Syllabus for Integrated M.Sc. Programme in Mathematics

Centre for Mathematics

(Under School of Basic Sciences & Information Sciences)

Central University of Orissa
Koraput

Course Structure

5 years Integrated M.Sc. Programme

Semester	Course Code	Course Title	L-P-T-D[C]
1st	HSS101	English Language	3-0-1-0[4]
	HSS102	2nd Language (Oriya/Hindi/Alternative English)	3-0-1-0[4]
	MTH101	Fundamental of Mathematics	3-0-1-0[4]
	PHY101	Physics – I	2-1-1-0[4]
	COMS101	Computer Science – I	3-0-1-0[4]
2nd	MTH102	Real Analysis – I	3-0-1-0[4]
	PHY102	Physics – II	2-1-1-0[4]
	COMS102	Computer Science – II	2-1-1-0[4]
	HSS103	Indian Culture and Heritage	3-0-1-0[4]
	HSS104	Environmental Science	3-0-1-0[4]
3rd	MTH 201	Real Analysis – II	3-0-1-0[4]
	MTH 202	Combinatorics	3-0-1-0[4]
	MTH 203	Linear Algebra	3-0-1-0[4]
	MTH 204	Analytical Geometry	3-0-1-0[4]
	COMS 201	Computer Science – III	3-0-1-0[4]
4th	MTH 205	Probability Theory	3-0-1-0[4]
	MTH 206	Computer Oriented Numerical Analysis using C	2-1-1-0[4]
	MTH 207	Real Analysis – III	3-0-1-0[4]
	MTH 208	Group Theory	3-0-1-0[4]
	MTH 209	Ordinary Differential Equation	3-0-1-0[4]
5th	MTH 301	Statistics – I	3-0-1-0[4]
	MTH 302	Complex Analysis	3-0-1-0[4]
	MTH 303	Partial Differential Equation	3-0-1-0[4]
	MTH 304	Rings and Modules	3-0-1-0[4]
	MTH 305	Number Theory	3-0-1-0[4]
6th	MTH 306	Statistics – II	3-0-1-0[4]
	MTH 307	Elementary Differential Geometry	3-0-1-0[4]
	MTH 308	Field Theory	3-0-1-0[4]
	MTH 309	Operation Research – I	3-0-1-0[4]
	MTH 310	Metric Space	3-0-1-0[4]
7th	MTH 401	Classical Mechanics	3-0-1-0[4]
	MTH 402	Lebsgue Measure & Integration	3-0-1-0[4]
	MTH 403	Data Base Management System	2-1-0-1[4]
	MTH 404	Mathematical Method	3-0-1-0[4]
	MTH 405	Topology	3-0-1-0[4]
8th	MTH 406	Functional Analysis	3-0-1-0[4]
	MTH 407	Fluid Dynamics	3-0-1-0[4]
	MTH 408	Graph Theory	3-0-1-0[4]
	MTH 409	Integral Equation & Transformation	3-0-1-0[4]
		Departmental Elective – I	

9th		Departmental Elective – II	
		Open Elective – I	
	MTH 501	Operation Research – II	3-0-1-0[4]
	MTH 502	Project – I	0-0-0-7[8]
10th		Departmental Elective – III	
		Open Elective – II	
	MTH 503	Project – II	0-0-0-7[12]

*Open Elective: Any course in any Department under Central University of Orissa

List of the Departmental Elective Courses:

Sl. No.	Course Code	Course Title	L-P-T-D[C]
01	MTH 410	Introduction to Continuum Mechanics	3-0-1-0[4]
02	MTH 411	Reliability Modelling and Analysis	3-0-1-0[4]
03	MTH 412	Statistical Genetics	3-0-1-0[4]
04	MTH 504	Mathematical Modelling	3-0-1-0[4]
05	MTH 505	Computational Fluid Dynamics	3-0-1-0[4]
06	MTH 506	Analysis of Design and Algorithms	3-0-1-0[4]
07	MTH 507	Finite Element Method	3-0-1-0[4]
08	MTH 508	Manifold Theory	3-0-1-0[4]
09	MTH 509	Non Linear Dynamics and Chaos	3-0-1-0[4]
10	MTH 510	Discrete Dynamical System	3-0-1-0[4]
11	MTH 511	Sampling Theory	3-0-1-0[4]
12	MTH 512	Statistical Pattern Recognition	3-0-1-0[4]
13	MTH 513	Statistical Simulations	3-0-1-0[4]
14	MTH 514	Medical and Health Statistics	3-0-1-0[4]
15	MTH 601	Computer Intensive Statistical Methods	3-0-1-0[4]
16	MTH 602	Design of Experiments	3-0-1-0[4]
17	MTH 603	Order Statistics	3-0-1-0[4]
18	MTH 604	Algebraic Geometry	3-0-1-0[4]
19	MTH 605	Algebraic Topology	3-0-1-0[4]
20	MTH 606	Wavelet Analysis	3-0-1-0[4]
21	MTH 607	Stochastic Process	3-0-1-0[4]
22	MTH 608	Set Theory & Logic	3-0-1-0[4]
23	MTH 609	Bio Mathematics	3-0-1-0[4]
24	MTH 610	An Introduction to Commutative Algebra	3-0-1-0[4]
25	MTH 611	Complex Analytic Dynamics and Fractal	3-0-1-0[4]
26	MTH 612	Statistical Ecology	3-0-1-0[4]

Course Description

HSS 101 **L-P-T-D[C]** 3-0-1-0[4]	**English language** **Pre. Req.: None** UNIT-1 PROSE: 1. THE MACMILLAN ANTHOLOGY OF MODERN ENGLISH PROSE Edited by: Dillip Kumar Das, Anusuya Kumari and Kshirod Kumar Padhi Pieces to be studied :- 1. G.B. Shaw : Spoken English and Broken English 2. E.M. Forster : Notes on the English Character 3. A.G. Gardiner : On Umbrella Morals 4. Mahatma Gandhi : Speech on Indian Civilization 5. R. K. Narayan : A snake in the grass UNIT – 2 POETRY : 2. THE MAGIC CASEMENTS: A MACMILLAN ANTHOLOGY OF POETRY. Edited by: Dr. Ram Narayan Panda Poems to be studied:- 1. Shakespeare : "All the world's a stage" 2. Pope : "Ode on Solitude" 3. Wordsworth: " Three years she grew in sun and shower" 4. Yeats : "The Second Coming" 5. Ezekiel : " Night of the scorpion" UNIT – 3 DRAMA : 3. Twelfth Night , By William Shakespeare UNIT – 4 NOVEL : 4. Chemmen by T.S. Pillai.
HSS 102 **L-P-T-D[C]** 3-0-1-0[4]	**2nd Language (Oriya/ Hindi/ Alternative English)** **Pre. Req.: None** **[ORIYA]** UNIT - 1 PROSE: 1. Achhu O Hebu : Nilakantha Das 2. Satyagraha Ashrama Jeevana : Gobinda Chandra Mishra 3. Chitragrebara Uchit Abhimana : Golakabihari Dhala 4. Puspapurare Barshabarana : Krushna Chandra Panigrahi UNIT - 2 POETRY: 1. Himachale Udaya Utsav: Madhusudan Rao 2. Manisha Bhai : Kuntalakumari Sabata 3. Chandramara Chudi : Ramakanta Rath 4. Jhia pain Gotie Kabita : Rajendra Kishore Panda UNIT - 3 FICTION: 1. Matira Manisa (Novel) : Kalindicharan Panigrahi

2. Daka Munsi : Fakirmohan Senapati
3. Dardura : Manoj Das

UNIT 4

DRAMA/ONE ACT PLAY:

1. Bhai Bhuja (Drama): Ramachandra Mishra
2. Abiskar: Manoranjan Das
3. Kaluribenta : Niladriabhusan Harichandan

UNIT - 5

GRAMMAR:

1. Bakya (Sagnya,Swarupa O Prakarabheda)
2. Sabda(Samotcharita,Biparita O Pratisabda)
3. Sudhha Odia Likhana (Bakya O Sabda)
4. Rudhi Prayoga

[HINDI]

Unit – 1

PROSE:

Text Book:- Nibandh-Chayan-Ed.by- Dr. Sudhansu Kumar Nayak

Pieces to be studied:

1. Grama Laxmi Ki Upasana- Binoba Bhabe
2. Bharatiya Sanskriti – Dr. Rajendra Prasad
3. Badri Dham – Kaka Kalelkar

Unit – 2

Standard Hindi Spelling:

Manak Hindi Bartani, Manak Hindi Varnamala, Paribardhit Hindi Varnamala, Hindi Varnati Sambandhi Adyatan Niyam, Hindi Ke Sankhya Vachak Sabda.

Unit – 3

Translation (English to Hindi)

Unit – 4

Precis Writing

Unit – 5

Sabda Sudhhi

Book for Reference:-

Adarsh Samanya Hindi – Vijay Agrawal, Jagatram & Sons, New Delhi

Samanya Hindi – Dr. Sudhansu Kumar Nayak, Vidya Sagar, Manik Ghosh Bazar, Cuttack

Anuprayogik Hindi – Dr.Krishna Kumar Goswami, Arunodaya Prakasan, Delhi

[ALTERNATIVE ENGLISH]

Unit –I

Drama:

The Tempest by William Shakespeare

Othello by William Shakespeare

Unit –II

Novel:

Great Expectations by Charles Dickens

Swami and Friends by R. K. Narayan

The Untouchables by Mulk Raj Anand

Unit –III

Poetry:

“Sonnet: 30” by William Shakespeare

“Lucy Gray” by William Wordsworth

“Gitanjali:35” by Rabindranath Tagore

"Night of the Scorpion" by Nissim Ezekiel

	Unit –IV **Short stories:** "Portrait of a Lady" by Khushwant Singh "The Bet" by Anton Chekhov Unit –V Basic concepts of phonology, phonetics, morphology, syntax, semantics, pragmatics, sociolinguistic, psycholinguistic, etc. **Prescribed books** A Textbook of English Phonetics for Indian Students by Balasubramaniam, T. An Introduction to Language by Fromkin Victoria and Robert Rodman
HSS 103 **L-P-T-D[C]** 3-0-1-0[4]	**Indian Culture and Heritage** **Pre. Req.: None** Section I- Indian Society: Unit – I Indian Society: Its decomposition and diversity, castes and tribes, Major Religions Little tradition and Great Tradition, Threats to Unity. Approaches to Social Integration. Unit – II Processes of Socio-cultural change in India. Sanskritization, Secularization, Westernization, Modernization and democratisation. Unit – III Globalisation and its impact on Indian Society. Local response to globalisation and the role of civil society Section – II Indian Culture: Unit – I "Roots of Indian Culture: Concept of Bharatavarsh religious faith and belief, social system in vedicage" Charastristics of Indian Culture: Protestant Religious movements during 6th century B. C. Cultural attainments with reference to the Gupta Period. Unit – II Cultural Expansion: Over Sea trade and commerce and its impact on South-East Asia. Hellenistic impact on art and architecture, impact of Islam on Indian life, Socio-religious reforms movements: Bhakti Movement, Brahmo Samaj And Arya Samaj. Unit – III Nationalism in India: Freedom struggle and the role of Gandhi Nehuru, Subhas and Jinaa. **Books for reference:** 1. Indian society & Culture by H. S. Patnaik, Dharavela Mohanty 2. Social and Economics History of India by S. C. Raychoudhury 3. Indian Society & Culture by Prof. N. R. Patnaik 4. Evolution of Indian Culture by B.N. Lumiya 5. The wonder that was India by A. L. Basham 6. Indian Society & Culture by S. K. Jena **7.** Bharatiya Samaj And Sanskruti (Oriya)by Dr. Trilochan Mishra.
HSS 104 **L-P-T-D[C]** 3-0-1-0[4]	**Environmental Science** **Pre. Req.: None** Unit – I Basic Concepts of Environmental studies: Definitions: the Environment-Air, Water and Land, Ecology, Ecosystem, Environmental factors (A biotic factors-light, temperature, soil water and air and biotic factors) Limiting factors, Ecological adaptations. Unit – II Ecosystem functioning, (Preliminary concept & structure) structure and its organisation, Ecological energetic, Energy flow, food chains, food web, Ecological

	pyramids, production-Bio-geo-chemical cycles (Hydrologic cycle (water), Gaseous cycle (Oxygen & Co2), Sedimentary cycle (Nitrogen and Sulphur) Unit – III Population density Natality, mortality, carrying capacity, Age population growth corves, community structure, Ecological succession, types of succession, succession patterns, theories of climax community, Biodiversity. Unit – IV Environmental Pollution: Air pollution, water pollution, terrestrial pollution, Noise pollution, Radiation Pollution, Industrial pollution, Sewage and sewage treatment. Types of pollutants, sources and fate of pollutants in the environment, Depletion of Ozone layer, Green House effects, smog, Acid rain, Biological concentration and biomagnifications of pollutants. Unit – V Conservation of natural resources: Types of renewable and non-renewable resources, soil erosion and conservation, Forest conservation, Deforestation, Afforestation, social forestry, photo geographical regions of India, Management and conservation of Wild life, Pollution control Board and their functions. Environmental awareness and Education. **Text Book:-** Ashok k Panigrahi, Alaka Sahu, "Environmental Studies", Sadgrantha Mandir, Berhampur **References:** 1. B.P. Odum, "Fundamental of Ecology" W. B. Saunders Company Philadelphia, London. 2. M. C. Dash, "Fundamentals of Ecology", Tata Mc Graw Hill publishing Company Limited, New Delhi 3. P. C. Mishra , "Fundamentals of Air and Water Pollution" Ashis publishing House, New Delhi 4. B. N. Mishra, M. K. Mishra , "Introductory practical Biostatistics" N. P. Publishers, Calcutta 5. Dr. Ranganath Mishra, "Paribasa Bigiana (odia)" 6. Dr. Basanta Ku Mahapatra , "Paribasa o Paribasa Bigiana (odia)" 7. Dr. Ranganath Mishra , "Concept of Env. Studies" 8. Dr. N. K. Tripathy, "Fundamental of Env. Studies" 9. Dr. M. C. Dash, "Man and Environment"
PHY 101 **L-P-T-D[C]** 2-1-1-0[4]	**Physics-I** **Pre. Req.: None** Unit -1: Kinematics: Displacement, Time and Average Velocity (x-t graph illustrations to be included), Instantaneous Velocity (Finding of velocity on an x-t graph), Average and Instantaneous Acceleration (Illustration with v – t and a – t graph), Motion with Constant Acceleration (Illustration with a – t and v – t graph), Freely Falling Bodies (Up and Down motion in fall with y-t and vy-t graph), Velocity and Position by Integration. Position and Velocity Vectors, Acceleration Vector Problems, Newton's laws of motion: Newton's First and Second Law and their explanation, Working with Newton's First and Second Law. Newton's Third Law of motion and its explanation with problems. Various types of forces in nature (explanation), Pseudo Forces (e.g. Centrifugal Force), Problems, Unit – 2: Work and Energy: Kinetic Energy, Work and Work-Energy Theorem, Calculation of Work done with i) Constant Force ii) Spring Force Illustration, Work-Energy Theorem, Potential Energy, Conservative and Non-conservative Forces. Definition of potential energy and conservation of Mechanical energy. Change in the potential energy in a rigid body motion. Mass-energy equivalence, Problems.

Unit – 3: Basic Concepts of Thermodynamics: Thermodynamic state of a system, Thermal Equilibrium, Zeroth law of Thermodynamics, Internal Energy of System-Concept of heat, Equation of State : The Ideal Gas Equation, Indicator Diagram, First law of Thermodynamics, Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric. Adiabatic relations of system for perfect gas. Work done during Isothermal and Adiabatic changes. Reversible and Irreversible changes. Problems, Second Law of

Unit – 4: Thermodynamics: Entropy [9 lectures]: Conversion of Heat into Work and its converse, Reversible and Irreversible Processes. Examples of Irreversible Processes. Carnot's Cycle and Carnot's Heat Engine and its efficiency. Second law of Thermodynamics: Statements. Carnot Theorem. Entropy. Principle of Increase in Entropy. Generalised form of the First and Second laws: Entropy changes for an Ideal Gas. Entropy of van der Waals' gas. Problems

Unit – 5: Sound: Definition of sound intensity, loudness, pitch, quality and timber. Acoustic intensity level measurement. Acoustic pressure and it's measurement. Reverberation time and Reverberation of a hall. Sabine's formula (without derivation). Stroboscope

Doppler Effect: Explanation of Doppler effect in sound. Expression for apparent frequency in different cases. Asymmetric nature of Doppler effect in sound. Doppler effect in light, symmetric nature of Doppler effect in light. Applications: Red shift, Violet shift, Radar, Speed trap, Width of a spectral line. Problems.

References:

1. University Physics, Sears and Zeemansky, XIth edition, Pearson education.
2. Concepts of Physics (Vol -1), H.C. Varma, Bharati Bhavan Publishers
3. Problems in Physics, P.K. Srivastava, Wiley Eastern Ltd.
4. Physics, 4th Edition, Volume I, Resnick/Halliday/Krane, JOHN WILEY & SONS (SEA) PTE LTD.
5. Heat and Thermodynamics, Mark. W. Zemansky, Richard H. Dittman, Seventh Edition, McGraw-Hill International Editions.
6. Heat and Thermodynamics, Brijlal, N. Subrahmanyam, S. Chand & Company Ltd, New Delhi.
7. Concept of Physics (Vol -2), H.C. Verma, Bharati Bhavan Publishers.
8. A text book of sound, Subramanyam and Brijlal, Vikas Prakashan.
9. Sound, Mee, Heinmann, Edition – London.

Practical:

1. Mechanics

(1) Range and Least Count of Instruments, Measurements using various instruments and error analysis (Vernier caliper, screw gauge, travelling microscope, spectrometer etc.)

(2) Interpretation of kinematics graphs – part I From data plotting of x vs. t graph, From this graph plotting of v vs. t and a vs. t graph

(3) Interpretation of kinematics graphs – part II From data plotting of a vs. t graph, From this graph plotting of v vs. t and x vs. t graph.

(4) Determination MI of disc using ring

(5) MI of Flywheel

(5) Determination of coefficient of viscosity by Poiseulli's method

(6) Determination of Y and n by flat spiral spring

(7) Determination of Y by bending

(8) Surface Tension by Jeager's method.

2. Heat and Thermodynamics

(1) Interpretation of isothermal and adiabatic curves on PV diagram (Theoretical).

	Theoretical study of Carnot's cycle by drawing graphs of isothermal and adiabatic curves. (2) Temperature coefficient of resistance. (3) Study of thermocouple and determination of inversion temperature (4) Thermal conductivity by Lee's method (5) Specific heat of graphite 3. Sounds (1)Velocity of sound by Ruben's flame method (2) Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, paper etc.) (3) Velocity of sound by phase shift method. (4) Audibility of human ear. (5) Directional characteristics of Microphone.
PHY 102 **L-P-T-D[C]** 2-1-1-0[4]	**Physics-II** **Pre. Req.: None** Unit – 1: Geometrical Optics: Introduction to development of Optics, Lenses: thin and thick lenses, Lens equation, Lens maker's formula, Cardinal points of an optical system, Combination of two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points). Problems. Lens Aberrations: Introduction, Types of aberrations: monochromatic and chromatic aberration, Types of monochromatic aberration and their reduction, Spherical aberration, Coma, Astigmatism, Curvature of field, Distortion, Types of chromatic aberration: Achromatism (lenses in contact and separated by finite,distance), Problems. Unit – 2: Optical Instruments: Simple microscope and Compound microscope, Telescopes, Reflection and transmission type of telescope, Eyepieces: Huygen's eyepiece, Ramsden's eyepiece, Gauss's eyepiece, Constant deviation spectrometer, Problems. Interference and Diffraction: Classification of interference of thin films, Interference by division of amplitude, Interference by wedge shaped film: Interference due to reflected light and transmitted light. Fringes of equal inclination, equal thickness, equal chromatic order (FECO fringes), colors of thin films, Interferometry: Michelson's interferometer and Fabry-Perot interferometer, Types of diffraction: Fresenel's diffraction and Fraunhoffer's diffraction, Fraunhoffer's diffraction at double slit and its analytical treatment, Fraunhoffer's diffraction at N slits, Plane diffraction grating, Rayleigh's criterian for resolution, Resolving power of a grating, Problems. Unit – 3: Electrostatics: Coulomb's law, Statement, Vector form of Coulomb's law for like and unlike charges, Variation force with distance (F.vs.r graph) (Ref. 2, 21.3), Superposition principle, Statement and explanation with illustration, Illustrations with specific configuration of three charges (triangular form) and four charges (square form), Problems on superposition principle, Energy of the system of charges, Illustration with three charges, Electric potential energy (Ref. 1, 1.5 and Ref. 2, 23.1), Concept of electric field, Electric field due to point charge, Electric field due to group of charges, Lines of force, Relation between electric intensity and electric potential (Ref. 2, 21.4, 21.6, 22.1, 22.3, 23.5), Concept of electric flux, Gauss's theorem in electrostatics (statement only and explanation), Illustrations of Gauss law with examples.(Ref. 2, 22.1, 22.3). Unit – 4: DIELECTRICS: Electric Dipole, Electric dipole and dipole moment, Electric potential due to dipole, Electric intensity due to dipole, Torque on electric dipole in external electric field, Polar and non – polar molecules with examples. Effect of external electric field on polar and non – polar molecules ,Dielectric materials, Electric polarization of dielectric material, Electric polarization vector, Strength of dielectric

	material and Dielectric breakdown, Electric displacement and Gauss law in dielectric, Relation between three electric vectors (E, D and P)(Without derivation, qualitative discussion only), Effect of dielectric on capacitance of problems (parallel plate capacitor only), Problems. (Ref. 2, 21.7, 24.4, 24. 6). Unit – 5: Magnetostatics: Concept of magnetic field, Definition and properties of magnetic field, Revision of Biot – Savart's law, Examples : 1. Long straight conductor, 2. Current carrying circular loop on the axis, Ampere's circuital law, Field of solenoid, Field of toroidal solenoid, Magnetic Field lines and Magnetic flux, Gauss's law for magnetism, Problems. (Ref. 2, 27.2, 27.3, 28.2, 28.3, 28.4, 28.6) (Ref. 1, 6.2). Magnetic Properties Of Material: Magnetic Materials, Bohr magneton, Magnetisation (M), Magnetic Intensity (H) and magnetic induction (B), Magnetisation and Susceptibility and magnetic permeability, Relation between B, M and H (without derivation, qualitative discussion only), Diamagnetic, paramagnetic and ferromagnetic. Explanation with the help of susceptibility and permeability, Problems. Hysteresis (Ref. 2, 28.8) **Reference:** 1. Optics, fourth edition, Pearson education, E. Hetch, A. R. Genesan 2. A Text book of Optics, N.Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand publication. 3. Introduction to Optics, Third Edition, F.L. Pedrotti, Pearson Education 4. Physical Optics by A.K.Ghatak, McMillan, New Delhi 5. Fundamental of Optics, F.A.Jenkins, H.E.White, McGraw-Hill international Edition. 6. Principles of optics, D.S. Mathur, Gopal Press, Kanpur 7. Optics and Atomic physics, D.P.Khandhelwal, Himalaya Publication Bombay. 8. Fundamentals of optics- Francies A Jenking, Harvey E.White, Tata McGraw Hill 9. Berkeley Physics Course – Vol – II Electricity and Magnetism. Edward M Purcell. 10. University Physics – H.D. Young R. A. Freedman Pearson – Freedman 11. Resnick and Halliday, Physics Vol – II 12. Electromagnetics by B.B.Laud **Practical:** Optics (Any 4 experiments) 1. Newton's Ring: Determination of wavelength of monochromatic light source 2. Dispersive power of glass prism 3. Total internal reflection (using spectrometer, Na/Hg Source, glass prism) and determination of refractive index of a liquid. 4. Diffraction at straight edge/cylindrical obstacle 5. Optical activity of sugar solution (polarimeter) 6. Goniometer to determine cardinal points and focal length. 7. To determine temperature of sodium flame. 8. Double refracting prism.
COMS 101 **L-P-T-D[C]** 3-0-1-0[4]	**Computer Science – I** **Pre. Req.: None** Unit – 1: Fundamentals of Computer: Model of a digital computer, Functioning of a digital computer, Historical evolution of computers, classification of computers, Human being vs computer, Input / Output devices, Storage devices, Memory and mass storage devices, characteristics of memory systems, types of memory, RAM, ROM, concepts of Virtual and Cache memory, Types of software, Application and system software and its functions, time sharing, multiprocessing, Applications of Computer. Unit – 2: Operating Systems and Utility programs, Application Software, Computer Networks, The Internet and World Wide Wave, Network and Internet Security.

	Unit – 3: Programming languages: Machine language, Assembly language, High level languages, Compilers and Interpreters. Problem Solving using Computers : Algorithms, Flowcharts Unit – 4: Introduction to Windows: Types of windows, windows as an operating system, windows explorer, using clipboard, using paintbrush, control panel, installing a printer. Unit – 5: MS Power Point: Introduction, Power point slide creation, Slide-show, Adding graphics, Formatting Customizing and Printing. MS-Word: Introduction to MS-Word, Standard Toolbar, Word Wrap, Text formatting, Indents, Tabs, Formatting paragraphs, Applying Effects to text, Applying animation to text. MS Excel: Introduction to MS Excel, Working with Toolbars, Formatting, Formulas, Data management, Graphs and Charts, Macros and other additional functions. **References:** 1. Donald Sanders, Computers Today, McGraw-Hill Publishers. 2. Davis, Introduction to Computers, McGraw-Hill Publishers. 3. V. Rajaraman, Fundamental of Computers, Prentice-Hall India Ltd., New Delhi.
COMS 102 **L-P-T-D[C]** 2-1-1-0[4]	**Computer Science – II** **Pre. Req.: None** Unit – 1: Introduction to C: History, Structure of a C program, Functions as building blocks, Application Areas, C Program development life cycle. C Tokens : Keywords, Identifiers, Variables, Constants – character, integer, float, string, escape, sequences, Data types – built-in and user defined, Operators and Expressions, Operator types (arithmetic, relational, logical, assignment, bitwise, conditional , other operators) , precedence and associativity rules. Input and Output : Character input and output, String input and output, Formatted input and output Unit – 2: Control Structures : Decision making structures- If, if-else, switch, Loop Control structures - While, do-while, for, Nested structures, break and continue Functions in C : What is a function, Advantages of Functions, Standard library ,functions, User defined functions, Declaration, definition, function call, parameter passing (by value), return keyword, Scope of variables, storage classes, Recursion Arrays : Array declaration, initialization, Types – one, two and multidimensional, Passing arrays to functions Unit – 3: Pointers : Pointer declaration, initialization, Dereferencing pointers, Pointer arithmetic, Pointer to pointer, Arrays and pointers, Functions and pointers – passing pointers to functions, function returning pointers, pointer to function, Dynamic memory allocation Strings: Declaration and initialization, Standard library functions, Strings and pointers, Array of strings. Unit – 4: Structures and Unions : Creating structures, Accessing structure members (dot Operator), Array of structures, Passing structures to functions, Nested structures, Pointers and structures, Unions, Difference between structures and unions. C Preprocessor: Format of Preprocessor directive, File Inclusion directive, Macro substitution, nested macro, argumented macro, Conditional compilation. Unit – 5: Command Line Arguments: Accessing command line arguments. File Handling: Streams, Types of Files, Operations on files, Random access to files **Text Books:**

	1. Balagurusamy : "C Programming" Tata McGraw-Hill 2. P. Dey & M. Ghosh, "Computer Fundamental & Programming in C"- Oxford University Press 3. Deitel -"C How to programme" PHI publication/ Pearson Publication **References:** 1. Structured Programming approach using C – Forouzan and Gilberg, Thomson learning publications 2. The C Programming language – Kernighan and Ritchie 3. Complete C Reference – Herbert Schildt 4. Y. Kanitkar – "Let us C" BPB Publisher 5. Schaum Series- "C Programming" - Gotterfried **Practical:** 1. Practical to demonstrate use of data types, simple operators (expressions) 2. Practical to demonstrate decision making statements (if and if-else, nested structures) 3. Practical to demonstrate decision making statements (switch case) 4. Practical to demonstrate use of simple loops 5. Practical to demonstrate use of nested loops 6. Practical to demonstrate menu driven programs. 7. Practical to demonstrate writing C programs in modular way (use of user defined functions) 8. Practical to demonstrate recursive functions. 9. Practical to demonstrate use of arrays (1-d arrays) and functions 10. Practical to demonstrate use of multidimensional array(2-d arrays) and functions 11. Practical to demonstrate use of pointers 12. Practical to demonstrate concept of strings (string & pointers) 13. Practical l to demonstrate array of strings. 14. Practical to demonstrate use of bitwise operators. 15. Practical to demonstrate structures (using array and functions) 16. Practical to demonstrate structures and unions 17. Practical to demonstrate command line arguments and pre-processor directives. 18. Practical to demonstrate file handling (text files) 19. Practical to demonstrate file handling (binary files and random access to files) 20. Practical to demonstrate graphics using C
COMS 201 **L-P-T-D[C]** 3-0-1-0[4]	**Computer Science – III** **Pre. Req.: None** Unit – 1: Introduction to data structures: Concept, Data type, Data object, ADT, Need of Data Structure, Types of Data Structure. Algorithm analysis : Algorithm – definition, characteristics, Space complexity, time complexity, Asymptotic notation (Big O, Omega _) Unit – 2: Linear data structures : Introduction to Arrays - array representation , sorting, algorithms with efficiency - bubble sort, Insertion sort, Merge sort, Quick Sort Linked List : Introduction to List, Implementation of List – static & dynamic representation, Types of Linked List, Operations on List, Applications of Linked List – polynomial manipulation, Generalized linked list – concept & representation. Unit – 3: Stacks : Introduction, Representation-static & dynamic, Operations, Application - infix to postfix & prefix, postfix evaluation, Recursion using implicit stack, Concept of Multiple stacks Queues :Introduction, Representation -static & dynamic, Operations, Circular queue, De Que, priority queues, Concept of Multiple Queues. Unit – 4: Trees : Concept & Terminologies, Binary tree, binary search tree,

	Representation – static & dynamic, Operations on BST – create. Insert, delete, traversals (preorder, inorder, postorder), counting leaf, non-leaf & total nodes, Application - Heap sort, Height balance tree- AVL trees- Rotations Unit – 5: Graph : Concept & terminologies, Graph Representation, Traversals – BFS & DFS, Applications – AOV network – topological sort, AOE network – critical path, Shortest path with implementation **References:** 1. Fundamentals of Data Structures ---- By Horowitz Sahani (Galgotia) 2. Data Structures using C --- By ISRD Group (Tata McGraw Hill) 3. Introduction to Data Structures using C---By Ashok Kamthane 4. Data Structures using C --- Bandopadhyay & Dey (Pearson)
MTH 101 **L-P-T-D[C]** 3-0-1-0[4]	**Fundamental of Mathematics** **Pre Req.: None** Unit – 1: Method of Mathematical Proofs: Induction, Construction, Contradiction, Contrapositive. Set: Union and Intersection of sets, Distributive laws, De Morgan's Law, Finite and infinite sets. Unit – 2: Relation: Equivalence relation and equivalence classes. Function: Injections, Surjections, Bijections, Composition of functions, Inverse function, Graph of a function. Unit – 3: Countable and uncountable sets, Natural numbers via Peano arithmetic, Integers, Rational numbers, Real Numbers and Complex Numbers, De Moivre's Theorem. Unit – 4: Matrices: Matrix Operation (Addition, Scalar Multiplication, Multiplication, Transpose, Adjoint and their properties), Special type of matrix(Null, Identity, Diagonal, Triangular, Idempotent, Nilpotent, Involuntary, Symmetric, Skew Symmetric, Hermitian, Skew Hermitian, Orthogonal, Unitary, Normal), Determinant, Solving system of linear equations, Gauss elimination method, Unit – 5: Linear mappings on R2 and R3, Linear transformations and Matrices. Symmetry of Plane Figures: Translations, Rotations, Reflections, Glide-reflections, Rigid motions. Inequalities (Cauchy's and Schwartz inequality, Theorem on means, Theorem on weighted means, Weierstrass's Inequality, Holder's Inequality, Jensen's Inequality, Jensen's Theorem, Minkowski's Inequality) **References:** 1. G. Polya, \How to Solve It", Princeton University Press, 2004. 2. K. B. Sinha et. al., \Understanding Mathematics", Universities Press (India), 2003. 3. M. Artin, \Algebra", Prentice-Hall of India, 2007 (Chapters 1, 4, 5). 4. J. R. Munkres, \Topology", Prentice-Hall of India, 2013 (Chapter 1).
MTH 102 **L-P-T-D[C]** 3-0-1-0[4]	**Real Analysis – I** **Pre Req.: None** Unit – 1: Concept of ordered field, Bounds of a set, ordered completeness axiom and characterization of R as a complete ordered field. Archimedean property of real numbers. Modulus of real numbers, Intervals, Neighbourhood of a point. Unit – 2: Sequences of Real Numbers: Definition and examples, Bounded sequences, Convergence of sequences, Uniqueness of limit, Algebra of limits, Monotone sequences and their convergence, Sandwich rule. Unit – 3: Series: Definition and convergence, Telescopic series, Series with non-

	negative terms. Tests for convergence [without proof]: Cauchy condensation test, Comparison test, Ratio test, Root test, Absolute and conditional convergence, Alternating series and Leibnitz test. Unit – 4: Limit of a function at a point, Sequential criterion for the limit of a function at a point. Algebra of limits, Sandwich theorem, Continuity at a point and on intervals, Algebra of continuous functions. Discontinuous functions, Types of discontinuity. Unit – 5: Differentiability: Definition and examples, Geometric and physical interpretations, Algebra of differentiation, Chain rule, Darboux Theorem, Rolle's Theorem, Mean Value Theorems of Lagrange and Cauchy. Application of derivatives: Increasing and decreasing functions, Maxima and minima of functions. Higher order derivatives, Leibnitz rule, L'Hopital rule. **Text Book:** 1. R. G. Bartle, D. R. Sherbert, \Introduction to Real Analysis", John Wiley & Sons, 1992. 2. W. Rudin, \Principles of Mathematical Analysis", McGraw Hill International **References:** 1. K. A. Ross, \Elementary Analysis", Undergraduate Texts in Mathematics, Springer, 2013. 2. S. K. Berberian, \A First Course in Real Analysis", Undergraduate Texts in Mathematics, Springer-Verlag, 1994.
MTH 201 **L-P-T-D[C]** 3-0-1-0[4]	**Real Analysis – II** **Pre Req.: MTH 102** Unit – 1: Countability of a set, Countability of rational numbers, Uncountability of real numbers. Limit point of a set, Bolzano-Weirstrass theorem, Open sets, Closed sets, Dense sets. Unit – 2: Subsequence, Limit superior and limit inferior of a sequence, Cauchy criterion for convergence of a sequence, Monotone subsequence. Unit – 3: Tests of convergence of series, Abel's and Dirichlet's tests for series, Riemann rearrangement theorem. Continuous functions on closed and bounded intervals, Intermediate value theorem, Monotone functions, Continuous monotone functions and their invertibility, Discontinuity of monotone functions. Uniform continuity, Equivalence of continuity and uniform continuity on closed and bounded intervals, Lipschitz condition, Other sufficient condition for uniform continuity. Unit – 4: Riemann Integration: Darboux's integral, Riemann sums and their properties, Algebra of Riemann integrable functions, Class of Riemann integrable functions, Mean value theorem, Fundamental theorems of calculus, Change of variable formula (statement only), Unit – 5: Riemann-Stieltjes integration (definition). Taylor's theorem and Taylor's series, Elementary functions. Improper integral, Beta and Gamma functions. **Text Books:** 1. R. G. Bartle, D. R. Sherbert, \Introduction to Real Analysis", John Wiley & Sons, 1992. 2. K. A. Ross, \Elementary Analysis", Undergraduate Texts in Mathematics, Springer, 2013. **References:** 1. T. M. Apostol, \Calculus Vol. I", Wiley-India edition, 2009. 2. S. K. Berberian, \A First Course in Real Analysis", Undergraduate Texts in

	Mathematics, Springer-Verlag, 1994. 3. W. Rudin, \Principles of Mathematical Analysis", McGraw Hill International
MTH 202 **L-P-T-D[C]** 3-0-1-0[4]	**Combinatorics** **Pre Req.: None** Unit – 1: Pigeonhole principle, Counting principles, Binomial coefficients, Principles of inclusion and exclusion, Unit – 2: Recurrence relations, generating functions, Catalan numbers, Stirling numbers, Partition numbers, SchrÖder numbers, Unit – 3: Block designs, Latin squares, Partially ordered sets, Unit – 4: Lattices, Boolean algebra, chromatic numbers and chromatic index, planarity, covering numbers, Orthogonal Latin squares, Hadamard Matrices, Unit – 5: Ramsey Theory : Ramsey theorem, applications to geometrical problems. **Text Books:** 1. R. A. Brualdi, \Introductory Combinatorics", Pearson Prentice Hall, 2010. 2. J. P. Tremblay, R. Manohar, \Discrete Mathematical Structures with Application to Computer Science", Tata McGraw-Hill Edition, 2008. 3. Alan Tucker, Applied Combinatorics (third edition), John Wiley & sons , New York (1995) **References:** 1. J. H. van Lint, R. M. Wilson, \A Course in Combinatorics", Cambridge University Press, 2001. 2. I. Anderson, \A First Course in Discrete Mathematics", Springer Undergraduate Mathematics Series, 2001. 3. R. P. Stanley, \Enumerative Combinatorics Vol. 1", Cambridge Studies in Advanced Mathematics, 49, Cambridge University Press, 2012. 4. H. J. Ryser, Combinatorial Mathematics, Carus Math. Monograph, MAA (1963). 5. M. J. Erickson, Introduction to Combinatorics, John Wiley (1996).
MTH 203 **L-P-T-D[C]** 3-0-1-0[4]	**Linear Algebra** **Pre Req.: None** Unit – 1: System of Linear Equations, Matrices and elementary row operations, Rowreduced echelon form of matrices, Unit – 2: Vector spaces, subspaces, quotient spaces, bases and dimension, direct sums, Unit – 3: Linear transformations and their matrix representations, Dual vector spaces, transpose of a linear transformation, Unit – 4: Polynomial rings (over a field), Determinants and their properties, Eigenvalues and eigenvectors, Characteristic polynomial and minimal polynomial, Unit – 5: Triangulation and Diagonalization, Simultaneous Triangulation and diagonalization, Direct-sum decompositions, Primary decomposition theorem. **Text Book:** 1. K. Hoffman, R. Kunze, \Linear Algebra", Prentice-Hall of India, 2012. **References:** 1. S. H. Friedberg, A. J. Insel, L. E. Spence, \Linear Algebra", Prentice Hall, 1997. 2. A. Ramachandra Rao, P. Bhimasankaram, \Linear Algebra", Texts and Readingsin Mathematics, 19. Hindustan Book Agency, New Delhi, 2000. 3. M. Artin, \Algebra", Prentice-Hall of India, 2007.

MTH 204 **L-P-T-D[C]** 3-0-1-0[4]	**Analytic Geometry** **Pre Req.: None** Unit – 1: Plane: General form, intercept and normal form, equation of a plane passing through the intersection of two planes, angle between two intersecting planes, bisectors of angles between two intersecting planes, parallelism and perpendicularity of two planes. Unit – 2: Straight Line: Equations (symmetric and parametric form), direction ratios and direction cosines, canonical equation of the line of intersection of two intersecting planes, angle between two lines, distance of a point from a line, condition of co-planarity of two lines, equations of skew lines, shortest distance between two skew lines. Unit – 3: Sphere: General equation, circle, sphere through the intersection of two spheres, radical plane, tangent and normal. Unit – 4: Cone: Right circular cone, general homogeneous second degree equation, section of a cone by a plane as a conic and as a pair of lines, condition of three perpendicular generators. Unit – 5: Cylinder: General equation, right circular cylinder, enveloping cylinder paraboloid, hyperboloid, ellipsoid. **Text Book:** 1. S.L.Loney, \The Elements of Coordinate Geometry", Macmillan 2. R. M. Khan, \Analytical Geometry and Vector algebra", New Central book agency, Kolkata. **References:** 1. J.G. Chakravorty, \Analytical Geometry & Vector Analysis", UBS Publishers' Distributors (p) Ltd. 2. P.K. Jain and Khalil Ahmed: \A Text Book of Analytical geometry of three dimension", Wiley Eastern Limited. 3. R.J.T. Bell, \An Elementary Treatise of Coordinate Geometry of Three Dimension", Macmillan
MTH 205 **L-P-T-D[C]** 3-0-1-0[4]	**Probability Theory** **Pre Req.: None** Unit – 1: Orientation. Combinatorial probability. Fluctuations in Coin Tossing and Random Walks. Combination of Events, Occupancy and Matching Problems. Conditional probabilities. Urn Models. Independence. Bayes' Rule, Bernoulli trials, Poisson trials, multinomial law, infinite sequence of Bernoulli trials, Markov chains. Unit – 2: Random variables and probability distributions: Univariate, bivariate and multivariate random variables, cumulative and marginal distribution functions, conditional and multivariate distributions, transformation of random variables in one and two dimensions. Mathematical expectations: Expectations for univariate and bivariate distributions, moments, variance, Unit – 3: Algebra of sets, fields and sigma-fields, limit of sequences of subsets, sigma-field generated by a class of subsets, Borel fields. Probability measure on a sigma-field, probability space, continuity of a probability measure, real and vector-valued random variables (r.v.s), distribution functions (d.f.), discrete r.v.s, r.v.s of the continuous type, decomposition of a d.f. Unit – 4: Expectation of a real r.v. and of a complex-valued r.v. Linear properties of

	expectations. Standard deviation, higher order moments, covariance, correlation, moment generating functions, conditional expectation. Characteristic functions, their simple properties, uniqueness theorem. Convergence of a sequence of r.v.s., convergence in distribution, convergence in probability, almost sure convergence and convergence in quadratic mean and , their inter-relations. Cramer's theorem on composition of convergence in distribution and convergence in probability. Slutkey's theorem. Unit – 5: Monotone convergence theorem and dominated convergence theorem. Independence of two events and n (> 2) events, sequence of independent events, independent classes of events, π-system and λ-system of events, Dynkin's theorem, independence of r.v.s, Borel zero-one law. Khintchin's weak law of large numbers, Kolmogorov strong law of large numbers (without proof), continuity theorem for characteristic functions. Lindeberg's CLT and its particular cases. **Text Books:** 1. Bhat, B. R. \Modern Probability Theory" , New Age International, 1985 2. Billingsley, P., \Probability and Measure", John Wiley, 1986 3. S. Ross, \First course in probability theory", Mac Millan, 1989. 4. P.G. Hoel, S.C. Port and C.J. Stone, \Introduction to probability theory Vols 1 and 3", Houghton Mifflin Co ,1971. **References:** 1. Feller, W.\ Introduction to Probability and its Applications" vol. I, Wiley Eastern Ltd., 1950 2. Feller, W \Introduction to Probability and its Applications" vol. II, Wiley Eastern Ltd., 1969 3. Loeve, M. \Probability Theory" (4th Edn), Springer Verlag, 1978 4. Gnedenko, B.V. \Probability Theory", Mir.Pub., 1988 5. K.L. Chung, \Elementary probability theory with stochastic processes", Springer, 1974.
MTH 206 **L-P-T-D[C]** 2-1-1-0[4]	**Computer Oriented Numerical Analysis using C** **Pre Req.: None** Unit – 1: Errors in computation: Representation and arithmetic of numbers, source of errors, error propagation, error estimation. Numerical solution of non-linear equations: Bisection method, Secant method, Newton-Raphson method, Fixed point methods, Muller's method. Unit – 2: Interpolations: Lagrange interpolation, Newton divided differences, Hermite interpolation, Piecewise polynomial interpolation. Approximation of functions: Weierstrass and Taylor expansion, Least square approximation. Unit – 3: Numerical Integration: Trapezoidal rule, Simpson's rule, Newton-Cotes rule, Guassian quadrature. Unit – 4: Numerical solution of ODE: Euler's method, multi-step methods, Runge-Kutta methods, Predictor-Corrector methods. Unit – 5: Solutions of systems of linear equations: Gauss elimination, pivoting, matrix factorization, Iterative methods - Jacobi and Gauss-Siedel methods. Matrix eigenvalue problems: power method. **Practical:** 1. Gauss elimination method 2. Gauss-seidal method 3. Jacobi's method 4. Power method 5. Lagrange's interpolation 6. Trapezoidal rule 7. Simpsons I/3rd and 3/8th rule. 8. Bisection method 9. Newton-Raphson's method 10. Runge-Kutta method (first

	and fourth order) **Text Books:** 1. K. E. Atkinson, \An Introduction to Numerical Analysis" Wiley-India Edition, 2013. 2. M.K. Jain, S.R.K Iyengar, R.K. Jain: Numerical Methods, New age International **References:** 1. C. Balachandra Rao and Shantha, C.K: Numerical Methods, University Press 2. Samuel D. Conte, Carl de Boor, \Elementary Numerical Analysis", Tata McGraw-Hill Edition
MTH 207 **L-P-T-D[C]** 3-0-1-0[4]	**Real Analysis – III** **Pre Req.: MTH 201** Unit – 1: Function of several variables, continuity of functions from $\mathbb{R}^n$ to $\mathbb{R}$ and from $\mathbb{R}^m$ to $\mathbb{R}^n$. Partial derivatives, directional derivatives, Differentiability and derivative as a linear transformation, chain rule, sufficient conditions for differentiability, higher derivatives, Unit – 2: stationary points and local maxima and minima, Lagrange's method of multipliers(without formal proof) Multiple integrals, existence of the multiple Riemann integral for sufficiently well behaved functions on rectangles, multiple integral as iterated simple integrals, Brief treatment of Multiple integrals on more general domains, Change of variables and Jacobian formula (without proof) with lots of illustrations. Unit – 3; Mean value theorem for functions of several variables, theorem of interchange of order of partial derivatives, Taylor expansion in several variables, Inverse function theorem and Implicit function theorem (without proofs). (some justification for Lagrange's method of undetermined multipliers), curve in $\mathbb{R}^2$ and $\mathbb{R}^3$, Unit – 4: line integral , surface integral , volume integral, Unit – 5: Vector calculus, gradient , divergence and curl of a vector gauss divergence theorem(proofs only for Cuboids), stokes theorem, green theorem and its application curvature **Text Books:** 1. W. Fleming, \Functions of Several Variables", Undergraduate Texts in Mathematics. Springer-Verlag, 1977. 2. T. M. Apostol, \Calculus Vol. II", Wiley-India edition, 2009. **References:** 1. W. Kaplan, \Advanced Calculus", Addison-Wesley Publishing Company, 1984. 2. T. M. Apostol, \Mathematical Analysis", Narosa Publishing House, 2013.
MTH 208 **L-P-T-D[C]** 3-0-1-0[4]	**Group Theory** **Pre Req.: None** Unit – 1: Integers, Binary operation, and its properties, Unit – 2: Definition of a group, Examples and basic properties. Subgroups, Coset of a subgroup, Lagrange's theorem. Cyclic groups, Order of a group. Normal subgroups, Quotient group. Unit – 3: Homomorphisms, Kernel, Image of a homomorphism, Isomorphism theorems. Permutation groups, Cayley's theorems. Direct product of groups. Group action on a set, Semi-direct product. Sylow's theorems. Structure of finite abelian groups. Applications, Some nontrivial examples. Unit – 4: Rings: definition, Examples and basic properties. Zero divisors, Integral

	domains, Fields, Characteristic of a ring, Quotient field of an integral domain. Subrings, Ideals, Quotient rings, Isomorphism theorems. Unit – 5: Ring of polynomlals. Prime, Irreducible elements and their properties, UFD, PID and Euclidean domains. Prime ideal, Maximal ideals, Prime avoidance theorem, Chinese remainder theorem. **Text Books:** Joseph Gallian, \Contemporary Abstract Algebra (Fourth Edition)" Narosa Publishing House **References:** 1. I. N. Herstein, \Topics in Algebra", Wiley-India edition, 2013. 2. M. Artin, \Algebra", Prentice-Hall of India, 2007.
MTH 209 **L-P-T-D[C]** 3-0-1-0[4]	**Ordinary Differential Equation** **Pre Req.: None** Unit – 1: Basic concept of differential equation , 1st order and 1st degree differential equation , equation of 1st order and of higher degree , Unit – 2: linear equation with constant co-efficient, linear equation with variable co-efficient , power series method for solving ordinary differential equation with application, Lipschitz functions, Integral inequalities, Uniqueness of solutions, Unit – 3: Boundary value problems, Green's functions, Distribution of zeros of solutions, Existence of solutions by Picard's method, Existence by Perron's method, Uniqueness and continuous dependence, Continuity and differentiability w.r.t., initial Conditions and parameters, Unit – 4: Solution of system of linear differential equation, Equations with periodic coefficients, Floquet's theory, Unit – 5: Classification of stationary points and phase portraits, Oscillation and boundedness of solutions, Lyapunov theory of stability, Poincare Bendixon theorem and applications. **Text Books:** 1. Martin Braun, \Differential Equation and their Application", Springer 2. S. L. Ross, \Differential Equations", Wiley-India Edition, 2009. 3. E. A. Coddington, \An Introduction to Ordinary Differential Equations", Prentice-Hall of India, 2012. **References:** 1. G. F. Simmons, S. G. Krantz, \Differential Equations", Tata Mcgraw-Hill Edition, 2007. 2. B. Rai, D. P. Choudhury, \A Course in Ordinary Differential Equation", Narosa Publishing House, New Delhi, 2002. 3. G. Birkhoff and G.C. Rota,\Ordinary Differential Equations", Blaisdell, Masachusetts
MTH 301 **L-P-T-D[C]** 3-0-1-0[4]	**Statistic - I** **Pre Req.: MTH 205** Unit – 1: Descriptive Statistics, Graphical representation of data, Curve fittings, Simple correlation and regression, Multiple and partial correlations and regressions. Unit – 2: Standard discrete distributions: uniform, binomial, Poisson, geometric, hypergeometric, negative binomial. Standard univariate densities: normal, exponential, gamma, beta, chi-square, Cauchy. Unit – 3: Sampling, Sampling distributions, Standard error. Normal distribution and its

	properties, The distribution of $\bar{x}$ and S^2 in sampling from a normal distribution, Exact sampling distributions: Chi-square, t, F. Unit – 4: Order statistics: Distribution of r-th order statistic, joint distribution of several order statistics and their functions. Unit – 5: Hazard rate and cumulative hazard rate, lack of memory property. IFR, IFRA, DFR and DFRA classes of distribution. **References:** 1. Hogg, R. V. and Craig, T. T. (1978). Introduction to Mathematical Statistics (Fourth Edition) (Collier- McMillan) 2. Rohatgi, V. K. (1988). Introduction to Probability Theory and Mathematical Statistics (Wiley Eastern) 3. C. R. Rao (1995). Linear Statistical Inference and Its Applications (Wiley Eastern) Second Edition 4. Barlow R. E. & Proschan F. (1975). Statistical Theory of Reliability & Life testing. Holt, Rinehart & Winston Inc.
MTH 302 **L-P-T-D[C]** 3-0-1-0[4]	**Complex Analysis** **Pre Req.: None** Unit – 1: Algebraic and geometric representation of complex numbers; elementary functions including the exponential functions and its relatives (log, cos, sin, cosh, sinh, etc.); concept of holomorphic (analytic) functions, complex derivative and the Cauchy-Riemann equations; harmonic functions. Unit – 2: Conformal Mapping, Linear Fractional Transformations, Unit – 3: Complex line integrals and Cauchy Integral formula, Representation of holomorpic functions in terms of power series, Morera's theorem, Cauchy estimates and Liouville's theorem, zeros of holomorphic functions, Uniform limits of holomorphic functions. Unit – 4: Behaviour of holomorphic function near an isolated singularity, Laurent expansions, Counting zeros and poles, Argument principle, Rouche's theorem, Calculus of residues and evaluation of integrals using contour integration. The Open Mapping theorem, Maximum Modulus Principle, Schwarz Lemma. **Text Books:** 1. J. B. Conway, \Functions of One Complex Variable", Narosa Publishing House, 2002. 2. R. E. Greene, S. G. Krantz, \Function Theory of One Complex Variable", American Mathematical Society, 2011. 3. E. M. Stein, R. Shakarchi, \Complex Analysis", Princeton University Press, 2003. 4. E.T. Whittaker and G.N. Watson A Course of Modern Analysis, Cambridge University Press. **References:** 1. W. Rudin, \Real and Complex Analysis", Tata McGraw-Hill, 2013. 2. L. V. Ahlfors, \Complex Analysis", Tata McGraw-Hill, 2013. 3. T. W. Gamelin, \Complex Analysis", Undergraduate Texts in Mathematics, Springer, 2006.
MTH 303 **L-P-T-D[C]** 3-0-1-0[4]	**Partial Differential Equation** **Pre Req.: MTH 209** Unit – 1: Simultaneous 1st order equation in three variable , method of solution of partial differential equation , condition of integrability, homogenous equation, solution

	of equation of the type Pp+Qq=R , Nonlinear equations. Cauchy-Kowalewski's theorem. Higher order equations and characteristics. Classification of second order equations. Riemann's method and applications. Unit – 2: One dimensional wave equation and De'Alembert's method. Solution of three dimensional wave equation. Method of decent and Duhamel's principle. Unit – 3: Solutions of equations in bounded domains and uniqueness of solutions. BVPs for Laplace's and Poisson's equations. Maximum principle and applications. Green's functions and properties. Unit – 4: Existence theorem by Perron's method. Heat equation, Maximum principle. Uniqueness of solutions via energy method. Uniqueness of solutions of IVPs for heat conduction equation. Green's function for heat equation. Finite difference method for the existence and computation of solution of heat conduction equation. **References:** 1. L. C. Evans, \Partial Differential Equations", Graduate Studies in Mathematics 19, American Mathematical Society, 2010. 2. F. John, \Partial Differential Equations", Springer International Edition, 2009. 3. G. B. Folland, \Introduction to Partial Differential Equations", Princeton University Press, 1995. 4. S. Kesavan, \Topics in Functional Analysis and Applications", John Wiley & Sons, 1989.
MTH 304 **L-P-T-D[C]** 3-0-1-0[4]	**Rings and Modules** **Pre Req.: MTH 208** Unit – 1; Rings, ideals, quotient rings, Unit – 2: Ring homomorphisms, isomorphism theorems, prime ideals, maximal ideals, Chinese remainder theorem, Field of fractions, Unit – 3: Euclidean Domains, Principal Ideal Domains, Unique Factorization Domains, Polynomial rings, Gauss lemma, irreducibility criteria for polynomials. Unit – 4: Modules, submodules, quotients modules, module, isomorphism theorems, generators, direct product and direct sum of modules, Unit – 5: Free modules, Finitely generated modules over a PID, Application: Structure theorem for finitely generated abelian groups. **Text Book:** 1. D. S. Dummit, R. M. Foote, \Abstract Algebra", Wiley-India edition, 2013. References: 1. I. N. Herstein, \Topics in Algebra", Wiley-India edition, 2013. 2. M. Artin, \Algebra", Prentice-Hall of India, 2007.
MTH 305 **L-P-T-D[C]** 3-0-1-0[4]	**Number Theory** **Pre Req.: None** Unit – 1: Divisibility, Primes, Fundamental theorem of arithmetic, Unit – 2: Congruences, Chinese remainder theorem, Linear congruences, Congruences with prime-power modulus, Unit – 3: Fermat's little theorem, Wilson's theorem, Euler function and its applications, Group of units, primitive roots, Quadratic residues, Jacobi symbol,

	Unit – 4: Binary quadratic form, Arithmetic functions, Möbius Inversion formula, Unit – 5: Dirichlet product, Sum of squares, Continued fractions and rational approximations. **Text Book:** 1. I. Niven, H. S. Zuckerman, H. L. Montgomery, \An Introduction to the Theory of Numbers", Wiley-India Edition, 2008. References: 1. T. M. Apostol, \Introduction to Analytic Number Theory", Springer International Student Edition, 2000. 2. G. A. Jones, J. M. Jones, \Elementary Number Theory", Springer Undergraduate Mathematics Series. Springer-Verlag, 1998.
MTH 306 **L-P-T-D[C]** 3-0-1-0[4]	**Statistics – II** **Pre Req.: MTH 301** Unit – 1: Sufficiency, completeness, Uniformly minimum variance unbiased estimators, C-R inequalities, exponential class of densities and its properties, some special classes of distributions admitting complete sufficient statistics, extensions of these results to multi-parameter situation. Unit – 2: Test function, Neyman- Pearson lemma for test functions. Uniformly most powerful tests for one sided alternative for one parameter exponential class of densities and extension to the distributions having monotone likelihood ratio property. Unit – 3: Confidence Intervals, shortest expected length confidence intervals, relations with testing of hypotheses, uniformly most accurate confidence intervals. Unit – 4: Bayesian estimation, prior distributions, posterior distribution, loss function, principle of minimum expected posterior loss, quadratic and other common loss functions, conjugate prior distributions. Common examples. Bayesian HPD confidence intervals. Probability Integral Transformation, Unit – 5: Rank orders and their exact null distributions. One and two sample examples of rank statistic such as sign statistic, Wilcoxon signed rank statistic, Wilcoxon two sample statistic etc. Recurrence relations for the null distribution of the Wilcoxon two sample statistic. **References:** 1. Kale, B.K. (2005). A First Course on Parametric Inference. Second Edition. (Narosa). 2. Casella G. and Berger R. L. (2002). Statistical Inference. 2nd Edition, Duxbury Advanced series. 3. Dudewicz, E. J. and Mishra, S.N.(1988). Modern Mathematical Statistics, (John Wiley) 4. Roussas, G. G. (1973). First Course in Mathematical Statistics (Addison Wesley) 5. Silvey, S. D. (1975). Statistical Inference (Chapman and Hall) 6. Wilks, S. S. (1962). Mathematical Statistics (John Wiley) 7. Lehmann, E. L. (1986). Testing of Statistical hypothesis (John Wiley) 8. Lehmann, E. L. (1988). Theory of Point Estimation (John Wiley) 9. Rohatgi, V. K. (1976). Introduction to theory of probability and Mathematical Statistics (John Wiley & Sons) 10. Berger, J.O. (1985). Statistical Decision Theory and Bayesian Analysis, (Second Edition) Springer – Verlag 11. Ferguson, T.S. (1967). Mathematical Statistics: A Decision Theoretic Approach. Academic Press.

	12. J. D. Gibbons & S. Chakraborti (1992). Nonparametric statistical Inference (Third Edition) Marcel Dekker, New York 13. W.J.Conover. (1999). Practical Nonparametric Statistics, Wiley. 3rd Edition
MTH 307 **L-P-T-D[C]** 3-0-1-0[4]	**Elementary Differential Geometry** **Pre Req.: None** Unit – 1: Local curve theory: Serret-Frenet formulation, Fundamental existence theorem of space curves; Unit – 2: Plane curves and their global theory: Rotation index, convex curves, isoperimetric inequality, Four vertex theorem; Unit – 3: Local surface theory: First fundamental form and arc length, normal curvature, geodesic curvature and Gauss formulae, Geodesics, parallel vector fields along a curve and paralelism; the second fundamental form and the Weingarten map; principal, Gaussian, mean and normal curvatures; Unit – 4: Riemannian curvature and Gauss's theorem Egregium; isometries and fundamental theorem of surfaces; Global theory of surfaces: Geodesic coordinate patches, Gauss-Bonnet formula & Euler characteristic, index of a vector field, surfaces of constant curvature.; Unit – 5: Elements of Riemannian geometry:Concept of manifold, tensors (algebraic and analytic), covariant differentiation, symmetric properties of curvature tensor, notion of affine connection, Unit – 6: Christofel symbols; Riemannian metric and its associated affine connection, geodesic and normal coordinates (if time permits). **References:** 1. S. Kumaresan, A Course in Differential Geometry and Lie Groups, Hindustan Book Agency, 2002. 2. W. Klingenberg, A Course in Differential Geometry, Springer-Verlag, 1978. 3. Christian Bar, Elementary Differential Geometry, Cambridge University Press, 2010. 4. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice Hall Inc., 1977.
MTH 308 **L-P-T-D[C]** 3-0-1-0[4]	**Field Theory** **Pre Req.: MTH 304** Unit – 1: Field extensions, algebraic extensions, Ruler and compass constructions, Unit – 2: splitting fields, algebraic closures, separable and inseparable extensions, cyclotomic polynomials and extensions, automorphism groups and fixed fields, Unit – 3: Galois extensions, Fundamental theorem of Galois theory, Fundamental theorem of algebra, Unit – 4: Finite fields, Galois group of polynomials, Computations of Galois groups over rationals, Unit – 5: Solvable groups, Solvability by radicals. **Text Book:** 1. D. S. Dummit, R. M. Foote, \Abstract Algebra", Wiley-India edition, 2013. **References:** 1. I. N. Herstein, \Topics in Algebra", Wiley-India edition, 2013.

	2. M. Artin, \Algebra", Prentice-Hall of India, 2007. 3. J. Rotman, \Galois Theory", Universitext, Springer-Verlag, 1998.
MTH 309 **L-P-T-D[C]** 3-0-1-0[4]	**Operation Research – I** **Pre Req.: None** Unit – 1: Linear Programming: Convex sets, Supporting and Separating Hyper-planes, Standard linear Programming Problem, basic feasible solution, Unit – 2: Simplex algorithm and simplex method, graphical solution, two phase method. Duality in linear programming, duality theorems, dual simplex method with justification, sensitivity. Transportation and assignment algorithms, Hungarian method of assignment, transhipment problems, duality theory of testing optimality of solution in transportation problem and transhipment problems, transportation problem and transhipment problems as network problems Balance and degeneracy in transportation problem. Maximization, prohibitions and other variations of assignment problems. Integer linear Programming Problem, branch and bound method, **References:** 1. Kambo, N.S. (1991) Mathematical Programming Techniques (Affiliated Eas-west press Pvt. Ltd.) 2. Hadley, G. (1987) Linear Programming. 3. Taha, H.A. (1992) Operations Research 5th ed. (Macmillan) 4. Panneerselvam, R. Operations Research (Prentic hall of India) 5. Medhi j. (1984) Stochastic Processes 2nd ed.(New Age International Pvt. Ltd.)
MTH 310 **L-P-T-D[C]** 3-0-1-0[4]	**Metric Space** **Pre Req.: MTH 102** Unit – 1: Basic notions, definition and examples, open balls and open sets, convergence of sequence, limit and cluster points, Unit -2: Cauchy sequence and completeness , bounded sets, dense sets, basis, boundary of a set, continuous functions, and its equivalent definitions, Unit – 3: topological property, uniform continuity , limit of function, open and closed maps, Unit – 4: compact spaces and there properties, continuous function on compact spaces, characterization of compact metric spaces, Arzela-Ascoli Theorem, connected Spaces, path connected spaces, complete metric spaces, and its examples , Unit – 5: completion of a metric space, Baire Category Theorem, Banach's contraction Principle **Text Books:** 1. G. F. Simmons, \Introduction to Topology and Modern Analysis", Tata McGraw-Hill, 2013. 2. S. Kumaresan, \Topology of Metric Spaces", Narosa Publishing House, 2005. **References:** 1. R. R. Goldberg, \Methods of Real Analysis", John Wiley & Sons, 1976. 2. G. B. Folland, \Real Analysis", Wiley-Interscience Publication, John Wiley & Sons, 1999.
MTH 401 **L-P-T-D[C]** 3-0-1-0[4]	**Classical Mechanics** **Pre Req.: None** Unit-1:Review of Newtonian mechanics, Generalized coordinates, The principle of least action, Lagrange's equation, The Lagrangian for a free particle and for a system of particles; Unit-2:Symmetries, Conservation laws and No ethers theorem, Conservation of energy, momentum and angular momentum; Integrating the equations of motion: motion in one dimension, Central force motion and Kepler's problem Unit-3:Collisions: elastic collisions, scattering and Rutherfords formula. Motion of a rigid body, Angular velocity, Moment of inertia, Angular momentum, Euler angles, Euler's equations. Motion in a non-inertial frame; Small oscillations: simple harmonic, forced, damped and anharmonic oscillations

	Unit-4: The Hamilton equations of motion, Legendre transformations, Cyclic coordinates, Routhian; Invariance properties of the Lagrangian and Hamiltonian descriptions, Poisson and Lagrange brackets Unit-5:Canonical transformations, Group properties and methods of constructing canonical transformations; Hamilton-Jacobi theory and action-angle variables, The harmonic oscillator as an example, The Kepler problem in action angle variables. **References:** 1. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, 3rd Ed. Addison- Wesley, 2005. 2. L. D. Landau and E. M. Lifshitz, Mechanics, Vol. 1 of course of Theoretical Physics, Pergamon Press, 2000.
MTH 402 **L-P-T-D[C]** 3-0-1-0[4]	**Lebsgue Measure and Integration** **Pre Req.: MTH 102** Unit-1:Lebesgue measure: _-algebras of sets, Borel sets, outer measure and its properties, σ -algebra of measurable sets, Lebesgue measure and its properties, a non-measurable set Unit-2:measurable functions, Littlewood's three principles, Egoroff's theorem, Lusin's theorem. Lebesgue integral: Simple functions, Lebesgue integral of a bounded function over a set of finite measure Unit-3 bounded convergence theorem, Lebesgue integral of nonnegative functions, Fatou's Lemma, monotone convergence theorem, the general Lebesgue integral, Lebesgue convergence theorem. Unit-4: Differentiation and integration: Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity. L_p-spaces: Definition and properties, Minkowski's inequality and Hölder's inequality, convergence and completeness of L_p, approximation in L_p, bounded linear functionals on L_p spaces. Unit-5:General measure and integration theory: Measure spaces, measurable functions, integration, general convergence theorems, signed measures, The Radon-Nikodym theorem, product measures - Fubini's theorem and Tonelli's theorem. **References:** 1. H. L. Royden, Real Analysis, 3rd Edition, Phi Learning, 2009. 2. W. Rudin, Real and Complex Analysis, 3rd Edition, Mcgraw-Hill Education (India) Ltd, 2007. 3. E. M. Stein and R. Shakarchi, Real Analysis: Measure Theory, Integration, and Hilbert Spaces, Princeton University Press, 2005. 4. G. B. Folland, Real Analysis: Modern Techniques and Their Applications, 2nd Edition, John Wiley & Sons, 1999. 5. Paul R. Halmos, Measure theory, Springer, 2009. 6. G. Debarra, Measure Theory and Integration, New Age International, 1981. 7. Michael Taylor, Measure Theory and Integration, American Mathematical Society, 2006. 8. K. B. Athreya and S. N. Lahiri, Measure Theory, Hindustan Book Agency, 2006. 9. T. Tao, An Introduction to Measure Theory, GSM, Vol. 126, AMS, 2011.
MTH 403 **L-P-T-D[C]** 3-0-1-0[4]	**Data base Management System** **Pre Req.: None** Unit-1:File Organization: Introduction, Physical / logical files Special characters in files, fields & record organization (fixed, variable length) types of file organization (heap, sorted, indexed, hashed), choosing a file organization. Indexed File Organization: Overview of indexes, types of indexes (dense, sparse, clustered, primary, secondary, tree (multilevel indexes, B+ tree) Unit-2:Introduction of DBMS: Overview, File system Vs DBMS, Describing & storing data (Data models (relational, hierarchical, network)), Levels of abstraction, data independence, Queries in DBMS (SQL : DDL, DML,DCL,TCL), Structure of DBMS, People who deal in DBMS, Advantages of DBMS.

	Unit-3:Conceptual Design (E-R model): Overview of DB design, ER data model (entities, attributes, entity sets, relations, relationship sets), Additional constraints (key constraints, participation constraints, weak entities, aggregation / generalization, conceptual design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER), Conceptual design for small to large enterprises, Case studies . Unit-4:Relational data model: Relations (concepts, definition), Conversion of ER to Relational model, integrity constraints (key, referential integrity, general constraints). Relational algebra: Preliminaries, Relational algebra (selection, projection, set operations, renaming, joins, division) Unit-5:SQL: DDL (create, drop, alter), forms of a basic SQL query (egs, expressions, strings in SQL), union / intersection / except, nested queries(introduction, correlated queries, set comparison operators), Aggregate operators (group by, having), aggrerate functions, Null values (comparison using NULL, logical connections (AND,OR,NOT) impact on SQL commands, outer joins, disallowing NULL), examples on SQL (case studies) **References:** 1. Korth, Silberchatz, Sudarshan , .Database System Concepts., McGraw-Hill. 2. Elmasri and Navathe, .Fundamentals of Database Systems., Pearson Education. 3. Raghu Ramakrishnan, Johannes Gehrke, .Database Management Systems., McGraw-Hill 4. Postgresql , O'Reilly publications. 5. Peter Rob and Coronel, .Database Systems, Design, Implementation and Management., Thomson Learning. 6. C.J.Date, Longman, .Introduction To Database Systems., Pearson Education
MTH 404 **L-P-T-D[C]** 3-0-1-0[4]	**Mathematical Method** **Pre Req.: None** Unit-1:Calculus of Variations: Extrema of Functionals, The variation of a functional and its properties - Euler's equation Unit-2:Field of extremals - sufficient conditions for the Extremum of a Functional conditional Extremum Moving boundary problems Unit-3: Discontinuous problems - one sided variations - Ritz method. Unit-4:Perturbation Methods: Perturbation theory, Regular perturbation theory, Singular perturbation theory Unit-5:Asymptotic matching, Time Scaling Method. Text Book: 1. Earl A. Coddington, Norman Levinson, \Theory of Ordinary Differential Equations", Tata McGraw Hill Edition 2. M. Gelfand, S.V. Fomin, \Calculus of Variations", Dover Publication Inc.
MTH 405 **L-P-T-D[C]** 3-0-1-0[4]	**Topology** **Pre Req.: MTH 102** Unit-1:Definition of Topologies in terms of open sets, neighborhood system, closed sets and closure operations and their equivalence, points of accumulation, interior, exterior and boundary points. Unit-2: Base and subbase of a topology, subspace, product space, quotient space Unit-3continuous, open and closed maps, homeomorphism convergence of sequence and filters Unit-4: separation axioms, separability, Lindeloff space, Urysohn's metrization theorem, compactness, local compactness, sequential and countable compactness Unit-5: Tychonov theorem, one point compactification, connectedness and local connectedness. **Textbooks:** 1. J.R. Munkres, Topology, 2nd Edition, Prentice Hall, 2000. 2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw- Hill, 1963.

	References: 1. J. Dugundji, Topology, Prentice Hall, 1965. 2. I.M. Singer and J.A. Thorpe, Lecture Notes on Elementary Topology and Geometry, Springer, 1976.
MTH 406 **L-P-T-D[C]** 3-0-1-0[4]	**Functional Analysis** **Pre Req.: MTH 203** Unit-1:Normed linear spaces, Riesz lemma, characterization of finite dimensional spaces, Banach spaces. Operator norm, continuity and boundedness of linear maps on a normed linear space. Unit-2: Fundamental theorems: Hahn-Banach theorems, uniform boundedness principle, divergence of Fourier series, closed graph theorem, open mapping theorem and some applications. Unit-3:Dual spaces and adjoint of an operator: Duals of classical spaces, weak and weak* convergence, adjoint of an operator. Hilbert spaces: Inner product spaces, orthonormal set, Gram-Schmidt ortho-normalization, Bessel's inequality, orthonormal basis, separable Hilbert spaces. Unit-4: Projection and Riesz representation theorems: Orthonormal complements, orthogonal projections, projection theorem, Riesz representation theorem. Bounded operators on Hilbert spaces: Adjoint, normal, unitary, selfadjoint operators, compact operators. Unbounded operators. Unit-5: Spectral theorem: Spectral theorem for compact self adjoint operators, statement of spectral theorem for bounded self adjoint operators. **Text Books:** 1. J. B. Conway, \A Course in Functional Analysis", Graduates Texts in Mathematics 96, Springer, 2006. 2. B. Bollobás, \Linear Analysis", Cambridge University Press, 1999. **References:** 1. G. F. Simmons, \Introduction to Topology and Modern Analysis", Tata McGraw-Hill, 2013.
MTH 407 **L-P-T-D[C]** 3-0-1-0[4]	**Fluid Dynamics** **Pre Req.: None** Unit-1:Streamlines and paths of the particles, Bernoulli's Equation, Bernoulli's theorem. Equations of Motion: Equation of continuity, Boundary conditions, Irrotational motion, Kelvin's minimum energy theorem. Unit-2:Two-Dimensional Motion: Motion in two dimensions, Stream function, Rankine's method, Velocity potential. Streaming Motions: Complex potential, Circulation, Circle theorem, Joukowski transformation, Theorem of Blasius, Aero foil, Joukowski's hypotheses, The theorem of Kutta and Joukowski, Lift on a Aero foil. Unit-3:Sources and Sinks: Two dimensional source, combination of sources and streams, Doublet, The method of images, Image of a Doublet in a sphere, Source outside a cylinder, Source in compressible flow. Unit-4:Stoke's stream function: Axisymmetric motion, Butlers sphere theorem, Image of a Source in a sphere, Force on an obstacle. Spheres and Ellipsolids: Circle hormonics, Kelvin's inversion theorem, Weiss's sphere theorem. Unit-5:Viscosity: The equation of motion, boundary conditions in viscous flows, Flow through a pipe, axisymmetric motion, drag on a slowly moving sphere. **Text Books:** 1. F. Chorlton : Text Book of Fluid Dynamics. 2. D. E. Rutherford : Fluid Mechanics. 3. J. L. Bansal : Viscous Fluid Dynamics. **References:** 1. Milne-Thomson : Theoretical Hydrodynamics. 2. G. K. Batchelor : An Introduction to Fluid Dynamics. 3. N. Curle and H. J. Davies : Modern Fluid Dynamics,Vol. I. 4. R. C. Binder : Advanced Fluid Mechanics.

	5. Landau and Lifshitz : Fluid Mechanics.
MTH 408 **L-P-T-D[C]** 3-0-1-0[4]	**Graph Theory** **Pre Req.: None** Unit1-:Graphs : Definitions and examples, Graphs as models. Subgraphs, walks, paths and cycles, Connectedness, Matrix representation of graphs, Operations on graphs, connectedness algorithm. Unit-2:Trees and connectivity : Definition and simple properties, Bridge, spanning trees, Caley's theorem. Connector problems. Kruskal's Algorithm, Prim Algorithm. Shortest path problems. The Breadth First Search Algorithm. The Back-tracking Algorithm. Dijkstra's Algorithm. Cut vertices, Connectivity. Unit-3: Euler Tours and Hamiltonian Cycles : Euler Tours, Konigsberg Seven bridges problem Eulerian graphs. Fleury's Algorithm, Hierholzer's Algorithm. The Chinese postman Problem. Hamiltonian graphs. Dirac theorem. Closure of a graph. Bondy and Chavatal Theorem. The travelling salesman problem. The two optimal algorithm. The closest Insertion Algorithm. Unit-4Matchings : Matching and Augmenting paths, Berge theorem. The Marriage problem. The Personnel Assignment problem. The matching algorithm for bipartite graps. The Hungerian Algorithm. The optimal assignment problem. The Kuhn-Munkrej Algorithm. Unit-5: Networks :Max-Min Theorem, Separating sets, Menger's Theorem. Ramsey Theory : Party Problem, relations among Ramsey numbers. **Text Books:** 1.John Clerk and Derek Allan Holton : A first look at Graph Theory (Allied Publishers Ltd./World Scientific). **References:** 1. F. Haray : Graph Theory. 2. Narsingh Deo : Introduction to Graph Theory with applications to Engineering and Computer Science. 3. Bhave and T. T. Raghunathan : Elements of Graph Theory.
MTH 409 **L-P-T-D[C]** 3-0-1-0[4]	**Integral Equation and Transformation** **Pre Req.: None** Unit-1:Classification of Liner Integral Equations : Fredholm, Volterra, Integro-Differential Equations, Singular Integral Equations, Converting Volterra Equation to ODE, Conversion of IVP to Volterra equation Conversion of BVP to Fredholm equation. Unit-2: Fredholm Intergral Equations - Decomposion method, Direct Computation method, successive approximation method, method of successive substitutions, Homogeneous Fredholm Equations, Comarison between alternative methods. Volterra Integral Equation - Adomian Decomposion method, Series solution method, converting Volterra equation to VIP, Successive Approximation method, successive substitution method, Unit-3: comparison between alternative methods Integro-Differential Equations - Introduction, Direct Computation method, Adomian Decompostion Method. Conversion to Fredholm integral Equation.Volterra Intego-Differential equations Series Solution, Decomposition Method, Conversion to IVP. Singular Integral Equations - Abel problem, Genralized Abel Integral Equation, Weakly-singular Volterra Equations. Non Liner Integral Equation`s - Non liner Fredholm Integral equations,Direct Computation, decomposition method, Unit-4: Non liner Volterra Integral Equation, Series solution, Decomposition method. Existence and uniqueness of solutions using fixed-point theorems in cash of Liner and nonliner Volterra and Fredholm integral equations. Fourier Transforms: [FT]

	Definition Properties evaluation of Fourier and inverse Fourier transforms of functions, Convolution theorem for FT. Sine and Cosine Fourier transforms. Solving differential equations and interal equations using FT. Unit-5: Laplace Transform :Definition Properties, evaluation of Laplace and Inverse Laplace transforms of functions. Convolution theorem for Laplace Transforms.Solving initial value problem using Laplace Transforms. Solving integral equation using Laplace Transforms. J) Mellin Transforms : Definition, properties and evaluation of transforms, Convolution theorem for Mellin transforms, Applications to integral equations. **References:** 1) A First course in integral equations –A.M. Wazwaz (1997) (world Scientific) 2) Introduction to Integral Equation with Applications –A.J. Jerri (1999) Second edition Wiley Interscience.
MTH 410 **L-P-T-D[C]** 3-0-1-0[4]	**Introduction to Continuum Mechanics** **Pre Req.: None** Unit-1:Introduction to tensors. Stress tensor. Equilibrium equations. Unit-2:Mohr's circle for plane stress. Deformation, Strain tensor, Rate of deformation tensor. Unit-3: Equations of motion. Dynamic similarity. Exact solutions. Unit-4: Laminar boundary layer over a float plat. Vorticity circulation & irrational flow. Unit-5: Torsion of cylindrical bars, Plane elastic waves. **Text Book:** 1. G. Thomas Mase, George E. Mase, \Continuum Mechanics for Engineers", CRC Press 2. Y.C. Fung, \A first course in Continuum Mechanics", Prentice Hall
MTH 411 **L-P-T-D[C]** 3-0-1-0[4]	**Reliability Modelling and Analysis** **Pre Req.: MTH 306** Unit-1: Basic concepts in reliability: Failure rate, mean, variance and percentile residual life, identities connecting them; Notions of ageing - IFR, IFRA, NBU, NBUE, DMRL, HNBUE, NBUC etc and their mutual implications. Unit-2: TTT transforms and characterization of ageing classes. Non monotonic failure rates and mean residual life functions, Study of life time models viz. exponential, Weibull, lognormal, generalized Pareto, gamma with reference to basic concepts and ageing characteristics; Bath tub and upside down bath tub failure rate distributions. Unit-3: Discrete time failure models:- Definition of basic functions and their properties; Ageing classes and their mutual implications, Reliability systems with dependents components:-Parallel and series systems, k out of n systems, ageing properties with dependent and independents components. Unit-4: concepts and measures of dependence in reliability - RCSI, LCSD, PF2, WPQD. Reliability estimation using MLE - exponential, Weibull and gamma distributions based on censored and non censored samples Unit-5: UMVUE estimation of reliability function; Bayesian reliability estimation of exponential and Weibull models. **Test Books:** 1. Lai, C.D and Xie, M. (2006) Stochastic ageing and dependence in reliability (Relevant topics) Springer. 2. Sinha S K (1986) Reliability and Life Testing, Wiley Eastern. 3. Barlow, R.E. and Proschan, F. (1975) Statisical Theory of Reliability and Life Testing, Holt, Reinhart and Winston.

	4. Marshall, A.W. and Olkin, I. (2007) Life Distributions, Springer 5. Galambos, J. and Kotz, S. (1978) Characterization of Probability distributions, Springer
MTH 412 **L-P-T-D[C]** 3-0-1-0[4]	**Statistical Genetics** **Pre Req.: None** Unit-1: Introduction, Mendel's Laws, Linkage and Crossing cover, Linkage Maps, Statistical Analysis for Segregation and Linkage: Single Factor Segregation, Two factor segregation Unit-2: Defection of Linkage, Estimation of Linkage. Random mating: Hardy-Weinberg law of equilibrium. Single Locus, Sex-linked genes, Autopraploids, Forces affecting gene frequency, Fisher's fundamental theorem Unit-3:inbreeding: Mutation and migration different approaches, concepts and definition, Path Coefficients, Stochastic Process of gene-frequency change, Diffusion approach, Transition matrix approach. Unit-4:Genetic components of variance: Relationship between phenotype and genotype, Different approaches, Genetic components of covariance between Track; Linkage effects, Sex-linked genes, Maternal effect, Epistatic interaction, Genotype X Environment interaction. Heritability, Estimation of Heritability, Precision of Heritability estimates. Unit-5:Repeatability, Estimates of Genetic correlation, Generalized Heritability Relation between phenotypic selection and genotypic selection, Intensity of selection correlated, Response to selection. Selection for improving several characters. **Text Books:** 1. Narain, P. (1990). Statistical Genetics, Wiley, Chapters 1-5, 7, 8, 9, 10, 14. **Reference Books:** 1. Liu, B.H. (1998). Statistical Genomics, CRC Press, New York. 2. Falconer, D.S. (1970). Introduction to Genetics, Oliver & Boyd.
MTH 501 **L-P-T-D[C]** 3-0-1-0[4]	**Operation Research – II** **Pre Req.: MTH 309** Unit-1:Games and strategies, Two-person (non) zerosum games. Unit-2:Network flows, maximal flow in the network. Nonlinear Programming: Kuhn-Tucker conditions, Quadratic programming, Wolfe's, Beale's and Fletcher's algorithms for solving quadratic programming problems. Unit-3: Markovian and Non-Markovian queueing models, cost profit models of (M/M/1) and (M/M/s) queueing systems. Unit-4:Simulation, event type simulation, simulation of a queuing systems. Unit-5:Geometric and Dynamic programming. **References:** 1. Kambo, N.S. (1991) Mathematical Programming Techniques (Affiliated Eas-west press Pvt. Ltd.) 2. Taha, H.A. (1992) Operations Research 5th ed. (Macmillan) 3. Panneerselvam, R. Operations Research (Prentic hall of India) 4. Medhi j. (1984) Stochastic Processes 2nd ed.(New Age International Pvt. Ltd.)
MTH 502 **L-P-T-D[C]** 0-0-0-7[8]	**Project – I** **Pre Req.: None**
MTH 503 **L-P-T-D[C]** 0-0-0-7[12]	**Project - II** **Pre Req.: None**
MTH 504 **L-P-T-D[C]**	**Mathematical Modelling** **Pre Req.: None** Unit-1:Matrix representation of compartment models. Introduction to compartment

3-0-1-0[4]	models, Transfer coefficients, discrete transfers, continuous transfers. Unit-2:Solution by Eigen value analysis. Eigen value-eigenvector solutions, solving initial value problems, repeated Eigen values. Unit-3: Computer Implementation. Spectral decompositions and the power method. The Leshe Matrix model. Model assumptions and equations, Eigen value solutions, estimating model parameters, Eigen value-Eigen vector theorems for Leshe matrices. Generalizations of the Leshe Matrix model. Survival in the last age class, A two-sex model, a forest harvesting model. Unit-4:Driving functions and non homogeneous linear systems. Driving functions, solving non homogeneous system. Constructing particular solutions. Introduction to tracer methods in physiology. Bath-tub models, the Stewart-Hamilton method for measuring cardiac output. Continuous infusion into a compartment elementary pharmacokinetics. Unit-5:Parameter estimation in two compartment models. The homogeneous case. The non homogeneous case, parameter estimation in multi compartment models. Models from social sciences. A business planning model. A model for the control of grade structure in an organization. **Text Book:** 1. J.N.Kapur, \Mathematical Modelling", New Age International (1988)
MTH 505 **L-P-T-D[C]** 3-0-1-0[4]	**Computational Fluid Dynamics** **Pre Req.: MTH 407** Unit-1:Governing Equation of Fluid Dynamics, Conservation Form Unit-2: Outline of Numerical Techniques for PDEs, Lax-Wendroff Technique , Mac Cormack's Scheme, Unit-3:Finite volume method, Upwind difference scheme, Application to Euler equations, Finite Element Method, Viscous flows, Boundary Layer, Staggered grid, Unit-3:MAC, SIMPLE Algorithm, SOLA Algorithm. Unit-4: Numerical techniques for Incompressible Flows, Application to Vortical Flows,5:Unit-2Electro-hydrodynamics Text Book: 1. Wendt, John, \An Introduction Computational Fluid Dynamics", Springer 2. John Anderson, \Computational Fluid Dynamics", McGraw- Hill
MTH 506 **L-P-T-D[C]** 3-0-1-0[4]	**Analysis of Design and Algorithms** **Pre Req.: None** Unit-1: Analysis: Algorithm definition, space complexity, time complexity, worst case –best case –average case complexity, asymptotic notation, sorting algorithms (insertion sort, heap sort) , sorting in linear time, searching algorithms, recursive algorithms (Tower of Hanoi , Permutations). Unit-2: Design strategies Divide and conquer: control abstraction, binary search, merge sort, Quick sort, Strassen's matrix multiplication Greedy method: knapsack problem, job sequencing with deadlines, minimum-cost spanning trees, Kruskal and Prim's algorithm, optimal storage on tapes, optimal merge patterns. Unit-3: Huffman coding Dynamic programming: matrix chain multiplication, . single source shortest paths, Dijkstra's algorithm, Bellman- ford algorithm , all pairs shortest path, longest common subsequence, string editing, 0/1 knapsack problem, Traveling salesperson problem. Unit-4:Decrease and conquer: DFS and BFS, Topological sorting, connected components Backtracking: General method, 8 Queen's problem, Sum of subsets problem, graph coloring problem, Hamiltonian cycle Branch and Bound Technique : FIFO, LIFO, LCBB, TSP problem, 0/1 knapsack problem Unit-5:Transform and conquer:- Horner's Rule and Binary Exponentiation – Problem

	Reduction Problem classification: Nondeterministic algorithm, The class of P, NP, NP-hard and NP- Complete problems, significance of Cook's theorem. **Text Books :** 1.. Ellis Horowitz, Sartaj Sahni & Sanguthevar Rajasekaran, Computer Algorithms, Galgotia. 2.T. Cormen, C. Leiserson, & R. Rivest, Algorithms, MIT Press, 1990 **References:** 1. A. Aho, J. Hopcroft, & J. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley, 1974 2. Donald Knuth, The Art of Computer Programming (3 vols., various editions, 1973-81), Addison Wesley 3.The Algorithm Manual, Steven Skiena, Springer ISBN:9788184898651 4.Graphs, Networks and Algorithms, Jungnickel, Springer, ISBN: 3540219056
MTH 507 **L-P-T-D[C]** 3-0-1-0[4]	**Finite Element Method** **Pre Req.: None** Unit-1: Introduction and motivation, Weak formulation of BVP and Galerkin approximation, Piecewise polynomial spaces and finite element method, Unit-2: Computer implementation of FEM, Results from Sobolev spaces, Variational formulation of elliptic BVP, Lax-Milgram theorem, Unit-3: Estimation for general FE approximation, Construction of FE spaces, Polynomial approximation theory in Sobolev spaces, Unit-4: Variational problem for second order elliptic operators and approximations, Unit – 5: Mixed methods, Iterative techniques. **Text Book:** 1. P. Seshu, \Text book of Finite Elements Analysis", PHI learning pvt. Ltd. 2. Brenner, Susanne, Scott, Ridgway, \The Mathematical Theory of Finite Element Method", Springer
MTH 508 **L-P-T-D[C]** 3-0-1-0[4]	**Manifold Theory** **Pre Req.: None** Unit-1: Idea of differential forms. Calculus of forms. Exterior derivatives. Examples of exterior differentiation. Unit-2:Stoke's theorem. Gauss's theorem. Hodge star operator and its properties. Unit-3:Differential Manifolds: definition and examples. The example of a circle. Orientation of a Manifold. Maps between Manifolds. Pull back maps. Lie brackets. Coordinate basis. Unit-4:Introduction to Lie derivatives. Properties of the Lie derivative. Poincare lemma. Unit-5:A brief discussion on de-Rham cohomology. Idea of Killing vectors. Integration on Manifolds. Partition of unity. Applications. **References:** B.Schutz, Geometrical Methods in Mathematical Physics, Cambridge University Press. D.Martin Manifold Theory: An introduction for mathematical Physicists, Albion/Horwood. Siddhartha Sen, A short course on Differentiable Manifolds, Calcutta University Press (2011).
MTH 509 **L-P-T-D[C]** 3-0-1-0[4]	**Non Linear Dynamics and Chaos** **Pre Req.: None** Unit-1: Picard's theorem, Boundedness of solutions, Omega limit points of bounded trajectories.LaSalle's invariance principle Unit-2:Stability via Lyapanov's indirect method, Converse Lyapanov functions, Sublevel sets of Lyapanov functions. Stability via Lyapanov's direct method, Converse Lyapanov's theorems, Unit-3: Brokett's theorem, Applications to control system; Stable and unstable

	manifolds of equilibria, Stable manifold theorem, Hartman-Grobman theorem, Examples and applications, Center manifold theorem, Center manifold theorem, Unit-4:Normal form theory, Examples and applications to nonlinear systems and control; Poincare map, and stability theorems for periodic orbits; Unit-5:Elementary Bifurcation theory. **References:** 1. S.H.Strogatz Nonlinear dynamics and Chaos Addison-Wesley. 2. R.C.Hilborn, Chaos and Nonlinear Dynamics, Oxford University Press. 3. R.K. Upadhyay, SRK Iyengar, \ Introduction to Mathematical Modeling and Chaotic Dynamics", CRC Press
MTH 510 **L-P-T-D[C]** 3-0-1-0[4]	**Discrete Dynamical System** **Pre Req.: None** Unit-1:Phase Portraits, Periodic Points and Stable Sets, Sarkovskii's Theorem, Hyperbolic, Attracting and Repelling Periodic Points. Unit-2: Families of Dynamical Systems, Bifurcation, Topological Conjugacy. The Logistic Function, Unit-3:Cantor Sets and Chaos, Period-Doubling Cascade. Symbolic Dynamics. Unit-4:Newton's Method. Numerical Solutions of Differential Equations. Complex Dynamics, Quadratic Family, Julia Sets, Mandelbrot Set. Unit-5:Topological Entropy, Attractors and Fractals, Theory of Chaotic Dynamical systems. **References:** 1. M W Hirsch, S Smale and R L Devaney Differential equations, Dynamical systems and an Introduction to Chaos, Elsevier Academic Press. 2. R L Devaney An introduction chaotic Dynamical System, Addison-Wesley. 3. A.Katok and B.Hasselblatt, Introduction to the Modern theory of Dynamical Systems, Cambridge University of Press.
MTH 511 **L-P-T-D[C]** 3-0-1-0[4]	**Sampling Theory** **Pre Req.: None** Unit-1:Basic methods of sample selection, simple random sampling with replacement (SRSWR), simple random sampling without replacement (SRSWOR) Unit-2:probability proportional sampling with and without replacement, systematic sampling, estimation problems, Horwitz- Thompson estimator and its properties. Unit-3: Stratification: Allocation problems and estimation problems, formation of strata and number of strata, method of collapsed strata. Use of supplementary information for estimation, ratio and regression estimators with their properties and generalizations. Unit-4: Jackknife methods. Cluster sampling, multistage-sampling. Double sampling procedures. Unit-5:Ratio and regression estimators, stratification. Non-sampling errors, response and non-response errors and their treatments, randomized response. **Text Books:** 1. Des Raj and Chandhok, P. (1998). Sample Survey Theory (Narosa) 2. Sukhatme P.V, Suktatme, B.V., Sukhatme S. and Asok C. (1984). Sampling Theory of Surveys with Applications (Indian Soc. for Agricultural Statistics, New Delhi). 3. Cochran, W.G. (1984). Sampling Techniques (Wiley) **References:** 1. Murthy, M.N. (1977). Sampling Theory and Methods
MTH 512 **L-P-T-D[C]** 3-0-1-0[4]	**Statistical Pattern Recognition** **Pre Req.: None** Unit-1:Linear classifiers: linear discriminant function (LDF) for minimum squared error, LDF for binary outputs, perception learning algorithm. Unit-2: Nearest neighbour decision rules: description, convergence, finite sample considerations, use of branch and bound methods. Unit-3:Probability of errors: two classes, normal distributions, equal covariance matrix assumptions. Unit-4: Chernoff bounds and Bhattacharya distance, estimation of probability of error.

	Unit-5:Feature selection and extraction: interclass distance measures, discriminant analysis, probabilistic distance measures, principal components. **Text Books:** Duda, R.O. and Hart, P.E. (1973). Pattern Recognition and Scene Analysis. (Wiley). Fukunaga,K. (1990). Introduction to Statistical Pattern Recognition, 2nd Ed. (Academic Press). McLachlan, G.J. (1992). Discriminant Analysis and Statistical Pattern Recognition. (Wiley). Ripley, B.D. (1996). Pattern Recognition and Neural Networks. (Cambridge University Press).
MTH 513 **L-P-T-D[C]** 3-0-1-0[4]	**Statistical Simulations** **Pre Req.: MTH 301** Unit-1:Stochastic simulations: generating random variables, simulating normal, gamma and beta random variables. Unit-2: Comparison of algorithms to generate random variables. Generating random variables from failure rates. Unit-3:Simulating multivariate distributions, MCMC methods and Gibbs sampler, Simulating random fields, simulating stochastic processes. Unit-4: Variance reduction techniques: importance sampling for integration, control variates and antithetic variables. Simulating a non-homogeneous Poisson process. Unit-5:Optimization using Monte Carlo methods, simulated annealing for optimization. Solving differential equations by Monte Carlo methods. **Text Books:** 1. Fishman, G.S. (1996) Monte Carlo: Concepts, Algorithms, and Applications. (Springer). 2. Rubinstein, R.Y. (1981); Simulation and the Monte Carlo Method. (Wiley). 3. Ripley B.D. (1987) Stochastic Simulations (Wiley) 4. Ross, S.M.(2002) Simulation (Third Edition) (Academic)
MTH 514 **L-P-T-D[C]** 3-0-1-0[4]	**Medical and Health Statistics** **Pre Req.: MTH 306** Unit-1:Study designs in epidemiology. Measures of disease occurrence and association, variation and bias. Unit-2: Identifying non-causal association and confounding. Defining and assessing heterogeneity of effects, interaction. Sensitivity and specificity of diagnostic test, .Cohort Study designs, statistical power and sample size computations. Unit-3:Log-linear models, 2xK and 2x2x2 contingency tables. Unit-4:: Logistic model. Analysis of binary data. Cross-control study designs, matched case-control studies Survival data: Proportional hazards model, multivariate survival data. Unit-5:Causal Inference, Longitudinal data. Communicating results of epidemiological studies, ethical issues in epidemiology. **Text Books:** 1. Selvin : Statistical analysis of epidemiological data. 2. Diggle, Liang and Zeger : Analysis of longitudinal data 3. Piantadosi : Clinical trials 4. Agresti : Categorical Data Analysis. 5. Clayton and Hills : Statistical methods in Epidemiology 6. McCullagh and Nelder : Generalized Linear Models. 7. Brookemeyer and Gail : AIDS Epidemiology : A Quantitative Approach 8. Zhou, Obuchowski and McClish : Statistical Methods in Diagnostic Medicine
MTH 601 **L-P-T-D[C]** 3-0-1-0[4]	**Computer Intensive Statistical Methods** **Pre Req.: MTH 306** Unit-1:Jackknife and Bootstrap. Bootstrap methods: re-sampling paradigms, bias and standard errors, Bootstrapping for estimation of sampling distribution. Unit-2:confidence intervals, variance stabilizing transformation, bootstrapping in

	regression and sampling from finite populations. Unit-3: Jackknife and cross-validation: jackknife in sample surveys, jack-knifing in regression with heteroscadisticity, cross-validation for tuning parameters. Unit-4: EM algorithm: applications to missing and incomplete data problems, mixture models. Applications to Bayesian analysis. Monte Carlo EM algorithm MCMC methods in missing data. Unit-5:Smoothing with kernels: density estimation, simple nonparametric regression. Failure rate. Permutation tests **Text Books:** 1. Fishman, G.S. (1996) Monte Carlo: Concepts, Algorithms, and Applications. (Springer). 2. Rubinstein, R.Y. (1981); Simulation and the Monte Carlo Method. (Wiley). 3. Tanner, M.A. (1996); Tools for Statistical Inference, Third edition. (Springer.) 4. Efron, B. and Tibshirani. R.J. (1993); An Introduction to the Bootstrap. 5.Davison, A.C. and Hinkley, D.V. (1997) Bootstrap methods and their applications (Chapman and Hall). 6. Shao J. and Tu, D. (1995); The Jackknife and the Bootstrap. Springer Verlag. 7. McLachlan, G.J. and Krishnan, T. (1997) The EM Algorithms and Extensions. (Wiley.) 8. Simonoff J.S. (1996) Smoothing Methods in Statistics. (Springer). 9. Kennedy W. J. & Gentle J. E. (1980) Statistical computing (Marcel Dekker)
MTH 602 **L-P-T-D[C]** 3-0-1-0[4]	**Design of Experiments** **Pre Req.: None** Unit-1:Block Designs and optimality, the C-Matrix, E-optimality, A-optimality, D-optimality. Unit-2:Plackett Burman Designs and their properties. Unit-3:Experimental Designs for fitting response surfaces. Design criterion involving bias and variance. Unit-4:Restricted Surface Methods and Taguchi's Parameter Design. Restricted Region Simplex Designs. Mixture experiments involving process variables. Unit-5:Weighing Designs. **Text Books:** Bapat, R.B. (1993): Linear Algebra and Linear Models, Hindustan Book Agency Publishers, Box, G.E.P. & Draper, N.R. (1989): Empirical Model-Building and Response Surfaces, John Wiley & Sons. Cornell, John, A. (1990): Experiments with mixtures; Design, Models and the Analysis of Mixture data. John Wiley & Sons, New York. Khuri, A. I. & Cornell, John, A. (1996): Response Surfaces: Design and Analysis, Marcel Dekker. Lin, D.K. J. & Draper, N.R. (1999): Projection Properties of Placket and Burman Designs, Technometrices Vol. 34 pp.423-428. Myers, R.H. and Montgomery, D.C.(1995): Response Surface Methodology, Process and Product Optimization Using design of Experiments. John Wiley & Sons, 1WC, New York. Raghavarao, D. (1971): Construction and Combinatorial Problems of Design of Experiments, John Wiley & Sons, New York. Shah, K.R. & Sinha, B.K. (1989): Theory of Optimal Designs, Springer Verlag, Berlin Lecture Notes in Statistics Volume 54. Wang, J. C. & Wu, C.F.J. (1995): A Hidden Projection Property of Placket Burman and Related Designs. Statistics Sinica, 5, 235-250.
MTH 603 **L-P-T-D[C]** 3-0-1-0[4]	**Order Statistics** **Pre Req.: MTH 306** Unit-1:Conditional distributions, Order Statistics and Markov chain, Order Statistic for independent non-identically distributed variates, permanent expressions for densities of

	order statistics. Discrete order statistics, Dependence structure in the discrete case, Geometric order statistics, order statistics from a without replacement sample. Unit-2:Bounds and approximations for moments of order statistics, Bounds in the case of dependent variates, Approximations to moments in terms of the inverse c.d.f. and its derivatives. Statistics expressible as maxima with applications, order statistics for exchangeable variates. Unit-3:Concomitants of order statistics, order statistics in estimation and hypothesis testing, Distribution-free confidence and tolerance intervals. Characterizations using order statistics. Unit-4:Recurrence relations and identities for moments of order statistics from an arbitrary continuous distribution and those from some specific distributions, viz. exponential, Logistic, Normal, Half logistic, right-truncated exponential and doubly truncated exponential. Unit-5:Order statistics from a sample containing a single outlier: Distributions of Order Statistics, Recurrence relations for single and product moments, Functional behaviour of order statistics in cases of location and scale-outlier models. Asymptotic theory, the asymptotic joint distribution of sample quantiles, the asymptotic distribution of extreme values. **Text Books:** Arnold, B.C. Balakrishanan, N. and Nagaraja, H.N. (1989): Relations, Bounds Approximations for Order Statistics. Lecture Notes in Statistics, Vol., 53 Springer-Verlag. Arnold, B.C., Balakrishanan, N. and Nagaraja, H.N. (1992): A First Course in Order Statistics, John Wiley. David, H.A. (1981): Order Statistics (2nd Ed.) John wiley. Galambos J. (1987): The Asymptotic Theory of Extreme Order Statistics (2nd Ed.). Krieger, F.L. Gumbel, E.J. (1958): Statistics of Extremes, Columbia University Press, New York. Sarhan, A.E. and Greenberg, B.G. (Eds.) (1962): Contributions to Order Statistics, Wiley, New York.
MTH 604 **L-P-T-D[C]** 3-0-1-0[4]	**Algebraic Geometry** **Pre Req.: None** Unit-1:Prime ideals and primary decompositions, Ideals in polynomial rings, Hilbert Basis theorem. Unit-2: Noether normalisation lemma, Hilbert's Nullstellensatz, Affine and Projective varieties Unit-3: Zariski Topology, Rational functions and morphisms, Elementary dimension theory, Unit-4:Smoothness, Curves, Divisors on curves, Unit-5:Bezout's theorem, Riemann-Roch for curves, Line bundles on Projective spaces. **References:** 1. K. Hulek, "Elementary Algebraic Geometry", Student Mathematical Library 20, American Mathematical Society, 2003. 2. I. R. Shafarevich, "Basic Algebraic Geometry 1: Varieties in Projective Space", Springer, 2013. 3. J. Harris, "Algebraic geometry", Graduate Texts in Mathematics 133, Springer Verlag, 1995. 4. M.Reid,"UndergraduateAlgebraicGeometry",LondonMathematicalSocietyStudent Texts 12, Cambridge University Press, 1988. 5. K.E.Smithet. al.,"AnInvitationtoAlgebraicGeometry",Universitext,SpringerVerlag, 2000. 6. R.Hartshorne, "AlgebraicGeometry", Graduate Textsin Mathematics 52, Springer

	Verlag, 1977.
MTH 605 **L-P-T-D[C]** 3-0-1-0[4]	**Algebraic Topology** **Pre Req.: MTH 304, MTH 405** Unit-1: Homotopy Theory: Simply Connected Spaces, Covering Spaces, Universal Covering Spaces, Deck Transformations, Path lifting lemma, Homotopy lifting lemma, Unit-2: Group Actions, Properly discontinuous action, free groups, free product with amalgamation, Unit-3: Seifert-Van Kampen Theorem, Borsuk Ulam Theorem for sphere, Jordan Separation Theorem. Unit-4:Homology Theory: Simplexes, Simplicial Complexes, Triangulation of spaces, Simplicial Chain Complexes, Simplicial Homology, Singular Chain Complexes, Cycles and Boundary, Singular Homology, Relative Homology. Unit-5: Short Exact Sequences, Long Exact Sequences, Mayer-Vietoris sequence, Excision Theorem, Invariance of Domain. **Text Books:** 1. J. R. Munkres, "Topology", Prentice-Hall of India, 2013. 2. A. Hatcher, "Algebraic Topology", Cambridge University Press, 2009. **References:** 1. G. E. Bredon, "Topology and Geometry", Graduates Texts in Mathematics 139, Springer, 2009.
MTH 606 **L-P-T-D[C]** 3-0-1-0[4]	**Wavelet Analysis** **Pre Req.: None** Unit-1:Fourier transforms, Unit-2:Wavelets transforms and time-frequency analysis, Unit-3:Cardinal spline analysis, Scaling functions and wavelets, Cardinal spline wavelets, Unit-4:Orthogonal bases of compactly supported wavelets. Unit-5:Applications to signal analysis. Text Book: 1. David F. Walnut, " An Introduction to Wavelet Analysis", Springer
MTH 607 **L-P-T-D[C]** 3-0-1-0[4]	**Stochastic Process** **Pre Req.: MTH 205** Unit-1:Discrete Markov chains with countable state space; Classification of states: recurrences, transience, periodicity. Unit-2:Stationary distributions, reversible chains, Several illustrations including the Gambler's Ruin problem Unit-3:queuing chains. Unit-4:birth and death chains etc. Poisson process. Unit-5: continuous time Markov chain with countable state space, continuous time birth and death chains. References: 1. P.G.Hoel,S.C.Port,C.J.Stone,"IntroductiontoStochasticProcesses",Houghton Mifflin Co., 1972. 2. R.Durrett,"EssentialsofStochasticProcesses",SpringerTextsinStatistics,Springer, 2012. 3. G. R. Grimmett, D. R. Stirzaker, "Probability and Random Processes", Oxford University Press, 2001. 4. S. M. Ross, "Stochastic Processes", Wiley Series in Probability and Statistics: Probability and Statistics, John Wiley & Sons, 1996 5. J. Medhi, " Stochastic Processes", New Age International
MTH 608 **L-P-T-D[C]** 3-0-1-0[4]	**Set Theory & Logic** **Pre Req.: None** Unit-1:Propositional calculus Unit-2: Set theoretic concepts; Truth on algebraic systems; The calculus of predicates; Unit-3:Model theory.

	Unit-4: Proof Theory. Unit-5:Algorithms and recursive functions. **Text Book:** 1. Karel Hrbacek, Thomas Jech, "Introduction to Set Theory", Marcel Dekker, Inc.
MTH 609 **L-P-T-D[C]** 3-0-1-0[4]	**Bio Mathematics** **Pre Req.: None** Unit-1: Biofluid dynamics; Blood flow & arterial diseases; Unit-2: Transport in intestines & lungs; Diffusion processes in human systems; Unit-3: Mathematical study of nonlinear Volterra equations, Unit-4: Stochastic & deterministic models in population dynamics Unit-5: Epidemics. Text Book: 1. James D. Murray, "Mathematical Biology: 1. An Introduction Third Edition", Springer 2. J. C Mishra, " Biomathematics Modelling and Simulation", World Scintific
MTH 610 **L-P-T-D[C]** 3-0-1-0[4]	**An Introduction to Commutative Algebra** **Pre Req.: MTH 304** Unit-1:Commutative rings, ideals, operations on ideals, prime and maximal ideals, nilradicals, Jacobson radicals, extension and contraction of ideals Unit-2: Modules, free modules, projective modules, exact sequences, tensor product of modules. Unit-3: Restriction and extension of scalars, localization and local rings, extended and contracted ideals in rings of fractions,. Unit-4:Noetherian modules, Artinian modules, Primary decompositions and associate primes, Integral extensions. Unit-5:Valuation rings, Discrete valuation rings, Dedekind domains, Fractional ideals, Completion, Dimension theory. **Text Book:** 1. M. F. Atiyah, I. G. Macdonald, "Introduction to Commutative Algebra", AddisonWesley Publishing Co., 1969. **References:** 1. R. Y. Sharp, "Steps in Commutative Algebra", London Mathematical Society Student Texts, 51. Cambridge University Press, 2000. 2. D. S. Dummit, R. M. Foote, "Abstract Algebra", Wiley-India edition, 2013.
MTH 611 **L-P-T-D[C]** 3-0-1-0[4]	**Complex Analytic Dynamics and Fractal** **Pre Req.: None** Unit-1:Chordal & spherical metrics, Unit-2:Normal families. Iteration of polynomials and rational functions, Periodic points & orbits, Unit-3:Julia & Fatou's sets and their characterizations, Dynamics of Julia and Fatou's sets for quadratic, Rational & entire functions; Unit-4:The Mandelbrot set. Julia sets & fractals. Unit-5: Self-similarity and fractal dimension. **Text Book:** 1. Michael Barnsley, "Fractal Everywhere", Academic Press Inc.

MTH 612 L-P-T-D[C] 3-0-1-0[4	**Statistical Ecology** **Pre Req.: None** **1) Population Dynamics** Unit-1: **1.1.**Introduction: Ecology, Statistical Ecology. **1.2.**Linear Growth $dN_t/dt = C$, Interpretation and limitation. **1.3.**Exponential Model: Solving $dN_t/dt = KN_t$, $K > 0$, $K < 0$ cases. Properties, Interpretation, Scope and Limitation. **1.4.**Logistic Growth Model: Density dependence, solving differential equation, Theta-Logistic Model **1.5.**$dN_t/dt = a.N_t(K-N_t)$ Properties, Carrying Capacity, Interpretation, Scope and Limitation. Unit-2: **1.6.** Geompertz Curve: Solving Differential equation $dN_t/dt = a.\log(K/N_t)$, Asymptotically stable Equilibrium, Properties, Interpretation, Scope and Limitation.Fitting the above growth models to data by linearization and regression.Harvesting model: different types of Harvesting **1.7.** Life tables: Force of mortality stable population and stationary population. Cohort, columns of life table, interrelation between columns interpretation, construction of life table, uses and application. **1.8.**Leslie matrix Models: fecundity and survival matrix, $n_t = M_t\, n_0$, future projections, stable age distribution, interpretation of largest sign value of M. **2) Smoothing Procedures** Unit-3: **2.1.**Poisson forest, Aggregated, Regular spatial point pattern, estimation of population density by quadrate sampling, nearest neighbor distances (Point to individual, individual to individual), i-th order nearest neighbor distance. $\lambda = n/\Pi X_i^2$, mle for Poisson forest, Bias and S.E. of λ estimate. **2.2.**Line Transect Method: Drawing random line transect, exponential detection function, mle of population density, other detection functions. **2.3.**Capture – recapture models: Closed population, Open population, Peterson estimator for single recapture, multiple captures, irative method to find mle of N, Population size. **2.4.**Removal Method: Zippin's estimator for closed population. **3) Diversity Indices** Unit-4: **a.** Concept of Biodiversity, need to protect it. **b.** Richness indices, Simpson's index, Shannon's index. **c.** Rare fraction Curves, Real life examples for computing these indices. **4) Distribution Models** Unit-5: **4.1.**Use of geometric distribution, lognormal distribution in ecology. **Reference Books:** 1. Pielou,E.C.(1977):An Introduction to Mathematical Ecology, Wiley. 2. Seber,G.A.F.(1982): The estimation of animal abundance and related parameters, C. Griffin. 3. Ludwig,J.A. and Reynold J.F.: Statistical Ecology, A primer on methods and computing. 4. Gore,A.P. and Prajpe, S.A. : A First Course on mathematical and Statistical Ecology.

Note: The word "Pre Req" means, the candidate should have passed in the specified pre-requisite subject(s) to register in that particular course. For example: - If a student wants to register in MTH 201 in 3rd semester, he/she must have passed MTH 102 in 2nd semester.