate leadership in diverse fields.
ii. Protective and nurturing environment for teaching, research, creativity, scholarship, social and economic justice.

Objectives

i. To impart undergraduate, post-graduate and Doctoral education in identified areas of higher education.
ii. To undertake research programmes with industrial interface.
iii. To integrate its growth with the global needs and expectations of the major stake holders through teaching, research, exchange & collaborative programmes with foreign, Indian Universities/Institutions and MNCs.
iv. To act as a nodal center for transfer of technology to the industry.
v. To provide job oriented professional education to the pecia student community with particular focus on Haryana.

2. About the School

The school imparts out both teaching and research through its various science disciplines viz Mathematics, Chemistry and Physics.

School of Basic and Applied Sciences imparts students technical knowledge, enhances their skill and ability, motivating them to think creatively, helping them to act independently and take decisions accordingly in all their scientific pursuits and other endeavors. It strives to empower its students and faculty members to contribute to the development of society and Nation.

The faculty is in constant touch with various experts in the relevant field and is willing to experiment with latest ideas in teaching and research.

The School comprises of Discipline of Chemistry, Physics and Mathematics.

VISION

School of Basic and Applied Sciences intends for continuum growth as centre of advanced learning, research and innovation by disseminating analytical and scientific knowledge in the areas of basic and applied sciences by promoting interdisciplinary research and scientific acumen.

MISSION

M1: Enable students to be scientists/ academicians /entrepreneurs by accomplishing fundamental and advanced research in diverse areas of basic and applied sciences.

M2: Build strong associations with academic organizations/industries for knowledge creation, advancement, and application of scientific fervor.

M3: Create conducive environment for lifelong learning.

M4: Empower students to be socially responsible and ethically strong individuals through value-based science education.

3. Programmes offered by the School

School offers undergraduate B.Sc. (Hons) Programmes and postgraduate M.Sc. Programmes. All these programmes are designed to impart scientific knowledge to the students and will provide theoretical as well as practical training in their respective fields.

3.1 B. Sc. (Hons.) Chemistry

This course aims to impart basic and applied knowledge in various branches in Chemistry with a view to produce good academics, researchers and professionals in the field.

Eligibility Criteria:- The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board in Science stream with an aggregate of 50% or more.

Course Outline:- Inorganic chemistry / Organic chemistry / Physical chemistry / Analytical methods in chemical sciences / Environmental chemistry / Biochemistry / Green Chemistry.

Career Options:- Opportunities exist in chemical industry, pharmacy, education and forensics.

3.2 B.Sc. (Hons.) Physics

Physics, as a stream of study, helps in understanding fundamentals and develop curiosity in understanding various physical aspects of universe. This course aims to impart basic and applied knowledge in physics with a view to produce good academicians, researchers and professionals in varied fields.

Eligibility Criteria: - The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board in Science stream with an aggregate of 50% or more.

Course Outline: - Mathematical Physics / Mechanics / Electricity & Magnetism/Waves & Optics / Thermal Physics / Digital Systems & Applications/Elements of Modern Physics/Analog Systems & Applications/Quantum Mechanics & Applications / Electromagnetic Theory / Statistical Mechanics/ Solid State physics / Elementary Nuclear Physics/ Elementary Particle Physics/Applied Optics.

Career Options: - Opportunities exist in academics, research laboratories and administration besides all the opportunities applicable to any other graduate like UPSC examination‘s, defense services and other govt. jobs.

3.3 B.Sc. (Hons.) Mathematics

Mathematics is a universal part of human culture. This course aims to impart basic and applied knowledge in Mathematics with a view to produce good Mathematicians and researchers. A degree in mathematics provides you with a broad range of skills in problem solving, logical reasoning and flexible thinking.

Eligibility Criteria: - The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board with an aggregate of 50% or more with Mathematics as a main subject.

Course Outline: - Calculus / Vector Calculus / Business Mathematics / Differential Equations / Solid Geometry / Computer Programming / Modern Algebra / Numerical Analysis / Linear Algebra / Real Analysis / Complex Analysis / Probability and Statistics / Operational research / Mechanics.

Career Options: - Mathematicians work in business, finance, industry, government offices, management, education and science.

Programme scheme: - For Programme scheme see Annexure.

4. Programme Duration

The minimum period required for the B.Sc. (Hons.) Programme offered by the University shall extend over a period of three Academic Years.

The maximum period for the completion of the B.Sc. (Hons) Programme offered by the University shall be five years.

5. Class Timings

The classes will be held from Monday to Friday from 09:10 am to 04:10 pm.

6. Syllabi

The syllabi of all programme offered by SBAS are given in the following pages. These are arranged as: (a) common courses (b) degree specific courses, in numeric order of the last three digits of the course code.

For each course, the first line contains; Course Code and Credits (C) of the course. This is followed by the course objectives, syllabus (Unit I to IV), Text book and reference books.

6.1 Syllabi of Common Courses in all B.Sc. (Hons.) Programme

BSCH125A ENVIRONMENTAL STUDIES (Credits 3)

Overview:

Everything that surrounds and affects living organisms is the environment. The environment includes all those things on which we are directly or indirectly dependent for our survival, whether it is living or biotic components like animals, plants or non-living or abiotic components like soil, air and water etc. It belongs to all, influences all and is important to all.

Environmental Protection Act (1986) defined ―Environment as the sum total of water, air and land, their interrelationship among themselves and with the human beings, other living organisms and materials.‖ Environmental studies are important since it deals with the most mundane problems of life like hygienic living conditions, safe and clean drinking water, fresh air, healthy food and sustainable development.

The syllabus for Environmental Studies includes conventional classroom teaching as well as field work. In this course the teacher simply acts as a catalyst to infer what the student observes or discovers in his/her own environment. Involvement of students in project work is one of the most effective learning tools for environmental issues. This syllabus is beyond the scope of textbook teaching and also the realm of real learning by observing the surroundings. The content of this course provides an overview of introduction to environment, concept of an ecosystem, various renewable and non-renewable resources, how are various biodiversity occur and different means to conserve these. This course also includes various types of pollution and environmental policies & practices related to the environment. Finally, it also highlights the relationship of human population with the environment. The course further integrates to project work such as visit to an area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds, and study of simple ecosystems. These studies are imperative as they form a unique synergistic tool for comprehensive learning process. This will help students to recognize and appreciate how technological advancement at global level, exponential growth of human population and their unlimited demands has put the environment at stake and has contaminated the environment worldwide.

Objective and Expected Outcome:

The main objective of the course is to create consciousness among the students with the idea about healthy and safe environment. This course is aimed to explain students that the rapid industrialization, crazy consumerism and over-exploitation of natural resources have resulted in degradation of earth at all levels. These changes need the discussion, concern and recognition at national and international level with respect to formulate protection acts and sustainable developments policies. It can be possible only if every citizen of

the nation is environmentally educated and gets involved into this matter at the grass root level to mitigate pollution.

After studying the course, the learners will be able to comprehend and become responsive regarding environmental issues. They will acquire the techniques to protect our mother earth, as without a clean, healthy, aesthetically beautiful, safe and secure environment no specie can survive and sustain. This is the only inheritance which every genera of specie passes to their future generation.

UNIT I

Introduction of Environmental Studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

Natural Resources: Renewable and Non-renewable Resources

Land resources: land use change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

Energy resources: Renewable and non- renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

UNIT II

Ecosystems: Definition and Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

Case studies of the following ecosystems:

a) Forest ecosystem

b) Grassland ecosystem

c) Desert ecosystem

d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biological Diversity: Levels of biological diversity; genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots ; India as a mega- biodiversity nation; Endangered and endemic species of India; Threats to biodiversity: Habitat loss,

poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UNIT III

Environmental Pollution: Types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks; Solid waste management: Control measures of urban and industrial waste; Pollution case studies.

Environmental Policies and practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. International agreements: Montreal & Koyoto protocol and convention on biological diversity. Nature reserves, tribal population and rights, human wild life conflicts in Indian context.

UNIT IV

Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Field work:

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc. Visit to a local polluted site-
Urban/Rural/Industrial/Agricultural.
Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems-pond, river, Delhi Ridge, etc.

TEXTBOOKS:

1. Erach Bharucha, Textbook of Environmental Studies, Universities Press (P) Ltd., Hyderabad, India.
2. Anubha Kaushik and C. P. Kaushik, Environmental Studies, New Age International Publishers (P) Ltd. New Delhi.

REFERENCE BOOKS:

1. A.K. De, Environmental Chemistry, New Age International Publishers (P) Ltd. New Delhi.
2. P. H. Raven, D. M. Hassenzahl & L. R. Berg, Environment, John Wiley & Sons, New Delhi.
3. J. S. Singh, S. P. Singh and S. R. Gupta, Ecology, Environmental Science and Conservation, S. Chand Publication, New Delhi.

BSEL155A COMMUNICATION SKILLS (Credits 4)

Course Level Learning Outcomes

1. Understand the basics of Grammar to improve written and oral communication skills.
2. Understand the correct form of English with proficiency
3. Improve student‘s personality and enhance their self-confidence.
4. Improve professional communication.
5. Enhance academic writing skills.

Course Content

UNIT I

Introduction to Communication: Importance of Communication Skills, Meaning, Forms & Types of Communication; Process of Communication; Principles of Effective Communication/7Cs, Barriers in Communication (Interpersonal, Intrapersonal and Organizational).

UNIT II

Academic Writing: Précis (Summary – Abstract – Synopsis – Paraphrase – Précis: Methods), Letter & Résumé (Letter Structure & Elements – Types of letter: Application & Cover - Acknowledgement – Recommendation – Appreciation – Acceptance – Apology – Complaint –Inquiry).Writing a proposal and synopsis. Structure of a research paper. Citations and plagiarism.

UNIT III

Technology-Enabled Communication: Using technology in communication tasks, E-mails, tools for constructing messages, Computer tools for gathering and collecting information; Different virtual medium of communication.

UNIT IV

Building Vocabulary: Word Formation (by adding suffixes and prefixes); Common Errors; Words Often Confused; One word substitution, Homonyms and Homophones; Antonyms &Synonyms, Phrasal Verbs, Idioms & Proverbs (25 each); Commonly used foreign words(15 in number);

UNIT V

Personality Development: Etiquettes& Manners; Attitude, Self-esteem & Self-reliance; Public Speaking; Work habits (punctuality, prioritizing work, bringing solution to problems), Body Language: Posture, Gesture, Eye Contact, Facial Expressions; Presentation Skills/ Techniques.

TEXTBOOK:

Kumar, Sanjay and Pushplata.*Communication Skills*.Oxford University Press, 2015.

REFERENCE BOOKS / SITES:

1. Mitra, Barun K. *Personality Development and Soft Skills*. Oxford University Press, 2012.
2. Tickoo, M.L., A. E.Subramanian and P.R.Subramaniam.*Intermediate Grammar, Usage and Composition*. Orient Blackswan, 1976.
3. Bhaskar, W.W.S., AND Prabhu, NS., ― English Through Reading‖, Publisher: MacMillan,1978
4. Business Correspondence and Report Writing‖ -Sharma, R.C. and Mohan K. Publisher: Tata McGraw Hill1994
5. Communications in Tourism & Hospitality- Lynn Van Der Wagen, Publisher: HospitalityPress
6. Business Communication-K.K.Sinha
7. Essentials of Business Communication By Marey Ellen Guffey, Publisher: ThompsonPress
8. How to win Friends and Influence People By Dale Carnegie, Publisher: Pocket Books
9. Basic Business Communication By Lesikar&Flatley, Publisher Tata McGraw Hills
10. Body Language By Allan Pease, Publisher SheldonPress

BSDM301A DISASTER MANAGEMENT (Credits 3)

Course Objective: The objective of the course is to create awareness about various types of disasters and to educate the learners about basic disaster management strategies. The course examines disaster profile of our country and illustrates the role played by various governmental and non- governmental organizations in its effective management. It also acquaints learners with the existing legal frame work for disaster management.

Learning Outcome: The course will -

1. Provide students an exposure to disasters, their significance and types.
2. Ensure that the students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
3. Provide the students a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
4. Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

UNIT I Introduction to Disasters: Concept and definitions- Disaster, Hazard, vulnerability, resilience, risks.

Different Types of Disaster: Causes, effects and practical examples for all disasters.

- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc
- Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc.

UNIT- II Disaster Preparedness and Response Preparedness

- Disaster Preparedness: Concept and Nature
- Disaster Preparedness Plan
- Prediction, Early Warnings and Safety Measures of Disaster.
- Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.
- Role of IT in Disaster Preparedness
- Role of Engineers on Disaster Management.
- Relief and Recovery
- Medical Health Response to Different Disasters

UNIT III Rehabilitation, Reconstruction and Recovery

- Reconstruction and Rehabilitation as a Means of Development.
- Damage Assessment
- Post Disaster effects and Remedial Measures.
- Creation of Long-term Job Opportunities and Livelihood Options,
- Disaster Resistant House Construction
- Sanitation and Hygiene
- Education and Awareness,
- Dealing with Victims‘ Psychology,
- Long-term Counter Disaster Planning
- Role of Educational Institute.

UNIT IV Disaster Management in India

- **Disaster Management Act, 2005:**

  Disaster management framework in India before and after Disaster Management Act, 2005, National Level Nodal Agencies, National Disaster Management Authority

- **Liability for Mass Disaster**

- Statutory liability
- Contractual liability
- Tortious liability
- Criminal liability
- Measure of damages

- **Epidemics Diseases Act, 1897: Main provisions, loopholes.**
- **Project Work**: The project/ field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived based on the geographic location and hazard profile of the region where the institute is located.

Reference Books:

- Government of India, Department of Environment, Management of Hazardous Substances Control
- Act and Structure and Functions of Authority Created Thereunder.
- Indian Chemical Manufacturers' Association & Loss Prevention Society of India, Proceedings of the National Seminar on Safety in Road Transportation of Hazardous Materials: (1986).
- Author Title Publication Dr. Mrinalini Pandey Disaster Management Wiley India Pvt. Ltd.
- Tushar Bhattacharya Disaster Science and Management McGraw Hill Education (India) Pvt. Ltd.
- Jagbir Singh Disaster Management: Future Challenges and Opportunities K W Publishers Pvt. Ltd.
- J. P. Singhal Disaster Management Laxmi Publications.
- Shailesh Shukla, Shamna Hussain Biodiversity, Environment and Disaster Management Unique Publications
- C. K. Rajan, Navale Pandharinath Earth and Atmospheric Disaster Management: Nature and Manmade B S Publication
- Indian law Institute (Upendra Baxi and Thomas Paul (ed.), Mass Disasters and Multinational Liability: The Bhopal Case (1986)
- Indian Law Institute, Upendra Baxi (ed.), Environment Protection Act: An Agenda for Implementation (1987)
- Asian Regional Exchange for Prof. Baxi., Nothing to Lose But our Lives: Empowerment to Oppose
- Industrial Hazards in a Transnational world (1989)
- Gurudip Singh, Environmental Law: International and National Perspectives (1995), Lawman (India) Pvt. Ltd.
- Leela Krishnan, P, The Environmental Law in India, Chapters VIII, IX and X (1999), Butterworths, New Delhi.

6.2 Syllabi of Courses specific to B.Sc. (Hons.) Mathematics

SEMESTER – I

BSMA121A **CALCULUS** **(Credits 4)**

Overview:

This is considered a first course in calculus, primarily for students intending to continue to advanced courses in calculus, and mathematics in general. Students conduct a detailed study of differential calculus and its applications, and are introduced to antiderivatives.

Course Learning Outcomes: This course will enable the students to:

i) Assimilate the notions of limit of a sequence and convergence of a series of real numbers.

ii) Calculate the limit and examine the continuity of a function at a point.

iii) Understand the consequences of various mean value theorems for differentiable functions.

iv) Sketch curves in Cartesian and polar coordinate systems.

v) Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Sequences and Integration: Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

Limit and Continuity: c $-$ δ definition of limit of a real valued function, Limit at infinity and infinite limits; Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Differentiability: Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Darboux‘s theorem, Rolle‘s theorem, Lagrange‘s mean value theorem, Cauchy‘s mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz‘s theorem.

Expansions of Functions: Maclaurin‘s and Taylor‘s theorems for expansion of a function in an infinite series, Taylor‘s theorem in finite form with Lagrange, Cauchy and Roche– Schlomilch forms of remainder; Maxima and minima.

Curvature, Asymptotes and Curve Tracing: Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

References:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*'Calculus (14th edition). Pearson Education.

BSMA171A CALCULUS LAB (Credits 2)

Overview:

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs.

Modeling of the following problems using MATLAB / Mathematica / Maple etc.

List of Practical's

- Plotting the graphs of the functions $exp(ax + b)$, $log(ax + b)$,$1/(ax + b)$, $sin(ax + b)$, $(ax + b)$, and to illustrate the effect of a and b on the graph.
- Plotting the graphs of the polynomial of degree 4 and 5.
- Calculate the limit and derivative of above function.
- Sketching parametric curves (eg. Trochoid, cycloid, hypocycloid).
- Obtaining surface of revolution of curves.
- Tracing of conics in Cartesian coordinates/polar coordinates.
- Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates)

BSMA123A ALGEBRA AND GEOMETRY (Credits 6)

Overview:

Algebra is designed to give students a foundation for all future mathematics courses. The fundamentals of algebraic problem-solving are explained. Students will explore the basic concepts of matrices, relation between the roots and coefficients of general polynomial equation in one variable, Nature of roots by inspection of change of sign of equations. Throughout the course the student learns how to apply the concepts in real-life situations.

This course will introduce to the analytic geometry with examples from real life and various sciences. In selecting such problems for our examples and exercises we highlighted this motivation by references to applications in the social, business, and life sciences. The course was prepared with three related objectives: concreteness, motivation and applicability.

Course Learning Outcomes: This course will enable the students to:

i) Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
ii) Familiarize with relations, equivalence relations and partitions.
iii) Employ De-Moivre‘s theorem in a number of applications to solve numerical problems.
iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
v) Find eigenvalues and corresponding eigenvectors for a square matrix.
vi) Explain the properties of three dimensional shapes.

Theory of Equations and Complex Numbers: Elementary theorems on the roots of an equations including Cardan‘s method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots, Integral and rational roots; Polar representation of complex numbers, The n^{th} roots of unity, De-Moivre‘s theorem for integer and rational indices and its applications.

Relations and Basic Number Theory: Relations, Equivalence relations, Equivalence classes; Functions, Composition of functions, Inverse of a function; Finite, countable and uncountable sets; The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering.

Row Echelon Form of Matrices and Applications: Systems of linear equations, Row reduction and echelon forms, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation, Matrix operations, Determinants, The inverse of a matrix, Characterizations of invertible matrices; Applications to Computer Graphics; Eigenvalues and eigenvectors, The characteristic equation and the Cayley-Hamilton theorem.

Planes, Straight Lines and Spheres: Planes-Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines- Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres- Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.

Locus, Surfaces, Curves and Conicoids: Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines.

References:

1. Titu Andreescu, & Dorin Andrica (2014). *Complex Numbers from A to...Z*. (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Macmillan India Ltd.
3. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
4. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
5. Edgar G. Goodaire & Michael M. Parmenter (2015). *Discrete Mathematics with Graph Theory*

   (3rd edition). Pearson Education Pvt. Ltd. India.
6. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.
7. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications*

   (5th edition). Pearson Education Pvt. Ltd. India.

BSMA126A LaTeX and HTML (Credits 2)

Course Learning Outcomes: After studying this course the student will be able to:
i) Create and typeset a LaTeX document.
ii) Typeset a mathematical document using LaTex.
iii) Learn about pictures and graphics in LaTex.
iv) Create beamer presentations.
v) Create web page using HTML.

Getting Started with LaTeX: Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.
Mathematical Typesetting with LaTeX: Accents and symbols, Mathematical typesetting (elementary and advanced)**:** Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

Graphics and Beamer Presentation in LaTeX: Graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions, Beamer presentation.

HTML: HTML basics, Creating simple web pages, Images and links, Design of web pages.

References:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Lamport, Leslie (1994). *LaTeX*: *A Document Preparation System*, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

BSMA176A LaTeX and HTML LAB (Credits 2)

Practical / Lab work to be performed in Computer Lab

- Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.
- Accents of symbols, Mathematical typesetting (elementary and advanced):
  Subscript/Superscript, Fractions, Roots, Ellipsis, Mathematical symbols, Arrays, Delimiters,
  Multiline formulas, Spacing and changing style in math mode.
- Graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions.
- Beamer presentation
- HTML basics, Creating simple web pages
- Adding images and links, Design of web pages

SEMESTER II

BSMA122A MULTIVARIABLE CALCULUS (Credits 4)

Overview:

The goal of this chapter is to see that many quantitates in various scientific fields depend on more than one variable: the strength of the gravitational force between two bodies depend on their masses and their distance apart; the monthly mortgage payments depend on the amount borrowed, the interest rate, and the number of years to pay off. Then we will see many different ways of representing functions of several variables including algebraic formulas, graphs, contour diagrams, cross sections, and numerical tables.

Course Learning Outcomes: This course will enable the students to:

i) Learn conceptual variations while advancing from one variable to several variables in calculus.

ii) Apply multivariable calculus in optimization problems.

iii) Inter-relationship amongst the line integral, double and triple integral formulations.

iv) Applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

v) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Partial Differentiation: Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Tangent planes, Chain rule, Directional derivatives, The gradient, Maximal and normal properties of the gradient, Tangent planes and normal lines.

Differentiation: Higher order partial derivatives, Total differential and differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables and more variables, Envelopes and evolutes.

Extrema of Functions and Vector Field: Extrema of functions of two and more variables, Method of Lagrange multipliers, Constrained optimization problems, Definition of vector field, Divergence, curl, gradient and vector identities.

Double and Triple Integrals: Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals, Dirichlet integral.

Green's, Stokes' and Gauss Divergence Theorem: Line integrals, Applications of line integrals**:** Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.

References:

1. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.
2. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.
3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

BSMA172A MULTIVARIABLE CALCULUS LAB (Credits 2)

Modelling of the following problems using MATLAB / Mathematica / Maple etc.

List of Practicals

- Evaluate the integration of the function
- Evaluate the double/ triple integral integration of the function
- Evaluate the area of closed curve
- Evaluate the arc length of curve
- Evaluate the Volume of closed curve
- Find the critical points and use Mathematica to graph the surface and determine the max/min/saddle nature of these points.
- Calculate the dot and cross product of vectors
- Calculate the Gradient of a vector, Divergence and Curl of vector

BSMA124A ORDINARY DIFFERENTIAL EQUATIONS (Credits 4)

Overview:

An ordinary differential equation (ODE) is an equation that involves some ordinary derivatives (as opposed to partial derivatives) of a function. Often, our goal is to solve an ODE, i.e., determine what function or functions satisfy the equation. In general, solving an ODE is more complicated than simple integration. ODEs of arbitrary order with constant coefficients are treated. It is shown how to obtain the general solution to a linear second-order ODE if a single solution to the related homogeneous ODE is available.

Course Learning Outcomes: The course will enable the students to:

i) Understand the genesis of ordinary differential equations.

ii) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.

iii) Know Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.

iv) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

v) Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

First Order Differential Equations: Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

Second Order Linear Differential Equations: Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

Higher Order Linear Differential Equations: Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non- homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

Series Solutions of Differential Equations: Power series method, Legendre's equation, Legendre polynomials, Rodrigue‘s formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

Applications: Orthogonal trajectories, Acceleration-velocity model, Minimum velocity of escape from Earth‘s gravitational field, Growth and decay models, Malthusian and logistic population models, Radioactive decay, Drug assimilation into the blood of a single cold pill; Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Lotka-Volterra population model.

References:

1. Belinda Barnes & Glenn Robert Fulford (2015). *Mathematical Modelling with Case Studies***:** *A Differential Equation Approach Using* Maple *and* MATLAB (2nd edition). Chapman & Hall/CRC Press, Taylor & Francis.
2. H. I. Freedman (1980). *Deterministic Mathematical Models in Population Ecology*. Marcel Dekker Inc.
3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
4. Daniel A. Murray (2003). *Introductory Course in Differential Equations*, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). *A Course in Ordinary Differential Equations* (2nd edition). Narosa.
6. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India.
7. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.

BSMA174A ORDINARY DIFFERENTIAL EQUATIONS LAB (Credits 2)

Modeling of the following problems using MATLAB / Mathematica / Maple etc.

List of Practicals

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model)
9. Basic Epidemic model of influenza
10. Basic Battle model

SEMESTER III

BSMA211A PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS (Credits 4)

Course Learning Outcomes: This course will enable the students to:

i) Apply a range of techniques to solve first & second order partial differential equations.
ii) Model physical phenomena using partial differential equations such as the heat and wave equations.
iii) Understand problems, methods and techniques of calculus of variations.

First Order Partial Differential Equations: Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

Second Order Partial Differential Equations with Constant Coefficients: Classification of linear partial differential equations of second order, Homogeneous and non-homogeneous equations with constant coefficients.

Second Order Partial Differential Equations with Variable Coefficients: Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Calculus of Variations-Variational Problems with Fixed Boundaries: Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

Calculus of Variations-Variational Problems with Moving Boundaries: Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation.

References:

1. A. S. Gupta (2004). *Calculus of Variations with Applications*. PHI Learning.
2. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
3. TynMyint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation for Scientists and Engineers* (4th edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on *Differential Equations and Their Applications.* CBS Publishers.
5. S. B. Rao & H. R. Anuradha (1996). *Differential Equations with Applications*. University Press.
6. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

BSMA275A **PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS LAB** **(Credits 2)**

PRACTICAL / LAB WORK

Modeling of the following problems using MATLAB / Mathematica / Maple etc.

List of Practicals

(i) Solution of Cauchy problem for first order PDE.
(ii) Finding the characteristics for the first order PDE.
(iii) Plot the integral surfaces of a given first order PDE with initial data.
(iv) Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

(a) $u(x,0) = \varphi(x)$, $u_t(x,0) = \psi(x)$, $x \in R$, t □□□
(b) $u(x,0) = \varphi(x)$, $u_t(x,0) = \psi(x)$, $u(0,t) = 0$, x □ $(0,$□□$)$, t □□□
(c) $u(x,0) = \varphi(x)$, $u_t(x,0) = \psi(x)$, $u_x(0,t) = 0$, x □ $(0,$ □$)$, t □□□
(d) $u(x,0) = \varphi(x)$, $u_t(x,0) = \psi(x)$, $u(0,t) = 0$, $u(1,t) = 0$, $0 < x < l$, $t > 0$
(v) Solution of wave equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions
(a) $u(x,0) = \varphi(x)$, $u(0,t) = a$, $u(1,t) = b$, $0 < x < l$, $t > 0$
(b) $u(x,0) = \varphi(x)$, $x \in R$, $0 < t < T$
(c) $u(x,0) = \varphi(x)$, $u(0,t) = a$, x □ $(0,$ □$)$, $t \geq$ □□

BSMA213A **GROUP THEORY** **(Credits 6)**

Course Learning Outcomes: The course will enable the students to:

i) Recognize the mathematical objects called groups.
ii) Link the fundamental concepts of groups and symmetries of geometrical objects.
iii) Explain the significance of the notions of cosets, normal subgroups, and factor groups.
iv) Analyze consequences of Lagrange's theorem.
v) Learn about structure preserving maps between groups and their consequences.

Groups and its Elementary Properties: Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups.

Subgroups and Cyclic Groups: Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem, Euler phi function, Euler's theorem, Fermat's little theorem.

Normal Subgroups: Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups; Classification of subgroups of cyclic groups.

Permutation Groups: Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications.

Group Homomorphisms, Rings and Fields: Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups; Definitions and elementary properties of rings and fields.

References:

1. Michael Artin (2014). *Algebra* (2nd edition). Pearson.
2. John B. Fraleigh (2007). *A First Course in Abstract Algebra* (7th edition). Pearson.
3. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition). Cengage.
4. I. N. Herstein (2006). *Topics in Algebra* (2nd edition). Wiley India.
5. Nathan Jacobson (2009). *Basic Algebra* I (2nd edition). Dover Publications.
6. Ramji Lal (2017). *Algebra 1: Groups, Rings, Fields and Arithmetic*. Springer.
7. I.S. Luthar & I.B.S. Passi (2013). *Algebra: Volume 1: Groups.* Narosa.

BSMA215A PROBABILITY AND STATISTICS (Credits 4)

Course Learning Outcomes: This course will enable the students to:

i) Understand distributions in the study of the joint behaviour of two random variables.
ii) Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
iii) Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve.

Probability Functions and Moment Generating Function: Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Univariate Discrete and Continuous Distributions: Discrete distributions - Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions - Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Bivariate Distribution: Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Correlation, Regression and Central Limit Theorem: The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Modeling Uncertainty: Uncertainty, Information and entropy, Uniform Priors, Polya's urn model and random graphs.

References:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

BSMA273A PROBABILITY AND STATISTICS LAB (Credits 2)

PRACTICAL/LAB WORK

List of Practical

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman rank correlation with and without ties.
11. Partial and multiple correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Planes of regression and variances of residuals for raw data.
14. Fitting of binomial distributions for n and $p = q = ½$.
15. Fitting of binomial distributions for given n and p.

16. Fitting of binomial distributions after computing mean and variance.
17. Fitting of Poisson distributions for given value of lambda.
18. Fitting of Poisson distributions after computing mean.
19. Fitting of negative binomial.
20. Application problems based on binomial distribution.
21. Application problems based on Poisson distribution.
22. Application problems based on negative binomial distribution.
23. Problems based on area property of normal distribution.
24. To find the ordinate for a given area for normal distribution.
25. Application based problems using normal distribution.
26. Fitting of normal distribution when parameters are given.
27. Fitting of normal distribution when parameters are not given.
28. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit

BSDM301A DISASTER MANAGEMENT (Credits 3)

COURSE OBJECTIVE: The objective of the course is to create awareness about various types of disasters and to educate the learners about basic disaster management strategies. The course examines disaster profile of our country and illustrates the role played by various governmental and non- governmental organizations in its effective management. It also acquaints learners with the existing legal frame work for disaster management.

LEARNING OUTCOME: The course will -

1. Provide students an exposure to disasters, their significance and types.
2. Ensure that the students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
3. Provide the students a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
4. Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

Introduction to Disasters: Concept and definitions- Disaster, Hazard, vulnerability, resilience, risks.

Different Types of Disaster: Causes, effects and practical examples for all disasters.

- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc
- Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc.

Disaster Preparedness and Response Preparedness

- Disaster Preparedness: Concept and Nature
- Disaster Preparedness Plan
- Prediction, Early Warnings and Safety Measures of Disaster.
- Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.
- Role of IT in Disaster Preparedness
- Role of Engineers on Disaster Management.
- Relief and Recovery
- Medical Health Response to Different Disasters

Rehabilitation, Reconstruction and Recovery

- Reconstruction and Rehabilitation as a Means of Development.
- Damage Assessment
- Post Disaster effects and Remedial Measures.
- Creation of Long-term Job Opportunities and Livelihood Options,
- Disaster Resistant House Construction
- Sanitation and Hygiene
- Education and Awareness,
- Dealing with Victims' Psychology,
- Long-term Counter Disaster Planning
- Role of Educational Institute.

Disaster Management in India

- **Disaster Management Act, 2005:**
  Disaster management framework in India before and after Disaster Management Act, 2005, National Level Nodal Agencies, National Disaster Management Authority

- **Liability for Mass Disaster**
  - Statutory liability
  - Contractual liability
  - Tortious liability
  - Criminal liability
  - Measure of damages

- **Epidemics Diseases Act, 1897: Main provisions, loopholes.**

- **Project Work**: The project/ field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived based on the geographic location and hazard profile of the region where the institute is located.

Reference Books:

- Government of India, Department of Environment, Management of Hazardous Substances Control
- Act and Structure and Functions of Authority Created Thereunder.
- Indian Chemical Manufacturers' Association & Loss Prevention Society of India, Proceedings of the National Seminar on Safety in Road Transportation of Hazardous Materials: (1986).
- Author Title Publication Dr. Mrinalini Pandey Disaster Management Wiley India Pvt. Ltd.
- Tushar Bhattacharya Disaster Science and Management McGraw Hill Education (India) Pvt. Ltd.
- Jagbir Singh Disaster Management: Future Challenges and Opportunities K W Publishers Pvt. Ltd.
- J. P. Singhal Disaster Management Laxmi Publications.
- Shailesh Shukla, Shamna Hussain Biodiversity, Environment and Disaster Management Unique Publications
- C. K. Rajan, Navale Pandharinath Earth and Atmospheric Disaster Management: Nature and Manmade B S Publication
- Indian law Institute (Upendra Baxi and Thomas Paul (ed.), Mass Disasters and Multinational Liability: The Bhopal Case (1986)
- Indian Law Institute, Upendra Baxi (ed.), Environment Protection Act: An Agenda for Implementation (1987)
- Asian Regional Exchange for Prof. Baxi., Nothing to Lose But our Lives: Empowerment to Oppose
- Industrial Hazards in a Transnational world (1989)
- Gurudip Singh, Environmental Law: International and National Perspectives (1995), Lawman (India) Pvt. Ltd.
- Leela Krishnan, P, The Environmental Law in India, Chapters VIII, IX and X (1999), Butterworths, New Delhi.

SEMESTER – IV

BSMA212A ADVANCED ALGEBRA (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Understand the basic concepts of group actions and their applications.
ii) Recognize and use the Sylow theorems to characterize certain finite groups.
iii) Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
iv) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

Group Actions: Group actions, Orbits and stabilizers, Conjugacy classes, Orbit-stabilizer theorem, Normalizer of an element of a group, Center of a group, Class equation of a group, Inner and outer automorphisms of a group.

Sylow Theorems: Cauchy's theorem for finite abelian groups, Finite simple groups, Sylow theorems and applications including nonsimplicity tests.

Rings and Fields: Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ring homomorphisms and isomorphisms, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field, Euclidean rings and their properties, Wilson and Fermat's theorems.

Polynomial Rings: Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain.

Field Extensions and Finite Fields: Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field, Classification of finite fields.

References:

1. Michael Artin (2014). *Algebra* (2nd edition). Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). *Basic Abstract Algebra* (2nd edition). Cambridge University Press.
3. David S. Dummit & Richard M. Foote (2008). *Abstract Algebra* (2nd edition). Wiley.
4. John B. Fraleigh (2007). *A First Course in Abstract Algebra* (7th edition). Pearson.
5. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition). Cengage.
6. N. S. Gopalakrishnan (1986). *University Algebra*, New Age International Publishers.
7. I. N. Herstein (2006). *Topics in Algebra* (2nd edition). Wiley India.
8. Thomas W. Hungerford (2004). *Algebra* (8th edition). Springer.
9. Nathan Jacobson (2009). *Basic Algebra I & II* (2nd edition). Dover Publications.
10. Serge Lang (2002). *Algebra* (3rd edition). Springer-Verlag.
11. I. S. Luthar & I. B. S. Passi (2013). *Algebra: Volume 1: Groups*. Narosa.
12. I. S. Luthar & I. B. S. Passi (2012). *Algebra: Volume 2: Rings*. Narosa.

BSMA214A LINEAR ALGEBRA (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
ii) Relate matrices and linear transformations, compute eigen values and eigen vectors of linear transformations.
iii) Learn properties of inner product spaces and determine orthogonality in inner product spaces.
iv) Realise importance of adjoint of a linear transformation and its canonical form.

Vector Spaces: Definition and examples, Subspace, Linear span, Quotient space and direct sum of subspaces, linearly independent and dependent sets, Bases and dimension.

Linear Transformations: Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem.

Further Properties of Linear Transformations: Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and eigen values of a linear transformation, Characteristic polynomial and Cayley□Hamilton theorem, Minimal polynomial.

Inner Product Spaces: Inner product spaces and orthogonality, Cauchy□Schwarz inequality, Gram□Schmidt orthog-onalisation, Diagonalisation of symmetric matrices.

Adjoint of a Linear Transformation and Canonical Forms: Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces.

References:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). *Linear Algebra* (4th edition). Prentice-Hall of India Pvt. Ltd.
2. Kenneth Hoffman & Ray Kunze (2015). *Linear Algebra* (2nd edition). Prentice-Hall.
3. I. M. Gel'fand (1989). *Lectures on Linear Algebra.* Dover Publications.
4. Nathan Jacobson (2009). *Basic Algebra* I & II (2nd edition). Dover Publications.
5. Serge Lang (2005). *Introduction to Linear Algebra* (2nd edition). Springer India.
6. Vivek Sahai & Vikas Bist (2013). *Linear Algebra* (2nd Edition). Narosa Publishing House.
7. Gilbert Strang (2014). *Linear Algebra and its Applications* (2nd edition). Elsevier.

BSMA216A REAL ANALYSIS (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
ii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
iii) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
iv) Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.

Real Number System: Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$,The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open, closed and perfect sets in $\mathbb{R}$, Connected subsets of $\mathbb{R}$, Cantor set and Cantor function.

Sequences of Real Numbers: Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano□Weierstrass theorem for sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion.

Infinite Series: Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series**;** Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence, Rearrangement of series and Riemann's theorem.

Riemann Integration: Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second mean value theorems.

Uniform convergence and Improper integral: Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability, Improper integrals, Dirichlet test and Abel's test for improper integrals.

References:

1. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition).Wiley India.
2. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
3. K. A. Ross (2013). *Elementary Analysis***:** *The Theory of Calculus* (2nd edition). Springer.

BSMA226A COMPUTER ALGEBRA SYSTEMS AND RELATED SOFTWARE (Credits 2)

Course Learning Outcomes: This course will enable the students to:

i) Use of computer algebra systems (Mathematica/MATLAB/Maxima/Maple etc.) as a calculator, for plotting functions and animations

ii) Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors.

iii) Understand the use of the statistical software **R** as calculator and learn to read and get data into **R.**

iv) Learn the use of **R** in summary calculation, pictorial representation of data and exploring relationship between data.

v) Analyze, test, and interpret technical arguments on the basis of geometry.

Introduction to CAS and Applications: Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and ContourPlot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.

Working with Matrices: Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, eigenvector and diagonalization.

R - The Statistical Programming Language: R as a calculator, Explore data and relationships in **R.** Reading and getting data into **R:** Combine and scan commands, Types and structure of data items with their properties, Manipulating vectors, Data frames, Matrices and lists, Viewing objects within objects, Constructing data objects and conversions.

Data Analysis with R: Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists, Summary tables, Stem and leaf plot, Histograms, Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts and bar charts, Copy and save graphics to other applications.

References:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Torrence, Bruce F., & Torrence, Eve A. (2009). *The Student's Introduction to Mathematica*R: *A Handbook for Precalculus, Calculus, and Linear Algebra* (2nd ed.). Cambridge University Press.
3. Gardener, M. (2012). *Beginning R*: *The Statistical Programming Language*, Wiley.

BSMA272A **COMPUTER ALGEBRA SYSTEMS AND RELATED SOFTWARE LAB** **(Credits 2)**

Practical / Lab work to be performed in Computer Lab

- Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Producing tables of values, Working with piecewise defined functions, Combining graphics. Simple programming in a CAS.
- Plotting functions of two variables using Plot3D and contour plot, Plotting parametric curves surfaces, Customizing plots, Animating plots.
- Working with matrices, Performing Gauss elimination, Operations (Transpose, Determinant, Inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, Eigenvector and diagonalization.
- **R** as a calculator, Explore data and relationships in **R.** Reading and getting data into **R:** Combine and scan commands, Types and structure of data items with their properties. Manipulating vectors, Data frames, Matrices and lists. Viewing objects within objects. Constructing data objects and conversions.
- Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists. Summary tables. Stem and leaf plot, histograms. Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts and Bar charts. Copy and save graphics to other applications.

SEMESTER – V

BSMA301A **NUMERICAL ANALYSIS** **(Credits 4)**

Course Learning Outcomes: This course will enable the students to:

i) Obtain numerical solutions of algebraic and transcendental equations.
ii) Find numerical solutions of system of linear equations and check the accuracy of the solutions.
iii) Learn about various interpolating and extrapolating methods.
iv) Solve initial and boundary value problems in differential equations using numerical methods.
v) Apply various numerical methods in real life problems.

Numerical Methods for Solving Algebraic and Transcendental Equations: Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton's method and secant method for solving equations.

Numerical Methods for Solving Linear Systems: Partial and scaled partial pivoting, Lower and upper triangular (LU) decomposition of a matrix and its applications, Thomas method for tridiagonal systems; Gauss-Jacobi, Gauss-Seidel and successive over-relaxation (SOR) methods.

Interpolation: Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation, Finite difference operators, Gregory-Newton forward and backward difference interpolations.

Numerical Differentiation and Integration: First order and higher order approximation for first derivative, Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rules and error analysis, Bulirsch-Stoer extrapolation methods, Richardson extrapolation.

Initial and Boundary Value Problems of Differential Equations: Euler's method, Runge-Kutta methods, Higher order one step method, Multi-step methods; Finite difference method, Shooting method, Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting.

References:

1. Brian Bradie (2006), *A Friendly Introduction to Numerical Analysis.* Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). *Applied Numerical Analysis* (7^{th} edition), Pearson Education, India.
3. F. B. Hildebrand (2013). *Introduction to Numerical Analysis*: (2^{nd} edition). Dover Publications.
4. M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Computation* (6^{th} edition). New Age International Publishers.
5. Robert J. Schilling & Sandra L. Harris (1999). *Applied Numerical Methods for Engineers Using* MATLAB *and C*. Thomson-Brooks/Cole.

BSMA371A NUMERICAL ANALYSIS LAB (Credits 2)

PRACTICAL/LAB WORK

(Modeling of the following problems Using MATLAB/ Mathematica/ Maple Etc.)

List of Practicals

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Bisection Method.
(v) Newton Raphson Method.
(vi) Secant Method.
(vii) Regulai Falsi Method.
(viii) LU decomposition Method.
(ix) Gauss-Jacobi Method.
(x) SOR Method or Gauss-Siedel Method.
(xi) Lagrange Interpolation or Newton Interpolation.
(xii) Simpson's rule.

BSMA303A SET THEORY AND METRIC SPACES (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Learn basic facts about the cardinality of a set.
ii) Understand several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano Weierstrass property, compactness, and connectedness.
iii) Identify the continuity of a function defined on metric spaces and homeomorphisms.

Theory of Sets: Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, Schröder Bernstein theorem, Cantor's theorem, Order relation in cardinal numbers, Arithmetic of cardinal numbers, Partially ordered set, Zorn's lemma and Axiom of choice, Various set theoretic paradoxes.

Concepts in Metric Spaces: Definition and examples of metric spaces, Open spheres and closed spheres, Neighbor hoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space.

Complete Metric Spaces and Continuous Functions: Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Compactness: Compact spaces, Sequential compactness, Bolzano Weierstrass property, Compactness and finite intersection property, Heine Borel theorem, Totally bounded sets, Equivalence of compactness and sequential compactness, Continuous functions on compact spaces.

Connectedness: Separated sets, Disconnected and connected sets, Components, Connected subsets of $\mathbb{R}$, Continuous functions on connected sets.

References:

1. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.
2. P. R. Halmos (1974). *Naive Set Theory*. Springer.
3. P. K. Jain & Khalil Ahmad (2019). *Metric Spaces*. Narosa.
4. S. Kumaresan (2011). *Topology of Metric Spaces* (2^{nd} edition). Narosa.
5. Satish Shirali & Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
6. Micheál O'Searcoid (2009). *Metric Spaces*. Springer-Verlag.
7. G. F. Simmons (2004). *Introduction to Topology and Modern Analysis*. McGraw-Hill.

DISCIPLINE SPECIFIC ELECTIVES I and II (Choose any two) :-

BSMA305A TENSORS AND DIFFERENTIAL GEOMETRY (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Explain the basic concepts of tensors.
ii) Understand role of tensors in differential geometry.
iii) Learn various properties of curves including Frenet□Serret formulae and their applications.
iv) Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae.
v) Understand the role of Gauss's Theorema Egregium and its consequences.
vi) Apply problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

Tensors: Contravariant and covariant vectors, Transformation formulae, Tensor product of two vector spaces, Tensor of type (*r*, *s*), Symmetric and skew-symmetric properties, Contraction of tensors, Quotient law, Inner product of vectors.

Further Properties of Tensors: Fundamental tensors, Associated covariant and contravariant vectors, Inclination of two vectors and orthogonal vectors, Christoffel symbols, Law of transformation of Christoffel symbols, Covariant derivatives of covariant and contravariant vectors, Covariant differentiat-ion of tensors, Curvature tensor, Ricci tensor, Curvature tensor identities.

Curves in $\mathbb{R}^2$ and $\mathbb{R}^3$: Basic definitions and examples, Arc length, Curvature and the Frenet□Serret formulae, Fundamental existence and uniqueness theorem for curves, Non-unit speed curves.

Surfaces in $\mathbb{R}$: Basic definitions and examples, The first fundamental form, Arc length of curves on surfaces, Normal curvature, Geodesic curvature, Gauss and Weingarten formulae, Geodesics, Parallel vector fields along a curve and parallelism.

Geometry of Surfaces: The second fundamental form and the Weingarten map; Principal, Gauss and mean curvatures; Isometries of surfaces, Gauss's Theorema Egregium, The fundamental theorem of surfaces, Surfaces of constant Gauss curvature, Exponential map, Gauss lemma, Geodesic coordinates, The Gauss□Bonnet formula and theorem.

References:

1. Christian Bär (2010). *Elementary Differential Geometry*. Cambridge University Press.
2. Manfredo P. do Carmo (2016). *Differential Geometry of Curves & Surfaces* (Revised and updated 2nd edition). Dover Publications.
3. Alferd Gray (2018). *Modern Differential Geometry of Curves and Surfaces with Mathematica* (4th edition). Chapman & Hall/CRC Press, Taylor & Francis.
4. Richard S. Millman & George D. Parkar (1977). *Elements of Differential Geometry*. Prentice-Hall.
5. R. S. Mishra (1965). *A Course in Tensors with Applications to Riemannian Geometry*. Pothishala Pvt. Ltd.
6. Sebastián Montiel & Antonio Ross (2009). *Curves and Surfaces*. American Mathematical Society.

BSMA307A MATHEMATICAL LOGIC (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Learn the syntax of first-order logic and semantics of first-order languages.
ii) Understand the propositional logic and basic theorems like compactness theorem, meta theorem and post-tautology theorem.
iii) Assimilate the concept of completeness interpretations and their applications with special emphasis on applications in algebra.

Syntax of First-order Logic: First-order languages, Terms of language, Formulas of language, First order theory.

Semantics of First-order Languages: Structures of first order languages, Truth in a structure, Model of a theory, Embeddings and isomorphism.

Propositional Logics: Syntax of propositional logic, Semantics of propositional logic, Compactness theorem for propositional logic, Proof in propositional logic, Meta theorem in propositional logic, Post tautology theorem.

Proof and Meta Theorems in First-order Logic: Proof in first-order logic, Meta theorems in first-order logic, Some meta theorem in arithmetic, Consistency and completeness.

Completeness Theorem and Model Theory: Completeness theorem, Interpretation in a theory, Extension by definitions, Compactness theorem and applications, Complete theories, Applications in algebra.

References:

1. Richard E. Hodel (2013). *An Introduction to Mathematical Logic.* Dover Publications.
2. Yu I. Manin (2010). *A Course in Mathematical Logic for Mathematicians* (2nd edition). Springer.
3. Elliott Mendelson (2015). *Introduction to Mathematical Logic* (6th edition). Chapman & Hall/CRC.
4. Shashi Mohan Srivastava (2013). *A Course on Mathematical Logic* (2nd edition). Springer.

BSMA309A **INTEGRAL TRANSFORMS AND FOURIER ANALYSIS** **(Credits 6)**

Course Learning Outcomes: This course will enable the students to:

i) Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.
ii) Solve ordinary differential equations using Laplace transforms.
iii) Familiarise with Fourier transforms of functions belonging to class, relation between Laplace and Fourier transforms.
iv) Explain Parseval's identity, Plancherel's theorem and applications of Fourier transforms to boundary value problems.
v) Learn Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier series.
vi) Apply the concepts of the course in real life problems.

Laplace Transforms: Laplace transform, Linearity, Existence theorem, Laplace transforms of derivatives and integrals, Shifting theorems, Change of scale property, Laplace transforms of periodic functions, Dirac's delta function.

Further Properties of Laplace Transforms and Applications: Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives, Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations.

Fourier Transforms: Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier sine and cosine transforms, Linearity property, Change of scale property, Shifting property, Modulation theorem, Relation between Fourier and Laplace transforms.

Solution of Equations by Fourier Transforms: Solution of integral equation by Fourier sine and cosine transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transform, Plancherel's theorem, Fourier transform of derivatives, Applications of infinite Fourier transforms to boundary value problems, Finite Fourier transform, Inversion formula for finite Fourier transforms.

Fourier Series: Fourier cosine and sine series, Fourier series, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, The complex form of Fourier series.

References:

1. James Ward Brown & Ruel V. Churchill (2011). F*ourier Series and Boundary Value Problems*. McGraw-Hill Education.
2. Charles K. Chui (1992). *An Introduction to Wavelets*. Academic Press.
3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
4. Walter Rudin (2017). *Fourier Analysis on Groups*. Dover Publications.
5. A. Zygmund (2002).*Trigonometric Series* (3rd edition). Cambridge University Press.

BSMA311A INFORMATION THEORY AND CODING (Credit 6)

Course Learning Outcomes: This course will enable the students to:

i) Study simple ideal statistical communication models.
ii) Understand the development of codes for transmission and detection of information.
iii) Learn about the input and output of a signal via transmission channel.
iv) Study detection and correction of errors during transmission.
v) Represent a linear code by matrices - encoding and decoding.

Concepts of Information Theory: Communication processes, A model of communication system, A quantitative measure of information, Binary unit of information, A measure of uncertainty, *H* function as a measure of uncertainty, Sources and binary sources, Measure of information for two-dimensional discrete finite probability schemes.

Entropy Function: A sketch of communication network, Entropy, Basic relationship among different entropies, A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, efficiency, and channel capacity; Binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rules for entropy, Conditional relative entropy and conditional mutual information, Jensen's inequality and its characterizations, The log sum inequality and its applications.

Concepts of Coding: Block codes, Hamming distance, Maximum likelihood decoding, Levels of error handling, Error correction, Error detection, Erasure correction, Construction of finite fields, Linear codes, Matrix representation of linear codes, Hamming codes.

Bounds of Codes: Orthogonality relation, Encoding and decoding of linear codes, The singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert□Varshamov bound, MacWilliams' identities.

Cyclic Codes: Definition and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose□Chaudhuri□Hocquenghem (BCH) code as a cyclic code.

References:

1. Robert B. Ash, (2014). *Information Theory*. Dover Publications.
2. Thomas M. Cover & Joy A. Thomas (2013). *Elements of Information Theory* (2nd edition). Wiley India Pvt. Ltd.
3. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition), Cengage.
4. Fazlollah M. Reza, (2003). *An Introduction to Information Theory*. Dover Publications.
5. Ron M. Roth (2007). *Introduction to Coding Theory*. Cambridge University Press.
6. Claude E. Shannon & Warren Weaver (1969). *The Mathematical Theory of Communication*. The University of Illinios Press.

BSMA313A GRAPH THEORY (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Appreciate the definition and basics of graphs along with types and their examples.
ii) Understand the definition of a tree and learn its applications to fundamental circuits.
iii) Know the applications of graph theory to network flows.
iv) Understand the notion of planarity and coloring of a graph.
v) Relate the graph theory to the real-world problems.

Paths, Circuits and Graph Isomorphisms: Definition and examples of a graph, Subgraph, Walks, Paths and circuits; Connected graphs, disconnected graphs and components of a graph; Euler and Hamiltonian graphs, Graph isomorphisms, Adjacency matrix and incidence matrix of a graph, Directed graphs and their elementary properties.

Trees and Fundamental Circuits: Definition and properties of trees, Rooted and binary trees, Cayley's theorem on a counting tree, Spanning tree, Fundamental circuits, Minimal spanning trees in a connected graph.

Cut-Sets and Cut-Vertices: Cut-set of a graph and its properties, Fundamental circuits and cut-sets, Cut-vertices, Connectivity and separability, Network flows, 1- isomorphism and 2-isomorphism.

Planar Graphs: Planar graph, Euler theorem for a planar graph, Various representations of a planar graph, Dual of a planar graph, Detection of planarity, Kuratowski's theorem.

Graph Coloring: Chromatic number of a graph, Chromatic partition, Chromatic polynomial, Matching and coverings, Four color problem.

References:

1. R. Balakrishnan & K. Ranganathan (2012). *A Textbook of Graph Theory*. Springer.
2. Narsingh Deo (2016). *Graph Theory with Applications to Engineering and Computer Science*. Dover Publications.
3. Reinhard Diestel (2017). *Graph Theory* (5th edition). Springer.
4. Edgar G. Goodaire & Michael M. Parmenter (2018). *Discrete Mathematics with Graph Theory* (3rd edition). Pearson.
5. Douglas West (2017). *Introduction to Graph Theory* (2nd edition). Pearson.

BSMA315A SPECIAL THEORY AND RELATIVITY (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Understand the basic elements of Newtonian mechanics including Michelson□Morley experiment and geometrical interpretations of Lorentz transformation equations.
ii) Learn about length contraction, time dilation and Lorentz contraction factor.
iii) Study 4-dimensional Minkowskian space-time and its consequences.
iv) Understand equations of motion as a part of relativistic mechanics.
v) Imbibe connections between relativistic mechanics and electromagnetism.

Newtonian Mechanics: Inertial frames, Speed of light and Gallilean relativity, Michelson□Morley experiment, Lorentz□Fitzgerold contraction hypothesis, Relative character of space and time, Postulates of special theory of relativity, Lorentz transformation equations and its geometrical interpretation, Group properties of Lorentz transformations.

Relativistic Kinematics: Composition of parallel velocities, Length contraction, Time dilation, Transformation equations for components of velocity and acceleration of a particle and Lorentz contraction factor.

Geometrical representation of space-time: Four dimensional Minkowskian space-time of special relativity, Time-like, light-like and space-like intervals, Null cone, Proper time, World line of a particle, Four vectors and tensors in Minkowiskian space-time.

Relativistic Mechanics: Variation of mass with velocity. Equivalence of mass and energy. Transformation equations for mass momentum and energy. Energy-momentum four vector. Relativistic force and Transformation equations for its components. Relativistic equations of motion of a particle.

Electromagnetism: Transformation equations for the densities of electric charge and current. Transformation equations for electric and magnetic field strengths. The Field of a Uniformly Moving Point charge. Forces and fields near a current carrying wire. Forces between moving charges. The invariance of Maxwell`s equations.

References:

1. James L. Anderson (1973). *Principles of Relativity Physics*. Academic Press.
2. Peter Gabriel Bergmann (1976). *Introduction to the Theory of Relativity*. Dover Publications.
3. C. Moller (1972). *The Theory of Relativity* (2nd edition). Oxford University Press.
4. Robert Resnick (2007). *Introduction to Special Relativity*. Wiley.
5. Wolfgang Rindler (1977). *Essential Relativity: Special, General, and Cosmological*. Springer-Verlag.
6. V. A. Ugarov (1979). *Special Theory of Relativity*. Mir Publishers, Moscow.

SEMESTER – VI

BSMA302A COMPLEX ANALYSIS (Credits 4)

Course Learning Outcomes: This course will enable the students to:

i) Visualize complex numbers as points of $\mathbb{R}$ and stereographic projection of complex plane on the Riemann sphere.
ii) Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.
iii) Learn the role of Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals.
iv) Apply Liouville's theorem in fundamental theorem of algebra.
v) Understand the convergence, term by term integration and differentiation of a power series.
vi) Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

Complex Plane and functions: Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere; Complex functions and their limits including limit at infinity; Continuity, Linear fractional transformations and their geometrical properties.

Analytic Functions and Cauchy-Riemann Equations: Differentiability of a complex valued function, Cauchy-Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability, Analytic functions; Analyticity and zeros of exponential, trigonometric and logarithmic functions; Branch cut and branch of multi-valued functions.

Cauchy's Theorems and Fundamental Theorem of Algebra: Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

Power Series: Sequences, series and their convergence, Taylor series and Laurent series of analytic functions, Power series, Radius of convergence, Integration and differentiation of power series, Absolute and uniform convergence of power series.

Singularities and Contour Integration; Meromorphic functions, Zeros and poles of meromorphic functions, Nature of singularities, Picard's theorem, Residues, Cauchy's residue theorem, Argument principle, Rouche's theorem, Jordan's lemma, Evaluation of proper and improper integrals.

References:

1. Lars V. Ahlfors (2017). *Complex Analysis* (3rd edition). McGraw-Hill Education.
2. Joseph Bak & Donald J. Newman (2010). *Complex Analysis* (3rd edition). Springer.
3. James Ward Brown & Ruel V. Churchill (2009). *Complex Variables and Applications* (9th edition). McGraw-Hill Education.
4. John B. Conway (1973). *Functions of One Complex Variable*. Springer-Verlag.
5. E.T. Copson (1970). *Introduction to Theory of Functions of Complex Variable*. Oxford University Press.
6. Theodore W. Gamelin (2001). *Complex Analysis*. Springer-Verlag.
7. George Polya & Gordon Latta (1974). *Complex Variables*. Wiley.
8. H. A. Priestley (2003). *Introduction to Complex Analysis*. Oxford University Press.
9. E. C. Titchmarsh (1976). *Theory of Functions* (2nd edition). Oxford University Press.

BSMA372A COMPLEX ANALYSIS LAB (Credits 2)

PRACTICAL/LAB WORK

(Modeling of the following problems Using MATLAB/ Mathematica/ Maple Etc.)

List of Practicals

1. Declaring a complex number and graphical representation. e.g. $Z1 = 3 + 4i, Z2 = 4 - 7i$

2. Program to discuss the algebra of complex numbers.
   e.g., if Z1 =3 + 4i, Z2 = 4 – 7i, then find Z1 + Z2, Z1 - Z2, Z1 * Z2,and Z1 / Z2

3. To find conjugate, modulus and phase angle of an array of complex numbers.
   e.g., Z = [2+ 3i 4-2i 6+11i 2-5i]

4. To compute the integral over a straight line path between the two specified end points.
   e. g., , where C is the straight line path from -1+ i to 2 - i.

5. To perform contour integration.
   e.g., (i) , where C is the Contour given by x = y2 +1; .
   (ii) , where C is the contour given by , which can be parameterized by x = cos (t), y = sin (t) for .
6. To plot the complex functions and analyze the graph.
   e.g., (i) f(z) = Z (ii) f(z)=Z3 (iii) f(z) = (Z4-1)1/4
7. To perform the Taylor series expansion of a given function f(z) around a given point z. The number of terms that should be used in the Taylor series expansion is given for each function. Hence plot the magnitude of the function and magnitude of its Taylors series expansion. e.g., (i) f(z) = exp(z) around z = 0, n =40.
   (ii) f(z)=exp(z2) around z = 0, n = 160.
8. To determine how many terms should be used in the Taylor series expansion of a given function f(z) around z = 0 for a specific value of z to get a percentage error of less than 5 %. e.g., For f(z) = exp(z) around z =0, execute and determine the number of necessary terms to get a percentage error of less than 5 % for the following values of z: (i) z = 30 + 30 i
9. To perform Laurents series expansion of a given function f(z) around a given point z.
   e.g., (i) f(z)= (sin z -1)/z4 around z = 0
   (ii) f(z) = cot (z)/z4 around z = 0
10. To compute the poles and corresponding residues of complex functions.
11. To perform Conformal Mapping and Bilinear Transformations.

BSMA304A LINEAR PROGRAMMING (Credits 4)

Course Learning Outcomes: This course will enable the students to:

i) Analyze and solve linear programming models of real life situations.
ii) Provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
iii) Understand the theory of the simplex method.
iv) Know about the relationships between the primal and dual problems, and to understand sensitivity analysis.
v) Learn about the applications to transportation, assignment and two-person zero-sum game problems.

Linear Programming Problem, **Convexity and Basic Feasible Solutions:** Formulation**,** Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Simplex Method: Optimality criterion, Improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-*M* method.

Duality: Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Sensitivity Analysis: Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programming problem.

Applications: *Transportation Problem***:** Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution. *Assignment Problem***:** Mathematical formulation and Hungarian method. *Game Theory***:** Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method for solving a game.

References:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). *Linear Programming and Network Flows* (4th edition). John Wiley & Sons.
2. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.
3. Frederick S. Hillier & Gerald J. Lieberman (2015). *Introduction to Operations Research* (10th edition). McGraw-Hill Education.
4. Hamdy A. Taha (2017). *Operations Research*: *An Introduction* (10th edition). Pearson.
5. Paul R. Thie & Gerard E. Keough (2014). *An Introduction to Linear Programming and Game Theory* (3rd edition). Wiley India Pvt. Ltd.

BSMA374A LINEAR PROGRAMMING LAB (Credits 2)

PRACTICAL/LAB WORK

List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation
    a. Degenerate solution
    b. Unbounded solution
    c. Alternate solution
    d. Infeasible solution
3. Post-optimality
    a. Addition of constraint
    b. Change in requirement vector
    c. Addition of new activity
    d. Change in cost vector
4. Allocation problem using Transportation model
5. Allocation problem using Assignment model
6. Problems based on game matrix
    a. Graphical solution to mx2 / 2xn rectangular game
    b. Mixed strategy

DISCIPLINE SPECIFIC ELECTIVES III and IV (Choose any two):-

BSMA306A ADVANCED MECHANICS (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.
ii) Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.
iii) Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed.
iv) Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.
v) Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

Statics in Space: Forces in three dimensions, Reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches; Nul points, lines and planes with respect to a system of forces, Conjugate forces and conjugate lines.

Motion of a Rigid Body: Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axes and moments of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigid body with a fixed point and angular momentum of a rigid body, Euler's equations of motion for a rigid body with a fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical polar coordinates, Motion about a fixed axis, Compound pendulum.

Kinematics of Fluid Motion: Lagrangian and Eulerian approaches, Material and convective derivatives, Velocity of a fluid at a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Cylindrical and spherical symmetry, Boundary surface, Streamlines and pathlines, Steady and unsteady flows, Velocity potential, Rotational and irrotational motion, Vorticity vector and vortex lines.

Kinetics of Fluid Motion: Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates; Bernoulli's equation, Impulsive motion.

Motion in Two-Dimensions: Stream function, Complex potential, Basic singularities: Sources, sinks, doublets, complex potential due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle, Milne□Thomson circle theorem.

References:

1. A. S. Ramsay (1960). *A Treatise on Hydromechanics, Part-II Hydrodynamics.* G. Bell & Sons.
2. F. Chorlton (1967). *A Textbook of Fluid Dynamics*. CBS Publishers.
3. Michel Rieutord (2015). *Fluid Dynamics An Introduction.* Springer.
4. E. A. Milne (1965). *Vectorial Mechanics,* Methuen & Co.Limited. London.

BSMA308A WAVELETS AND APPLICATIONS (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Know basic concepts of signals and systems.
ii) Understand the concept of Haar spaces.
iii) Learn Fourier transform and wavelet transform of digital signals.
iv) Learn applications of wavelets to the real-world problems.
v) Apply wavelets in signal processing and image processing.

Signals and Systems: Basic concepts of signals and systems, Frequency spectrum of signals; Classification of signals: Discrete time signals and continuous time signals, periodic and non-periodic signals; Classification of systems: Linear, nonlinear, time-variant, time-invariant, stable and unstable systems.

Haar Scaling Function and Wavelet, Time-Frequency Analysis: Orthogonal functions, Orthonormal functions, Function spaces, Orthogonal basis functions, Haar scaling function, Haar spaces: Haar space , general Haar space ; Haar wavelet, Haar wavelet spaces: Haar wavelet space , general Haar wavelet space ; Decomposition and reconstruction, Time-frequency analysis, Orthogonal and orthonormal bases.

Fourier Transforms and Wavelets: Discrete Fourier transform of a digital signal, Complex form of a Fourier series, Inverse discrete Fourier transform, Window Fourier transform, Short time Fourier transform, Admissibility condition for a wavelet, Classes of wavelets: Haar, Morlet, Maxican hat, Meyer and Daubechies wavelets; Wavelets with compact support.

Discrete Wavelet Transforms: Stationary and non-stationary signals, Haar transform, 1-level Haar transform, Multi-level, Haar transform, Conservation and compaction of energy, Multiresolution analysis, Decomposition and reconstruction of signals using discrete wavelet transform (DWT).

Applications: Wavelet series expansion using Haar and other wavelets, Applications in signal compression, Analysis and classification of audio signals using DWT, Signal de-noising: Image and ECG signals.

References:

1. Charles K. Chui (1992). *An Introduction to Wavelets*. Academic Press.
2. Ingrid Daubechies (1999). *Ten Lectures on Wavelets*. SIAM
3. Michael W. Frazier (1999). *An Introduction to Wavelets Through Linear Algebra*. Springer-Verlag.
4. Stéphane Mallat (2008). *A Wavelet Tour of Signal Processing* (3rd edition). Academic Press.
5. M.J. Roberts (2004). *Signals and Systems: Analysis Using Transform Methods and* MATLAB. McGraw-Hill Education.
6. David K. Ruch & Patrick J. Van Fleet (2009), *Wavelet Theory***:** *An Elementary Approach with Applications*. John Wiley & Sons.
7. James S. Walker (2008). *A Primer on Wavelets and Their Scientific Applications* (2nd edition). Chapman & Hall/CRC, Taylor & Francis.

BSMA310A NUMBER THEORY (Credits 6)

Course Learning Outcomes: This course will enable the students to:

i) Learn about some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences.
ii) Learn about number theoretic functions, modular arithmetic and their applications.
iii) Familiarise with modular arithmetic and find primitive roots of prime and composite numbers.
iv) Know about open problems in number theory, namely, the Goldbach conjecture and twin-prime conjecture.
v) Apply public crypto systems, in particular, RSA.

Distribution of Primes and Theory of Congruencies: Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Twin-prime conjecture, Odd perfect numbers conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Number Theoretic Functions: Number theoretic functions for sum and number of divisors, Multiplicative function, The Möbius inversion formula, Greatest integer function, Euler's phi-function and properties, Euler's theorem.

Primitive Roots: Order of an integer modulo *n*, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, Euler's criterion.

Quadratic Reciprocity Law: The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli.

Applications: Public key encryption, RSA encryption and decryption with applications in security systems.

References:

1. David M. Burton (2007). *Elementary Number Theory* (7th edition). McGraw-Hill.
2. Gareth A. Jones & J. Mary Jones (2005). *Elementary Number Theo*ry. Springer.
3. Neville Robbins (2007). *Beginning Number Theory* (2nd edition). Narosa.
4. I.Niven (2012). *An Introduction to the Theory of Numbers* (5th edition). John Wiley & Sons.
5. Neal Koblitz (1994). *A Course in Number Theory and Cryptography* (2nd edition). Springer-Verlag.

BSMC671A MATHEMATICAL FINANCE (Credit 6)

Course Learning Outcomes: This course will enable the students to:

i) Understand financial markets and derivatives including options and futures.
ii) Appreciate pricing and hedging of options, interest rate swaps and no-arbitrage pricing concepts.
iii) Learn stochastic analysis, Ito's formula, Ito integral and the Black−Scholes model.
iv) Study and use Hedging parameters, trading strategies and currency swaps.

Basic Theory of Interest and Fixed-Income Securities: Principal and interest: simple, compound and continuous; Present and future value of cash flow streams; Net present value, Internal rates of return and their comparison; Inflation, Annuities; Bonds, Bond prices and yields, Macaulay duration and modified duration.

Term Structure of Interest Rates, Bonds and Derivatives: Spot rates, forward rates and explanations of term structure; Running present value, Floating-rate bonds, Immunization, Convexity; Putable and callable bonds; Exchange-traded markets and over-the-counter markets; Derivatives: Forward contracts, Future contracts, Options, Types of traders, Hedging, Speculation, Arbitrage.

Mechanics of Options Markets: No-arbitrage principle, Short selling, Forward price for an investment asset; Types of options: Call and put options, Option positions, Underlying assets, Factors affecting option prices, Upper and lower bounds for option prices, Put-call parity, Effect of dividends.

Stochastic Analysis of Stock Prices and Black□Scholes Model: Binomial option pricing model, Risk neutral valuation: European and American options on assets following binomial tree model; Lognormal property of stock prices, Distribution of rate of return, Expected return, Volatility, Estimating volatility from historical data, Extension of risk-neutral valuation to assets following geometric Brownian motion, Black□Scholes formula for European options.

Hedging Parameters, Trading Strategies and Swaps: Hedging parameters: Delta, gamma, theta, rho and vega; Trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.

References:

1. John C. Hull & Sankarshan Basu (2018). *Options, Futures and Other Derivatives* (10th edition). Pearson Education.
2. David G. Luenberger (2013). *Investment Science* (2nd edition). Oxford University Press.
3. Sheldon M. Ross (2011). *An Elementary Introduction to Mathematical Finance* (3rd edition). Cambridge University Press.

BSCS113A C++PROGRAMMING FOR MATHEMATICS (Credits 4)

Course Learning Outcomes: This course will enable the students to:

i) Understand and apply the programming concepts of C++ which is important for mathematical investigation and problem solving.
ii) Use mathematical libraries for computational objectives.
iii) Represent the outputs of programs visually in terms of well formatted text and plots.

C++ Essentials: Fundamentals of programming, Organization of logic flow in stored program model of computation, C++ as a general purpose programming language, Structure of a C++ program, Common compilers and IDE's, Basic data-types, Variables and literals in C++, Operators, Expressions, Evaluation precedence and type compatibility; Outline of program development in C++, Debugging and testing; Applications**:** Greatest common divisor and random number generation.

Structured Data: Structured data-types in C++, Arrays and manipulating data in arrays; Objects and classes**:** Information hiding, modularity, constructors and destructors, methods and polymorphism; Applications**:** Factorization of an integer, Euler's totient, Images in Cartesian geometry using points in two & three dimensions, Pythagorean triples.

Containers and Templates: Containers and Template Libraries**:** Sets, iterators, multisets, vectors, maps, lists, stacks and queues; Applications**:** Basic set algebra, modulo arithmetic and congruences, projective plane, permutations, monotone sequences and polynomials.

Libraries and Packages: Libraries and Packages for arbitrary precision arithmetic and linear algebra**;** Features of C++ for input/output and visualization**:** Strings, streams, formatting methods, processing files in a batch, command-line arguments, visualization packages and their uses; Applications**:** Arbitrary precision arithmetic using GMP, BOOST; Finding nullity, rank, eigen values, eigen vectors, linear transformations, systems of linear equations; Plots.

Odds and Ends: Runtime errors and graceful degradation, Robustness in a program; Exception handling: Try-catch and throw; Defining and deploying suitable exception handlers in programs; Compiler options; Conditional compilation; Understanding and defining suitable pragmas; Applications**:** Identification and description of install parameters of mathematical libraries, debugging installation, working with multiple libraries simultaneously and maintaining correctness and consistency of data.

References:

1. Nell Dale & Chip Weems (2013).*Programming and Problem Solving with C++* (6th edition). Jones & Bartlett Learning.
2. Peter Gottschling (2016). *Discovering Modern C++***:** *An Intensive Course for Scientists, Engineers, and Programmers*. Pearson.
3. Nicolai M. Josuttis (2012). *The C++ Standard Library*: *A Tutorial and Reference* (2nd edition). Addison-Wesley, Pearson.
4. Donald E. Knuth (1968). *The Art of Computer Programming.* Addison-Wesley.
5. Edward Scheinerman (2006). *C++ for Mathematicians*: *An Introduction for Students and Professionals*. Chapman & Hall/CRC. Taylor & Francis.
6. B. Stroustrup (2013). *The C++ Programming Language* (4th edition). Addison-Wesley.

BSCS167A C++PROGRAMMING FOR MATHEMATICS LAB (Credits 2)

LIST OF EXPERIENTS

Q1. A point on the two-dimensional plane can be represented by two numbers: an X coordinate and a Y coordinate. For example, (4,5) represents a point 4 units to the right of the origin along the X axis and 5 units up the Y axis. The sum of two points can be defined as a new point whose X coordinate is the sum of the X coordinates of the points and whose Y coordinate is the sum of their Y coordinates.

Write a program that uses a structure called a point to model a point. Define three points, and have the user input values to two of them. Than set the third point equal to the sum of the other two, and display the value of the new point. Interaction with the program might look like this:

Enter coordinates for P1: 3 4

Enter coordinates for P2: 5 7

Coordinates of P1 + P2 are : 8, 11

Q2. Create the equivalent of a four function calculator. The program should request the user to enter a number, an operator, and another number. It should then carry out the specified arithmetical operation: adding, subtracting, multiplying, or dividing the two numbers. (It should use a switch statement to select the operation). Finally it should display the result. When it finishes the calculation, the program should ask if the user wants to do another calculation. The response can be 'Y' or 'N'. Some sample interaction with the program might look like this.

Enter first number, operator, second number: 10/ 3
Answer = 3.333333
Do another (Y/ N)? Y
Enter first number, operator, second number 12 + 100
Answer = 112
Do another (Y/ N) ? N

Q3. Create two classes DM and DB which store the value of distances. DM stores distances in metres and centimeters and DB in feet and inches. Write a program that can read values for the class objects and add one object of DM with another object of DB.
Use a friend function to carry out the addition operation. The object that stores the results maybe a DM object or DB object, depending on the units in which the results are required.
The display should be in the format of feet and inches or metres and cenitmetres depending on the object on display.

Q 4. Create a class rational which represents a numerical value by two double values- NUMERATOR & DENOMINATOR. Include the following public member Functions:
• constructor with no arguments (default).
• constructor with two arguments.
• void reduce( ) that reduces the rational number by eliminating the highest common factor between the numerator and denominator.
• Overload + operator to add two rational number.
• Overload >> operator to enable input through cin.
• Overload << operator to enable output through cout.
Write a main ( ) to test all the functions in the class.

Q5. Consider the following class definition
class father {
protected : int age;
public;
father (int x) {age = x;}
virtual void iam ( )
{ cout < < “I AM THE FATHER, my age is : ”<< age<< end1:}
};
Derive the two classes son and daughter from the above class and for each, define iam ( ) to write
our similar but appropriate messages. You should also define suitable constructors for these classes.
Now, write a main ( ) that creates objects of the three classes and then calls iam ( ) for them. Declare pointer to father. Successively, assign addresses of objects of the two derived classes to this pointer and in each case, call iam ( ) through the pointer to demonstrate polymorphism in action.

Q6. Create a base class called shape. Use this class to store two double type values that could be used to compute the area of figures. Derive two specific classes called triangle and rectangle from the base shape. Add to the base class, a member function get_data ( ) to initialize base class data Members and another member function display_area ( ) to compute and display the area of figures. Make display_area ( ) as a virtual function and redefine this function in the derived classes to suit their requirements.

Using these three classes, design a program that will accept dimensions of a triangle or a rectangle interactively and display the area.

Remember the two values given as input will be treated as lengths of two sides in the case of rectangles and as base and height in the case of triangles and used as follows:

Area of rectangle = x * y

Area of triangle = ½ * x * y

Q7. A Pythagorean triplet is a set of three positive integers a, b and c such that $a^2 + b^2 = c^2$. Given a limit, generate all Pythagorean Triples with values smaller than given limit.

Q8. A stack is an abstract data structure that contains a collection of elements. Stack implements the LIFO mechanism i.e. the element that is pushed at the end is popped out first. Some of the principle operations in the stack are −

- Push - This adds a data value to the top of the stack.
- Pop - This removes the data value on top of the stack
- Peek - This returns the top data value of the stack

Write a program that implements a stack using array?

Q9. Consider a matrix A. We must find the column vector X and the constant L (L=lamda) such that:

[A]{X} = L{X}

Now, consider these three set of equations:

a11x1 + a12x2 + a13x3 = Lx1

a12x1 + a22x2 + a23x3 = Lx2

a31x1 + a32x2 + a33x3 = Lx3

These equations can be written as:

(a11-L)x1 +a12x2 +a13x3 = 0

a21x1 +(a22-L)x2 +a23x3 = 0

a31x1 +a32x2 + (a33-L)x3 = 0

Now the determinant of the 3*3 matrix formed of the coefficients of x1, x2 and x3 terms gives three roots, namely L1, L2 and L3 (read L as lamda). These values are called characteristic or eigen values. For each of these values, we get a set of column vector with elements x1, x2 and x3. This vector is the required eigen vector. Write a program to determine eigen values?

Q10.Write a program using standard template library for implementing stack and queue?

BSMA312A **CRYPTOGRAPHY** **(Credits 6)**

Course Learning Outcomes: This course will enable the students to:

i) Understand the difference between classical and modern cryptography.
ii) Learn the fundamentals of cryptography, including Data and Advanced Encryption Standards (DES & AES) and RSA.
iii) Encrypt and decrypt messages using block ciphers, sign and verify messages using well-known signature generation and verification algorithms.
iv) Know about the aspects of number theory which are relevant to cryptography.

Introduction to Cryptography and Classical Cryptography: Cryptosystems and basic cryptographic tools: Secret-key cryptosystems, Public-key cryptosystems, Block and stream ciphers, Hybrid cryptography, Message integrity: Message authentication codes, Signature schemes, Nonrepudiation, Certificates, Hash functions, Cryptographic protocols, Security; Hybrid cryptography: Message integrity, Cryptographic protocols, Security, Some simple cryptosystems, Shift cipher, Substitution cipher, Affine cipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis of affine, substitution, Vigenère, Hill and LFSR stream ciphers.

Cryptographic Security, Pseudo Randomness and Symmetric Key Ciphers: Shannon's theory, Perfect secrecy, Entropy, Spurious keys and unicity distance; Bit generators, Security of pseudorandom bit generators. Substitution-permutation networks, Data encryption standard (DES), Description and analysis of DES; Advanced encryption standard (AES), Description and analysis of AES; Stream ciphers, Trivium.

Basics of Number Theory and Public-Key Cryptography: Basics of number theory; Introduction to public-key cryptography, RSA cryptosystem, Implementing RSA; Primality testing, Legendre and Jacobi symbols, Solovay□Strassen algorithm, Miller□Rabin algorithm; Square roots modulo *n*, Factoring algorithms, Pollard $p \square 1$ algorithm, Pollard rho algorithm, Dixon's random squares algorithm, Factoring algorithms in practice; Rabin cryptosystem and its security.

More on Public-Key Cryptography: Basics of finite fields; ElGamal cryptosystem, Algorithms for the discrete logarithm problem, Shanks' algorithm, Pollard rho discrete logarithm algorithm, Pohlig□Hellman algorithm; Discrete logarithm algorithms in practice, Security of ElGamal systems, Bit security of discrete logarithms.

Hash Functions and Signature Schemes: Hash functions and data integrity, SHA-3; RSA signature scheme, Security requirements for signature schemes, Signatures and Hash functions, ElGamal signature scheme, Security of ElGamal signature scheme, Certificates.

BSMA314A	DISSERTATION	L	T	P	C
Version 1.0		0	0	0	6
Total Contact Hours					
Pre-requisites/Exposure	--				
Co-requisites	--				

References:

1. Jeffrey Hoffstein, Jill Pipher & Joseph H. Silverman (2014). *An Introduction to Mathematical Cryptography* (2nd edition). Springer.

2. Neal Koblitz (1994). *A Course in Number Theory and Cryptography* (2nd edition). Springer-Verlag.
3. Christof Paar & Jan Pelzl (2014). *Understanding Cryptography*. Springer.
4. Simon Rubinstein-Salzedo (2018). C*ryptography*. Springer.
5. Douglas R. Stinson & Maura B. Paterson (2019). *Cryptography Theory and Practice*

BSMA314A DISSERTATION ON ANY TOPIC OF MATHEMATICS (Credits 6)

In this course, students are encouraged to choose the topic of their interest and do an in-depth study of the same and with some illuminating real time applications under supervision of a faculty member.

Course Objectives

Demonstrate advanced critical research skills in relation to career development or work-related learning studies.

:quire the skills to publish the data in reputed journals, conference proceeding and workshops.

:monstrate an ability to present and defend their research work to a panel of experts.

Course Outcomes

On completion of this course, the students will be able to

CO1	Know the concept, scope of research.
CO2	Enable the students to gain knowledge on particular areas of research.
CO3	Understand the scientific methods to study region.
CO4	Analyze the practical knowledge of research and apply the subject matter knowledge in the field
CO5	Learn the art of reporting.
CO6	Able to educate the technical skill of writing.

Catalog Description

The objective of research project is to enable the student with hands-on experiences with learning to lead a research work. Research gives them experience based and active learning. It engages students with contexts, including the social and civic. The mentoring and collaboration dimensions of undergraduate research can foster ownership for commitment to high standards and accountability. While the research process in a discipline may be well-established, research always requires creativity, as well as patience and resolve in grappling with what sometimes feels ambiguous to all participants, including the faculty mentor. These features create opportunities for students to explore their own learning styles as well as develop exposure to those of others.

Guidelines

1. Students will be divided among faculty members for the supervision of the research work.
2. In the first week of Semester V, each faculty member will assign a suitable research topic to the students from the selected topics in the areas of mathematical sciences.
3. The student will work on the assigned research topic during semesters V and VI in regular consultation with his/her assigned faculty member.
4. The student will write a dissertation based on the research work carried out during Semesters V and VI and prepare two copies to be submitted to the office of the Dean duly signed by the student and the supervisor in the sixth week of VI semester or a date decided by the Dean of the school.
5. Before preparing power point presentation and submission of dissertation, each student has to deliver a seminar talk on his/ her research project work on a date fixed by HOD, necessary suggestions has to be incorporated in the final draft of dissertation.
6. The student will make a power point presentation based on the work carried out and mentioned in the dissertation to the board of examiners appointed by the University.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal (Interaction of Student with Supervisor)	External			Total
		Relevance of topic (20)	Presentation (20)	viva (10)	100
Weightage (%)	50	20	20	10	

Proposed LOCF and CBCS Structure for BoS June, 2020											**APPENDIX I**
B.Sc. (H) Maths			**Year 2020 - 2023 (Scheme of studies)**								**SBAS**
ODD SEMESTER									**EVEN SEMESTER**		
Year	**SN**	**Course Code**	**Nature**	**Course Title**	**C**		**SN**	**Course Code**	**Nature**	**Course Title**	**C**
First	1	BSMA121A	CC	Calculus	4		1	BSMA122A	CC	Multivariable Calculus	4
	2	BSMA123A	CC	Algebra and Geometry	6		2	BSMA124A	CC	Ordinary Differential Equations	4
	3	BSCH125A	AECC	Environmental Studies	3		3	BSEL155A	AECC	Communication Skills	4
	4		GEC	Generic Elective I	6		4		GEC	Generic Elective II	6
	5	BSMA126A	CC	LaTeX and HTML	2		5	BSMA172A	SEC	Multivariable Calculus Lab	2
	6	BSMA171A	SEC	Calculus Lab	2		6	BSMA174A	SEC	Ordinary Differential Equations Lab	2
	7	BSMA176A	SEC	LaTeX and HTML Lab	2						
	TOTAL				**25**		**TOTAL**				**22**
Second	1	BSMA211A	CC	Partial Differential Equations and Calculus of Variations	4		1	BSMA212A	CC	Advanced Algebra	6
	2	BSMA213A	CC	Group Theory	6		2	BSMA214A	CC	Linear Algebra	6
	3	BSMA215A	CC	Probability and Statistics	4		3	BSMA216A	CC	Real Analysis	6
	4		GEC	Generic Elective III	6		4		GEC	Generic Elective IV	6
	5	BSDM301A	AECC	Disaster Management	3		5	BSMA226A	CC	Computer Algebra Systems and Related Software	2
	6	BSMA273A	SEC	Probability and Statistics Lab	2		6	BSMA272A	SEC	Computer Algebra Systems and Related Software Lab	2
	7	BSMA275A	SEC	Partial Differential Equations and Calculus of Variations Lab	2		7	VAC	VAC	VAC	0
	TOTAL				**27**		**TOTAL**				**28**
Third	1	BSMA301A	CC	Numerical Analysis	4		1	BSMA302A	CC	Complex Analysis	4
	2	BSMA303A	CC	Set Theory and Metric Spaces	6		2	BSMA304A	CC	Linear Programming	4
	3		DSE	Discipline Specific Elective I	6		3		DSE	Discipline Specific Elective III	6
	4		DSE	Discipline Specific Elective II	6		4		DSE	Discipline Specific Elective IV	6
	5	BSMA371A	SEC	Numerical Analysis Lab	2		5	BSMA372A	SEC	Complex Analysis Lab	2
	6	VAC	VAC	VAC	0		6	BSMA374A	SEC	Linear Programming Lab	2
	7	MOOC	MOOC	MOOC	2		**TOTAL**				**24**
	TOTAL				**26**						

Discipline Specific Elective I and II (Choose any two)				
1	BSMA305A	DSE	Tensors and Differential Geometry	6
2	BSMA307A	DSE	Mathematical Logic	6
3	BSMA309A	DSE	Integral Transforms and Fourier Analysis	6
4	BSMA311A	DSE	Information Theory and Coding	6
5	BSMA313A	DSE	Graph Theory	6
6	BSMA315A	DSE	Special Theory and Relativity	6
Discipline Specific Elective III and IV (Choose any two)				
1	BSMA306A	DSE	Advanced Mechanics	6
2	BSMA308A	DSE	Wavelets and Applications	6
3	BSMA310A	DSE	Number Theory	6
4	BSMC671A	DSE	Mathematical Finance	6
5	BSMA312A	DSE	Cryptography	6
6	BSCS113A	DSE	C++Programming for Mathematics	4
	BSCS167A	DSE	C++Programming for Mathematics Lab	2
7	BSMA314A	DSE	Dissertation on Any Topic of Mathematics	6

Course Type	**Nomenclature**
CC	Core Course
SEC	Skill Enhancement Course
AECC	Ability Enhancement Compulsory Course
GEC	Generic Elective Course
DSE	Discipline Specific Elective
VAC	Value added course
MOOC	Massive open online course

Total Credits [C]	**152**

Students can choose two non credit courses (2 hours per week), one in odd semester and one in even semester during the entire duration of Programme from the pool of courses provided by the university.