BABU BANARASI DAS UNIVERSITY, LUCKNOW

B.Sc. (Hons.) Mathematics

COURSE STRUCTURE

(For Academic Session 2021-22 and After)

Course	Code	Title	Teaching			Evaluation					Credits
						Theory		Lab/Seminar/ Viva Voce/ Dissertation		Total	
			L	T	P	CIA	ESE	CIA	ESE		
SEMESTER – I											
Core	BSM2101	Calculus	5	1	-	40	60	-	-	100	6
Core	BSM2102	Algebra and Geometry	5	1	-	40	60	-	-	100	6
GE		Generic Elective – I									6
AECC	HSAE 2101	Communicative English	4	-	-	40	60	-	-	100	4
CC	BSGP21	General Proficiency						100	-	100	1
											23
SEMESTER – II											
Core	BSM2201	Multivariable Calculus	5	1	-	40	60	-	-	100	6
Core	BSM2202	Ordinary Differential Equations	5	1	-	40	60	-	-	100	6
GE		Generic Elective – II									6
AECC	BSAE2201	Environmental Studies	4	-	-	40	60	-	-	100	4
CC	BSGP22	General Proficiency				-	-	100	-	100	1
											23
SEMESTER – III											
Core	BSM2301	Real Analysis	5	1	-	40	60	-	-	100	6
Core	BSM2302	Group Theory	5	1	-	40	60	-	-	100	6
Core	BSM2303	Probability and Statistics	5	1	-	40	60	-	-	100	6
GE		Generic Elective - III									6
SEC		Skill Enhancement Course – I									4
CC	BSGP23	General Proficiency	-	-	-	-	-	100	-	100	1
											29
SEMESTER – IV											
Core	BSM2401	Mechanics	5	1	-	40	60	-	-	100	6
Core	BSM2402	Linear Algebra	5	1	-	40	60	-	-	100	6
Core	BSM2403	Partial Differential Equations and Calculus of Variations	5	1	-	40	60	-	-	100	6
GE		Generic Elective - IV									6
SEC		Skill Enhancement Course – II									4
CC	BSGP24	General Proficiency	-	-	-	-	-	100		100	1
											29

SEMESTER – V										
Core	BSM2501	Set Theory and Metric Spaces	5	1	-	40	60	-	-	100	6
Core	BSM2502	Advanced Algebra	5	1	-	40	60	-	-	100	6
DSE		Discipline Specific Elective – I									6
DSE		Discipline Specific Elective – II									6
SEC	BSMS25	Seminar	-	-	-			100	-	100	2
											26
SEMESTER – VI											
Core	BSM2601	Complex Analysis	5	1	-	40	60	-	-	100	6
Core	BSM2602	Numerical Analysis	5	1	-	40	60	-	-	100	6
DSE		Discipline Specific Elective – III									6
DSE		Discipline Specific Elective – IV									6
VV	BSMV26	Vice Voce	-	-	-	-	-	-	100	100	2
											26

ELECTIVE COURSES – B. Sc. (Hons.) Mathematics

Generic Elective – I										
BSC2101	Programming Fundamentals Using C	5	1	-	40	60	-	-	100	6
BSC2102	Computer System Architecture	5	1	-	40	60	-	-	100	6
BSE1101	Basic Circuit Theory and Network Analysis	4	-	4	40	60	20	30	150	6
Generic Elective – II										
BSC2201	Data Structure	4	-	4	40	60	20	30	150	6
BSC2202	Discrete Structures	5	1	-	40	60	-	-	100	6
BSE 1201	Semi Conductor Devices	4	-	4	40	60	20	30	150	6
Generic Elective – III										
BSC2301	Operating System	5	1	-	40	60	-	-	100	6
BSC2302	Programing in JAVA	5	1	-	40	60	-	-	100	6
BSE 1302	Digital Electronics	4	-	4	40	60	20	30	150	6
Generic Elective – IV										
BSC2401	Software Engineering	5	1	-	40	60	-	-	100	6
BSC2402	DBMS	4	-	4	40	60	20	30	150	6
BSE1401	Operational Amplifiers and Applications	4	-	4	40	60	20	30	150	6

Discipline Specific Elective – I										
BSM2551	Tensor and Differential Geometry	5	1	-	40	60	-	-	100	6
BSM2552	Boolean Algebra &Automata	5	1	-	40	60	-	-	100	6

	Theory									
BSM2553	Integral Transforms and Fourier Analysis	5	1	-	40	60	-	-	100	6
Discipline Specific Elective – II										
BSM2554	Linear Programming	5	1	-	40	60	-	-	100	6
BSM2555	Analytical geometry	5	1	-	40	60	-	-	100	6
BSM2556	Mathematical Modeling	5	1	-	40	60	-	-	100	6
Discipline Specific Elective – III										
BSM2651	Advance Mechanics	5	1	-	40	60	-	-	100	6
BSM2652	Number Theory	5	1	-	40	60	-	-	100	6
BSM2653	Industrial Mathematics	5	1	-	40	60	-	-	100	6
Discipline Specific Elective – IV										
BSM2654	Graph Theory	5	1	-	40	60	-	-	100	6
BSM2655	Cryptography	5	1	-	40	60	-	-	100	6
BSM2656	Dissertation	-	-	-	-	-	50	50	100	6

Skill Enhancement Course – I										
BSSE2301	LaTeX and HTML	1	-	2	40	60	-	-	100	4
BSSE2302	Programming in MATLAB	1	-	2	40	60	-	-	100	4
BSSE2303	GNU Image Manipulation Program	1	-	2	40	60	-	-	100	4
BSSE2304	Python Programming	1	-	2	40	60	-	-	100	4
Skill Enhancement Course – II										
BSSE2401	Mobile Application Development	1	-	2	40	60	-	-	100	4
BSSE2402	Web Programming	1	-	2	40	60	-	-	100	4
BSSE2403	Linux / Unix Programming	1	-	2	40	60	-	-	100	4
BSSE2404	Network Programming	1	-	2	40	60	-	-	100	4

Semester	First		
Course Name	Calculus		
Category: Core	Code: BSM2101		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Assimilate the notions of limit of a sequence and convergence of a series of real numbers.
2. Calculate the limit and examine the continuity of a function at a point.
3. Understand the consequences of various mean value theorems for differentiable functions.
4. Sketch curves in Cartesian and polar coordinate systems.
5. Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

SYLLABUS

Module I

Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions([1] Chapter 5), Reduction formulae([1] Chapter 7).Sequences of real numbers, Convergence of sequences and series, Boundedand monotonic sequences ([1] Chapter 9).

Module II

ε-δ definition of limit of a real valued function, Limit at infinity and infinite limits, Continuity of a real valued function, Properties of continuous functions, Intermediate valuetheorem, Geometrical interpretation of continuity, Types of discontinuity; Uniformcontinuity([1]Chapter1).

Module III

Differentiability of a real valued function, Geometrical interpretation of differentiability,Relation between differentiability and continuity, Differentiability and monotonicity, Chainrule of differentiation ([1], Chapter 2).Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem,Cauchy's mean value theorem, Geometrical interpretation of mean value theorems ([1], Chapter 4)Successive differentiation, Leibnitz's theorem ([4], Chapter 5), Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder ([4], Chapter 6).

Module IV

Polar equations of Tangents and Normals ([4], Chapter 7), Curvature ([4], Chapter 9), Asymptotes of general algebraic curves, Parallelasymptotes, Asymptotes parallelto axes ([4], Chapter 8), Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar andparametric curves ([4], Chapter10).

Recommended Books:

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

Semester	First		
Course Name	Algebra and Geometry		
Category: Core	Code: BSM2102		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
2. Familiarize with relations, equivalence relations and partitions.
3. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
4. Find eigen values and corresponding eigenvectors for a square matrix.
5. Explain the properties of three dimensional shapes.

Syllabus

Module I

Theremainder and factor theorems , Synthetic division, Factored form of a polynomial, The Fundamentaltheoremofalgebra,Relationsbetweentherootsandthecoefficientsofpolynomialequations, ([1] Chapter II). Elementarytheoremsontherootsofanequationsincluding Cardan's method([1] Chapter IV),Integralandrationalroots, Imaginaryroots([1] Chapter II, VII). Relations, Equivalence relations, Equivalence classes.([2] Chapter II) Functions, Composition of functions,Inverse ofa function, Finite,countableanduncountable sets. ([2] Chapter III) The divisionalgorithm,Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic ([2] Chapter IV). Principles of mathematical induction and wellordering. ([2] Chapter V).

Module II

Row reduction and echelon forms, Linear independence, Therankofamatrixandapplications, Systems of linear equations. Introductiontolineartransformations,Thematrixofalinear transformation. ([3] Chapter 1).Theinverseofamatrix,Characterizationsofinvertible matrices([3] Chapter 2).Eigenvalues and eigenvectors, TheCayleyHamiltontheorem.([3] Chapter 5).

Module III

Planes: Distanceofapointfromaplane,Anglebetweentwoplanes,pairofplanes,Bisectorsofangles between two planes; Straight lines: Equations of straight lines, Distance of a point from astraightline,Distancebetweentwostraightlines,Distancebetweenastraightlineandaplane, ([4] Chapter III). Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents andnormal, Radicalplane, Radicalline,Coaxialsystemofspheres,Pole,PolarandConjugacy ([4] Chapter V).

Module IV

Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces, Classification ofquadricsurfaces,Cone,Cylinder,Centralconicoids,Tangentplane,Normal,Polarplanes,andPolarlines. ([4] Chapter VI,VII).

Recommended Books:

1. Leonard Eugene Dickson (2009). First Course in the Theory of Equations. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785).
2. Edgar G. Goodaire& Michael M. Parmenter (2015). Discrete Mathematics with Graph Theory (3rd edition).Pearson Education Pvt. Ltd. India.
3. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). Linear Algebra and its Applications (5th edition).Pearson Education Pvt. Ltd. India.
4. Robert J. T. Bill (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd.

Semester	Second		
Course Name	Multivariable Calculus		
Category: Core	Code: BSM2201		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Learn conceptual variations while advancing from one variable to several variables in calculus.
2. Apply multivariable calculus in optimization problems.
3. Inter-relationship amongst the line integral, double and triple integral formulations.
4. Applications of multivariable calculus tools in physics, economics, optimization and understanding the architecture of curves and surfaces in plane and space etc.
5. Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Syllabus

Module I

Functions of several variables, Limits and continuity, partial derivatives, Higher orderPartialderivatives,Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives([1] Chapter 15), Jacobians, Change ofvariables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of twovariables and more variables ([2] Chapter 15 & 16).

Module II

Envelopes and Evolutes([3] Chapter 12),Extrema of functions of two and more variables, Method of Lagrange multipliers([1] Chapter 15), Optimization problems([4] Chapter 3).

Module III

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals,Triple integration in cylindrical and spherical coordinates, Change of variables in double andtriple integrals. Dirichlet integral([1] Chapter 16) ([2] Chapter 17).

Module IV

Definition of vector field,gradient andvector identities, Line integrals,Applications of line integrals: Mass and Work,Fundamental theorem for lineintegrals, Conservative vector fields,Green's theorem,Divergence, curl,Area as a line integral, Surfaceintegrals,Stokes' theorem, The Gauss divergence theorem([1] Chapter 17).

Recommended Books:

1. James Stewart (2012). Multivariable Calculus (6th edition). Thomson Brooks/Cole. Cengage.
2. S. C. Malik and S. Arora, Mathematical Analysis, 4th Ed., Wiley Eastern Ltd., 2011.
3. G. Prasad, Text Book on Differential Calculus, PothishalaPtv. Ltd.
4. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

Semester	Second		
Course Name	Ordinary Differential Equations		
Category: Core	Code: BSM2202		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Understand the genesis of ordinary differential equations.
2. Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
3. Know Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.
4. Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
5. Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

Syllabus

Module I

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation ([2]: Chapter 1, Part I), Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor ([2]: Chapter 2, Part I), First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions ([2]: Chapter 4, Part I).

Module II

Second Order Linear Differential Equations: Statement of existence and uniqueness theorem for linear differential equations, linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients ([1] Chapter-2), Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters([2] Chapter 10, Part I), Reduction of order ([1] Chapter-2). Higher Order Linear Differential Equations: Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, General solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation([1] Chapter-3).

Module III

Power series method ([2] Chapter 7, Part II),Frobenius method ([2] Chapter 8, Part II),Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials ([2] Chapter 9, Part II), Bessel's equation, Bessel functions and their properties, Recurrence relations ([2] Chapter 11, Part II).

Module IV

Orthogonal trajectories ([2] Chapter 3, Part I), Acceleration-velocity model, Minimum velocity of escape from Earth's gravitational field, Growth and decay models, Malthusian and logistic population models ([3] Chapter 1, Part I), Radioactive decay, Drug assimilation into the blood of a single cold pill, Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits([2] Chapter 11, Part I).

References:

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

Semester	Third		
Course Name	Real Analysis		
Category: Core	Code: BSM2301		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Understandmanypropertiesoftherealline ℝ andlearntodefinesequenceintermsoffunctionsfr omℝtoasubsetofℝ.
2. Recognizebounded,convergent,divergent,Cauchyandmonotonicsequencesandtocalculate theirlimitsuperior,limitinferior,andthelimitofaboundedsequence.
3. Applytheratio,root,alternatingseriesandlimitcomparisontestsforconvergenceandabsolutec onvergenceofaninfiniteseriesofrealnumbers.
4. LearnsomeofthepropertiesofRiemannintegrablefunctions,andtheapplicationsofthefunda mentaltheoremsofintegration.

Syllabus

Module I

Algebraic and order properties of ℝ, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of ℝ,The completenesspropertyofℝ,Archimedeanproperty,Densityofrationalnumbersinℝ,Definitionandtypes of intervals, Nested intervals property.([1] Chapter 2) Neighborhood of a point in ℝ, Open, closed, Cantorset. ([1] Chapter 11)

Module II

Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, BolzanoWeierstrass theorem for sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy’s convergence criterion. ([1] Chapter 3)

Module III

Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence. ([2] Chapter 4)

Module IV

Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second mean value theorems ([2] Chapter 9). Improper integrals, Abel's test and Dirichlet test for improper integrals ([2] Chapter 11). Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Abel's test and Dirichlet test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation. ([2] Chapter 12).

Recommended Books

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

Semester	Third		
Course Name	Group Theory		
Category: Core	Code: BSM2302		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Recognize the mathematical objects called groups.
2. Link the fundamental concepts of groups and symmetries of geometrical objects.
3. Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4. Analyze consequences of Lagrange's theorem.
5. Learn about structure preserving maps between groups and their consequences.

Syllabus

Module I

Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups. Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem, Euler phi function, Euler's theorem, Fermat's little theorem. ([1] Chapter 2).

Module II

Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups,Classification of subgroups of cyclic groups. ([1] Chapter 3).

Module III

Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications.([1] Chapter 3).

Module IV

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups; ([1] Chapter 3). Definitions and elementary properties of rings and fields.([1] Chapter 7).

Recommended Books:

1. Vijay k Khanna and S K Bhambri (2013). A Course in Abstract Algebra(4th edition), Vikash Publishing House Pvt Ltd.
2. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
3. I. N. Herstein (2006). Topics in Algebra (2 nd edition).Wiley India.
4. Nathan Jacobson (2009). Basic Algebra I (2nd edition). Dover Publications.

Semester	Third		
Course Name	Probability and Statistics		
Category: Core	Code: BSM2303		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Understanddistributionsinthestudyofthejointbehaviouroftworandomvariable
2. Establishaformulationhelpingtopredictonevariableintermsoftheotherthati, correlation and linear regression.
3. Understandcentrallimittheorem,whichestablishtheremarkablefactthattheempiricalfrequenciesofsomanynaturalpopulations,exhibitabellshapedcurve.

Syllabus

Module I

Basic notions of probability, Conditional probability and independence, Baye's theorem;Random variables - Discrete and continuous, Cumulative distribution function, Probabilitymass/densityfunctions;Transformations,Mathematicalexpectation,Moments,Momentgeneratingfunction,Characteristicfunction. ([1] Chapter 1 & 2)

Module -II

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric andPoisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta andnormal;Normalapproximationtothebinomialdistribution ([1] Chapter 3).

Module -III

BivariateDistribution Joint cumulative distribution function and its properties, Joint probability density function,Marginal distributions, Expectation of function of two random variables, Joint momentgeneratingfunction,Conditionaldistributionsandexpectations ([2] Chapter 5 & 6).

Module -IV

The Correlation coefficient, Covariance,Calculation ofcovariance from jointmomentgeneratingfunction,Independentrandomvariables,Linearregressionfortwovariables,Themethod of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law oflargenumbers,Centrallimittheoremandweaklawoflargenumbers. ([2] Chapter 14)

Recommended Books:

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

Semester	Fourth		
Course Name	Mechanics		
Category: Core	Code: BSM2401		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers and engineers together.
2. Understand necessary conditions for the equilibrium of particles acted upon byvarious forces and learn the principle of virtual work for a system of coplanar forces acting on rigid body.
3. Determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.
4. Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
5. Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

Syllabus

Module I

Moment of a force about a point, Moment of a force about a line, Couples,Moment of a couple, Work and potential energy, Principle ofvirtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omitted informing the equations of virtual work. ([1] Chapter II, V).

Module II

Centres of gravity of plane area including a uniform thin straight rod, triangle, circular arc,semicircularareaandquadrantofacircle,Centreofgravityofaplaneareaboundedbyacurve,Centreofgravityofavolumeofrevolution ([1] Chapter VIII).

Flexiblestrings,Commoncatenary,IntrinsicandCartesianequationsofthecommoncatenary,Approximationsofthecatenary. ([1] Chapter XIII)

Module III

Simple harmonic motion (SHM) and its geometrical representation, SHM under elasticforces, Motion under inverse square law ([2] Chapter II), Motion in resisting media, Concept of terminalvelocity,Motionofvaryingmass ([2] Chapter VII).

Module IV

Kinematicsandkineticsofthemotion,ExpressionsforvelocityandaccelerationinCartesian,polarandintrinsiccoordinates.Equationofmotionunderacentralforce,Differential equationoftheorbit,(p,r)equationofthe orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler’s laws of planetary motion. ([2] Chapter IV,V&VI).

Recommended Books:

1. S. L. Loney (2006). An Elementary Treatise on Statics, Kalyani Publishers, New Delhi.
2. S. L. Loney (1987). An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies. Read Books.
3. P. L. Srivatava (1964). Elementary Dynamics. Ram NarinLal, Beni Prasad Publishers Allahabad.
4. J. L. Synge & B. A. Griffith (1949). Principles of Mechanics.McGraw-Hill.
5. A. S. Ramsey (2009). Statics.Cambridge University Press.
6. A. S. Ramsey (2009). Dynamics.Cambridge University Press.
7. R. S. Varma (1962). A Text Book of Statics. Pothishala Pvt. Ltd.

Semester	Fourth		
Course Name	Linear Algebra		
Category: Core	Code: BSM2402		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
2. Relate matrices and linear transformations; compute eigen values and eigen vectors of linear transformations.
3. Learn properties of inner product spaces and determine orthogonality in inner product spaces.
4. Realize importance of adjoint of a linear transformation and its canonical form.

Syllabus

Module I

Definition and examples of Vector Spaces, Subspace, Linear span, Quotient space and direct sum of subspaces, Linearly independent and dependent sets, Bases and dimension. ([1] Chapter 10). Definition, examples and Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem. ([1] Chapter 11).

Module II

Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and eigen values of a linear transformation, Characteristic polynomial and Cayley Hamilton theorem, Minimal polynomial. ([1] Chapter 12).

Module III

Inner product spaces and orthogonality, Cauchy Schwarz inequality, Gram Schmidt orthogonalisation, Diagonalisation of symmetric matrices.([1] Chapter 10).

Module IV

Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; ([4] Chapter 4). Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces. ([4] Chapter 3).

Recommended Books:

1. Vijay k Khanna and S K Bhambri (2013). A Course in Abstract Algebra(4th edition), Vikash Publishing House Pvt Ltd
2. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
3. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition).Dover Publications.
4. VivekSahai&VikasBist (2013). Linear Algebra (2nd Edition).Narosa Publishing House.
5. Gilbert Strang (2014). Linear Algebra and its Applications (2nd edition).Elsevier.

Semester	Fourth		
Course Name	Partial Differential Equations and Calculus of Variations		
Category: Core	Code: BSM2403		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Apply a range of techniques to solve first & second order partial differentia equations.
2. Model physical phenomena using partial differential equations such as the heat and wave equations.
3. Understand problems, methods and techniques of calculus of variations.

Syllabus

Module I

Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order ([1] Chapter 1, Part II), Lagrange's method ([1] Chapter 2,Part II), Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method ([1] Chapter 3,Part II).

Module II

Homogeneous and non-homogeneous equations with constant coefficients ([1] Chapter 4 & 5, Part II), Partial differential equations reducible to equations with constant coefficient ([1] Chapter 6,Part II), Second order PDE with variable coefficients ([1] Chapter 7,Part II), Classification of second order PDE([1] Chapter 8,Part II) Solution of heat and wave equations in one and two dimensions by method of separation of variables ([1] Chapter 1,Part III).

Module III

Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation ([2]: Chapter 1).

Module IV

Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations ([2] Chapter 2).Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation ([2] Chapter 3).

Recommended Books:

1. M. D. Raisinghania, Advanced Differential Equations, Nineteenth Edition 2018 (Reprint with updates 2020), S. Chand.
2. A. S. Gupta (2015). Calculus of Variations with Applications.PHI Learning.
3. L. Elsgolts, Differential Equation and Calculus of Variations, Pergamon Press, Poland
4. Erwin Kreyszig, (2011). Advanced Engineering Mathematics (10th edition). Wiley.
5. TynMyint-U &LokenathDebnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition).Springer India.
6. H. T. H. Piaggio (2004). An Elementary Treatise on Differential Equations and Their Applications.CBS Publishers.
7. S. B. Rao& H. R. Anuradha (1996). Differential Equations with Applications, University Press.
8. I. N. Sneddon (2006). Elements of Partial Differential Equations.Dover Publications.

Semester	Fifth		
Course Name	Set Theory and Metric Space		
Category: Core	Code: BSM2501		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Learn basic facts about the cardinality of a set.
2. Understand several standard concepts of metric spaces and their properties like openness, closeness, completeness, Bolzano Weierstrass property, compactness, and connectedness.
3. Identify the continuity of a function defined on metric spaces and homeomorphisms.

SYLLABUS

Module I

Finite and infinite sets, Countable and uncountable sets, Cardinality of sets ([2] Chap. 4), Partially ordered set ([1] Chapter 14), Axiom of choice ([1] Chapter 15), Zorn's lemma ([1] Chapter 16), Schröder Bernstein theorem ([1] Chapter 22), Arithmetic of cardinal numbers ([1] Chapter 24, 25).

Module II

Metric spaces, Distance between two sets, Diameter of a set, Open spheres and closed spheres, Neighbourhood of a point,Interior point, Open sets, Limit points, Closed sets, Subspace of a metric space, Adherent Point,closure of a set,Interior of a set, exterior and boundary points, Subspace of a metric space([2] Chapter 19).

Module III

Dense sets,Nowhere dense sets, separable spaces, Continuous and uniformly continuous functions, Homeomorphism, Cauchy and Convergent sequences, Complete metric Space, Cantor's intersection theorem, Baire's category theorems ([2] Chapter 19).

Module IV

Compact spaces, Compactness and finite intersection property, Bolzano Weierstrass property, Sequentially compact metric space,Totally bounded sets,Continuous functions on compact spaces, Separated sets, connected and Disconnected sets, Components of a metric spaces([2] Chapter 19).

Recommended Books

1. P. R. Halmos (1974). Naive Set Theory. Springer.
2. Shanti Narayan (2012) Elements of Real Analysis 13th edition, S. Chand Publication
3. E. T. Copson (1988). Metric Spaces.Cambridge University Press.

4. P. K. Jain & Khalil Ahmad (2019). Metric Spaces.Narosa.
5. S. Kumaresan (2011). Topology of Metric Spaces (2nd edition).Narosa.
6. SatishShirali&Harikishan L. Vasudeva (2006). Metric Spaces.Springer-Verlag.
7. MicheálO'Searcoid (2009). Metric Spaces.Springer-Verlag.
8. G. F. Simmons (2004). Introduction to Topology and Modern Analysis.McGraw-Hill.

Semester	Fifth		
Course Name	Advanced Algebra		
Category: Core	Code: BSM2502		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Understand the basic concepts of group actions and their applications.
2. Recognize and use the Sylow's theorems to characterize certain finite groups.
3. Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
4. Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

Syllabus

Module I

Group actions, Orbits and stabilizers, Conjugacy classes, Orbit-stabilizer theorem, Normalizer of an element of a group, Center of a group, Class equation of a group, Inner and outer automorphisms of a group. Cauchy's theorem for finite abelian groups, Finite simple groups, Sylow theorems and applications including non- simplicity tests. ([1] Chapter 6).

Module II

Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ring homomorphisms and isomorphisms, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field, Euclidean rings and their properties, Wilson and Fermat's theorems.([1] Chapter 7).

Module III

Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain. ([1] Chapter 9).

Module IV

Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field, Classification of finite fields.([1] Chapter 13).

Recommended Books

1. Vijay k Khanna and S K Bhambri (2013). A Course in Abstract Algebra (4th edition), Vikash Publishing House Pvt Ltd
2. David S. Dummit& Richard M. Foote (2008). Abstract Algebra (2nd edition).Wiley.
3. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
4. I. N. Herstein (2006). Topics in Algebra (2nd edition).Wiley India.
5. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition).Dover Publications.

Semester	Sixth		
Course Name	Complex Analysis		
Category: Core	Code: BSM2601		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Visualize complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere.

2. Understand the significanceofdifferentiabilityandanalyticityofcomplexfunctionsleadingtotheCauchyRiemannequations.

3.Learn the role of Cauchy Goursat theorem and Cauchy integral formula in evaluation of contour integrals.

4. Apply Liouville's theorem in fundamental theorem of algebra.

5. Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

SYLLABUS

Module I

Complex numbers and their representation, algebra of complex numbers, Complex plane,Open set, Domain and region in complex plane, Stereographic projection and Riemannsphere, Complex functions and their limits including limit at infinity, Continuity ([1]Chapter 1,2).

Module II

Differentiabilityof a complex valued function, Analytic functions, CauchyRiemannequations, sufficient conditions for differentiability,Harmonicfunctions,Analyticity and zeros ofexponential, trigonometric and logarithmic functions, Branch cutandbranchofmulti-valuedfunctions ([1]Chapter 2,3).

Module III

Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy Goursat theorem(without proof), Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Moreara's theorem, Maximum Moduli of functions, Liouville's theorem, Fundamental theorem of algebra ([1]Chapter 4).

Module IV

Sequences, series and their convergence, Power series, Radius of convergence, Taylor series, Laurent series, Nature of singularities, Residues, Cauchy's residue theorem, Jordan's lemma, Evaluation of proper and improper integrals ([1]Chapter 5,6).

Recommended Books:

1. James Ward Brown &Ruel V. Churchill (1990). Complex Variables and Applications (Vth edition).McGraw-Hill Education.
2. Lars V. Ahlfors (2017). Complex Analysis (3rd edition). McGraw-Hill Education.
3. Joseph Bak& Donald J. Newman (2010). Complex Analysis (3rd edition). Springer.
4. John B. Conway (1973). Functions of One Complex Variable.Springer-Verlag.
5. E.T. Copson (1970). Introduction to Theory of Functions of Complex Variable.Oxford University Press.
6. Theodore W. Gamelin (2001). Complex Analysis.Springer-Verlag.
7. George Polya& Gordon Latta (1974). Complex Variables.Wiley.
8. H. A. Priestley (2003). Introduction to Complex Analysis.Oxford University Press.
9. E. C. Titchmarsh (1976). Theory of Functions (2nd edition). Oxford University Press.

Semester	Sixth		
Course Name	Numerical Analysis		
Category: Core	Code: BSM2601		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Obtain numerical solutions of algebraic and transcendental equations.
2. Find numerical solutions of system of linear equations and check the accuracy of the solutions.
3. Learn about various interpolating and extrapolating methods.
4. Solve initial and boundary value problems in differential equations using numerical methods.
5. Apply various numerical methods in real life problems.

Syllabus

Module I

Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence ([1] Chapter 1), Bisection method, False position method, Fixed point iteration method, Newton's method and secant method for solving equations([1]Chapter2).

Module II

Partial and scaled partial pivoting, Lower and upper triangular (LU) decomposition of a matrix and its applications, Thomas method for tridiagonal systems, Gauss–Jacobi, Gauss–Seidel and successive over-relaxation (SOR) methods ([1] Chapter 3).

Module III

Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation, Finite difference operators, Gregory–Newton forward and backward difference interpolations ([1] Chapter 5). First order and higher order approximation for first derivative, Approximation for second derivative Numerical integration: Trapezoidal rule, Simpson's rules and error analysis ([1] Chapter 6).

Module IV

Bulirsch–Stoer extrapolation methods, Richardson extrapolation ([1]Chapter 6). Euler’s method, Runge–Kutta methods, Higher order one step method ([1] Chapter 7), Multi-step methods, Finite difference method, Shooting method ([1] Chapter 8).

RecommendedBooks

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

Semester	Fifth		
Course Name	Tensors and Differential Geometry		
Category: DSE-I	Code: BSM2551		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Explain the basic concepts of tensors.
2. Understand role of tensors in differential geometry.
3. Learn various properties of curves including Frenet-Serret formulae and their applications.
4. Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae.
5. Understand the role of Gauss's Theorem a Egregium and its consequences.
6. Apply problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

SYLLABUS

Module I

Contravariant and covariant vectors, Transformation formulae, Tensor product of two vector spaces, Tensor of type (r, s), Symmetric and skew-symmetric properties, Contraction of tensors, Quotient law, Inner product of vectors([1] Chapter 1).

Module II

Fundamental tensors, Associated covariant and contravariant vectors, Inclination of two vectors and orthogonal vectors, Christoffel symbols, Law of transformation of Christoffel symbols, Covariant derivatives of covariant and contravariant vectors, Covariant differentiation of tensors, Curvature tensor, Ricci tensor, Curvature tensor identities ([1] Chapter 2,3 & 4).

Module III

Arc length, Curvature and the Frenet - Serret formulae, Fundamental existence and uniqueness theorem for curves, Non-unit speed curves([1] Chapter 5).

Module IV

The first fundamental form, Arc length of curves on surfaces, Normal curvature, Geodesic curvature, Gauss and Weingarten formulae, Geodesics, The second fundamental form and the Weingarten map, Principal, Gauss and mean curvature, Isometries of surfaces, Gauss's Theorem a Egregium, The fundamental theorem of surfaces ([1] Chapter 5,6,7 & 8).

Recommended Books

1. P.K. Nayak, Textbook of Tensor Calculus and Differential Geometry, PHI Learning Pvt. Ltd.
2. Christian Bär (2010). Elementary Differential Geometry.Cambridge University Press.
3. Manfredo P. doCarmo (2016). Differential Geometry of Curves & Surfaces (Revised and updated 2nd edition). Dover Publications.
4. AlferdGray (2018). Modern Differential Geometry of Curves and Surfaces with Mathematica (4th edition).Chapman & Hall/CRC Press, Taylor & Francis.
5. Richard S. Millman& George D. Parkar (1977). Elements of Differential Geometry.Prentice-Hall.
6. R. S. Mishra (1965). A Course in Tensors with Applications to Riemannian Geometry. PothishalaPvt. Ltd.
7. SebastiánMontiel& Antonio Ross (2009). Curves and Surfaces.American Mathematical Society.

Semester	Fifth		
Course Name	Boolean Algebra & Automata		
Category: DSE-I	Code: BSM2552		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

1. Acquire the knowledge of Lattices and Boolean algebra.
2. Able to optimize simple logic using Karnaugh maps.
3. Develop a strong background in reasoning about finite state automata and formal languages.

SYLLABUS

Module I

Definition, examples and basic properties of ordered sets, maps between orderedsets, duality principle, lattices as ordered sets, lattices as algebraic structures, sub lattices, productsand homomorphism. ([1] Chapter7).

Module II

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.([1]Chapter10).

Module III

Introduction: Alphabets, strings, and languages, Finite Automata and RegularLanguages: deterministic and non-deterministic finite automata, regular expressions, regularlanguages and their relationship with finite automata, pumping lemma and closure propertiesofregularlanguages.([2] Chapter3, 4 &5).

ModuleIV

Context Free Grammars and Pushdown Automata: Context free grammars(CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) andthe language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties ofcontextfreelanguages. ([2] Chapter6 &7).

Recommended Books:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, 7th Ed., McGraw-Hill, Indian Edition, 2012.

2. K. L. P. Mishra and N. Chandrasekaran, Theory of Computer Science, Automata, Languages and Computation, 3rd Ed. Printice Hall of India Pvt. Ltd., New Delhi, 2008.
3. Peter Linz, Formal Languages and Automata, Narosa Publishing House, New Delhi. [4].B. A. Davey and H. A. Priestley, Introduction to Lattices and Order, CambridgeUniversity Press, Cambridge, 1990.
4. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore), Indian Reprint 2003.
5. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Semester	Fifth		
Course Name	Integral Transforms and Fourier Analysis		
Category: DSE-I	Code: BSM2553		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Know about piece wise continuous functions, Laplace transforms and its properties.
2. Solve ordinary differential equations using Laplace transforms.
3. Familiarise with Fourier transforms of functions belonging to$L^1(\mathbb{R})$ class, relation between Laplace and Fourier transforms.
4. ExplainParseval'sidentity,Plancherel'stheoremandapplicationsofFouriertransforms toboundaryvalueproblems.
5. LearnFourierseries,Bessel'sinequality,termbytermdifferentiationandintegrationofF ourierseries.
6. Apply the concepts of the course in real life problems.

SYLLABUS

Module I

Laplace transform, Linearity, First Shifting theorem, Change of scale property, Existence theorem, Laplace transforms of derivatives andintegrals, Laplace transforms of periodicfunctions, Dirac Delta function([1] Chapter 6).

Module II

Convolution theorem, Integral equations, Differentiation and integration of transforms, Inverse Laplace transform, Linearity property of inverse Laplace transform, Inverse transform of derivatives, Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations ([1] Chapter 6).

Module III

Fourier series, Absolute and uniform convergence of Fourier series, Fourier cosine and sine series, Differentiation and integration of Fourier series, Bessel's inequality, The complex form of Fourier series([1] Chapter 11).

Module IV

Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier sine and cosine transforms, Linearity property, Change of scale property, Shifting property, Modulation Theorem, Relation between Fourier and Laplace transforms. Solution of integral equation by Fourier sine and cosine transforms, Convolution theorem for Fourier transform, Fourier transform of derivatives, Applications of infinite Fourier transforms to boundary value problems ([2] Chapter 20).

Recommended Books:

1. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
2. B.S. Grewal, Higher Engineering Mathematics, 33rd Edition-Fifth reprint, Khanna Publishers.
3. Charles K. Chui (1992). An Introduction to Wavelets.Academic Press.
4. Walter Rudin (2017). Fourier Analysis on Groups. Dover Publications.
5. A. Zygmund (2002).Trigonometric Series (3rd edition). Cambridge University Press.

Semester	Fifth		
Course Name	Linear Programming		
Category: DSE-II	Code: BSM2554		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Analyse and solve linear programming models of real life situations.
2. Provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
3. Understand the theory of the simplex method.
4. Know about the relationships between the primal and dual problems, and to understand sensitivity analysis.
5. Learn about the applications to transportation, assignment and two-person zero-sum game problems.

SYLLABUS

Module I

Formulation, Canonical and standard forms, Graphical method, Convex and polyhedral sets, Hyperplanes, Extreme points, Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points, Optimality criterion, Improving a basic feasible solution, Simplex algorithm Unboundedness, Unique and alternate optimal solutions ([1] Chapter 2 & 3).

Module II

Artificial variables,Two-phase method, Big-M method ([1] Chapter 3),Duality, formulation of the dual problem, primal-dual relationships, dual simplex method ([1] Chapter 4).

Module III

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem([1] Chapter 5).

Module IV

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games. ([1] Chapter 13).

Recommended Books:

1. Hamdy A. Taha, Operation Research: An Introduction, 8th Ed., Prentice-Hall India,2007.
2. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming andNetwork Flows, 2ndEd., John Wiley and Sons, India, 2004.
3. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
4. F.S. Hillierand G.J. Lieberman, Introduction to Operations Research, 9thEd., Tata
5. McGraw Hill, Singapore, 2009.

Semester	Fifth		
Course Name	Analytical Geometry		
Category: DSE-II	Code: BSM2555		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Understand how to analyze and synthesize given data to solve problems in geometry.
2. Find the polar equation of a line, circle , tangent and normal to conics.
3. Explain the ideas of conics and their various applications.

SYLLABUS

Module I

General equation of second degree ([1] Chapter 2), polar equation of a conic and its properties. ([1]Chapter4), system of conics,([1]Chapter5),confocal conics.([1]Chapter6).

ModuleII

Three dimensional system of co-ordinates ([1]Chapter1), projection and direction cosines ([1] Chapter 1), Plane([1]Chapter1), Straight line.([1]Chapter1).

ModuleIII

Sphere([1]Chapter2), cone([1]Chapter3) and cylinder([1]Chapter3).

Module IV: Central conicoids ([1] Chapter 4), Plane sections of general conicoids ([1]Chapter 6), Generating lines of conicoids ([1] Chapter 7), reduction of general equation ofseconddegree ([1] Chapter9).

RecommendedBook:

1. R. Ballabh, A Text Book of Co-Ordinate Geometry, 12th Ed.Prakashan Kendra, Lucknow, 1987.
2. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
3. R. J. T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.

Semester	Sixth		
Course Name	Mathematical Modeling		
Category: DSE-II	Code: BSM2556		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Able to assess and articulate what type of modeling techniques are appropriate for a given physical system.
2. Construct a mathematical model of a given physical system and analyze it.
3. Learnt to predictions of the behavior of a given physical system based on the analysis of its mathematical model.

SYLLABUS

Module I

Introduction to Mathematical modeling, its need, techniques and classifications. Linear growth and decay model and its uses in modelling dynamical and geometrical problems, mathematical modeling in population dynamics and Economics([1] Chapter 1, 2&3).

ModuleII

Compartmental model, exponential decay model, Mathematical Modeling in Economics, Exponential growth of population ([1] Chapter2 &3).

Module III

Modeling through linear programming; graphical solution, simplex method([1]Chapter10).

Module IV

Mathematical models on environmental pollution: air and water pollution([1]Chapter6).

RecommendedBooks:

1. J. N. Kapur,MathematicalModeling, New Age International Publisher, 2005.
2. Frank R. Giordano, D. Maurice Weir and William P. Fox: A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.
3. J. N. Kapur,MathematicalModeling in medicine and Biology, New Age Publication. [4].D. N. Burghes,MathematicalModeling in the Social Management and Life Science, Ellie Herwood and John Wiley.

Semester	Sixth		
Course Name	Advanced Mechanics		
Category: DSE-III	Code: BSM2651		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Understand the reduction of force system in three dimensions to a resultant forceacting at a base point and a resultant couple, which is independent of the choice of base of reduction.
2. Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.
3. Know the inertia constants for a rigid body and the equation of momental ellipsoidtogetherwiththeideaofprincipalaxesandprincipalmomentsofinertiaandtode riveEuler'sequationsofmotionofarigidbody, moving about a point which is kept fixed.
4. Study the kinematics and kinetics of fluid motions to understand the equation ofcontinuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.
5. Deal with two-dimensional fluid motion using the complex potential and also tounderstand the concepts of sources, sinks, doublets and the image systems of thesewithregardtoalineandacircle.

Syllabus

Module I

Forces in three dimensions, Reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches Nul points, lines and planes with respect to a system of forces, Conjugate forcesandconjugatelines([1] Chapter XI).

Module II

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

Module III

Lagrangian and Eulerian approaches, Material and convective derivatives, Velocity of a fluid at a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Boundary surface, Stream lines and path lines, Steady and unsteady flows, Velocity potential, Rotational and irrotational motion, Vorticity vector and vortex lines ([2] Chapter 2).

Module IV

Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates,Bernoulli'sequation([2] Chapter 3),Stream function, Complex potential, Basic singularities, Sources, sinks, doublets, complexpotential due to these basic singularities,MilneThomsoncircletheorem([2] Chapter 5),

Recommended Books

1. S. L. Loney (2006). An Elementary Treatise on Statics, Kalyani Publishers, New Delhi.
2. A. S. Ramsay (1960). A Treatise on Hydromechanics, Part-II Hydrodynamics. G. Bell & Sons.
3. F. Chorlton (1967). A Textbook of Fluid Dynamics.CBS Publishers.
4. Michel Rieutord (2015). Fluid Dynamics An Introduction. Springer.
5. E. A. Milne (1965). Vectorial Mechanics, Methuen &Co.Limited. London.

Semester	Sixth		
Course Name	Number Theory		
Category: DSE-III	Code: BSM2652		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Acquire the basic knowledge of Elementary Number Theory.
2. Apply the knowledge of Number Theoretic Problems in practical situations.
3. Understand various theorems associated with Number Theory.

SYLLABUS

ModuleI

Divisibity Theorem in Integers, Primes and their Distributions, Fundamental Theorem of Arithmetic, Greatest Common Divisor, Euclidean Algorithms, Modular Arithmetic, Linear Diophantine Equation([1]Chapter2), Prime Counting Function, Statement of Prime Number theorem, Gold Bach Conjecture([1] Chapter3).

ModuleII

Introduction to Congruence, Linear Congruence. Chinese Remainder Theorem ([1] Chapter 4) Polynomial Congruence, System of Linear Congruence, complete set of Residues, Fermat's Little Theorem, Wilsons Theorem ([1]Chapter5).

ModuleIII

Number Theoretic Functions, Sum and Number of Divisors, Totally Multiplicative Functions, Definition and Properties of the Dirichlet Product, the Mobius Inversion Formula, the Greatest Integer Function ([1]Chapter6), Euler's Phi function, Euler's Theorem, Reduced Set of Residues, Some Properties of Euler's Phi-Function ([1]Chapter7).

Module IV

Order of an Integer Modulo N, Primitive Roots for Primes, Composite Numbers Having Primitive Roots ([1] Chapter 8), Euler's Criterion, The Legendre Symbol and its Properties, Quadratic Reciprocity, Quadratic Congruence with Composite Moduli ([1]Chapter6).

RecommendedBook:

1. D. M. Burton: Elementary Number Theory, (6thEditiobn), McGraw Hill.

2. K.H. Rosen: Elementary Number Theory & its Applications, Pearson Addition Wesley.
3. I. Niven and H.S. Zuckerman: An Introduction to Theory of Numbers, Wiley Eastern Pvt. Ltd.
4. Neville Robinns, Beginning Number Theory (2nd Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.

Semester	Sixth		
Course Name	Industrial Mathematics		
Category: DSE-III	Code: BSM2653		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Understand how to analyze and synthesize given data to solve problems in geometry.
2. Find the polar equation of a line, circle, tangent and normal to conics.
3. Explain the ideas of conics and their various applications.

SYLLABUS

Module I:

Medical Imaging and Inverse Problems: The content is based on Mathematics ofX-ray and CT scan based on the knowledge of calculus, Elementary differential equations,Complex numbers and matrices([1] Chapter 1 & 4).

Module II

Introduction to Inverse problems: Illustration of Inverse problems in Pre-Calculus, Calculus, Matrices and differential equations, Geological anomalies in Earth'sinterior frommeasurements at its surface (Inverse problems for Natural disaster) andTomography([1] Chapter 5 & 8).

Module III

X-ray: Introduction, X-ray behavior and Beers Law (The fundament question ofimageconstruction), Lines in the place, Radon Transform: Definition and Examples,Linearity, Phantom (Shepp-Logan, Phantom–Mathematical phantoms), Back Projection,Definition, Properties and examples([1]: Chapter 1, 2 & 3).

Module IV

CT scan: Revision of properties of Fourier and inverse Fourier transforms andapplications of their properties in image reconstruction, Algorithms of CT scan machine,Algebraicreconstruction techniques abbreviated as ART with application to CT scan([1]Chapter 5, 9 & 10).

Recommended Books:

1. Timothy G. Feeman,*The Mathematics of Medical Imaging, A Beginners Guide*,Springer Under graduate Text in Mathematics and Technology, Springer, 2010.
2. C.W. Groetsch,*Inverse Problems, Activities for Undergraduates*, The Mathematical
3. Association of America, 1999.
4. Andreas Kirsch,*An Introduction to the Mathematical Theory of Inverse Problems*, 2nd
5. Ed., Springer, 2011.

Semester	Sixth		
Course Name	Graph Theory		
Category: DSE-III	Code: BSM2654		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

CourseLearningOutcomes:

1. Acquire the basic ideas of Graphs.
2. Able to solve the problems on walk, path and circuits.
3. Know the applications of shortest path, Dijikstra's algorithm and FloyedWarshall algorithm.

SYLLABUS

Module I

Examples and basic properties of graphs, finite and infinite graphs, incidence anddegree, isolated and pendent vertices, Null graph, pseudo graph, complete graph, bipartitegraph ([1] Chapter 1).

Module II

Isomorphism, subgraphs, walk, path and circuits, connected graph, disconnectedgraph and components ([1] Chapter 2).

Module III

Euler circuit, Euler graph, Chinese post man problem, Hamiltonian circuit,Hamiltoniangraph, travelling salesman problem ([1] Chapter 2).

Module IV

Adjacency matrix, weighted graph, shortest path, Dijikstra's algorithm, Floyed-Warshall algorithm. ([1] Chapter 7 & 11).

Recommended Books:

1. NarsinghDeo, *Graph Theory with Applications to Engineering and Computer Science*,Prentice Hall.
2. B. A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, CambridgeUniversityPress, Cambridge, 1990.

3. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with GraphTheory*, 2ndEdition, Pearson Education (Singapore), Indian Reprint 2003.
4. Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra*, 2nd Ed., UndergraduateTexts inMathematics, Springer (SIE), Indian reprint, 2004.

Semester	Sixth		
Course Name	Cryptography		
Category: DSE-III	Code: BSM2655		Credits: 6
L-5 T-1 P-0	Exam: Theory 3 hrs.	ESE: 60 Marks	CIA: 40 Marks

Course Learning Outcomes:

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

SYLLABUS

Module I

Cryptosystems and basic cryptographic tools: Secret-key cryptosystems, Public-keycryptosystems, Block and stream ciphers, Hybrid cryptography, Message integrity: Messageauthentication codes, Signature schemes, Nonrepudiation, Certificates, Hash functions,Cryptographic protocols, Security; Hybrid cryptography: Message integrity, Cryptographicprotocols, Security, Some simple cryptosystems, Shift cipher, Substitution cipher, Affinecipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis ofaffine, substitution, Vigenère, Hill and LFSR stream ciphers.

Module II

Shannon's theory, Perfect secrecy, Entropy, Spurious keys and unicity distance; Bitgenerators, Security of pseudorandom bit generators. Substitution-permutation networks,Data encryption standard (DES), Description and analysis of DES; Advanced encryptionstandard (AES), Description and analysis of AES; Stream ciphers, Trivium.

Module III

Basics of number theory; Introduction to public-key cryptography, RSA cryptosystem, Implementing RSA; Primality testing, Legendre and Jacobi symbols, Solovay Strassen algorithm, Miller Rabin algorithm; Square roots modulo n, Factoring algorithms, Pollardp -1 algorithm, Pollard rho algorithm, Dixon's random squares algorithm, Factoringalgorithms in practice; Rabin cryptosystem and its security.

Module IV

Basics of finite fields; ElGamal cryptosystem, Algorithms for the discrete logarithmproblem, Shanks' algorithm, Pollard rho discrete logarithm algorithm, Pohlig-Hellmanalgorithm; Discrete logarithm algorithms in practice, Security of ElGamal systems, Bitsecurity of discrete logarithms.Hash functions and data integrity, SHA-3; RSA signature scheme, Security requirements forsignature schemes.

Recommended Books:

1. Jeffrey Hoffstein, Jill Pipher& Joseph H. Silverman (2014). *An Introduction to*
2. *Mathematical Cryptography* (2nd edition). Springer.
3. Neal Koblitz (1994). *A Course in Number Theory and Cryptography* (2nd edition).
4. Springer-Verlag.
5. ChristofPaar& Jan Pelzl (2014). *Understanding Cryptography*. Springer.
6. Simon Rubinstein-Salzedo (2018). C*ryptography*. Springer.
7. Douglas R. Stinson & Maura B. Paterson (2019). *Cryptography Theory and Practice*
8. (4th edition). Chapman & Hall/CRC Press, Taylor & Francis.