National Institute of Technology, Agartala

Department of Mathematics

Syllabus for

Integrated BS-MS Dual Degree

in Mathematics and Computing

Syllabus for Integrated BS (4-year) / MS (5-year) programme for Mathematics and Computing

Semester-I

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Mathematics-I		3	1	0	4
2.	Chemistry-I		3	1	0	4
3.	Physics-I		3	1	0	4
4.	Language and Technical Writing		2	0	1	3
5.	Physics Lab-I		0	0	3	2
6.	Chemistry Lab-I		0	0	3	2
						Total Credit = 19

Semester-II

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Mathematics-II		3	1	0	4
2.	Chemistry-II		3	1	0	4
3.	Physics-II		3	1	0	4
4.	Basic environmental and atmospheric science		2	0	1	3
5.	Physics Lab-II		0	0	3	2
6.	Chemistry Lab-II		0	0	3	2
						Total Credit = 19

Semester-III

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Introduction to Differential Equation		3	1	0	4
2.	3D Geometry		3	1	0	4
3.	Introduction to Real Line		3	1	0	4
4.	Probability & Statistics		3	1	0	4
5.	Programming in C (Theory)		2	0	0	2
6.	Programming in C (Lab)		0	0	3	2
						Total Credit = 20

Semester-IV

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Data Mining and Ware Housing		3	1	0	4
2.	Introduction to Algebra		3	1	0	4
3.	LPP and Game theory		3	1	0	4
4.	Mathematical Logic & Numerical Analysis		3	1	0	4
5.	Number Theory and Cryptology		3	1	0	4
						Total Credit = 20

Semester-V

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Data Structure and Algorithm		3	1	0	4
2.	Soft Computing-I		3	1	0	4
3.	Integral Transform and its Application		3	1	0	4
4.	Artificial Intelligence		3	1	0	4
5.	Statics and Dynamics		3	1	0	4
Total Credit = 20						

Semester-VI

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Numerical Methods		2	0	0	2
2.	Numerical Lab		0	0	3	2
3.	Theory of computation		3	1	0	4
4.	Soft Computing-II		3	1	0	4
5.	Ordinary Differential Equation		3	1	0	4
6.	Discrete Mathematics		3	1	0	4
Total Credit = 20						

Semester-VII

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Graph Theory		3	1	0	4
2.	Linear Algebra		3	1	0	4
3.	Real Analysis		3	1	0	4
4.	Abstract Algebra		3	1	0	4
5.	Computer Programming Theory		2	0	0	2
6.	Computer Programming Practical		0	0	3	2
						Total Credit = 20

Semester-VIII

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Topology		3	1	0	4
2.	Tensor Calculus and Riemannian Geometry		3	1	0	4
3.	Complex Analysis		3	1	0	4
4.	Statistical inference and Stochastic Processes		3	1	0	4
5.	Project Work – I		0	4	0	4
						Total Credit = 20

Semester-IX

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
1.	Mathematical Methods		3	1	0	4
2.	Partial Differential Equation		3	1	0	4
3.	Measure Theory		3	1	0	4
4.	* Elective – I		3	1	0	4
5.	Project Work – II		0	4	0	4
						Total Credit = 20

Semester-X

##Option – 1

Sl. No.	Name of the Subject	Subject Code	Teaching Scheme Hours per Week			Credit
			L	Tu.	Pr.	
a)	Functional Analysis		3	1	0	4
b)	* Elective – II		3	1	0	4
c)	* Elective – III		3	1	0	4
d)	Project Work – III		0	8	0	8
						Total Credit = 20
						*** Subject to the availability of the Faculty**
	##Option – 2					
e)	Industrial Project		0	0	0	15
f)	Project Seminar		0	0	0	3
g)	Comprehensive Viva		0	0	0	2
						Total Credit = 20

Student of BSMS Mathematics and Computing can choose either Option – 1 or Option – 2 in Xth Semester

Total Credit - 198

*Elective – I

Subject Code	Name of the Subject
	Operation Research – I
	Differential Geometry
	Mathematical Modelling and Simulation – I

*** Subject to the availability of the faculty any one elective papers will be offered**

#Elective – II & #Elective – III

Subject Code	Name of the Subject
	Operation Research – II
	Advanced Numerical Analysis
	Mathematical Modelling and Simulation – II
	Fluid Mechanics
	Mechanics
	Advanced Topology
	Fuzzy Mathematics
	Decision Theory & Computational Statistics
	Financial Mathematics

#Subject to the availability of the faculty any two elective papers will be offered

Detailed Syllabus

BSMS 1st Semester
[Compulsory]

Mathematics – I

Differential Calculus

Limits and continuity (definition and examples only). Partial derivative. Composite function. Implicit function. Total differentials. Directional derivative. Euler's theorem of homogeneous functions of two variables. Statement of Taylor's theorem for functions of two variables, Jacobian, maxima, minima. Lagrange's multipliers.

Applications of differential calculus

Tangent, normal, sub tangent and sub normal. Length of tangent and normal. Angle between radius vector and tangent. Length of arc and its derivative. Differential of arc length in polar form. Curvature. Radius of curvature. Newtonian method. Centre and circle of curvature. Envelopes. Curve tracing, Rectilinear asymptote for cartesian and polar curve, Concavity, Convexity, Singular points. Nodes. Cusp, points of inflexion, simple problems on species of cusps of a curve (Cartesian curves only). Area enclosed by a curve, determination of C.G., moments and products of inertia (Simple problems only).

Integral Calculus

Improper integral, Beta and Gamma function, Double integral, Triple integral, Calculation of area and volume.

Vector Calculus

Vector function, limit and continuity, Tangent vector to a curve at a point, Scalar and vector point function. Gradient, Normal. Directional derivative. Examples. Divergence, Curl. Laplacian operator. Line Integral, Green's theorem. Surface Integrals, Gauss and Stokes's theorem.

Reference Books

a) *Advanced Engineering Mathematics, Jain and Iyengar, 2016.*

b) *Vector Analysis-Louis Brand, 2006.*

c) *Vector Analysis- Barry Apain, 1979.*

d) *Vector Analysis- Maity and Ghosh, New Central Book Agency, 2015.*

e) *Thomas's Calculus, Thomas and Finney, Pearson publishers, 2018.*

f) *An Introduction to Analysis: Differential Calculus, R. K. Ghosh & K. C. Maity, 2008*

g) *Vector Analysis- Schaum's series, Tata McGraw Hill, 1980.*

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BSMS 1st Semester

[Compulsory]

Chemistry-I

Atomic structure

Rutherford's model for atom, Bohr's model, Bohr's orbit, radii, energy, ionization potential, atomic spectra and atomic number. Hydrogen atom: Spectra, Balmer formula, Rydberg formula, Bohr's interpretation of atomic spectra, Bohr's correspondence principle, Moseley's experiment, fine structure of spectra and Somerfield's new energy states, Zemman effect: magnetic quantum number, vector model of atom, quantum numbers, Pauli exclusion principle, Hund's rule for atomic spectra, Aufbau principle, coupling scheme and atomic states in the vector model, qualitative description of s-, p-, and d-orbitals, electronic configuration for many electron system. Nature of bonding: covalent and ionic bonds.

Periodic Table and Properties of Elements

Long periodic Table, extended Periodic Table: classification of elements: s-, p-, d-, and fblock elements, post actinides and super actinides, important properties of elements and their periodic trends: atomic and ionic radii, ionization potential, electron affinity and electronegativity, different electronegativity scales, screening effect, effective nuclear charge, Slater's rules, inert pair effect, melting points; boiling points; diagonal relationship.

Basic organic chemistry

Different classes of organic molecules and their mechanistic classification: Ionic, radical and pericyclic reactions; heterolytic bond cleavage and heterogenic bond formation, hemolytic bond cleavage and homogenic bond formation. Nomenclature IUPAC. Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions, free radicals, carbenes and arenes.

Gaseous and liquid states

Gaseous states: Gas laws, kinetic theory of gases, derivation of gas laws from kinetic theory. Maxwell theory of velocity distribution. Mean free path. viscosity of gases. Real gases, Van der waal's equation of state, Virial coefficients and equation of state. Liquid state: Physical properties of liquids and their measurements. Surface tension and
viscosity.

Reference Books

- ***a)*** *J. D. Lee, Concise Inorganic Chemistry, 4th Ed., ELBS, 1991.*
- ***b)*** *G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edition, Pearson, Delhi, india.*
- ***c)*** *R. L. Dutta, Elementary Inorganic Chemistry, 5th Ed. The New Book Stall, Calcutta.*
- ***d)*** *R. Sarkar, General Chemistry Part-I and Part-II, New Central Book Agency (P) Ltd.*
- ***e)*** *A. K. Das, Fundamental Concepts of Inorganic Chemistry Part-I and Part-II, CBS Publishers & Distributors, New Delhi.*
- ***f)*** *J. H. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principle of structure and reactivity, 4th Ed., Pearson, New Delhi.*
- ***g)*** *Shriver & Atkins, Inorganic Chemistry, 4th Ed., Oxford University Press, Delhi.*
- ***h)*** *T. W. Graham Solomon, C. B. Fryhle, Organic Chemistry, John-Wiley and Sons.*
- ***i)*** *J. March, Advanced Organic Chemistry: Reactions Mechanism and Structure John-Wiley and Sons.*
- ***j)*** *R. T. Morrison and R. N Boyd, 'Organic Chemistry', Prentice Hall.*
- ***k)*** *Peter Sykes, 'A guide Book to Mechanism in Organic Chemistry,' Longman.*

l) D.A. McQuarrie and J.D. Simon, Physical Chemistry, Viva Books.
m) Elements of Physical Chemistry by Peter Atkins & Julio De Paula, 5/E, Oxford University Press, Indian Edition.
n) P.W. Atkins, Physical Chemistry, 7th ed. Oxford University press 2006.

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BSMS 1st Semester

[Compulsory]

Physics-I

Mathematical Preliminary
Vector Differentiation, Scalar and Vector Fields, Directional Derivatives, Vector Differential Operator, Gradient, Divergence, Curl, Line, Surface & Volume integrals and their applications, Green's theorem.

Mechanics
Newton's laws of motion for a system of particles, Constraints, D'Alembert's Principle, Generalized Coordinates, Generalized velocity and momentum, Lagrangian formulation, Hamiltonian formulation.

Physics of Waves
Simple Harmonic Motion, superposition of two linear SHMs, Lissajous figures, Damped Vibration:- differential equation and solution, critical damping, logarithmic decrement, analogy with electrical circuit, Normal mode analysis (Matrix Inversion) Progressive waves, Forced Vibration, Amplitude and Velocity Resonance, sharpness of resonance and quality factor.

Time Varying Field and Maxwell's Equation
Laws of Electromagnetic Induction, Self and Mutual induction, Concept of Displacement Current, Difference between Conduction Current and Displacement Current, Eddy Current, Maxwell's Equations, Derivation of Maxwell's Equations, Propagation of Electromagnetic Waves in Free Space and Conductors, Solution of propagation of Plane Electromagnetic Wave in free space and conductors, Concept of Field Energy (Poynting Vector).

Optics: Interference, Diffraction, Polarization Interference
Coherence (temporal and spatial), Fresnel's Bi-prism, Interference of Light due to division of amplitude (Newton's Ring), colour of thin film.

Diffraction
Types of Diffraction, Difference between Interference and Diffraction, Fraunhofer Diffraction at a Single Slit and Double slit, Plane transmission diffraction grating spectra, Comparison between Prism and Grating Spectra, Resolving Power of Microscope, Telescope and other optical instruments and limit of resolution.

Polarization
Plane of Vibration and Plane of Polarization, Classification of Polarized Light, Preferential direction in a wave; polarized light; natural light; production of linearly polarized light; Methods of Producing Plane polarized light: Brewster's law and Malus Law, Nicol's Prism: polarizer and analyzer; Polaroid, Anisotropic crystal; calcite crystal; Huygens' explanation of double refraction; Huygens' construction of wave fronts;

experimental determination of principal refractive indices; electromagnetic theory of double refraction; phase difference between o – ray and e – ray; superposition of waves linearly polarized at right angles; types of polarized light; effect of polarizer on transmission of polarized light; retarders or wave plates; Birefringes, Babinet Compensator.

Reference Books

- ***a)*** *H. Georgi, Physics of Waves.*
- ***b)*** *Rana & Joag, Classical Mechanics, Tata McGraw-Hill Education, India.*
- ***c)*** *3Waves – Pain.*
- ***d)*** *D. J. Griffith, Introduction to Electrodynamics, PHI Pubs.*
- ***e)*** *Hecht, Optics.*
- ***f)*** *A. Ghatak, Optics, Tata Mc Graw Hill.*
- ***g)*** *Feynman Lectures on Physics.*
- ***h)*** *Berkley Physics – Vol I & II.*

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BSMS 1st Semester

[Compulsory]

Language and Technical Writing

Course Objective

To introduce the important aspects of communication skills – speaking, reading, writing, listening and interpersonal communication. To enrich the students with communicational tools. To pursue their present and future academic as well as career goals – both inside and outside the classroom domain.

Course content

Unit -1: Organizational Communication:

Process of communication; Features of Successful Professional Communication; Importance of Communication; Purpose of Professional Communication; Different Forms of Communication; Communication Network in an Organization; Barriers to communication.

Unit -2: Listening Skills:

Listening is an art ; Listening vs. Hearing; Poor Listening vs. Effective Listening ; Important facts about listening; Advantages of Good Listening; Process of Listening ; Types of Listening; Intensive vs. Extensive Listening; Barriers to Effective Listening; Techniques for Effective Listening; Listening and Note Taking.

Unit -3: Effective Presentation Strategies:

Introduction; Defining Purpose; Analyzing Audience and Locale; Organizing Contents; Preparing an Outline; Kinesics; Proxemics; Paralinguistic.

Unit -4: Oral Communication:

Communication/ public speaking skill, features of effective speech-verbal; group discussion-principle and practice (the context of a GD, positive and negative roles played in a GD, different stages in a GD etc. and practice sessions), Interview skills and Non –verbal Communication using Audio-Visual aids, Pronunciation and Vocabulary extension.

Unit-5: Writing Skills
Fundamentals of Grammar, Models of Technical Writing: Notice Writing, Letters, Reports, Essays, CV, Comprehension and Advertisements.

Course outcome
Handle all aspects of that experience with a professional demeanour by interacting with team members responsibly, meeting deadlines, preparing and presenting effectively. Display competence in oral, written, and visual communication. Possess skills to effectively deliver formal and informal oral presentations to a variety of audiences in multiple contexts.

Reference Books

- ***a)*** *Raman Meenakshi and Sangeeta Sharma. Technical Communication; Principles and Practice, (II Edition), Oxford University Press, 2011.*
- ***b)*** *Taylor Shirley .Model Business Letters, E-Mail and other Business Documents (VI Edition) Person Education/ Prentice Hall, 2012.*
- ***c)*** *Raymond Murphy. Intermediate English Grammar. (II Edition) Cambridge University Press, 2011.*
- ***d)*** *Mitra, Barun. Personality Development and Soft Skills. Oxford University Press, 2012.*

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BSMS 1st Semester

[Compulsory]

Physics Lab-I

[At least seven experiments are to be performed]

1. Determination of MH and M/H of a bar magnet.
2. To determine the Young's Modulus of the material of a beam by bending of beam method.
3. Determination of unknown resistance of a given wire the help of Carey-Foster Bridge.
4. To determine the Dispersive power of the material of the prism, angle of prism is supplied.
5. Determination of Rigidity Modulus of a wire using dynamic method.
6. Determination of surface tension of water by capillary tube.
7. Determination of Wavelength of light by Newton's ring.
8. Study of polarization of light.
9. To determine the wavelength of Laser by diffraction grating method.
10. Verification of Stefan's law.
11. To determine the Numerical aperture & bending coupling losses of an Optical fiber by quick approximation method.

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BSMS 1st Semester

[Compulsory]

Chemistry Lab-I

1. (a) Preparation of standard solution of oxalic acid and standardization of NaOH solution and $KMnO_4$ solution.

(b) Preparation and standardization of Mohr's salt solution by $KMnO_4$ solution.

(c) Preparation of standard $K_2Cr_2O_7$ solution and standardization of Mohr's salt solution and sodium thiosulphate solution.

(d) Preparation and standardization of Na2EDTA solution.

2. Analysis of water samples by BOD and COD.

3. Estimation of Iron in water.

4. Preparation of organic and inorganic compounds using green chemistry principle

I. Benzilic acid,
II. Dibenzalpropanone,
III. Acetanilide,
IV. Biodiesel.
V. $[Cu(NH_3)_4]SO_4.H_20$
VI. $[Mn(acac)_3]$

Reference Books

a) *Vogel's Textbook of Quantitative Chemical Analysis, 5th Ed., ELBS with Longman.*

b) *R. A. Day, A. L. Undrwood, Quantitative analysis 6th Ed., Prentice-Hall of India (P.), Ltd., New Delhi.*

c) *W.G. Palmer,Experimental Inorganic chemistry, Cambridge University Press (1962).*

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BSMS 2nd Semester

[Compulsory]

Mathematics – II

Matrix and Linear System

Matrix Operations: Elementary row operations, Row reduced echelon form, Determinant. Systems of Linear Equations: Rank of a matrix, Solvability of linear equations, Gauss-Jordan elimination, Normal form, Cayley-Hamilton theorem, Quadratic form.

Complex Numbers

De-Moivre's theorem and its applications. Exponential, sine, cosine and logarithm of complex number. Direct and inverse circular and hyperbolic functions. Roots of unity.

Theory of Equations

Polynomials with real coefficient, statement of fundamental theorem of classical algebra. Statement of Descartes' rule of sign and its applications. Relations between root and coefficient. Transformation of equations. Standard form of cubic and bi – quadratic equations. Cardan's solution of cubic equations. Ferrari's method of solving bi – quadratic equations.

Infinite Series

Series, Convergence of infinite series. Statement and use of different tests for convergence of series of non-negative terms, Alternating series.

Reference Books

a) *Advanced Engineering Mathematics, Jain and Iyengar, 2016.*

b) *The theory of equations (Vol. I)- Burnside and Panton, 2011.*

c) *Foundation of Complex Analysis; S. Ponnusamy, Narosa, 2011.*

d) *Advanced Higher Algebra: Ghosh and Chakraborty, U. N, Dhur, 1987.*

e) *Complex Variables: Theory and Applications- H. S. Kasana, Prentice Hall India, 2005.*

f) *Thomas's Calculus, Thomas and Finney, Pearson publishers, 2018.*

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BSMS 2nd Semester

[Compulsory]

Chemistry-II

Chemical Bonding and Structure-I

Introduction to chemical bonding, ionic compounds: lattice energy: calculation and implications, solvation energy, Born-Haber cycle and its applications, Fajan's rules and its applications. Covalent compounds: sigma and pi-bonds, hybridization, Bent's rule of hybridization, resonance, dipole moment, Geometry: Qualitative description of VBT and MOT (diatomic homo and heteronuclear molecules), VSEPR theory, hydrogen bonding, hydrogen bridge bond, delta-bond, metal-metal bond.

Basic stereochemistry

Elements of symmetry: simple axis, plane of symmetry, center of symmetry, alternate axis of symmetry, chirality, optical activity, specific rotation, optical purity. Configuration: Types of isomerism. Geometrical and Optical. Isomerism, Enantiomerism, Diastereomerism and Meso compounds. D and L; cis - trans nomenclature; Concept of chirality.

Chemical Kinetics and Chemical equilibrium:

Order and molecularity of a reactions, rate laws and rate equation for first order, second order, and zeroth order reactions. Determination of order of reactions, Energy of activation. Catalytic reactions: homogeneous and heterogeneous catalytic reaction. Enzyme catalyzed and auto catalyzed reactions, Michelis-Menten equation. General Characteristics of catalytic reactions. The law of mass action, equilibrium constants, the reaction isotherms, the reaction isochore, Le chatelier's principle.

Coordination Chemistry-I

Addition compounds: double salts and complex salts; Werner's theory; ligands and denticity, classification of ligands, pi-acidic ligands, macrocyclic ligands, chelates, chelate effects, chelation therapy, supercomplex, geometry, coordination number; IUPAC nomenclatures.

Isomerism: structural and stereoisomerism: geometrical and optical, facial amd meridional isomers, chirality.

Thermodynamics - I

Definitions of systems and surroundings**:** Thermodynamic systems: Open, Close, isolated, state of a system, state function; Variables: Intensive, Extensive properties.

Thermodynamic process: Cyclic, reversible, irreversible, isothermal, adiabatic, isochoric, isobaric. Concept of heat, work, energy, internal energy. Concept of thermal equilibrium and Zeroth law of thermodynamics, Graphical explanation of work done during expansion and compression of an ideal gas. First law of Thermodynamics. Concept of enthalpy and as a state function: Heat change at constant volume and constant pressure, relation between Cp&Cvusing ideal gas and van der Waals equations. Second law of thermodynamics.Concept of entropy, Gibb's free energy, Helmholtz's free energy.Carnot's cycle.

Reference Books:

- ***a)*** *J. D. Lee, Concise Inorganic Chemistry, 4th Ed., ELBS, 1991.*
- ***b)*** *G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edition, Pearson, Delhi, india.*
- ***c)*** *R. L. Dutta, Elementary Inorganic Chemistry, 5th Ed. The New Book Stall, Calcutta.*
- ***d)*** *R. Sarkar, General Chemistry Part-I and Part-II, New Central Book Agency (P) Ltd.*
- ***e)*** *A. K. Das, Fundamental Concepts of Inorganic Chemistry Part-I and Part-II, CBS Publishers &Distributors, New Delhi.*
- ***f)*** *J. H. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principle of structure andreactivity, 4th Ed., Pearson, New Delhi.*
- ***g)*** *Shriver & Atkins, Inorganic Chemistry, 4th Ed., Oxford University Press, Delhi.*
- ***h)*** *T. W. Graham Solomon, C. B. Fryhle, Organic Chemistry, John-Wiley and Sons.*
- ***i)*** *J. March, Advanced Organic Chemistry: Reactions Mechanism and Structure John-Wiley and Sons.*
- ***j)*** *Finar I. L., 'Organic Chemistry' volume 1, Longman, London.*
- ***k)*** *E. L. Eliel, 'Stereochemistry of carbon compounds,; Tata-McGraw Hill.*
- ***l)*** *Peter Sykes, ' A guide Book to Mechanism in Organic Chemistry,' Longman.*
- ***m)*** *P.S.Kalsi, 'Organic Reactions, Stereochemistry and Mechanism,' New age International Ltd.*
- ***n)*** *D. Nasipuri, Stereochemistry of Organic Compounds, New age International.*

- ***o)*** *G.M. Barrow, 'Physical Chemistry' 5th ed. Tata Mc.Grow Hill, New Delhi, 1992.*
- ***p)*** *P.W Atkins, Physical Chemistry, 7th ed. Oxford University press 2006.*
- ***q)*** *G.W Castellan, 'Physical Chemistry' 4th ed. McGrow Hill 1999.*

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BSMS 2nd Semester
[Compulsory]

Physics – II

Introduction to Quantum Mechanics
Particle properties of wave: Planck's hypothesis, Wave properties of particle: De Broglie wave as mater waves, Davison-Germer experiment, Heisenberg's uncertainty principle and its application, Interpretation of wave function, Schrödinger equation (time dependent and time independent), particle in a box, Eigen values and Eigen function.

Concepts of Solids
Statistical distributions, M-B, B-E and F-D statistics (No Derivations) and their simple applications, Planck's radiation law, Degenerate Fermi Gas. Crystalline and amorphous solids, crystal structure, Bravais Lattice, Packing Fraction, Crystallographic planes and miller indices, Inter-planer spacing (cubic system only), Bragg's diffraction, Crystal structure analysis, Lattice Vibration, Electrons in a crystalline solid.

Plasma Physics
Definition of plasma and collective behaviour, concept of temperature, quasineutrality and Debye shielding, criteria for plasmas, plasma oscillations, Single particle motions in - uniform and non-uniform electric and magnetic fields, time varying electric and magnetic fields, Applications of Plasma.

Introduction to Laser and Optical Fiber
Spontaneous and stimulated emission, Einstein's A-B coefficient, meta-stable state, population inversion, basic principle of laser (three and four level), optical cavity and resonator, Ruby and He-Ne laser. Propagation of light in fiber, step and graded index fiber, numerical aperture, attenuation in optical fiber, introduction of optical window, application of laser and optical fiber.

Relativity
Reference Frames, Lorentz Transformation, Postulates of Relativity, Relativistic Mass & Mass-Energy Equivalence.

Reference Books

- ***a)*** *Plasma Physics and Controlled Fusion, Francis F. Chen, Springer Pub.*
- ***b)*** *Lasers, Fundamentals and Applications, K. Thyagrajan, A. Ghatak, Springer Pub.*
- ***c)*** *K. Huang, Statistical Mechanics.*
- ***d)*** *D.C. Tayal, Nuclear Physics, 4th edition, Himalaya House, Bombay.*
- ***e)*** *Kittel, Introduction solid State Physics, Willy Eastern Limited.*
- ***f)*** *A.K.Ghatak and S.Lokanathan, Quantum Mechanics, Macmillan India Limited.*
- ***g)*** *B.K. Agarwal, Elements of Statistical Mechanics.*
- ***h)*** *Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, R. Eisberg and Resnick, Wiley India Pvt. Ltd.*

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BSMS 2nd Semester

[Compulsory]

Basic Environmental and Atmospheric Science

Introduction to Environmental Sciences

Introduction to the Environment. Acquisition, transformation and utilization of energy: the geochemical, biogeochemical and hydrological cycles. Concept of ecosystem.

Biodiversity

Problems and issues in biodiversity and forestry. Conservation and utilization of biodiversity. Global warming and climate change. Recent records of climate change. Impact of climate change on Indian environment. Measures to cope with climate change. Mineral and energy resources. Impact of mining and other human activities on the environment.

Environmental impact assessment and environmental audit: an introduction. Environmental policy matters and law.

Environmental Pollution and Health

Air pollution: Composition of pollutants and sources. Disease associated with their Pollutants. Air quality monitoring, National and international standards for monitoring air quality. Quality of indoor air and its effect on health. Ventilation: standards, methods and health hazards. Analysis of gas effluents, SO_2, NOx ,CO_2 etc.

Water Pollution

Sources and types of water pollutants; Ground water and surface water pollution; Sampling and analysis and measurement of water; Water quality standards; Effects on aquatic ecosystem, Heavy metal (Arsenic, Cadmium, Lead, Mercury, fluoride, nitrate) analysis with respect to health significance. Disease related to these pollutants. Measurement of DO, BOD and COD.

Soil Pollution

Introduction, Major routes of soil pollution. Some important pollutants in soil. Diseases related to soil pollution.

Noise pollution:

Sound wave ants its characteristics: Hearing of sound. Measurement of noise level, Noise levels at different sources, Effects of noise on human health.

Industrial Pollution

Introduction, characterization of industrial wastes present in Effluents, Types of industrial wastes in Effluents, Treatment and disposal of industrial Effluents.

Radiation Pollution

Introduction, Nature of radioactive Emission, Units for measurement of radioactivity and radiation. Effects of radiation on Human Health. Radioactive Fallout.

Pollution from Agriculture – Pesticides and Fertilisers

General aspects and classification. Major disasters from pesticides and herbicides, Fertilizers and environmental hazards from fertilizers.

Pollution control in India

Government obligation, mechanism and legislation in the context of public health.

Green Chemistry:

Introduction, Principle and Concepts of Green Chemistry

What is green Chemistry? Need for green chemistry; inception and evolution of green chemistry; twelve principles of green chemistry with their explanations and examples; designing a green synthesis using these principles; green chemistry in day to day life.

Reference Books

- ***a)*** *Anjaneyulu. Y, 2004, Introduction to Environmental Science. B. S. Publications.*
- ***b)*** *D. Daniel Chiras, 2001, Environmental Science, 6th Ed., Jones and Bartlett Publishers.*
- ***c)*** *De, A. K., Environmental chemistry, 5th Ed., 2005, New Age International (P) Ltd., New Delhi.*
- ***d)*** *Subramanian. V, 2002, A text book in Environmental Science, Narosa Publishing House, New Delhi.*
- ***e)*** *Wright. R.T, and Nebel. B. J, 2004, Environmental Science, 8th Ed. Prentice Hall India Ltd.*
- ***f)*** *Asim K. Das, Environmental Chemistry with Green Chemistry, Books and allied (P) Ltd.*
- ***g)*** *Leslie collier, Balows Albert and Sussman Max, Topley and Wilson's Microbiology and Microbial infections. Oxford University Press.*
- ***h)*** *Murray J.F. and Nadel. J.A., 2000, Text book of respiratory medicine, 3rd Edn., W.B. Saunders & Co.*
- ***i)*** *Park. J.E. and Park. K., 1994, Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur.*
- ***j)*** *Green Chemistry, theory and practice. Paul T. Anastas and John C. Warner.*
- ***k)*** *Asim K. Das, Environmental Chemistry with Green Chemistry, Books and allied (P) Ltd.*
- ***l)*** *Organic Synthesis in Water, Paul A. Grieco Blackie.*

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BSMS 2nd Semester

[Compulsory]

Physics Lab-II

Experiment 1: Determination of damping constant of the Pohl's pendulum for different eddy damping current. Estimation of the natural frequency of the Pohl's pendulum.

Experiment 2: Determination of the co-efficient of viscosity of a liquid from its rate of flow through a capillary tube.

Experiment 3: To construct a one ohm coil.

Experiment 4: Determination of the frequency of a tuning fork by Melde's Apparatus.

Experiment 5: Determination of Acceleration due to Gravity (g) by a Kater's pendulum.

Experiment 6: Determination of moment of inertia of a body about an axis passing through its centre of gravity and perpendicular to its length.

Experiment 7: Measuring unknown wavelength of a laser with a diffraction grating.

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BSMS 2^{nd} Semester

[Compulsory]

Chemistry Lab-II

Experiment 1: To determine the viscosity of aqueous solution of ethanol/glycerol/amyl alcohol.

Experiment 2: To determine the surface tension of a given solution of aqueous solutions of NaCl/acetic acid.

Experiment 3:. Verification of Lambert-Beer's law.

Experiment 4: To determine the specific reaction rate constant of the acid catalyzed hydrolysis of methyl acetate/ethyl acetate at room temperature.

Experiment 5: Determination of Fe(II), Fe(III), Cu(II), Ca(II), Mg(II), Zn(II) and Cl– in their respective compounds volumetrically through redox, precipitation and complexometric titrations.

Experiment 6: Determination of hardness of water.

Experiment 7: Determination of functional groups in organic compounds.

Reference Books

a) *Vogel's Textbook of Qualitative Inorganic Analysis, 5^{th} Ed., ELBS with Longman.*

b) *W.G. Palmer, Experimental Inorganic chemistry, Cambridge University Press (1962).*

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BSMS 3rd Semester

[Compulsory]

Introduction to Differential Equation

Ordinary Differential Equation (ODE)

Introduction

Introduction, Formation of ODE, Significance of ODE, geometrical and physical consideration. Solution of ODE in separable form.

First Order ODE

Exact and non-exact differential equations, simultaneous equations. First order linear equations. Bernoulli's equation. First order higher degree equations solvable for x, y, and p. Clairaut's form and singular solutions.

Second Order ODE

Linear differential equations with constant coefficients. Homogeneous and non-homogeneous linear ordinary differential equations. Linear differential equations of higher order. Complementary function. Method of Undetermined Coefficients.

Partial Differential Equation (PDE)

Introduction

Origin of PDE, Order, degree, linear, non-linear. Surfaces and curves, classification of first order P.D.E., quasi-linear equations. Derivation of PDE.

Linear PDE

Solutions of Linear PDE of order one: Lagrange's solution (Type 1, Type 2, Type 3, and Type 4).

Non-linear PDE

Complete integral, Particular integral, Singular integral, General integral. Solution of Non-linear PDE: Charpit's method.

Reference Books

a) *W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.*

b) *E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 2012.*

c) *E. A. Coddington; An Introduction to Ordinary Differential Equations; PHI Learning 1999.*

d) *M. Braun, Differential Equations and Their Applications, 3rd Ed., Springer-Verlag, 2016.*

e) *T. Amarnath, An Elementary Course in Partial Differential Equations, 2nd Edn, 2003.*

f) *P. Hartman; Ordinary Differential Equations; John Wiley and sons, New York, 1964.*

g) *M. Hirsch, S. Smale and R. Deveney; Differential Equations, Dynamical Systems and Introduction to Chaos; Academic Press, 3rd Edn, 2012.*

h) *I. N. Sneddon: Elements of Partial Differential Equations, Dover, 2006.*

i) *S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 2007.*

j) *R. Haberman, Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem, 4th Ed., Prentice Hall, 2019.*

k) *L. C. Evans; Partial Differential Equations; American Mathematical Society, Rhode Island, 2012.*

l) *F. John; Partial Differential Equations; Narosa Publishing House, New Delhi, 1979.*

m) *M.D. Raisinghania, Ordinary and Partial Differential Equation, S. Chand, 20th Edn, 2020.*

n) *P. Hartman; Ordinary Differential Equations; John Wiley and sons, New York, 1964.*

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BSMS 3rd Semester

[Compulsory]

3D Geometry

Plane Geometry

Transformation of rectangular axes, translation, rotation and their combinations, theory of invariants, general equation of 2nd degree in two variables, reduction into canonical form, length and position of the axes. Pair of straight lines, circles and conic referred to a focus as pole, equation of chord, tangent, normal.

Rectangular cartesian coordinates in space, cylindrical, polar and spherical polar co-ordinates in 3 dimensions, concept of geometric vector, distance between two points. Division of a directed line segment in a given ratio. Equation of a plane in general form, intercept and normal form, signed distance of a point from a plane, equation of a plane passing through intersection of two planes, angle between two intersecting planes, parallel and perpendicularity of two planes.

Straight Lines

Straight lines in a space, equation in symmetric and parametric form, canonical equation of a line of intersection of two intersecting planes, angle between two lines, distance of a point from a line, coplanar lines, skew-lines, shortest distance. General equation of a sphere, circle, sphere through a given circle, sphere through intersection of two spheres, radical plane, tangent, normal.

Conicoids

Cone, right circular cone, enveloping and reciprocal cone. Cylinder: Right circular cylinder and enveloping cylinder. Central Conicoids: Equation of tangent plane. Director sphere, Normal to the conicoids. Polar plane of a point. Enveloping cone of a conicoid. Enveloping cylinder of a conicoid. Paraboloids: Circular section, Plane sections of conicoids. Generating lines. Confocal conicoid. Reduction of second degree equations in 3 variables in canonical form.

Space Curves

Curves in two and three dimensions. Parameterized curves, re-parameterizations. Regular and singular points. Curvature and torsion for space curves. Existence theorem for space curves. Serret-Frenet formula for space curves.

Reference Books

a) *S.L.Lony, Co-ordinate Geometry, Macmillan and co.2010*

b) *Dr. P.K. Mittal & Shanti Narayan, Analytical Solid Geometry, S. Chand. 2005*

c) *S.B.Sengupta, Co-ordinate Geometry and Vector Analysis, Joy Durga Library.2014*

d) *Ajay Kumar, Ravi Prakash, Usha Gupta, Co-Ordinate Geometry (2-D and 3-D), McGraw Hill Education, First edition, 2016.*

e) *N.P. Bali, Golden Co-Ordinate Geometry, Laxmi Publications, Second edition, 2013.*

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BSMS 3rd Semester
[Compulsory]

Introduction to Real Line

Numbers

Axioms for R. The supremum principle. The Natural numbers, integers, roots, rational and irrational numbers, extended real numbers, finite and infinite sets. Newton's Binomial theorem. Bounded subset of R, L.U.B. (supremum) and G.L.B. (infimum) of a set. Least upper bound axiom. Characterization of R as a complete ordered field. Definition of an Archimedean ordered field. Archimedean property of R. Ordered completeness.

Neighbourhoods and Some Properties

Limit points of a set and isolated point of a set, closed sets, dense sets, countable and uncountable sets. Neighbourhood of a point, interior point. Open set, union, intersection of open sets. Bolzano-Weierstrass theorem.

Real Sequences

Sequence, limit points of a sequence, limit inferior, limit superior, convergent sequence, non-convergent sequences, Cauchy's general principle of convergences, algebra of sequence, monotonic sequences, Sandwich rule. Nested interval theorem. Covering and compactness, Heine Borel theorem.

Function of Single Variable

Limits, continuous function, uniform continuity, Rolle's theorem, Lagrange's mean value theorem, Cauchy mean value theorem, derivatives.

Fourier Series

Basic of Fourier series and some problems.

Riemann Integration

Riemann integration on [a, b]. Darboux's approach and Darboux's theorem, R-integrability of sum, product and quotient. R-integrability of monotone functions, continuous functions and discontinuous functions. Function defined by definite integral and its properties. Primitives or indefinite integrals. First mean value theorem of integral calculus. Second mean value theorem of integral calculus (both Bonet's and Weierstrass's forms).

Reference Books

a) *K.R. Stromberg,Introduction to Classical Real Analysis, Wadsworth International, 2019.*

b) *J.M. Howie, A First Course in Real Analysis, Springer, 2001.*

c) *H.L. Royden and Patrick Fitzpatrick,Real Analysis, 4th Edn, 2010.*

d) *Robert G. Bartle , Donald R. Sherbert, Introduction to Real Analysis, 4th Edn, 2011.*

e) *S. C. Malik,Principles of Real Analysis, New Age International Publishers, 5th Edn, 2017.*

f) *S. K. Mapa,Introduction to Real Analysis, Sarat Impressions Pvt. Ltd, 8th Edn, 2019.*

g) *M. D. Raisinghania, Shanti Narayan, Elements of Real Anyalsis , S. Chand Group. 2003*

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BSMS 3rd Semester

[Compulsory]

Probability and Statistics

Probability

Introduction

Random experiment, σ-field, sample space, probability as a set function, probability axioms, probability space. Finite sample spaces. Independence, conditional probability, Bayes theorem, Real random variables (discrete and continuous), cumulative distribution function, probability mass functions, probability density functions, mathematical expectation, moments, moment generating function, characteristic function.

Discrete Distributions

Uniform. Binomial. Poisson. Geometric. Negative binomial.

Continuous Distributions

Uniform. Normal. Exponential

Joint Distribution Function

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, moments, covariance, correlation coefficient, independent random variables, joint moment generating function (JMGF) and calculation of covariance from JMGF, characteristic function. Conditional expectations, linear regression for two variables, regression curves. Bivariate normal distribution.

Statistics

Introduction

Markov and Chebyshev's inequality. Convergence in Probability. Statement and interpretation of weak law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance.

Sampling and Sampling Distributions

Populations and samples. Random sample. Distribution of the sample. Simple random sampling with and without replacement. Sample characteristics.

Sampling Distributions

Statistic, sample moments, sample variance, sampling from the normal distributions, Chi-square, t and F-distributions.

Estimation of Parameters

Point estimation and interval estimation. Mean-squared error. Properties of good estimators - unbiasedness, consistency, sufficiency, Minimum-Variance Unbiased Estimator (MVUE).

Method of Maximum Likelihood

Likelihood function, ML estimators for discrete and continuous models.

Bivariate Frequency Distribution

Bivariate data, scatter diagram, correlation, linear regression, principle of least squares and fitting of polynomials and exponential curves

Reference Books

- ***a)*** *William Feller, An introduction to Probability Theory and its Application, Volume 1, 3e.2008*
- ***b)*** *Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2013.*
- ***c)*** *R. L. Berger and G. Casella, Statistical Inference, 2015.*
- ***d)*** *S.C. Gupta and V. K. Kapoor; "Fundamentals of mathematical Statistics", Sultan Chand & Sons publication, 2014.*
- ***e)*** *N.G. Das; "Statistical Methods—Combined edition (vol. I & II)", Mc. Graw Hill Education, 2017.*

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BSMS 3rd Semester

[Compulsory]

Programming in C (Theory and Lab)

Introduction

Review of basic concepts of C-programming, further data types, structures, defining new data types. Unions. Coercion or Type-Casting, types, static, pointers, pointer and functions, pointers and arrays, arrays of pointers, multidimensional, arrays and pointers. Static initialization of pointer arrays, pointers and structures, common pointer pitfalls, exercise.

The C Preprocessor

#define, #undef, #include, #if -- conditional inclusion, preprocessor compiler control, other preprocessor commands.

Input and Output (I/O)

stdio.h, Reporting Errors, perror( ), errno, exit( ), Streams. Predefined Streams. Redirection. Basic I/O. Formatted I/O. Printf. scanf, Files, reading and writing files, sprintf and sscanf, stream, status Enquiries. Low Level I/O, exercises.

Cell Arrays and Structures

Cell array creation, its manipulation, retrieving cell array content, comma separated list, cell functions, cell array of strings, structure creation, structure manipulation, structure functions. Character string: String construction, string evaluation, string functions, cell array of strings.

Relational and Logical Operations

Relational and logical operators, relational and logical functions. Nans and empty, operator precedence. Control flow: For loops, while loops, if else end construction, switch case construction, try catch blocks.

Reference Books

a) *B. Kernighan and D. Ritchie, The C Programming Language Prentice Hall, India, 2015.*

b) *V. Rajaraman, Computer Progmamming in C, Prentice Hall, India, 2nd Edn, 2019.*

c) *Subrata Saha, Subhodip Mukherjee,Basic Computation and Programming with C, Cambridge University Press, 1st edition, 2017.*

d) *Reema Thareja, Programming in C, OUP India, 2nd edition, 2018.*

e) *Ajay Mittal, Programming in C, Pearson Education, First edition, 2010.*

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BSMS 4th Semester

[Compulsory]

Data Mining and Ware Housing

Introduction & Data Mining Algorithms

Introduction to data mining and knowledge discovery. Relation to statistics. databases, data mining functionalities, steps in data mining process, architecture of a typical data mining systems, classification of data mining systems, overview of data mining techniques, data preprocessing, data cleaning, data integration, data transformation and data reduction, data generalization and summarization based characterization.

Web Mining

Mining association rules in large databases, classification and prediction, issues regarding classification and prediction, classification by decision tree induction, Bayesian classification, other classification methods, prediction, clusters analysis, types of data in cluster analysis, Categorization of major clustering methods. Partitioning Methods. Hierarchical Methods.

Visualization

Web content mining, web structure mining, web usage mining. spatial mining, temporal mining.

Overview and Concepts

Need for data warehousing, basic elements of data warehousing. Trends in data warehousing.

Planning and Requirements

Project planning and management. Collecting the requirements. Architecture & Infrastructure: Architectural components, infrastructure and metadata.

Data Design and Data Representation

Principles of dimensional modelling, dimensional modelling advanced topics, data extraction, transformation and loading, data quality. Information Access & Delivery: Matching information to classes of users, OLAP in data warehouse, Data warehousing and the web. Implementation And Maintenance: Physical design process, data warehouse.

Reference Books

a) *Margaret Dunham, "Data Mining: Introductory and Advanced Topics", Prentice Hall, 2006.*

b) *Adriaans, P. (1996), Data mining, Addison-Wesley.*

c) *Paulraj Ponnian, "Data Warehousing Fundamentals", John Wiley, 2nd Edn, 2012.*

d) *W.H. Inmon, "Building the Data Warehouses", Wiley Dreamtech, 3rd Edn, 2002.*

e) *M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education, 2006.*

f) *Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd Edn, 2011.*

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BSMS 4th Semester

[Compulsory]

Introduction to Algebra

Abstract Algebra

Groups, Permutation Group, Symmetric group, Subgroups, Coset, Normal Subgroup, Centralizers, Normalizers, Stabilizers, Kernels, Cyclic groups, Subgroups generated by a subset of a group, Quotient groups, Lagrange's theorem, Homomorphisms, Isomorphism theorems, Composition series, Epimorphism, Endomorphism, Automorphisms, Rings, Ring homomorphisms, Boolean Ring, Ideal, Quotient ring, Ring embeddings, Integral Domain, Properties, Fields with examples, Characteristic of a field, Properties of Field.

Linear Algebra

Vector spaces, Bases and dimensions, Change of bases and change of coordinates, Sums and direct sums, Spanning sets and independence, the dimension of a vector space, Existence of eigen values, eigen vectors, eigen space, generalized eigenvectors. The complexification of a real vector space, Quotient spaces. Linear transformations. The kernel and image of a linear transformation, The rank and nullity theorem, change of bases for linear transformations.

Reference Books

- ***a)*** *Axler, S., Linear Algebra Done Right, 2nd edn. Springer International Student Edition (1997).*
- ***b)*** *Hoffman, K., Kunze, R., Linear Algebra, 2nd edn. Prentice Hall Int. Inc., Englewood Cliffs (1971)*
- ***c)*** *S. Lang, Algebra 3rd Edition, Addison-Wesley, 1999.*
- ***d)*** *J. A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.*
- ***e)*** *M. Artin, Algebra, Prentice Hall inc 1994.*
- ***f)*** *I. N. Herstein, Topics in Algebra, John-Wiley, 1995.*
- ***g)*** *M. T. Nair and A. Singh, Linear Algebra, Springer, 2018.*
- ***h)*** *D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John-Wiley, 1999.*

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BSMS 4th Semester

[Compulsory]

LPP and Game Theory

Linear Programming

Lines and hyperplanes, convex sets, convex hull and their properties. Formulation of a linear programming problem, theorems dealing with vertices of feasible regions and optimality. Graphical solution. Simplex method (including Big M method and two phase method), infeasible and unbounded LPPs, alternate optima, dual problem and duality theorems, dual simplex method and its application in post optimality analysis, revised simplex method. Sensitivity analysis - parametric programming.

Transportation problem

Introduction, existence of solution, degeneracy, MODI method (including the theory). Assignment problem. Hungarian method for solving assignment problems. Travelling salesman problem.

Theory of Games

Introduction, Minimax (maximin), criterion and optimal strategy, solution of games with saddle points, Rectangular games without saddle points – 2 □ 2 games – dominance principle – m □ 2 & 2 □ n games –graphical method.

Reference Books

- **a)** *Kambo, Mathematical Programming Techniques, East-West Publi., Delhi.*
- **b)** *Kanti Swarupet. al., Operations Research, Sultan Chand and Co., 2010,*
- **c)** *S. D. Sharma , Operations Research, Kedarnath, 7th Edn, 1976.*
- **d)** *J. K. Sharma, Operation Research, MacMilan, 6th Edn.*
- **e)** *Hiller and Libermann, Introduction to Operation Research, TMH, 10th Edn, 2017.*
- **f)** *Wayne L.Winston, Operation Research, Thomson BrooCole., 2009.*
- **g)** *H.A.Taha, An Introduction to Operations Research, PHI, 9th Edn, 2014.*
- **h)** *J. G. Chakravorty and P. R. Ghosh, Linear Programming and Game theory, Moulik Library,2020.*

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BSMS 4th Semester

[Compulsory]

Mathematical Logic and Numerical Analysis

Mathematical Logic (25 marks)

General Notions

Formal language, object and meta language, general definition of a Formal Theory & Formal Logic.

Propositional Logic

Formal theory for propositional calculus, derivation, proof, theorem, deduction theorem, conjunctive and disjunctive normal forms, semantics, truth tables, tautology, adequate set of connectives, applications to switching circuits, logical consequence, consistency, maximal consistency, Leindenbaum lemma, soundness and completeness theorems, algebraic semantics.

Predicate Logic

First order language, symbolizing ordinary sentences into first order formulae, free and bound variables, interpretation and satisfiability, models, logical validity, formal theory for predicate calculus, theorems and derivations, deduction theorem, equivalence theorem, replacement theorem, choice rule, Prenex normal form, soundness theorem, completeness theorem, compactness theorem, First order theory with equality, examples of first order theories (groups, rings, fields etc.).

Combinatorics (25 marks)

Overview of (Recurrence relation, Fibonacci – type relations, Generating functions. Inclusion- Exclusion principles). Rook polynomials, permutation groups, Polya's Theorem, finite fields, Latin squares, errors.

Codes
Linear codes, error-corrections codes, hamming on error, correction codes, balanced in complete block design.

Algebra for digital system
Logic gates, simplification Boolean expression by Veitech-Karnaugh map method combinational switching circuit: Its design procedure, implementing combinational logic circuit.

Numerical Analysis (50 marks)

Errors in Numerical Computation
Sources of errors and estimations, propagation of errors, backward error analysis, sensitivity and conditioning, stability, accuracy, precision floating-point arithmetic.

Numerical Solution of Non-Linear Equations
Bisection method. Fixed point iteration method. Regula-Falsi and Newton-Raphson methods.

Interpolation
Newton's forward and backward interpolation formulae. Stirling's and Bessel's interpolation formulae. Lagrange's and Divided difference interpolation formula. Inverse interpolation. Numerical Differentiation.

Numerical Integration
Newton-Cote's formula. Trapezoidal, Simpson's $1/3^{rd}$. Simpson's $3/8^{th}$ and Weddle's formulae.

Numerical Solution of a System of Linear Equations
Gauss elimination method, Gauss Jacobi and Gauss-Seidal iteration method.

Numerical Solution or Ordinary Differential Equation
Taylor series method, Picards Method, Euler and modified Euler methods.

Reference Books

- ***a)*** *James L. Buchanan and Peter R. Turner, Numerical Methods and Analysis (McGraw-Hill), 1992.*
- **b)** John H. Mathews, Numerical Methods for Mathematics, Science and Engineering (Prentice- Hall) 2nd edition, 1992.
- ***c)*** *Kendall E. Atkinson, An Introduction to Numerical Analysis (John Wiley and Sons), 2nd Edn.2012*
- ***d)*** *M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Competition (Wiley Eastern), 6th Edn, 2012.*
- ***e)*** *S. S. Sastry, Introductory methods of numerical analysis, 5th Edition, (PHI), 2012.*

- ***f)*** *Elliott Mendelson, Introduction to mathematical logic, Chapman & Hall, London, 5th Edn, 1997.*
- ***g)*** *Angelo Margaris, First order mathematical logic, Dover publications, Inc, New York (1990).*
- ***h)*** *S. C. Kleene, Introduction to Metamathematics, Amsterdam, Elsevier (1952).*
- ***i)*** *J. H. Gallier, Logic for Computer Science, John.Wiley& Sons (1987).*
- ***j)*** *H.B.Enderton, A mathematical introduction to logic, Academic Press, New York (1972).*

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BSMS 4th Semester
[Compulsory]

Number Theory and Cryptology

Number Theory

Basis Representation
Principles of mathematical induction. The basis representation theorem. The fundamental theorem of arithmetic: Euclid’s division lemma. Divisibility. The linear Diophantine equation. The fundamental theorem of arithmetic.

Combinatorial and Computational Number Theory
Fermat’s little theorem, Wilson’s theorem, Generating functions, The use of computers in number theory, Fundamentals of congruences, Basic properties of congruences, residue systems, riffling.

Solving Congruences
Linear congruences. The Theorems of Fermat and Wilson revisited. The Chinese remainder theorem. Polynomial congruences.

Arithmatic Functions
Combinatorial study of $\emptyset(n)$, formulae for $d(n)$ and $\emptyset(n)$, multiplicative arithmetic functions. The Mobius inversion formula, primitive roots. Properties of reduced residue systems. Primitive root modulo p.

Cryptology

Introduction
Basic objects of Cryptography, secret-key and public-key cryptography, one way and trapdoor one-way functions. Cryptanalysis attack models. Classical cryptography.

Block and Stream Ciphers
Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, Blow Fish, AES, linear and differential cryptanalysis. Stream ciphers based on linear feedback shift registers, SEAL, Unconditional security

Message Digest
Properties of Hash function, MD2, MD5 and SHA-1, keyed hash function, attack on hash function.

Public Key Parameters
Modular arithmetic, GCD, Primality testing. Modular square root, finite fields.

Intractable Problems
Integer fatorisation problem. RSA problem, Modular square root problem, discrete logarithm problem. Diffie-Hellman problem, known algorithm for solving the intractable Problems.

Public Key Encryption
RSA, Rabin and EIGamal scemes, side channel attacks, Key Exchange: Diffie-Hellman and MQV algorithms.

Reference Books

a) *Douglas R. Stinson, Cryptography, Theory & Practice, Second Edition, CRC Press, 4th Edn, 2018.*
b) *Alfred J. Menezes, Paul C. Van Oorschot And Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.*
c) *Johannes. A. Buchmann, Introduction to Cryptography, Springer, September 2000.*
d) *Steven D. Galbraith, Mathematics of Public Key Cryptography, Cambridge university press, 2012.*
e) *Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, Chapman & Hall/CRC, 2nd Edn, 2014.*
f) *Jay R Goldman, The Queen of Mathematics: a historically motivated guide to number theory, A K Peters Ltd.2020*
g) *Saban Alaca, Kenneth S Williams, Introduction to Algebraic Number Theory, Cambridge University Press, 2003.*
h) *Richard A Mollin, Advanced Number Theory with Applications, CRC Press, A Chapman & Hall Book.2011*
i) *Kenneth. H. Rosen, Elementary Number Theory & Its Applications, AT&T Bell Laboratories, AdditionWesley Publishing Company, 3rd Edition, 2013.*
j) *Kenneth Ireland & Michael Rosen, A Classical Introduction to Modern Number Theory, 2nd edition; Springer-verlag. 1998*

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BSMS 5th Semester

[Compulsory]

Data Structure and Algorithm

Basic Concepts

Mathematical Background; Complexity Analysis; Arrays: one dimensional, multi-dimensional, Sparse Matrix, Elementary Operations; Asymptotic notations- o, O, θ, Θ, ω, Ω and their properties.

Preliminaries

Growth of functions, recurrence relation, generating functions, solution of difference equations, Master's theorem (without proof). Sorting and Order Statistics: Bubblesort, mergesort, heapsort, quicksort, sorting in linear time, median and order statistics.

Linear Data Structure

Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching; Queues: Simple queue, circular queue, dequeue, elementary operations and applications; Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation.

Non - Linear Data Structure

Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries, red-black tree, B-tree, other operations and applications of trees; Graphs: representation, Adjacency list, graph traversal, path matrix, connected components, DAG, topological sort, Spanning tree; Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort; Searching: linear and binary search; Hashing: hash tables, hash functions, open addressing.

File Structures

Introduction, data file types, file organization, file access methods.

Algorithms Design Techniques

Divide-and-conquer method. Greedy method. Dynamics programming technique. Branch-and-bound method. Examples. Representation of graph in a computer. Binary tree traversals. Spanning tree. Shortest path problem. NP-Completeness.

Reference Books

a) Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Data Structures and Algorithms, Addison Wesley, 1983.

b) M. A. WeiSS, Data Structures and Algorithm Analysis in CTT, 3rd Edn, Pearson, Addison Wiesley, 2006.

c) A. M. Tenenbaum, Y. Langsam, and M.J. Augenstein, Data Structures using C, PHI, New Delhi, 2009.

d) S. K. Srivastava, Data Structures Through C in Depth, BPB Publications, 2004.

e) T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms, 3rd Edn, PHI, New Delhi, 2009.

f) Debasis Samanta, Classical Data Structure, PHI Pvt. Limited. 2011.

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BSMS 5th Semester

[Compulsory]

Soft Computing – I

Introduction

Introduction to Soft Computing, components of Soft Computing. Importance of Soft Computing.

Fuzzy Set Theory

Fuzzy sets, characteristics function and definition of fuzzy sets, α- level Fuzzy sets, fuzzy point, convex fuzzy sets, basic operations on fuzzy sets. Cartesian products, algebraic products, bounded sum and difference, t-norms and t-co norms, quasi-coincidence of two fuzzy subsets. Fuzzy numbers, triangular fuzzy numbers.

Fuzzy Optimization

Linear Programming Problems with Fuzzy Resources: Verdegay's approach and Werner's approach. L.P.P. with fuzzy resources and objectives.

Zimmermann's approach, L.P.P with fuzzy parameters in the objective function. Fuzzy multi-objective Linear Programming Problem. Methodologies of solving fuzzy M.O.L.P.

Evolutionary Algorithm

Genetic Algorithms. Evolution Strategies. Evolutionary Programming. Genetic Programming. Differential Evolution and modified methods. Ant Colony Optimization, Particle Swarm Optimization and some recent Algorithms.

Reference Books

a) *Jang J.S.R, Sun C.T. and Mizutani E. Neuro Fuzzy and Soft Computing, 1997.*

b) *Ama Haykin. An Introduction to Neural Networks.2008*

c) *Klir and Yuan, Fuzzy Sets and Fuzzy Logic Goldberg. Genetic Algorithms.*

d) *S. N. Sivanandam, S.N.Deepa, Principles of Soft Computing, Wiley Publication, 2011.*

e) *A. Das Bhattacharjee, Artificial Intelligence and Soft Computing for Beginners, 2018.*

f) *H. J. Zimmermann , Fuzzy Set Theory — and Its Applications, Allied Publisher's Limited, 2014.*

g) *George Klir, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson, 1995.*

h) *Robert Babuška, Fuzzy Modelling for Control, International Series in Intelligent Technologies,Volume 12, 1996.*

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BSMS 5th Semester

[Compulsory]

Integral Transform and its application

Integral transform

Basic Concepts and definitions, integral transform operator, kernel of the transformation.

Fourier Transform

Definition & properties of Fourier Transform. Fourier sine and cosine Transform. Convolution Theorem for Fourier transforms. Parseval's Identity. Finite Fourier Sine and Cosine Transform. Inversion.

Laplace Transform

Definition and properties. Laplace Transform of some elementary functions. Laplace transform of the derivatives and integrals. Shifting theorems. Initial and final value theorems. Inverse of Laplace transform. Convolution theorem. Applications.

Hankel Transform

Definition and properties of Hankel transform with examples. Inversion formula. Basic concept of Bessel's equation and Bessel's function. Recurrence relations of Bessel's function. Operational properties of Hankel transform. Parseval's theorem. Hankel transform of derivatives. Applications.

Mellin Transform

Definition of Mellin transform and examples. Mellin transform of some special functions. Mellin transform of derivatives and integrals. Parseval's theorem. Convolution theorem. Applications.

Z-Transform

Definition. Elementary properties. Inverse Z – Transform (Using Partial Fraction and Residues). Convolution Theorem. Formation of Difference Equations. Solution of Difference Equations Using Z – Transform.

Reference Books

a) *I. N. Sneddon, The Uses of Integral Transforms, McGraw-Hill Inc., US, 2020.*
b) *C. J. Tranter, Integral Transforms.*
c) *I. N. Sneddon, fourier Transform, 2020.*
d) *Lovitt, Linear Integral Equations, 2005.*
e) *Tricomi, Integral Equations, 2012.*
f) *Andrews & Shivamoggi, Integral transforms for Engineers, 1988.*
g) *Dr. G. S. Sandhu, Integral Transforms and Their Applications, 2015.*
h) *L. Debnath & D.Bhatta, Integral Transforms and Their Applications, 2007.*

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BSMS 5th Semester

[Compulsory]

Artificial Intelligence

Introduction

What is AI? The foundations of AI. Importance of AI and related fields.

Review on Logic

Propositional and predicate logic, representation atoms, connectives, literals, CNF, DNF and casual form, interpretation and model, satisfiability, resolution principle and unification.

Rules

Working memory, rule base, conflict set, conflict resolution strategies, backward and forward chaining, meta rules.

Reasoning Under Uncertainty

Basic probability notation, probabilistic reasoning, Bayesian networks, certainty factor methods, Dempster-Shafer theory.

ANN

Neural Networks: Overview of biological Neuro-system, Mathematical models of neurons, ANN architecture, Learning rules; Learning paradigms - Supervised, Unsupervised and Reinforcement learning; ANN training algorithms - perceptions, Training rules, Delta, Back propagation algorithm; Multilayer perceptron model; Applications of artificial neural networks; Competitive learning networks; Kohonen self organizing networks; Hebbian learning; Hopfield networks; Associative memories.

Reference Books

- ***a)*** *Jang J.S.R, Sun C.T. and Mizutani E. Neuro Fuzzy and Soft Computing,1997.*
- ***b)*** *Ama Haykin. An Introduction to Neural Networks.*
- ***c)*** *Klir and Yuan, Fuzzy Sets and Fuzzy Logic Goldberg. Genetic Algorithms.*
- ***d)*** *S. N. Sivanandam, S.N.Deepa, Principles of Soft Computing, Wiley Publication, 2011.*
- ***e)*** *A.Das Bhattacharjee, Artificial Intelligence and Soft Computing for Beginners, 2018.*
- ***f)*** *Artificial Intelligence by E Rich and K Knight, McGraw-Hill, 2008.*
- ***g)*** *Artificial Intelligence (3rd Ed) PH Winston, Addison-Wesley, 1992.*
- ***h)*** *Introduction of Artificial Intelligence and expert systems by DW Patterson, PHI,1990.*
- ***i)*** *Artificial Intelligence a Modern Approach-Stuart Russell, Peter Norvig, PHI, 2013.*
- ***j)*** *Artificial Intelligence and Soft Computing by A. Konar, CRC Press 2000.*
- ***k)*** *R2. Golub, G.,H., and Van Loan,C., F., Matrix Computations, JHU Press,2013.*
- ***l)*** *R1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.*

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BSMS 5th Semester

[Compulsory]

Statics and Dynamics

Statics

Preliminary concepts

Parallel forces, Couples, Reduction of coplanar forces. Analytical conditions of equilibrium of coplanar forces.

Friction

Friction, laws of friction, limiting friction, equilibrium of a particle in rough inclined plane.

Virtual Work

Principle of virtual work in two dimensions. Stable and unstable equilibrium, Common catenary and catenary of uniform strength.

Stable and Unstable Equilibrium

Definition, Energy Test of Stability, Stability of a system, Examples.

Centre of Gravity

Centre of gravity of a plane area, arc and sector of a curve. C. G. of solids and surface of revolution.

Dynamics

Dynamics-I

Simple Harmonic Motion, damped vibrations, forced vibration, damped forced oscillations, elastic string, Hook's law, Tangent and normal acceleration. Velocity and acceleration along radial and transverse directions, Central orbits, central forces, motion of a particle under central force. Differential equation in polar and pedal coordinates, velocity under central force. Apse, apsidal distance and apsidal angle.

Dynamics- II

Kepler's laws of planetary motion, artificial satellites, Escape velocity, Geo stationary satellite Disturbed orbits, Motion in resisting medium. Motion of particle of varying mass, Motion of a particle in three dimensions. Accelerations in terms of different coordinates, Moment Ellipsoid, equimomental system, principle axis. D'Alemberts principle, D'Alembert's equation of motion, principles of conservation of linear and angular momentum. Independence of the motion of center of inertia and the motion relative to the center of inertia. Principle of conservation of energy, Equation of motion of a rigid body about a fixed axis, expression for kinetic energy and moment of momentum of a rigid body moving about a fixed axis. Compound pendulum, interchangeability of the point of suspension and the point of oscillation, simple equivalent pendulum, Equation of motion of a rigid body moving in two dimension, expression for kinetic energy and the angular momentum about the origin of a rigid body moving in two dimension. Equation of motion under impulsive forces.

Reference Books

a) *Rao, S. Engineering Mechanics, Statics and Dynamics (Pearson Education, 2008.*

b) *A text book on statics, M.Ray-S.Chand, 1995.*

c) *Chakroborty and Ghosh, Dynamics of Particle and Rigid Bodies, U.N.Dhur and Sons, 1982.*

d) *S. L. Lony, Dynamics of a Particle and of Rigid Bodies, Radha Publishing House, 2009.*

e) *Loney, S. L., Elements of Statics & Dynamics, Part I, Maxford Books, 2003.*

f) *S. A. Mollah, Numerical Analysis, New Central Book Agency, 2011.*

g) *M. Ray- A text book on statics, S. Chand, 1995.*

h) *S. Pradhan, S. Sinha, Analytical Statics, Academic Publishers, 2013.*

i) *Loney, S. L., Elements of Statics & Dynamics, Part I, Maxford Books, 2003.*

j) *Rao, S. Engineering Mechanics, Statics and Dynamics, Pearson Education, 2008.*

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BSMS 6th Semester

[Compulsory]

Numerical Methods

Solution of System of Linear and Nonlinear Equations

Triangular factorization, relaxation method. Roots of Polynomial equations: Sensitivity of Polynomial Roots, Steffenson's method, Bairstows method of quadratic factors, Graeffe's root squaring method.

Matrices and Eigen Value Problem

LU decomposition of matrices, Power method of extreme eigen values, Jacobis method for symmetric matrices.

Interpolation

Hermite interpolation, Spline interpolation – cubic splines, least square approximation to discrete data.

Integration

Gaussian Legendre and Gaussain Chebyshev's quadrature, Richardson's extrapolation, Euler Maclaurins sum formula, Romberg integration.

Differential Equations:

First order differential equation: existence, uniqueness, stability of solution, Euler's method, Multistep predictor corrector method, Runge Kutta method.

Reference Books

a) James L. Buchanan and Peter R. Turner: Numerical Methods and Analysis (McGraw-Hill).1992.

b) John H. Mathews: Numerical Methods for Mathematics, Science and Engineering (Prentice-Hall) 2nd edition.2002.

c) Kendall E. Atkinson: An Introduction to Numerical Analysis (John Wiley and Sons).2012.

d) M. K. Jain, S. R. K. Iyengar, R. K. Jain : Numerical Methods for Scientific and Engineering Competition (Wiley Eastern).1986.

e) S. S. Sastry, Introductory methods of numerical analysis,5th Edition,(PHI).2012.

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BSMS 6th Semester

[Compulsory]

Numerical Lab

Experiments to be handled using computer

A Write a C program for Bisection Method

B Write a C program for method of false position and secant method

C Write a C program for Improved Euler's method

D Write a C program for Euler's method

E Write a C program for Newton-Raphson method

F Write a C program for Trapezoidal rule of integration

G Write a C program for Simpson's one-third rule

H Write a C program for Simpson's three-eighth rule

I Write a C program for Runge-Kutta second and fourth order methods

J Write a C program for Predictor-corrector methods

K Write a C program for Taylor series method

L Write a C program for Finite Element Problem

M Write a C program for Finite Difference Problem

N Write a C program for Newton's forward and backward interpolation

O Write a C program for Everette's formula

P Write a C program for Lagrange's interpolation

Q Write a C program for Numerical differentiation

R Write a C program for Eigen values and eigen vectors

S Write a C program for Method of successive approximation

T Write a C program for Gaussian elimination method

U Write a C program for Gauss-Seidel iterative method

V Write a C program for Inversion of a matrix

Reference Books

a) *Numerical Methods And Computer Programming, Anju Khandelwal, Narosa, 2015.*

b) *C Language and Numerical Methods, C. Xavier, New Age Int. Publishers, 2007.*

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BSMS 6th Semester

[Compulsory]

Theory of Computation

Introduction

Introduction to language theory, Alphabets, definition of phrase structure grammar, Production rules, sentences, sentential forms, language definitions, derivations.

Regular Languages

Definition, Pumping Lemma of regular sets, Chomsky Hierarchy of languages. Iteration theorems. Recursive and recursively enumerable sets models, Regular languages models: finite state machines (deterministic and non-deterministic), regular grammars, regular expressions, equivalence of deterministic and non-deterministic machines and of the three models. Properties: closure, decidability.

Finite Automata
Finite automaton, Deterministic, Non-Deterministic and their equivalence, Equivalence of regular expressions. Moore and Mealy machines.

Context -Free Languages
Relations between classes of languages, Context Free Grammar, Derivation trees, ambiguity simplification, Normal forms, applications.

Pushdown Automata
Pushdown automata, definitions, context free languages, construction of PDA for simple CFLs, Linear bounded automata, Properties: closure, iteration theorems, parsing.

Turing Machines
Turing machines, Introduction to computability, Universal Turing Machines, Types of Turing Machines, Techniques for construction of Turing machines, Undesirability and Halting Problem.

Reference Books

a) *D. S. Malik and M. K. Sen, Discrete mathematical structure: theory and applications, Thomson, Australia, 2004.*

b) *K. P. L. Mishra and N. Chandrasekaran, Theory of Computer Science, Prentice Hall of India, New Delhi, 2001.*

c) *J. E. Hopcropt and J.D. Ullman; Introduction to Automata Theory, Language and computing, Norasa Publishing, New Delhi, 2000.*

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BSMS 6th Semester

[Compulsory]

Soft Computing-II

Fuzzy Systems

Arithmetic operations on Fuzzy intervals and Fuzzy numbers, Lattice of Fuzzy numbers, L-R representation of fuzzy numbers, Fuzzy equations.

Generalization and Variants of Fuzzy Sets

Generalization and variants of fuzzy sets : L-fuzzy sets, interval-valued fuzzy sets, Type 2 fuzzy sets, Intuitionistic fuzzy sets and set operation of Intuitionistic fuzzy sets, The Zadeh’s extension principle.

Fuzzy Logic

Related Definitions, Fuzzy Expert Systems, Fuzzy Inference Rules and Fuzzy Reasoning, Introduction to Fuzzy logic, Fuzzy rule generation, Linguistic variables.

Hybrid Systems

Neuro-genetic systems, Hybrid Evolutionary Algorithms, Fuzzy Neural Systems.

Reference Books

b) *Jang J.S.R, Sun C.T. and Mizutani E. Neuro Fuzzy and Soft Computing, Ama Haykin. An Introduction to Neural Networks, 1996.*

c) *Klir and Yuan, Fuzzy Sets and Fuzzy Logic Goldberg. Genetic Algorithms, 1995.*

d) *S. N. Sivanandam, S.N.Deepa, Principles of Soft Computing, Wiley Publication, 2007.*

e) *A.Das Bhattacharjee, Artificial Intelligence and Soft Computing for Beginners, 2018.*

f) *H.J Zimmermann , Fuzzy Set Theory — and Its Applications, Allied Publisher's Limited, 1992.*

g) *George Klir, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson, 1995.*

h) *Robert Babuška, Fuzzy Modelling for Control, International Series in Intelligent Technologies, Volume 12, 1998.*

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BSMS 6th Semester

[Compulsory]

Ordinary Differential Equation

Existence and Uniqueness of Solutions

Existence and uniqueness of solution, Picards theorems, Gronwall's inequality, Dependence of solution on initial conditions and on function, Continuation of solutions, Nonlocal existence of solution.

Strum-Liouvilles System and Green's Function

Strum-Liouvilles system, Green's function and its applications to boundary value problems, some oscillation theorems such as Strum theorem, Strum comparison theorem and related results.

Homogeneous and Non-homogeneous Equation

System of first order equation, Existence and Uniqueness of solution for systems, fundamental matrix, Non homogeneous linear system, Linear system's with constant as well as periodic coefficients, General theory of homogeneous and non homogeneous linear ODE, Second order linear equations with variable co-efficients. Reduction of order when one solution of the homogeneous part is known. Complete solution. Reduction to normal form, Change of independent variable, Transformation of the equation by changing the dependent variables / the independent variable. Wronskian and its properties, variation of parameters, Cauchy-Euler equations.

Series Solution

Series solutions, Legendre differential equation and Legendre polynomials, Bessel's differential equation and Bessel's function. Laguerre differential equation and Lagurre polynomial, Hermite differential equation and Hermite polynomial; recurrence relations, orthogonal properties.

Reference Books

a) *E.A. Coddington, An introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 1991.*

b) *P. Haitman, Ordinary Differential Equations, Wiley, New York, 1964.*

c) *E.A. Coddington and H. Davinson, Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.*

d) *M. Braun, Differential Equations and Their Applications, 3rd Ed., Springer-Verlag, 1983.*

e) *S.C. Deo, Y. Lakshminathan and V. Raghavendra, Text Book of Ordinary Differential Equation (Second Edition) Tata McGraw Hill, New Delhi.1997*

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BSMS 6th Semester

[Compulsory]

Discrete Mathematics

Set Theory

Sets and classes, relations and functions, recursive definitions, Posets, Zorn's lemma, cardinal and ordinal numbers.

Logic

Propositional and predicate calculus, well-formed formulas, tautologies, equivalence, normal forms, theory of inference.

Combinatorics

Permutation and combinations, partitions, Pigeonhole principle, inclusion-exclusion principle, generating functions, recurrence relations.

Graph Theory

Graphs and digraphs, Eulerian cycle and Hamiltonian cycle, adjacency and incidence matrices, vertex colouring, planarity, trees.

Reference Books

a) *N. Deo, Graph Theory, Prentice Hall of India, 1974.*

b) *J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, New Delhi, 2001.*

c) *C. L. Liu, Elements of Discrete Mathematics, 2nd Edn., Tata McGraw-Hill, 2000.*

d) *K. H. Rosen, Discrete Mathematics & its Applications, 6th Edn., Tata McGraw-Hill, 2007.*

e) *V. K. Balakrishnan, Introductory Discrete Mathematics, Dover, 1996.*

f) *J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Edn., Jones and Bartlett, 2010.*

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BSMS 7th Semester

[Compulsory]

Graph Theory

Introduction to Graphs

The concept of a graph, Paths in graphs, Graph models, Graph terminology and special types of graphs, Bipartite graphs, Complete graphs, External graphs, Intersection graphs, Operations on graph, Graph Isomorphism.

Blocks

Cutpoints, bridges and blocks. Block graphs and cutpoint graphs.

Trees

Introduction to trees and characterizations, Applications of Trees, Spanning Trees, Minimum Spanning Trees, Trees in computer science, Centers and centroids, Block cutpoint trees, Independent cycles and cocycles, Matroids.

Connectivity

Connectivity and line-connectivity, Graphical version of Menger's theorem. Traversability : Eulerian Graphs, Hamiltonian Graphs.

Coverings and Matching

Coverings and independence, Critical points and lines, Matching, Maximum Matching Problem, Minimum covering problems.

Representing Graphs

Adjacency matrix, Incidence matrix, Cycle matrix.

Planarity

Plane and planar graphs, Outerplanar graphs, Kuratowski's theorem, other characterizations of planar graphs.

Colorability

Vertex coloring, Chromatic number, Edge coloring, Five color theorem, Four color conjecture, Unique colorable graphs.

Directed Graphs

Basic definitions, Type of Connectedness, Covers and Bases, Distance concepts and matrices, Connectivity, Acyclic digraphs, Cycles and traversability, Orientations and Tournaments.

Network Flows

Max Flow – Min Cut Theorem, Menger's Theorem.

Reference Books

a) *Graph Theory, F. Harary, Narosa Publishing House, 1993.*

b) *Introduction to Graph Theory, Douglas B. West, Prentice-Hall of India Pvt. Ltd., New Delhi 1999.*

c) *Graph Theory with Applications to Engineering and Computer Science, Narsingh Deo, Prentice-Hall of India Pvt.Ltd., New Delhi, 1997.*

d) *Basic Graph Theory, K.R. Parthasarathi, Tata McGraw-Hill Publ. Co. Ltd., New Delhi, 1994.*

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BSMS 7th Semester
[Compulsory]

Linear Algebra

Review of Vector Spaces

Vector space, subspace, span, linear independence, basis, dimension. Linear transformation: Linear transformation, rank-nullity, Isomorphisms. Matrix representation, change of basis, space of linear transformations, Existence of eigenvalues, characteristic polynomial, eigenspace, generalized eigenvectors.
Linear functional, Representation of linear transformations by matrices, Dual spaces, Second dual, Reflexive spaces, Invariant subspaces, Direct-sum decomposition, Cyclic subspaces and Annihilators, minimal polynomial, The rational and Jordan canonical forms.

Inner Product Spaces

Inner products, norm and angle, orthogonality, Gram-Schmidt process, orthogonal complement, best approximation and least squares, Riesz representation and adjoint. Block diagonalization: Diagonalizability, Schur triangularization, Jordan form.
Spectral representation: Operators on inner product spaces, projections, normal operators, self-adjoin operators, singular value decomposition, polar decomposition.

Reference Books

a) *Axler, S., Linear Algebra Done Right, 2nd edn. Springer International Student Edition, 1997.*
b) *Hoffman, K., Kunze, R., Linear Algebra, 2nd edn. Prentice Hall Int. Inc., Englewood Cliffs, 1971.*
c) *Linear Algebra, M.T.Nair and A.Singh, Springer, 2018.*

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BSMS 7th Semester
[Compulsory]

Real Analysis

Point Set Topology

Limit points of a set and isolated point of a set, closed sets, dense sets, countable and uncountable sets. Neighbourhood of a point, Interior point, Open set. Union, intersection of open sets and closed sets. Bolzano-Weierstrass theorem.

Series and Sequence

Abel’s test, Dirichlet’s test, Mertens’ theorem, Abel’s theorem, limit of a function.

Metrics and Norms

Metric spaces, normed vector spaces, convergence in metric spaces, continuous functions, completeness, Baire Category Theorem, Contraction mapping theorem, connectedness, Intermediate Value Theorem, Compactness, Heine-Borel Theorem.

Differentiation

Differentiation, Taylor's theorem.

Integration

Function of bounded variation, Riemann- Stieltjes integral and relation with Riemann integral, Darboux-Stieltjes integral. Mean value theorems.

Sequences and Series of Functions

Sequences and series of functions, Uniform convergence, power series and Fourier series, Fourier Series, Dirichlet's Kernel, Riemann- Lebesgue theorem, pointwise convergence of Fourier Series of functions of bounded variation. Weierstrass approximation theorem, Equicontinuity, Arzela-Ascoli theorem.

Reference Books

a) *K.R. Stromberg, Introduction to Classical Real Analysis, Wadsworth International, 2017.*

b) *J.M. Howie, A First Course in Real Analysis, Springer, 2006.*

c) *H.L. Royden, Real Analysis, Paperback, 1988.*

d) *R. Robert, G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, 2014.*

e) *S.C. Malik, Principles of Real Analysis, New Age International Publishers, 2011.*

f) *S.K. Mapa, Introduction to Real Analysis, Sarat Impressions Pvt. Ltd, 2019.*

g) *Shanti Narayan, M D Raisinghania, Elements of Real Anyalsis, S. Chand Group, 2008.*

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BSMS 7th Semester

[Compulsory]

Abstract Algebra

Group Theory

Review of basic Group Theory, Group Actions, Kernel and Stabilizer of Group Actions, Transitive Group Action, Cayley's Theorem, The Class Equation, Sylow's Theorems, Solvable groups, Nilpotent groups, Direct Products, Structure Theorem for Finite Abelian Groups, Existence and universal Properties of free Groups, Examples of Groups specified by Generators and Relations.

Ring Theory

Review of basic Ring Theory, Properties of Ideals, Prime and Maximal Ideals, Two-sided ideals and Quotient Rings, Chinese Reminder Theorem, Euclidean Domain, Euclidean Algorithm, Principal Ideal Domain, Euclidean Domain is a Principal Ideal Domain, UFD, PID implies UFD, Universal Property of a Polynomial Ring, Criteria for Irreducibility, Definition and simple examples of modules over commutative and non-commutative rings.

Field Theory

Finite and Algebraic Extensions, Existence and Cardinality of Algebraic Closure, Finite Fields, Galois Theory of Polynomial in characteristic zero and simple examples, Classical Straightedge and Compass construction and examples, normal, separable and Galois extensions.

Reference Books

a) *D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John-Wiley, 1999.*
b) *S. Lang, Algebra, 3rd Edition, Addison-Wesley, 1999.*
c) *J.A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.*
d) *M. Artin, Algebra, Prentice Hall inc 1994.*
e) *I.N. Herstein, Topics in Algebra, John-Wiley, 1995.*
f) *T. A. Hungerford, Algebra, Graduate Texts in Mathematics, Springer-Verlag, 1980.*

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BSMS 7th Semester
[Compulsory]

Computer Programming Theory & Practical

Basic Features
The Matlab workspace about variables, complex number, floating point arithmetic, Mathematical functions.

Script M files
Use, Block comments and code cells, startup and finish. Array and Array operations: Simple array, Array addressing or indexing, Array construction, Array orientation, Scalar Array Mathematics, array Manipulation, Array sorting, Sub array searching, Array size, Array and Memory utilization, Multidimensional Array construction & its manipulation. Numeric data type: Integer data type, floating point data types.

Cell Arrays and structures
Cell array creation, its manipulation, Retrieving cell array content, comma separated list, cell functions, cell array of strings, structure creation, structure manipulation, structure functions. Character string: String construction, string evaluation, string functions, cell array of strings.

Relational and logical operations
Relational and logical operators, Relational and logical functions, Nans and empty, operator precedence. Control flow: For loops, while loops, if else end construction, switch case construction, Try catch blocks.

Application to Numerical Analysis
The following topics may be covered in MATLAB. Bisection Method, Newton Raphson Method, Regula Falsi method, Iteration Method, Graffe's Root squaring method, Power Method, L.U. Decomposition Method, Romberg Method, Muller Method, Adams Moulton Method, Newton's Method (forward & backward), Lagrange's interpolation, Divided Difference method, Numerical Differentiation (1st & 2nd Order), Numerical Integration, Least square method, Gauss Elimination method, Gauss Seidal Method, Jacobi's iteration method, Milne's Method, Runge Kutta Method.

Reference Books

a) *A. Gilat, Matlab an Introduction with Applications, Wiley Publication, 2010.*
b) *S. C. Chapra, Applied Numerical Methods with Matlab for Engineers and Scientists, Tata McGraw-Hill, 2008.*
c) *R. Pratab, Getting started with Matlab, 2016.*

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BSMS 8th Semester

[Compulsory]

Topology

Topology on the real line and plane, Topological Spaces, Subspace topology, Bases and Sub-bases, Continuous Functions and homeomorphisms, Connected spaces, Components and Local Connectedness, Path connectedness, Compact spaces, Local compactness. Countabilities and Separation axioms. Product Topology, Quotient Topology. The Urysohn Lemma, The Urysohn Metrization Theorem. The Tietze Extension Theorem, Tychonoff Theorem.

Reference Books

- ***b)*** *J.V. Deshpande, Introduction to Topology, Tata McGraw-Hill, 1988.*
- ***c)*** *J. Dugundji, Topology, Allyn and Bacon, Inc, 1966.*
- ***d)*** *J.L. Kelley, General Topology, Van Nostrand, Princeton, 2014.*
- ***e)*** *M.G. Murdeswar, General Topology, New Age International, 2020.*
- ***f)*** *G.F. Simmons, Introduction to Topology and modern Analysis International Student edition, 1983.*
- ***g)*** *S. Willard, General Topology, Addison Wesley, Reading Mass, 1970.*
- ***h)*** *Seymour Lipschutz, General Topology, Mc Graw-Hill, 1965.*
- ***i)*** *K.D. Joshi, Introduction to General Topology, New Age International, 1983.*
- ***j)*** *J.R. Munkres, Topology, 2nd Ed., Pearson Education India, 2002.*

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BSMS 8th Semester

[Compulsory]

Tensor calculus and Riemannian Geometry

Tensor Calculus

Tensor Analysis – I

Summation Convension, Kronecker symbol. n-dimensional space, transformation of coordinates in S_n. Invariants, covariant vectors, contravariant vectors and mixed tensors. Algebra of tensors. Symmetric and skew-symmetric tensors, contraction, outer and inner product of tensors. Quotient law, reciprocal tensor. Riemann space, the line element and metric tensor. Raising and lowering of indices. Associate tensor. Magnitude of a vector, Inclination of two vectors. Orthogonal vectors. Christoffel symbols and their properties, Law of transformation, law of Christoffel symbols, covariant differentiation of tensors, covariant differentiation of sum, difference and product of tensors, Gradient, Divergence, Curl and Laplacian.

Tensor Analysis – II

Curvilinear coordinate system in E_3: Line element, length of vector, angle between two vectors in E_3 in a curvilinear coordinate system. Basis in a curvilinear coordinate system, reciprocal base, covariant and contravariant components of a vector in E_3. Partial derivative of a vector. Spherical and cylindrical coordinate system. Curves in E_3. Parallel vector fields along a curve in E_3, parallel vector field in E_3, parallel vector space in a Riemannian space, parallel vector field in a surface of a Riemannian space. Serret-Frenet formulas. Riemann-Christoffel curvature tensor. Ricci tensor. Flat space, Bianchi identities. Intrinsic differentiation. Conformal curvature tensor. Space of constant curvature.

Riemannian Geometry

Riemannian Manifold

Riemannian metric, existence of Riemannian metric, linear connection, existence of linear connection, torsion and curvature of a linear connection, symmetric connection, metric connection, Riemannian connection, existence of Riemannian connection. Riemann curvature, sectional curvature, Ricci tensor, scalar curvature, tensors in Riemannian manifold, Schur's theorem.

Parallel Vector Field, Geodesics

Existence of geodesic, parallel translation, length minimizing property of geodesic. Complete manifold. Hopf-Rinow theorem. Hadamard theorem. Parametrised surface. Gausslemma. Totally geodesic sub-manifold.

Isometric Immersion

Riemannian sub-manifold. Second fundamental form of a Riemannian sub-manifold. Gauss equation, Ricci equation. Coddazi equation.

Reference Books

a) I. S. Sokolnikoff, Tensor Analysis-Theory & Applications to Geometry & Mechanics of Continua, 2nd edition, John Wiley & Sons, Inc, 1965.
b) M. Majumder and A. Bhattacharyya, Differential Geometry, Books and Allied (p) Ltd, 2010.
c) S. Boothby, An Introduction to Differentiable Manifolds and Riemannian Geometry, Accademic Press, 1975.
d) U. C. Dey, Differential Geometry & Manifolds, 2007.
e) Barry Spain, Tensor Calculus, Radha Publishing House, Calcutta.

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BSMS 8th Semester

[Compulsory]

Complex Analysis

Limits, Continuity and Differentiability, Analytic functions, Harmonic functions and multi-valued functions.

Convergence of numerical series, Radius of convergence of power series, and power series as an analytic function, Laurent series.

Classification of singularities, Cauchy's Residue theorem and evaluation of Real Integrals. Cauchy's integral theorem, Cauchy integral formula, Morera's theorem, Taylor`s theorem, Laurent's theorem, Liouville's theorem, Schwarz lemma; Maximum Modulus Principle, Branch of Lagarithm: Branch cut, Branch point.

Conformal mappings, Topology of the complex plane, Stereographic Projections, Riemann sphere, Linear fractional Transformations, Critical Points and Inverse Mappings, Cross ratio, Bilinear Transformation. Exponential and Trigonometric Transformation.

Reference Books

a) *Lars V. Ahlfors, Complex Analysis, McGraw-Hill Book Company, Inc., New York, 1986*

b) *1. S. Ponnusamy and H. Silverman, Complex Variables with Applications, Birkhauser, Boston, 2006.*

c) *J.W. Brown and R.V. Churchil, Complex Variables and Applications, McGraw Hill, 2008.*

d) *H. A. Priestly, Introduction to complex analysis, Clarendon Press, Oxford, 1990.*

e) *A. I. Markushivich, Theory of Functions of Complex Variables, Vol-I, II; Prentice-Hall, 1965.*

f) *John B. Conway, Functions of One Complex Variable, Second Edition, Springer International Student-Edition, Narosa Publishing House, 1980.*

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BSMS 8th Semester
[Compulsory]

Statistical Inference and Stochastic Processes

Statistical Inference

Introduction

Parametric models, Parameters, Random sample and its likelihood, Statistic and its sampling distributions, Problems of inference. Examples from standard discrete and continuous models such as Bernoulli, Binomial, Poisson, Negative Binomial, Normal, Exponential, Gamma, Weibull, Pareto etc.

Sufficiency and Estimators

Concept of sufficiency, minimal sufficiency, Neyman factorization criterion, Fisher information, Exponential families. Maximum likelihood estimators, Method of moment estimators, Percentile estimators, Least squares estimators, Minimum mean squares estimators, Uniformly minimum variance unbiased estimators.

Statistical Hypothesis

Simple and composite hypotheses, Null hypotheses, Alternative hypotheses, One-sided and two-sided hypotheses. The critical region and test statistic, Type I error and Type II error, Level of significance. Power function of a test, Most powerful test. The p-value (observed level of significance), Calculating p-values. Simple hypothesis versus simple alternative: Neyman-Pearson lemma (Statement only).

Stochastic Process

Stochastic Processes

Definition and examples of stochastic processes, Classifications of stochastic processes.

Markov Chains

Definition and examples, Transition Probability matrices, Classification of states of a Markov chain, Determination of higher order transition probabilities, Graph theoretic approach, Reducible Markov chains, Markov Chains with continuous state spaces, Non-homogeneous Markov Chains, Markov chains in continuous time: General pure birth and death processes, Birth and death processes with absorbing states.

Poisson Processes

Markov Processes with Discrete State Space: Poisson Process and Its Extensions, Poisson Process, Postulates for Poisson Process, Properties of Poisson Process, Poisson Process and Related Distributions, Inter arrival Time, Further Interesting Properties of Poisson Process, Generalisations of Poisson Process.

Stochastic Processes in Queuing and Reliability

General concepts of queuing systems, Steady state and transient behaviour, Birth and death process in queuing theory, Network of Markovian queuing systems, Reliability.

Introduction to Brownian motion
Wiener processes, Differential equations for a Wiener process, Kalmogrov's equations.

Reference Books

a) *J. O. Berger, Statistical Decision Theory, 1980.*
b) *E. L. Lehmann, Testing of Statistical Hypotheses, 1986.*
c) *P. J. Bickel and K. A. Doksum, Mathematical Statistics, 2006.*
d) *J Medhi, Stochastic Processes, New Age International Publishers, 2009.*
e) *S.C. Gupta and V. K. Kapoor, Fundamentals of mathematical Statistics, Sultan Chand & Sons publication, 2002.*
f) *R. L. Berger and G. Casella, Statistical Inference, 2006.*

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BSMS 9th Semester
[Compulsory]

Mathematical Methods
Integral Transform

Legendre Transforms
Introduction, definition of the Legendre Transform and Examples, Basic Operational Properties of Legendre Transforms, Applications of Legendre Transforms to Boundary Value Problems, Applications.

Hermite Transforms
Introduction, Definition of the Hermite Transform and Examples, Basic Operational Properties, Applications.

Radon Transform
Introduction, properties of the Radon Transform, Radon Transform of Derivatives and integral, Convolution theorem for the Radon Transform. inverse of the Radon Transform and the Parseval's Relation, Applications.

Integral Equations

Definition, different types of integral equations, kernels, Conversion of ordinary differential equations into integral equations, eigen value and eigen function problem. Solution of integral equation, Fredholm integral equation of the second kind with separable kernels.

Solution of Fredholm and Voltera integral equations by successive approximation.

Classical Fredholm theory: Statements of Fredholm's first, second and third fundamental theorems and their applications.

Integral equations with symmetric kernels, Hilbert Schmidt theorem and some immediate consequences.
Singular integral equations, Integral transform method of solution of integral equations.

Approach to reduce BVP of a self-adjoint DE with homogeneous boundary conditions to integral equation forms.
Auxiliary problem with more general and inhomogeneous boundary conditions. Modified Green's function.

Calculus of Variation

Variational Problems with Fixed Boundaries
The variation of a functional and its properties. Euler's equation, functionals dependent on several dependent variables, on higher order derivatives, several independent variables etc. Isoperimetric problems.

Variational Problems with Moving Boundaries
Transversality conditions, problems related to moving bounderies, one sided variation.

Sufficient Conditions for an Extremum
Jacobi condition, Legender condition, weak and strong extremum. Hamiltons canonical equation of motion.

Variational Methods for Boundary Value Problem
Rayleigh Ritz method, Galerkins method for BVP in ordinary differential and partial differential equations.

Reference Book

- ***a)*** *I.N.Sneddon, The Use of Integral Transforms, Tata McGraw Hill,1979.*
- ***b)*** *B.P.Parasar, Differential equation and integral equation, CBS Publications,2008.*
- ***c)*** *Petrovsky,Lectures on the Theory of Integral Equations,Mir Publication,1971.*
- ***d)*** *G.Yankovsky, Problems and exercise in Integral Equation, Mir Publication,1971.*
- ***e)*** *R.R.Goldberg, Fourier Transform, Cambridge Univ. Press,2009.*
- ***f)*** *Gelfand, I. M. and Fomin, S. V., Calculus of Variations, revised English edition translated and edited by Richard A. Silverman, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1963.*
- ***g)*** *Krasnov, M. L.; Makarenko, G. I. and Kisel ev, A. I., Problems and Exercises in Integral Equations, translated from the Russian by George Yankovsky, 1975.*
- ***h)*** *LokenathDebnath ,Dambaru Bhatta, Integral transforms and their applications , Taylor & Francis, 2006.*
- ***i)*** *Brunt, Bruce van, The Calculus of Variations , Springer,2004.*
- ***j)*** *Pipkin, Allen C., A Course on Integral Equations, Texts in Applied Mathematics, 9, Springer-Verlag, New York, 1991.*

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BSMS 9th Semester

[Compulsory]

Partial Differential Equation

Higher Order Partial Differential Equation

Homogeneous equations with constant coefficients, Cauchy Problems for first order Hyperbolic Equations, Classification of seconds order partial differential equation, Monge's Method.

Heat Equation

Solution by the method of separation of variables, Applications to one dimensional heat flow, Properties of solutions.

Wave Equation

Solution by the method of separation of variables, Solution by spherical means and Riemann method of solution, Applications to vibration of strings.

Laplace's Equation

Solution by the method of separation of variables, Boundary value problems, maximum and minimum principles, uniqueness and continuity theorems, Dirichlet problem for a circle, Dirichlet problem for a circular annulus, Neumann problem for a circle, theory of Green's function for Laplace's equation.

Reference Books

- ***a)*** *I. N. Sneddon, Elements of Partial Differential Equations, McGraw Hill Book Company, 1957.*
- ***b)*** *Phoolan Prasad, RenukaRavindran,Partial Differential Equations, Wiley Eastern Limited, 1987.*
- ***c)*** *F. John, Partial Differential equations, Springer,1982.*
- ***d)*** *T. Amarnath, An Elementary Course in Partial Differential Equations,2003.*
- ***e)*** *L.C. Ivans, M Graduate,Partial Differential Equations Studies in Mathematics, Volume 19, AMS, 1968.*

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BSMS 9th Semester

[Compulsory]

Measure Theory

The Lebesgue Measure

Outer measure, Measurable sets and Lebesgue measure, Properties of Measurable sets, σ-Algebras, Borel sets and their measurability, Non measurable sets.

Measurable Functions

Definition and properties of Measurable functions, Sets of Measure Zero, Borel measurable functions, Sequence of functions, Littlewood's three principles, Convergence in measure.

Lebesgue Integral

The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a nonnegative function, The general Lebesgue integral.

Differentiation and Integration

Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, Absolute continuity, Convex Functions.

The Lebesgue L^p spaces

The L^p spaces, The Minkowski and Holder inequalities, Convergence and completeness, Approximation in L^p, Bounded linear functionals on the L^p spaces.

Reference Books

a) *I. K. Rana, An Introduction to Measure and Integration, Second Edition,Narosa, 2005.*

b) *G. De. Barra, Measure Theory and Integration, Horwood Publishing Corporation, 2003.*

c) *P. K. Jain, V. P. Gupta, Lebesgue Measure and Integration, New Age International, 2006.*

d) *H. L. Royden, Real Analysis (Third Edition), Macmillan Publishing Company, 1988.*

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BSMS 9th Semester

[Elective – I]

Operation Research – I

Goal Programming

Introduction, Difference between LP & GP approach, Concept of Goal Programming, Graphical solution- method of GP, Modified simplex method of GP.

Dynamic Programming

Introduction, Nature of Dynamic Programming, Deterministic processes, Non- sequential discrete optimization, Allocation problems, Assortment Problems, Sequential discrete optimization, Long-term planning problem, Multi-stage decision process, Application of Dynamic Programming in production scheduling and routine problems.

Inventory Control

Inventory control – Deterministic including price breaks and Multi-item with constraints. Probabilistic (with and without lead time). Fuzzy and Dynamic inventory models.

Queuing Theory

Basic Structure of queuing models. Poisson queues, M/M/I, M/M/C or finite and infinite queue length, Non-Poisson queue- M/G/I, Machine-Maintenance (steady state).

Network: PERT and CPM

Introduction, Basic difference between PERT and CPM. Steps of PERT/CPM Techniques, PERT/ CPM Network Components and precedence relationships, Critical path analysis, Probability in PERT analysis, Project Time-Cost, Trade-Off. Updating of the project, Resource allocation – resource smoothing and resource levelling.

Replacement and Maintenance Models

Introduction. Failure Mechanism of items, Replacement of items deteriorates with time, Replacement policy for equipment when value of money changes with constant rate during the period. Replacement of items that fail completely individual replacement policy and group replacement policy. Other replacement problems staffing problem. Equipment renewal problem.

Simulation

Introduction. Steps of simulation process, Advantages and disadvantages of simulation. Stochastic simulation and random numbers. Monte – Carlo simulation. Random number. Generation. Simulation of inventory problems, Simulation of Queuing problems, Role of computers in Simulation. Application of Simulations.

Reference Books

a) *A. P. Verma, Introduction to Operations Research, S. K. Kataria & Sons, 3rd Edition 2014.*

b) *Hamdy A. Taha, Operations Research: An Introduction, 10th Edition, Pearson Education 2017*

c) *P. K. Gupta, Operations Research, S. Chand, Fifth Edition, 1976.*

d) *J. K. Sharma, Operations Research, Theory and Applications, Macmillan India Ltd., 1997.*

e) *D. S Hira and P. K. Gupta, Operations Research, S. Chand, 2015.*

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BSMS 9th Semester

[Elective – I]

Differential Geometry

Differentiable Manifold

Calculus on R^n: Continuity and differentiability of function from R^n to R^m, Inverse function theorem, Implicit function theorem, the existence and uniqueness theorem of solution of ODE. Smooth manifold, Differentiable manifold, Tangent space, Derivative of a smooth map, Tangent bundle, Immersion, submersion, embedding, submanifold, regular and critical point, Whitney weak embedding theorem and its consequences.

Vector Fields

Height of the level set, level curves, Lie bracket, Lie algebra, Lie derivative, integral curve of a vector field, flows and local flows, existence of integral curve, complete vector field, existence of complete vector field, vector fields related by a differentiable map. Distribution: Involutive distribution, the Frobenious theorem and its applications.

Surfaces

Hyperplane, Lagrange multiplier, Vector Fields on Surfaces, maximal integral curve, orientation and its consistency, Osculating plane, SerretFrenet formula, first and second fundamental form, the Gauss map spherical image.

Geodescis

Maximal geodesic, covariant derivative and acceleration, Fermi derivative, The Weingarten Mapgeodesic flow,

Curvature of Plane Curves

Center of curvature, radius of curvature, Isometries, Intrinsic differentiation, Gauss-Kronecker curvature, Fundamental theorem on curves. Curvature of surfaces: Parametrized surfaces, local equivalence of surfaces. Gauss-Bonnet Theorem and its application to constant curvatures, theorems of Hadmard.

Lie Group and Lie Algebra

Left invariant vector fields, exponential map and its applications, Lie algebra homomorphism, One parameter subgroups, Adjoint representation.

Reference Books

- ***a)*** *J. A. Thorpe, Elementary Topics in Differential Geometry (Springer), 2004.*
- ***b)*** *Mannfredo. P. DoCarmo, Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.*
- ***c)*** *J.J. Stoker, Differential Geometry, Wiley-Interscience, 1969.*
- ***d)*** *Andrew Pressley, Elementary Differential Geometry, Springer, 2002.*
- ***e)*** *B. O`Neill, Elementary Differential Geometry, Academic Press, 1966.*

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BSMS 9th Semester

[Elective – I]

Mathematical Modelling and Simulation – I

Mathematical Models of Population Biology or Ecology

Mathematical Models

Deterministic and Stochastic. Single species population models. P-V Logistic equation. Population growth model– An age structured model.

Interactions Between Two Species

Host-Parasite type of interactions, Competitive type of interactions. Trajectories of interactions of H-P and competitive types between two species. Effect of migration on H-P interactions. Some consequences of Lotka-Volterra equations. Generalized L-V equations. Constant of motion in the dynamical system.

Stochastic Processes and Need of Stochastic Models

Pure birth process, Pure death process, Birth and death process. Linear birth-death-immigration-emigration processes. Effects of both immigration and emigration on the dynamics of population.

Biological Mechanisms Responsible for "Time-Delay"

Discrete and continuous time-delay. The single species logistic model with the effect of time-delay. Stability of equilibrium position for the logistic model with general delay function. Stability of logistic model for discrete time lag. Time-delayed H-P model together with their stability analysis.

Mathematical Theory of Epidemics

Introduction

Some basic definitions. Simple epidemic model, General epidemic model.Kermack-McKendrikthreshold theorem. Recurring epidemic model. A comparative study of these models.

Control of an Epidemic

Stochastic epidemic model without removal. Models having multiple infections.Epidemic model with multiple infections. Stochastic epidemic model with removal. Stochastic epidemic model with removal, immigration and emigration. Special discussion on the stochastic epidemic model with carriers.

Simple Extensions of SIR Model

Different case studies - (i) Loss of immunity, (ii) Inclusion of immigration and emigration, (iii) Immunization. SIR endemic disease model.

Reference Books

a) *X. Q. Zhao, Dynamical Systems in Population Biology, Canadian Mathematical Society,(2017).*

b) *R. M.Andersson and R M May, Infectious Diseases of Humans,(1992).*

c) *J. N. Kapur ,Mathematical Models in Biology and Medicine, East West Press Pvt Ltd (1985).*

d) *R. Habermann, Mathematical Models, Prentice Hall (1977).*

e) *R. W. Poole, An Introduction to Quantitative Ecology, McGraw- Hill,(1974).*

f) *E. C. Pielou, An Introduction to Mathematical Ecology, Wiley, New York (1977).*

g) *R. Rosen, Foundation of Mathematical Biology (vol. I& II), Academic Press,(1972).*

h) *Mark Kot, Elements of Mathematical Ecology,Cambridge University Press (2003)*

i) *J. D. Murray, Mathematical Biology, Springer-Verlag, Berlin (1989).*

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BSMS 10th Semester

[Compulsory]

Functional Analysis

Introduction to Normed Space

Normed linear space, Hӧlder's inequality, Minkowski's inequality, Banach space, equivalent norms, Riesz lemma, Finite dimensional normed spaces and subspaces, Quotient space**,** Compactness and finite dimension.

Finite Dimensional Normed Space

Bounded and continuous linear operators, Linear functional, Linear operators and functional on finite dimensional spaces, Dual of normed spaces, Reflexive space, Open mapping theorem and closed graph theorems, Uniform boundedness principle.

Inner Product Spaces

Inner product spaces, Cauchy- Schwarz inequality. Parallelogram law, Pythagorian, theorem, Bessel's Inequality, Gram-Schmidt orthogonalisation process, Hilbert space Examples, Orthonormal sets, Complete orthonormal sets and Parseval's Inequality, Orthogonal complement, Projection theorem, Riesz Representation theorem.

Operators on Inner Product Spaces

Adjoint of an operator on Hilbert space, Properties of adjoint operation, Self-adjoint operator and its characterisation, Projection operator, Unitary operator, Concept of normal operator and its characterisation, Normed operator, Unitary operator and its characterisation, Zorn's lemma, Hahn-Banach theorem, Topological vector spaces.

Reference Books

a) *Bachman and Naric, Functional Analysis, Academic Press (1966).*

b) *G. F. Simmon, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company (1963).*

c) *Goffman and Pedrick, First Course in Functional Analysis, Prentice-Hall, Inc.1983*

d) *John B. Conway, A Course in Functional Analysis, Springer (1990).*

e) *A. E. Taylor, Introduction to Functional Analysis, John Wiley & Sons. (1958).*

f) *B. V. Limaye, Functional Analysis, New Age International Ltd.2014*

g) *M. Thamban Nair, Functional Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi (2002).*

h) *Jain, Ahuja and Ahmad, Functional Analysis, New Age International (P) Ltd. (1997).*

i) *Kreyszig Erwin, Introductory Functional Analysis with Applications, Wiley Classics Library, John Wiley & Sons, Inc., New York (1989).*

j) *Walter Rudin, Functional Analysis, Tata McGraw-Hill (1974).*

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BSMS 10^{th} Semester

[Elective – II & Elective – III]

Operation Research – II

Stochastic Programming
Chance constraint programming techniques.

Geometric Programming
Geometric programming (both unconstrained and constrained), Fuzzy geometric programming.

Games
Preliminaries concepts of continuous Game, Bimatrix Games, Nash equilibrium, solution of Bimatrix Games through quadratic programming (relation with non-linear programming). Multiobjective Linear & Non-linear programming,Complete optimal solution, Pareto & Weak Pareto optimal solution, Utility function method , Global criterion method, Fuzzy programming technique.

Optimal Control
Performance indices, methods of calculus of variation, Transversally conditions, simple optimal problems of Mechanics, Pontryagin's Principle (with proof assuming smooth condition), Linear regulator, application of dynamic programming in proving Pontryagin's Principle, Bang-Bang control.

Sequencing
Problem with n jobs two machines, n jobs three machines and n jobs m machines.

Reliability
Concepts, Reliability definition, system Reliability, system failure rate, Reliability of the systems connected in series or/ and parallel.

Information Theory
Introduction, communication process-memory less channel, the channel matrix, probability relation in a channel, noiseless channel.

Measure of information—Properties of Entropy function, measure of other information quantities—marginal and joint Entropies, conditional Entropies, expected mutual information, axiom for an Entropy function, properties of Entropy function. Channel capacity, Efficiency and Redundancy.

Encoding
Objectives of encoding, Shannon-Fano Encoding Procedure, Necessary and sufficient condition for noiseless encoding.

Reference Books

a) *A.P. Verma, Introduction to Operations Research, S.K. Kataria& Sons, 3rd Edition, 2014.*
b) *Hamdy A. Taha, Operations Research: An Introduction, 10th Edition, Pearson Education India, 2017.*
c) *P. K. Gupta, Operations Research, S Chand, Fifth Edition, 1976.*
d) *J. K. Sharma, Operations Research, Theory and Applications, Macmillan India Ltd., 1997.*
e) *D.S. Hira, P. K. Gupta, Operations Research, S Chand, 2015.*

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BSMS 10^{th} Semester

[Elective – II & Elective – III]

Advanced Numerical Analysis

Finite Difference Methods for PDEs

Basics on Finite Differences. Finite Difference Approximation of the Laplacian in Two Dimensions .The Discrete Maximum Principle for a Finite Difference Operator. Stability and Convergence of the Finite Difference Approximation of the Poisson Problem with Dirichlet Boundary Conditions. An Efficient Solver for the Dirichlet Problem in the Rectangle. Approximate solution of Fredholm equation by finite sums and degenerate Kernels. Numerical approximation of Volterra equations.

Finite Volume Methods

Different types of finite volume grids, approximation of surface and volume integrals, interpolation methods.

Finite Element and Boundary Element Methods

Weighted residual method,Galerkin, Least square, partition, moment and collection methods. Solution of boundary value problems by Ritz method. Finite elements and boundary elements of various terms. Constant elements by Gaussian quadrature. Numerical integration over finite elements. Solution boundary value problems by Finite element and Boundary element methods.

Reference Books

a) *Isacson and Keller, Analysis of Numerical methods, 1994.*
b) *Ralston and Rabinowitz, A first course in Numerical Analysis, 2012.*
c) *G.D.Smith, Numerical solution of partial differential equations, 1985.*
d) *B.P. Demidovich, J.A.Maron, Computational Mathematics.*
e) *A. Gourdin, M. Boumahrat, Applied Numerical Methods, 2004.*
f) *M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Competition (Wiley Eastern), 1985.*
g) *A.R.Mitchell, The finite elements method in partial differential equations, 1977.*
h) *Prem K. Kytbe, An introduction to boundary element methods, 1995*

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BSMS 10^{th} Semester

[Elective – II & Elective – III]

Mathematical Modelling and Simulation – II

Some Mathematical Aspects of Oscillations of the Biological Systems

Introduction; Biological Clock; Model for the circadian oscillator. Pharmacokinetics. Mathematical models in Pharmacokinetics -Compartmental Analysis. Technique. Two compartment model - Clinical Bromsulphalein (BSP) Test. Basic equations for an n-compartment system. Distributions of drugs in n- compartment model for (i) given initial dose, (ii) repeated medication, (iii) constant rate of infusion and (iv) truncated infusion. Compartment model for diabetes mellitus. Stochastic compartment models. Drug action. Some general principles for real biological oscillations. Cellular mechanism and genesis of Atherosclerosis.

Arterial Biomechanics

Importance of studies on the mechanics of blood vessels. Structure and functions of blood vessels, Mechanical properties. Viscoelasticity, Linear discrete viscoelastic (spring-dashpot) models: Maxwell Fluid, Kelvin Solid, Kelvin Chains and Maxwell models. Creep Compliance, Relaxation Modulus. Hereditary Integrals, StieltjesIntegrals. Constituents of blood. Structure and functions of the constituents of blood. Mechanical properties of blood. Equations of motion applicable to blood flow. Non-Newtonian fluids - Power law, Bingham Plastic, Herschel-Bulkley and Casson fluids. Steady non- Newtonian fluid flow in a rigid circular tube. Fahraeus-Lindqvist effect. Pulsatile flow in both rigid and elastic tubes. Blood flow through arteries with mild stenosis. Shear stress on surface of the stenosis, Two-layered flow in a tube with mild stenosis. Large deformation theory. Various forms of strain energy functions. The base vectors and metric tensors, Green's deformation and Lagrangian strain tensors. Cylindrical model, Constitutive equations for blood vessels, Equations of motion for the vascular wall.

Biological Diffusion and Diffusion-Reaction Models

Fick's laws of diffusion, One-dimensional diffusion model and its solution, Some solutions of two-dimensional diffusion equation, Various modifications of diffusion equation to diffusion-reaction models arising in pharmacokinetics and ecology. Hemodialyser and dialysis of blood, Basic equations for a circular-duct and a parallel-plate dialyser, Pecletnumber, Sherwood number, Solutions of basic equation for a circular-duct dialyser by (i) separation of variables method and (ii) Galerki's method. Solution for parallel-plate dialyser.

Reference Books

a) *D. A. MacDonald, Blood Flow in Arteries, The Williams and Wilkins Company, Baltimore , 1974.*
b) *Y. C. Fung, Biomechanics of Soft Biological Tissues, Springer Verlag.*
c) *R. Habermann, Mathematical Models , Prentice Hall, 1977.*
d) *R. W. Poole, An Introduction to Quantitative Ecology, McGraw- Hill, 1974.*
e) *E. C. Pielou, An Introduction to Mathematical Ecology, Wiley, New York, 1977.*
f) *R. Rosen, Foundation of Mathematical Biology (vol. I& II), Academic Press, 1973.*
g) *W Flugge, Viscoelasticity, Springer-Verlag, 1975.*
h) *M Zamir, E L Ritman, The Physics of Pulsatile Flow, 2012.*
a) *J. N. Kapur, Mathematical Models in Biology and Medicine, East West Press Pvt Ltd, 1985.*

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BSMS 10th Semester

[Elective – II & Elective – III]

Fluid Mechanics

Review of gradient, divergence and curl. Elementary idea of tensors. Velocity of fluid, Streamlines and path lines, Steady and unsteady flows, Velocity potential, Vorticity vector.

Continuum hypothesis, forces acting on a fluid, stress tensor, analysis of relative motion in the neighborhood of a point, Euler's theorem, Reynolds transport theorem, conservation of mass, material surface, momentum equation.

Stream lines, Bernoulli's theorem, circulation, Kelvin's circulation theorem, vorticity, Lagrange's theorem on permanence of vorticity, two dimensional irrotational flow of an incompressible fluid, Milne-Thomson circle theorem, Blasius theorem, flow past an airfoil, the Joukowski transformation, Theorem of Joukowski and Kutta.

Axisymmetric flows, Stokes stream function, Butler's sphere theorem, flows due to source, doublet, uniform flow past a sphere, irrotational three dimensional flow, Weiss' sphere theorem.

Constitutive equations for incompressible fluids, derivation of Navier-Stokes equations. Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen-Poiseuille flows, (ii) Generalized plane Couette flow, (iii) Steady flow between two rotating concentric circular cylinders, (iv) Stokes's first and second problems. Dynamical similarity and Reynolds number.

Reference Books

a) *G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, 1970.*
b) *F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 2000.*
c) *H. Lamb, Hydrodynamics, University Press, 1916.*
d) *C.S. Yih, Fluid Mechanics, McGraw-Hill Book, Company, 1988*

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BSMS 10th Semester

[Elective – II & Elective – III]

Mechanics

Classical Mechanics

Coordinate System and Basic Concepts

Generalized co-ordinates, holonomic and non-holonomic systems, unilateral and bilateral constraints, principle of virtual work, D'Alemberts principle.

Variational Principles

Variational principles, problems of mechanics, moving problems of calculus of variations, shortest distance, minimum surface of revolution, Brachistochrone problem, iso-perimetric problem, geodesic, fundamental, lemma of calculus of variations.

Lagrange's Equations of Motion

Lagrange's equations, uniqueness of solution, Energy equation of conservative fields.

Hamilton's Principle

Generalized momentum, problem of Liouville type, cyclic coordinates. Hamilton's principle, Hamiltonian, principle of least action.

Hamiltonian Dynamics

Derivation of Lagrange's equations from Hamilton's principle, Routh's equation, Hamilton-canonical equation of motion**.**

Poisson Bracket

Poisson bracket, Poisson's identity, Liouville's theorem, Jacobi-Poisson theorem.

Canonical Transformations

Canonical transformations, Legendre transformations, generating functions, bilinear invariant condition.

Continuum Mechanics

Stress

Body force, Surface force, Cauchy's stress principle. Stress vector, State of stress at a point, Stress tensor, The stress vector- stress tensor relationship. Force and moment equilibrium, Stress tensor symmetry, Stress quadric of Cauchy, Stress transformation laws, Principal stress, Stress invariant, Stress ellipsoid.

Strain

The Continuum hypothesis. Deformation Gradients, Displacement Gradient, Deformation tensor, Finite strain tensors, Small deformation theory—infinitesimal strain tensor, Relative displacement, Linear rotation tensor, Interpretation of the Linear strain tensors, Strain ratio, Finite strain interpretation, principal strains, strain invariant, cubical dilatation, Compatibility equation for linear strain, Strain energy function. Hook's Law. Saint Venant's Principle, Airy's strain function.

Isotropic media, Elastic constraints, Moduli of elasticity of isotropic bodies and their relations, displacement equation of motion. Waves in isotropic elastic media. Perfect fluid, Kinematics of fluid, Lagrangian method, Eulerian method, Acceleration, Equation of continuity, The boundary surface, Stream lines and Path lines, Irrotational motions and its physical interpretation , Velocity potential, Euler's equation of motion of an inviscous fluid, Cauchy integral, Bernouli's equation, Integration of Euler's equation.

Reference Books

- ***a)*** *Rana and Joag, Classical Mechanics, Narosa Publications, 1991.*
- ***b)*** *D.N. Berghese and A.M. Downs, Classical mechanics and Control, John Willey.*
- ***c)*** *E.T. Whittecker, Treatise on the Analytical Dynamics and Rigid Bodies, 1988.*
- ***d)*** *I.S. Sokolnikoff, Mathematical Theory of Elasticity , Tata Mc. Grawhill, 1997.*
- ***e)*** *S. Valliappan, Continuum Mechanics , Oxford & IBH Publishing Company, 1981.*
- ***f)*** *L.E. Malvern, Introduction to the Mechanics of a continuous medium, Prentice - Hall, Inc, 1977.*
- ***g)*** *J. B. Marion, S. T. Thornton, Classical Dynamics of Particles and Systems-, Harcourt Brace Jovanovich, 1988.*
- ***h)*** *Scheck, Florian, Mechanics - From Newton's Laws to deterministic Chaos, Graduate Texts in Physics, Springer, 2010.*
- ***i)*** *J. E. Marsden, Ratiu, Tudor, Introduction to Mechanics and Symmetry, Texts in Applied Mathematics, Springer-Verlag, 1999.*
- ***j)*** *H. Goldstein, Poole. C. P., J. Safko, Classical Mechanics, Pearson, 2000.*

k) *F. Chorlton, Textbook of Dynamics, Ellis Horwood Series, Mathematics and its Applications, Halsted Press (John Wiley & Sons, Inc.), 1983.*

l) *H. Goldstein, Poole. C. P. and J. Safko, Classical Mechanics, Pearson, 2002.*

m) *F. Chorlton, Textbook of Dynamics, Ellis Horwood Series: Mathematics and its Applications, Halsted Press (John Wiley & Sons, Inc.), 1977.*

n) *J. E. Marsden, Ratiu, Tudor, Introduction to Mechanics and Symmetry, Texts in Applied Mathematics, Springer-Verlag, 1998.*

o) S.C. Deo, Y. Lakshminathan and V. Raghavendra, Text Book of Ordinary Differential Equation (Second Edition) Tata McGraw Hill, New Delhi.

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BSMS 10th Semester

[Elective – II & Elective – III]

Advanced Topology

Nets, Filters, Ultra filters, Convergence of nets and filters with special reference to zero-set filters and ultrafilters, Compact sets, Cmpact spaces, Alexander's theory, Tychonoff's theory, Locally compact spaces, Tychonoff's spaces, Topological embedding, Embedding Lemma, Embedding theory, Compactification, one point compactification. Alexanderoff one point compactification, Stone-Cech compactification, Ordering of compactification, minimality of X and maximality of β(X).

Weak topology and completely regular topology, Topology generated by a family of pseudometrics. Uniform spaces, total boundedness, Cauchy nets and filters, Completeness, Uniformly continuous maps, Uniform isomorphism, Product uniform space, Quasi uniform spaces, Proximity spaces, Induced topology, Proximal neighbourhoods, Quasiproximity spaces.

Reference Books

a) *K.D. Joshi, Introduction to General Topology, New Age International, New Delhi, 2017.*
b) *J.R. Munkres, Topology, 2nd Ed., Pearson Education India, 2002.*
c) *N. Bourbaki, General Topology Part-I (Transl.), Addison Wesley, Reading, 1989.*
d) *J. G. Hocking, C. S. Young, Topology, Addison-Wesley, Reading, 2012.*
e) *J. Dugundji, Topology, Allyn and Bacon, Inc, 1966.*
f) *J.L. Kelley, General Topology, Van Nostrand, Princeton, 1955.*
g) *M.G. Murdeswar, General Topology, New Age International, 1990.*
h) *S. T. Hu, Elements of General Topology, Holden-Day, San Francisco, 1964.*
i) *S. Willard, General Topology, Addison Wesley, Reading Mass, 2004.*

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BSMS 10th Semester

[Elective – II & Elective – III]

Fuzzy Mathematics

Fuzzy Relations

Fuzzy relations on fuzzy sets, composition of fuzzy relations, Types of fuzzy relations, similarity methods, fuzzy graphs.

Fuzzy Functions

Fuzzy functions on fuzzy sets, image and inverse image of fuzzy sets, Integration and differentiation of fuzzy functions.

Fuzzy Matrix

Sum, multiplication of two fuzzy matrices, Idempotent fuzzy matrix and their problems.

Fuzzy Rough Set

Introduction to rough set, Fuzzy rough set, soft sets and application.

Fuzzy Topology

Chang's definition and Lowen's definition, basic concepts, fuzzy open sets, fuzzy closed sets, fuzzy interior & fuzzy closure, fuzzy continuous function, lower (upper) semi continuous functions, their basic properties, subspaces, product spaces, quotient spaces, intuitionistic fuzzy topological spaces, Induced fuzzy topology, Separation axioms in fuzzy topological spaces, Fuzzy filter and fuzzy net, Fuzzy compact spaces, Fuzzy connected space and fuzzy countability axioms.

Reference Books

- ***a)*** *H. J. Zimmermann, Fuzzy Set Theory and Its Applications, Allied Publisher's Limited, 2014.*
- ***b)*** *Robert Babuška, Fuzzy Modelling for Control, International Series in Intelligent Technologies, Volume 12, 2012.*
- ***a)*** *N. Palaniappan, Fuzzy Topology, Norosa, 2006*

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BSMS 10th Semester

[Elective – II & Elective – III]

Decision Theory and Computational Statistics

Decision Theory

Games and statistical games, Statistical decision problem, Decision function, Risk function, Prior and posterior distribution, Baye's risk and Baye's rules.

Least favourable prior, Minimaxity, Admissibility and complete classes, Admissibility of Baye's rules, Existence of minimal complete class and Baye's rules.

The Supporting and Separating Hyperplane theorems, Essential completeness of the class of nonrandomized rules, Minimax and complete class theorems.

Solving for minimax rules, Essential completeness of class of rules based on sufficient statistics, Continuity of risk function, Invariant decision problems, Admissible and minimax invariant decision rules.

Computational Statistic

Analysis of variance, one- way and two – way classification. Concept of design of experiment, Some standard design: Completely randomized design, randomized block design , Latin Squares, Graeco Latin Squares and Factorial Design Confounding and blocking in Factorial design, fractional factorial design.

Simple and multiple regression models. Classical techniques of Time series analysis, Smoothing and decomposition, Analysis of covariance model.

Reference Books

a) James O. Berger, Statistical Decision Theory, Foundation, Concepts and Methods, Springer series in Statistics, 1980.

b) J. E. Gentle and Wolfgang HSrdle, Yuichi Mori, Handbook of computational statistics: Concepts and methods, 2004.

c) *James O Berger, Statistical Decision Theory and Bayesian Analysis, Springer series, 2nd edition, 1993*

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BSMS 10th Semester

[Elective – II & Elective – III]

Financial Mathematics

Introduction

Some Basic definitions and terminology.

Basic Theory of Option Pricing

Single and Multi-Period Binomial Pricing Models, Cox-Ross Rubinstein (CRR) Model, Black-Scholes Formula for Option Pricing as a Limit of CRR Model.

Stochastic Calculus

Brownian and Geometric Brownian Motion, Theory of Martingales. Stochastic Calculus, Stochastic Differential Equations, Ito's Formula to Solve SDE's. Applications of Stochastic Calculus in Option Pricing.

Mean-Variance Portfolio Theory

Markowitz Model of Portfolio Optimization and Capital Asset Pricing Model (CAPM). Limitations of Markowitz Model and New Measures of Risk.

Interest Rates and Interest Rate Derivatives

Binomial Lattice Model, Vasicek, Hull and White Models for Bond Pricing.

Reference Books

a) *D. G. Luenberger, Investment Science, Oxford University Press, 2013.*

b) *M. Capińsky, T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer, 2010.*

c) *Thomas Mikosch, Elementary Stochastic Calculus with Finance in view, World Scientific, 1998.*

d) *Suresh Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani, Financial Mathematics: An Introduction, Narosa Publishing House, 2013.*
e) *S. E. Shreve, Stochastic Calculus for Finance, Vol. I & Vol. II, Springer, 2010.*
f) *Sean Dineen, Probability Theory in Finance: A Mathematical Guide to the Black-Scholes Formula, American Mathematical Society, Indian edition, 2013.*

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BSMS 10th Semester

Syllabus for industrial project will be specified by the respective industry.

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