Gujarat University

Choice Based Credit System

Revised Syllabus for Under Graduate (B. Sc.) Mathematics

Effective from June-2022

PROGRAMME EDUCATIONAL OBJECTIVES (POs) FOR B. Sc. MATHEMATICS

Our programme will produce Graduates who will attain following PEOs after three years of graduation		
PEO1	**:**	**Core competency:** will develop the competency to pursue higher education or successful professional career with synergistic combination of the knowledge and skills of mathematics and allied sciences.
PEO2	**:**	**Breadth of knowledge:** will show capabilities of independently designing, executing and interpreting mathematical problems by integrating the interdisciplinary knowledge of Mathematics and other domains.
PEO3	**:**	**Preparedness:** will reflect professional behaviour and have the potential to show preparedness to take any task or assignment in the capacity of a leader or team member in their chosen occupations or careers and communities.
PEO4	**:**	**Professionalism:** will reflect values and responsibilities in the character to make them fit to work in a multidisciplinary team and to become socio-ethically responsible citizen.
PEO5	**:**	**Learning environment:** will show attitude of self-learning abilities and keep themselves abreast with new development in all spheres of life.

PROGRAM OUTCOMES (POs) FOR B. Sc. MATHEMATICS

After completion of the programme the Graduate will be able to:		
PO1	:	**Domain knowledge:** Demonstrate the knowledge of concepts, principles and applications of Mathematics in various fields.
PO2	:	**Problem analysis:** Acquire critical thinking skills to understand and solve contemporary problems with knowledge and skills.
PO3	:	**Design/development of solutions:** Make decisions to develop solutions to given situations/questions, formulate strategies to identify, define and solve problems including, as necessary, global perspectives.
PO4	:	**Conduct investigations of complex problems:** Gain ability to design, conduct experiments, analyse and interpret data for investigating problems in Mathematics and allied sectors
PO5	:	**Modern tool usage:** The ability to acquire, develop, employ and integrate a range of technical, practical and professional skills, in appropriate and ethical ways within a professional context, autonomously and collaboratively and across a range of disciplinary and professional areas.
PO6	:	**The Mathematics Professional and society:** An awareness of the role of science within a global culture and willingness to contribute to the shaping of community views on complex issues where the methods and findings of science are relevant.
PO7	:	**Communication:** Communicate effectively using different modes (viz. written, verbal and digital) not only with scientific community but also with the society at large.
PO8	:	**Life-long learning:** Able to recognize the need to undertake life-long learning and acquire the capacity to do so.

PROGRAMME SPECIFIC OUTCOME (PSOs) FOR B. Sc. MATHEMATICS

After completion of the programme the Graduate will:		
PSO1	:	Understand the advanced concepts of mathematics and demonstrate the ability to apply the knowledge of mathematics at an advanced level.
PSO2	:	Collect, organize and adapt contemporary knowledge effectively and utilize appropriate computational tools independently and analyse and perform a broad variety of mathematical experiments using mathematical software and internet.
PSO3	:	Develop and apply new theories of mathematics to solve a broad variety of problems involving mathematics.
PSO4	:	Apply critical thinking skills for the sustainable development and develop the knowledge and skills to secure employment.
PSO5	:	Exhibit the capacity to identify, formulate, and solve problems pertaining to mathematics through research and critically evaluate the theoretical results and recognize the need for, and an ability to engage in life–long learning.

Design and Structure of B. Sc. Semester based Credit system to be implemented from June-2022

Department	Semester		Course	No. of Hours per Week				Course Credits
			Name	Lectures	Others	Practi-cals	Total	
MATHEMATICS	1	EC 101	Mathematics Basics and Quantitative Skills	3	-	-	3	2
		MAT101	Calculus – I	4	-	-	4	4
		MAT102	Calculus - I Practicals	-	-	4	4	3
			Total	7	-	4	11	9
	2	MAT103	Calculus – II	4	-	-	4	4
		MAT104	Calculus - II Practicals	-	-	4	4	3
			Total	4	-	4	8	7
	3	MAT201	Linear Algebra – I	4	-	-	4	4
		MAT202	Group Theory	4	-	-	4	4
		MAT203	Practicals (Based on MAT201, MAT202)	-	-	6	6	2.5
			Total	8	-	6	14	10.5
	4	MAT204	Linear Algebra – II	4	-	-	4	4
		MAT205	Ring Theory	4	-	-	4	4
		MAT206	Practicals (Based on MAT204, MAT205)	-	-	6	6	2.5
			Total	8	-	6	14	10.5
	5	MAT301	Numerical Methods	4	-	-	4	4
		MAT302	Analysis – I	4	-	-	4	4
		MAT303	Complex Variables and Fourier Series	4	-	-	4	4
		MAT304	Mathematical Programming	4	-	-	4	4
		MAT305E	C Programming for Mathematical Problems	3	-	-	3	2
			Discrete Mathematics					
			Financial Mathematics					
			Number Theory					
		MAT306	Practical - I (Based on MAT301, MAT302)	-	-	12	12	5
			Practical - II (Based on MAT303, MAT304)					
			Total	19	-	12	31	23
	6	MAT307	Coordinate Geometry	4		-	4	4
		MAT308	Analysis - II	4	-	-	4	4
		MAT309	Analysis - III	4	-	-	4	4
		MAT310	Graph Theory	4	-	-	4	4
		MAT311E	Cryptography	3	-	-	3	2
			Operations Research					
			Bio-Mathematics					
			Mechanics					
			Convex Analysis and Probability Theory					
		MAT312	Practical - I (Based on MAT307, MAT308)	-	-	12	12	5
			Practical - II (Based on MAT309, MAT310)					
			Total	19	-	12	31	23
			Grand Total (for Mathematics only)				109	83

Syllabus for Semester – I (MATHEMATICS)

EC 101: Mathematical Basics and Quantitative skills

Hours: 3/week Credits: 2

Unit I Trigonometry

Unit circle, trigonometric functions, values of trigonometric function at distinct points, relation among trigonometric functions, trigonometric formulae, $\sin(x \pm y)$, $\cos(x \pm y)$, $\tan(x \pm y)$, $\sin c \pm \sin d$, $\cos c \pm \cos d$, $2 \sin x \cos y$ (and others),

inverse of trigonometric functions.

Unit II Co-ordinate Geometry and Vectors

Distance Formula, Section Formula, Equation of a line and its slope, intersection of two lines, Equation of a circle and its tangent, elementary vector algebra.

Unit III Limit and Differentiation

Right hand limit, Left hand limit and limit of a function $\lim_{x \to 0} \frac{x^n - a^n}{x - a}$, $\lim_{x \to 0} \frac{\sin x}{x}$, $\lim_{h \to 0} \frac{a^h - 1}{h}$ and $\lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$, continuity, derivative of x^n, e^x, trigonometry functions, inverse trigonometry functions, chain rule, geometric meaning of derivative.

Unit IV Integration

Integration of x^n, e^x, trigonometry functions, well known functions like $\frac{1}{x^2 \pm a^2}$, $\frac{1}{\sqrt{x^2 \pm a^2}}$, $\sqrt{x^2 \pm a^2}$, Method of substitution, integration by parts, definite integral (Up to Fundamental Theorem of Integral Calculus)

N.B. All the results / formulae are without proof.

Reference Books:

1) Gujarat Rajya Pathya Pustak Mandal for std 11 and std 12.
2) A Textbook for class XI & XII, National Council of Educational Research and Training.
3) A Class Book of Mathematics for class XII by Chakrabarty S. K., Biswajit Bhagwati, S. Chand Publishers.
4) Short Calculus by Serge Lang, Springer (India).

Syllabus for Semester – I (MATHEMATICS)

MAT101: CALCULUS - I

UNIT I

(a) Successive Derivatives, Standard results for n derivative, Leibniz's theorem.

(b) Taylor's and Maclaurin's theorems, Using Taylor's and Maclaurin's theorems find power series of various functions.

UNIT II

(a) Roll's Theorem, Lagrange's and Cauchy's Mean Value Theorem, Increasing and decreasing functions.

Indeterminate forms: L' Hospital Rules.

UNIT III

(a) Introduction to function of several variables, Limit – Continuity of function of several variables and partial derivatives.

(b) Vector Analysis, different notations and its geometric interpretation.

UNIT IV

(a) Differential Equations of First order and First Degree:
Variable Separable, Homogeneous & non – homogeneous Differential Equations, Exact Differential Equations, Integrating factors, Linear Differential Equations of First order and First Degree, Bernoulli's Differential Equations.

(b) Method of solving Differential Equations of First order and higher degree:
Solvable for y, Solvable for x, Solvable for p, Clairaut's Differential Equation, Lagrange's Differential Equation.

Reference Books:

1) Calculus and Analytic Geometric – G. B. Thomas & R. L. Finney. Pearson Education. Indian Reprint
2) Calculus – James Stewart, Sixth Edition (E -Book)
3) Calculus - T. M. Apostol. Volume – I
4) Differential Calculus – Shanti Narayan, P. K. Mittal, S. Chand & Co
5) Differential Calculus – Harikishan, Atlantic Publishers
6) Calculus – M. Spivak
7) Mathematical Analysis – S. C. Malik & Savita Arora, Second Edition, New Age Int. (P) Ltd
8) Differential Calculus – Shanti Narayan
9) Calculus – James Stewart

Syllabus for Semester – I (MATHEMATICS)

MAT102: CALCULUS - I PRACTICAL

UNIT I: Problems based -Successive Derivative, Leibniz's theorem

UNIT II: Problems on Mean Value Theorems and L' Hospital Rule

UNIT III: Example of Limit, Continuity, & Differentiation of function of several variables using definition and Problems based on Vector Analysis

UNIT IV: Problems on solving differential equations

Reference Books:

1) Calculus and Analytic Geometric – G. B. Thomas & R. L. Finney. Pearson Education. Indian Reprint
2) Calculus – James Stewart, Sixth Edition (E -Book)
3) Calculus - T. M. Apostol. Volume – I
4) Differential Calculus – Shanti Narayan, P. K. Mittal, S. Chand & Co
5) Differential Calculus – Harikishan, Atlantic Publishers
6) Calculus – M. Spivak
7) Mathematical Analysis – S. C. Malik & Savita Arora, Second Edition, New Age Int. (P) Ltd
8) Differential Calculus – Shanti Narayan
9) Calculus – James Stewart

Syllabus for Semester – II (MATHEMATICS)

MAT103: CALCULUS - II

UNIT I

Differentiability of function of several variables:
Differential of function of two variables, Total derivative, Harmonic function, Schwartz's theorem and Young's theorem, Derivatives of implicit functions.

UNIT II

Homogeneous functions, Euler's theorem for homogeneous functions of n – variables, Extreme values of functions of two variables and its theorems, Lagrange's method of undetermined multipliers.

UNIT III

Applications of Partial derivatives:
Taylor's theorem for function of two variables, Maclaurin's theorem, problems on Taylor and Maclaurin theorems, Concept of multiple points, double points, different types of double points and examples, radius of curvature for Cartesian – Parametric – Polar equations of a curve in R^2.

UNIT IV

Multiple Integral: - Introduction to double Integral, repeated or iterated integral, double integral over a closed region, evaluation of double integral, changing the order of double integral, triple integrals, iterated triple integrals, Geometric interpretation of double and triple integrals and problems based on it, Introduction to Jacobian, transformation of double and triple integrals.

Reference Books:

1) Mathematical Analysis – S. C. Malik & Savita Arora, Second Edition, New Age Int. (P) Ltd
2) Differential Calculus – Shanti Narayan
3) Calculus – David V. Widder – PHI – Second Edition
4) Advance Calculus Volume – II – T. M. Apostol
5) Calculus – James Stewart
6) Calculus with Early Transcendental functions - James Stewart, Indian Edition, Engage learning India Pvt. Ltd.
7) Calculus and Analytic Geometry - G. B. Thomas & R. L. Finney Addition, Wesley pub. India
8) A course in Multivariable Calculus & Analysis – S. R. Ghorpade & B. V. Limaye, Springer, India

Syllabus for Semester – II (MATHEMATICS)

MAT104: CALCULUS – II PRACTICAL

UNIT I

Practical based on Differentiability of function of several variables: - Practical based on Homogeneous functions of n – variables, Extreme values of functions of two variables, Lagrange's method of undetermined multipliers.

UNIT II

Practical based on Applications of Partial derivatives: - Problems on Taylor's theorems, Concept of multiple points, double points, different types of double points and examples, radius of curvature for Cartesian – Parametric – Polar equations of a curve in R^2.

UNIT III

Example based on Beta and Gama function: - Beta and gamma functions examples using Definition and properties, examples using relation between beta and gamma functions, examples using duplication formula, examples using evaluation of definite integrals.

UNIT IV

Example of Line surface and Volume Integral: - examples using definition of Line, Surface and Volume Integral, examples based on Green theorem, Gauss's- divergence theorem and Stoke's theorem.

Reference Books:

1) Mathematical Analysis – S. C. Malik & Savita Arora, Second Edition, New Age Int. (P) Ltd
2) Differential Calculus – Shanti Narayan
3) Calculus – David V. Widder – PHI – Second Edition
4) Advance Calculus Volume – II – T. M. Apostol
5) Calculus – James Stewart
6) Calculus with Early Transcendental functions - James Stewart, Indian Edition, Engage learning India Pvt. Ltd.
7) Calculus and Analytic Geometry - G. B. Thomas & R. L. Finney Addition, Wesley pub. India
8) A course in Multivariable Calculus & Analysis – S. R. Ghorpade & B. V. Limaye, Springer, India

Syllabus for Semester - III (MATHEMATICS)

MAT201 LINEAR ALGEBRA-I

UNIT I

Vector space: Definition of vector space, examples, results, subspaces, examples, results, theorems on subspace, intersection, union, addition and direct sums of subspaces.

UNIT II

Dimension theorem of vector space

Definition of Linearly independence, Linearly dependence, Finite linear combination, examples and results, dimension and basis of vector space, examples, results, dimension theorem, examples on dimension theorem.

UNIT III

Linear transformation: Definition of linear transformation, examples, results, range, kernel, rank & nullity of linear transformations, examples and results, rank-nullity theorem, examples, results, verification of rank-nullity theorem.

UNIT IV

Matrices: Matrix associated with linear map, linear map associated with matrix, examples, results, linear operations in $\mu_{m,n}$, define L(U,V) and isomorphism between μ,n & L(U,V), dimension theorem $\mu_{m,n}$ & L(U,V), rank nullity of matrices examples, verifications.

Reference Books

1) An Introduction to Linear Algebra- V. Krishnamurthy, V P Mainra, J L Arora, East-West press pvt Ltd., New Delhi.
2) Linear Algebra Geometric Approach – S. Kumaresan , PHI.

Syllabus for Semester - III (MATHEMATICS)

MAT202 Group Theory

UNIT I

Relation, Binary operations & Groups: Relation, Equivalence Relation, Partition of set, Binary operations. Division Algorithm for Integers, Congruence modulo Relation in Z, Definition and Examples of Groups, Elementary properties of Group, Equivalent Definitions of a Group, Finite Groups and their tables, Commutative and non-commutative groups.

UNIT II

Subgroups & Lattice diagrams: Subgroups: Definition and Examples, normalizer and centralizers, order of an element, order of a group, cyclic subgroup generated by an element, Lattice diagrams of finite groups, cosets and its properties, Lagrange's theorem and its applications, Euler's theorem, Fermat's theorem.

UNIT III

Permutations & Normal subgroups: Permutations: Definitions and Examples, cycle, transposition, even and odd permutations, order of a permutation, inverse of a permutation, Symmetric groups and Alternating groups. Examples, Quotient groups.

Normal subgroups: Definitions and Examples, Quotient group.

Unit IV

Homomorphism & Isomorphism of Groups: lsomorphism of groups: Definitions and Examples, lsomorphism as an equivalence relation. *v•lic Groups: Properties of Cyclic Groups, lsomorphism of Cyclic Groups. Homomorphism of groups: Definitions and Examples, Kernel of a Homomorphism, Fundamental Theorem of Homomorphism, Caley's Theorem, Automorphism of Groups.

Text Book

Abstract Algebra - I. H. Sheth, PHI, New Delhi, Second edition-2009.

Reference Books

1) Topics in Algebra - I. N. Herstein, Vikas Publishing, New Delhi.
2) A First Course in Abstract Algebra — J. B. Fraleigh, Narosa Publishing, New Delhi. Basic Abstract Algebra—P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Foundation Books, New Delhi.
3) Abstract Algebra - Dipak Chatterajee, PHI Learning Pvt. Ltd, New Delhi. A survey of Modern - G. Birkhoff & S. Maclane, Algebra Univ. Press.

Syllabus for Semester – III (MATHEMATICS)

MAT203 Practical (Based on MAT201 & MAT202)

Practicals

1) Introduction to matrices, types of matrices, operations on matrices, symmetric and skew- symmetric matrices, Hermitian and Skew-Hermitian matrices.
   Examples of vector space and subspace.
2) Examples of LI set, LD set and basis of vector space.
3) Examples of verification of dimension theorem.
4) Examples of linear map.
5) Verification of rank-nullity theorem
6) Examples on matrix associated with linear map and linear map associated with matrix.
7) Examples on rank-nullity of matrices.
8) Examples of Relations and Equivalence Relations.
9) Examples of Groups.
10) Examples of Subgroups and Cyclic Subgroups
11) Examples of drawing Lattice Diagrams of Finite Groups.
12) Experiment determining even/odd permutation finding inverse of permutations and finding order of permutations.
13) Experiment of preparing group table and Lattice diagram of for symmetric groups S_3 and Examples of Normal subgroups along with Quotient groups.
14) Examples of cyclic groups, examples of group isomorphism and examples of Isomorphism between cyclic groups.
15) Experiment based on examples of group Homomorphism and finding the Kernel of Group Homomorphisms. Examples of Automorphisms.

Syllabus for Semester - IV (MATHEMATICS)

MAT204 Linear Algebra - II

UNIT I

L(U,V) and inner product space: The space L(U,V), Operator equation, linear functional, Dual spaces, bilinear forms, inner product space, examples, results, norm.

UNIT II

Gram Schmidt orthogonalization process, Cauchy-Schwartz inequality, orthogonalization and orthonormalization of basis , Gram-Schmidt orthogonalization process , orthogonal complement and its properties , orthogonal transformations.

UNIT III

Determinants: Determinants and their properties, value of determinant, Basic results, Laplace expansion, Cramer's rule.

UNIT IV

Cayley –Hamilton's theorem: Eigenvalues and Eigenvectors of linear operators and square matrices, Caley-Hamilton's theorem and its verification, Application to reduction of Quadrics, classification of Quadrics, Diagonalization of real and symmetric Matrices, Spectral Theorem.

Reference books

1) An Introduction to Linear Algebra- V. Krishnamurthy, V P Mainra, J L Arora, East-West press Pvt Ltd., New Delhi)
2) Linear Algebraa Geometric Approach – S.Kumaresan , PHI

Syllabus for Semester - IV (MATHEMATICS)

MAT205 Ring Theory

Unit I

Rings: Definition and examples, commutative ring, division ring, unity and unit elements of a ring, Field, properties of a ring, Boolean ring, Finite rings.

Integral Domain: Zero divisor, Definition and examples of Integral Domain (Finite and of infinite order), Characteristic of a ring.

Unit II

Subrings: Definition and examples, necessary and sufficient criterion for subring, Ideals: Definition and examples, necessary and sufficient criterion for ideal, principal ideal ring, quotient ring and its operation tables.

Homomorphism: Definition and some examples, Kernel of homomorphism, Isomorphism of rings, Fundamental theorem on homomorphism, homomorphism and characteristic.

Unit III

Polynomial ring: Introduction and definition of polynomial, degree of polynomial, operation between polynomials, Integral domain D[x], different types of polynomials, factorization of polynomials, Division algorithm for polynomials, irreducibility of polynomial over field, Remainder and factor theorem, solution of polynomial equation, zero of polynomial, Eisenstein's criterion for irreducibility, rational zero of polynomial.

Unit IV

Fields: Fields, Subfields, Extension field, The field of quotients and integral domain, Prime fields, Finite fields, Maximal ideals, Prime ideals and their characterization

Text Book

1) Abstract Algebra - I. H. Sheth, PHI, New Delhi, Second edition-2009.

Reference Books

1) Topics in Algebra - I. N. Herstein, Vikas Publishing, New Delhi.
2) A First Course in Abstract Algebra - J. B. Fraleigh, Narosa Publishing, New Delhi.
3) Basic Abstract Algebra - P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Foundation Books, New Delhi.
4) Abstract Algebra - Dipak Chatterajee, PHI Learning Pvt. Ltd, New

Syllabus for Semester - IV (MATHEMATICS)

MAT206 Practical (Based on MAT-204 & MAT-205)

Practicals

1) Examples of solving an operator equation.
2) Examples of Bilinear map.
3) Examples of inner product.
4) Examples of orthogonalization and orthonormalization of basis through Gram-Schmidt orthogonalization process.
5) Examples of finding value of determinant through the properties.
6) Examples of finding eigen values and eigen vectors of a square matrix.
7) Examples of the verification of Caley-Hamilton Theorem.
8) Examples of diagonalization of square matrices
9) Experiment based on examples of Rings, Commutative Rings, Non- commutative Rings. Examples of Groups.
10) Experiment based on examples of Boolean Rings, Finite Rings and Integral Domains and finding characteristics of Rings.
11) Experiment based on examples of Subrings, Left-Right Ideals, Ideals and Quotient Rings and it's operation tables.
12) Experiment based on examples of Ring Homomorphism, Kernel of Ring Homomorphism and Isomorphism of Rings.
13) Experiment based on examples of operation between polynomials, factorization of polynomials and division of polynomials in $Zn[x$
14) Experiment based on examples of reducibility or irreducibility of polynomials and Application of Eisenstein's criterion for irreducibility of polynomials and finding rational zeros of polynomials.
15) Experiment based on examples of fields, subfields, extension fields.
16) Experiment based on examples of Maximal Ideals, Prime Ideals, Finite Fields, Prime Fields and finding prime ideals and their characterization through quotient ring.

Syllabus for Semester - V (MATHEMATICS)

MAT301 Numerical Methods

Unit I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.

Unit II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Interpolation: Lagrange and Newton's methods

Unit III

Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule,

Unit IV

Composite Trapezoidal rule, Composite Simpson's rule, Ordinary Differential Equations: Euler's method. Runge-Kutta methods of orders two and four.

Reference Books

1) Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
3) C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2
4) Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
5) John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

Syllabus for Semester - V (Mathematics)

MAT302 Analysis – I (Theory)

Unit I

The Real Numbers: Set and Functions. (1.1), Mathematical induction. (1.2), Finite and infinite sets. (1.3), The Algebraic and Order properties of R. (2.1), Absolute Value and Real Line. (2.2), The completeness Property of R. (2.3), The Applications of Supremum Property. (2.4), Intervals. (2.5)

Unit II

Convergence of Sequences: Introduction. (4.1), Convergence. (4.2), Limit theorems. (4.3), Weierstrass completeness principle. (4.4), Cantor's completeness principle. (4.5), Subsequence and Bolzano- Weierstrass theorem. (4.6), Cauchy's completeness principle. (4.7)

Unit III

Functions and Continuity: Limit of Function. (3.1), Limit Theorems. (3.2), Other limits. (3.3), Continuity. (3.4), Intermediate values, extreme values. (3.5), Uniform continuity. (3.6)

Unit IV

The Derivatives: Definition of the derivative. (4.1), Rules for differentiation. (4.2), The mean value theorem. (4.3), Inverse functions. (4.4), Indeterminate forms (L' Hospital's rule). (7.5)

Books

1) An introduction to Analysis –Gerald G. Biloeau, Paul R. Thie and G. E. Keough. (For topic 1 to 4).

2) Fundamentals of Mathematical Analysis – G.Das & S Pattanayak. (For topic 5).

Syllabus for Semester - V (Mathematics)

MAT303 Complex Variables and Fourier Series (Theory)

Unit I

Complex Numbers: Sums and products (1), Basic algebraic properties (2,3), Vectors and moduli (Triangle inequality) (4), Complex conjugates (5), Exponential form (6), Product and powers in exponential form (7), Arguments of products and quotients (8), Roots of complex numbers (9,10), Region in the complex plane (11), Trigonometric functions (34), Hyperbolic functions (35), Invers trigonometric and hyperbolic functions (36), Convergence of sequences (55), Convergence of series (56)

Unit II

Analytic Functions: Functions of complex variables (12), Mappings (13), Mappings by exponential function (14), Limits (15), Theorems on limits (16), Limit involving the point at infinity (17), Continuity (18), Derivatives (19). Differentiation formulas (20), Cauchy-Riemann equations (21), Sufficient conditions for differentiability (22), Polar co-ordinates (23), Analytic functions (24, 25), Harmonic functions (26)

Unit III

Mapping by elementary functions & Conformal mappings: Linear transformations (90), The transformation $w = \frac{1}{z}$ (91), Mappings by $w = \frac{1}{z}$ (92), Linear fractional transformations (93), An implicit form (94), Preservations of angles (101), Scale factors. (102)

Unit IV

Fourier series: Introduction (10.1), Pointwise convergence of the Fourier series (Up to theorem 2, Bessel's inequality & Riemann-Lebesgue theorem.) (10.2)

Books:

1. Complex variables and applications, James Ward Brown & Ruel V. Churchil, McGraw HILL International Edition, Eighth edition). **(For UNIT I – III)**

2. A first course in Mathematical analysis – D. Somasundaram & B. Choudhry **(For UNIT IV)**

Syllabus for Semester - V (Mathematics)

MAT304 Mathematical Programming (Theory)

UNIT I

Convex Analysis and Linear Programming Problem: Convex set, Extreme point of a convex set, Convex combination, Examples of convex set and Theorems on convexity, Formulation technique of LP problems (Only examples and Graphical Method)

UNIT II

Problem solving techniques for LP Problems: Simplex method-I for solving LP Problem, Simplex method-II (Big M or Penalty method) for solving LPP, Simplex method-III (Two-Phase method) for solving LPP

UNIT III

Duality, Dual Simplex Method and Integer Programming Problem: Introduction, Definition of the dual problem, General rules for converting any primal problem into it's dual, Interpretation of the solution of its dual from primal and vice versa, Comparison of the solution of the primal and its dual, Dual simplex method

Integer Programming Problem (Only Gomory's Cutting Plane method)

UNIT IV

Transportation and Assignment Problem: Introduction of TP and Mathematical formulation of TP, Tabular Representation and Some Definitions, Methods for finding Initial basic feasible solution (North West Corner Rule, Least Cost Method, Vogel's Appro. Method), Optimality Test (MODI method), Degeneracy in TP and Unbalanced Transportation Problem

Introduction and Mathematical formulation of Assignment Problem: Method for solving Assignment Problem (Hungarian Method), Unbalanced Assignment Problem and Examples

Text Book

1) Operations Research by "Nita H. Shah , Ravi M. Gor and HardikSoni" (PHI-Learning)

UNIT I: 2.4 (pages 24 to 30) , Unit-1 (3.1 to 3.3) (pages 33 to 50)

UNIT II: (3.6 to 3.8) (Pages 58 to 85)

UNIT III: (3.9) (Pages 89 to 100) , Unit-3 (4.1 to 4.3) (Pages 125 to 127)

UNIT IV: (8.1 to 8.8) (Pages 195 to 219) , Unit-4 (9.1 to 9.3 (9.3.4)) (Pages 241 to 243)

Reference Books

1) Mathematical Models in O.R. – J. K. Sharma (Tata McGraw Hills)
2) Optimization Method in O.R. & System Analysis – K. V. Mittal, New Age
3) Operation Research – S. D. Sharma, KedarnathRamnath & Co.
4) Operation Research – Kantiswaroop & Man Mohan, Sultan Chand & Co.

Syllabus for Semester - V (Mathematics)

MAT305 (Elective Course): C Programming for Mathematical Problems (Practical)

Unit I

1) To generate the first n terms of the Fibonacci sequence, where $n \geq 1$.
2) To find the greatest common divisor and the least common multiple factorial of given two non-zero integer.
3) To find all the prime numbers in the first n positive integers.
4) To find (i) all the prime divisors (ii) all the divisors (iii) the prime power factorization of a given positive integer.

Unit II

5) To evaluate x^n for a given positive integer n and a given real number x.
6) To find the nth Fibonacci number without finding all the preceding Fibonacci numbers.
7) To remove all duplicates from an ordered array and contract the array accordingly.
8) To partition the elements of a given randomly ordered array of n elements and a given an element x into two subsets such that the elements $\leq x$ are in one subset and the elements $> x$ are in the other subset.

Unit III

9) To merge two monotonically increasing arrays into a single monotonically increasing array.
10) To sort a given randomly ordered array of n elements into non-descending order using (i) the selection sort method (ii) the exchange method (iii)Shell's diminishing increment insertion method.

Text Books

1) For "C" programming language "Programming in ANSI C" covers the course -second edition E. BALAGURUSAMY, Tata McGraw-Hill Publishing Company Limited ISBN 0-07460401-5. Chapter 1-7, 9,11,13 (omit case studies, 7.8, 9.20, 11.16, 13.14)
2) Algorithms and Practicals are covered by "How to Solve It by Computer"-R. G. Dromey (second edition) Prentice Hall of India.

Reference book:

1) Algorithms + Data Structures = Programs Niklaus Wirth-Prentice-Hall of India ISBN-81-203-05698.
2) Numerical Methods with C++ programming – Nita H Shah. PHI Learning.

Syllabus for Semester - V (Mathematics)

MAT305 (Elective Course): Discrete Mathematics (Theory)

Unit I Relation & Ordering:

Binary Relation, Reflexive, Irreflexive, Symmetric, Antisymmetric, Transitive, Partial Ordering (omit lexicographic ordering), Hasse Diagram, Upper bound, lower bound, lub, glb, Lattice as a poset, Properties of lattices.

Unit II Lattice & Boolean Algebra:

Lattice as an algebraic system (only definition), Sublattice, Homomorphism, Some Special Lattices, Boolean Algebra, Subalgebra, Direct Product, Homomorphism, Join Irreducible, Atoms.

Unit III Boolean Expression & Canonical forms:

Boolean Expression, Equivalent Boolean Expression, Minterm, Maxterm, Values of Boolean Expressions, Stone's Representation Theorem for finite Boolean Algebra, Sum of Products Canonical forms, Product of Sums Canonical forms, Symmetric Boolean expression.

Text Book

1) Discrete Mathematical Structures with Applications to Computer Science -J. R. Tremblay and R. Manohar, Macgraw-Hill International Editions, ISBN 0-07-065142-6. Definitions: 2-3.3 to 2-3.7, Definition 2-3.16, 2-3.17(omit Lexicographic ordering), Article 2-3.9, Chapter 4 up to 4-3.

Reference Books

1) Boolean Algebra and its Application – J. E. Whitesitt, Addison-Wesley Publishing Co. Inc.
2) Foundation of Discrete Mathematics – K. D. Joshi, New Age International Limite Publishers, ISBN 81-224-0120-1.
3) Logic and Boolean Algebra – B. H. Arnold, P H Inc LCCN 62-19100.
4) Introduction to Lattice Theory – D. E. Rutherford, University Mathematical Oliver and Boyed Ltd.
5) Modern Applied Algebra - Garret Birkhoff and Thomas C Bartee, CBS Publishers and Distributors.
6) Sets Lattices and Boolean Algebras - James C Abbott.

Syllabus for Semester - V (Mathematics)

MAT 305(Elective Course): Financial Mathematics (Theory)

Unit I

Basic Concepts: Arbitrage, Return and Interest, Time Value of Money, Bonds, Shares and Indices, Models and Assumptions.

Unit II

Deterministic Cash Flows: Net Present Value (NPV), Internal Rate of Return (IRR), Comparison of IRR and NPV, Bonds price and yield, Clean and Dirty Price, Price – Yield Curves, Duration, Term structure of Interest rates, Immunisation, Convexity.

Unit III

Random Cash Flows: Random Returns, Portfolio Diagrams and Efficiency, Feasible Set, Markowitz Model.

Text Book

1) The Calculus of Finance - Amber Habib, University Press, Chapters 1, 2, 3 (upto 3.4).

Syllabus for Semester - V (Mathematics)

MAT305 (Elective Course): Number Theory (Theory)

Unit I

Some Preliminary Consideration: Well-Ordering Principle, Mathematical Induction, the Binomial Theorem & binomial coefficients.

Divisibility Theory: the division algorithm, divisor, remainder, prime, relatively prime, the greatest common divisor, the Euclidean algorithm (Without proof), the least common multiple, the linear Diophantine equation & its solution.

Unit II

Prime Numbers: Prime and composite number, the Fundamental Theorem of Arithmetic (without proof), canonical form of a number, the Sieve of Eratosthenes.

Theory of Congruence: Definition and basic properties of congruence, Residue class &complete system of residues, special divisibility test, linear congruence, Chinese Remainder Theorem. (without proof)

Unit III

Fermat's Theorem: Fermat's Factorization method, Fermat's little theorem, Wilson theorem,

Euler's theorem: Euler's Phi-function $\phi(n)$ and formula for $\phi(n)$, Euler's theorem (without proof) and only problems on Euler's theorem.

Text Book

Elementary Number Theory - David M. Burton, Sixth Edition, Universal Book stall, New Delhi.

Chapter 1: (1.1 - 1.2), Chapter 2: (2.1 - 2.4), Chapter 3: (3.1 - 3.2), Chapter 4: (4.1 - 4.3), Chapter 5: (5.2 - 5.3), Chapter 7: (7.2 – 7.7)

Reference Books:

1 An introduction to the Theory of numbers - Niven and Zuckerman, Wiley Eastern Ltd.
2 Number Theory - S. G. Telang, Tata Mc Graw-Hill Publishing Company Limited, New Delhi
3 Elementary Theory of Numbers - C. Y. Hsiung, Allied Publishers Ltd.-India, ISBN 81-7023-464-6.
4 Number Theory - George E. Andrews, Hindustan Publishing Corporation- Delhi.
5 Elementary Number Theory - Gareth A. Jones & J. Mary Jones, Springer Verlag, ISBN 81-8128-278-7.
6 Number Theory - J. Hunter, Oliver and Boyd-London.
7 Beginning Number Theory - Neville Robbins, Narosa Pub. House -New Delhi ISBN 978-81-7319-836
8 Introduction to the theory of Numbers - G. H. Hardy & E. M. Wright, Oxford Uni. Press
9 Higher Algebra - S. Barnard & J. M. Child, Macmillan India Ltd
10 Elements of Number Theory - I. M. Vinogradov , Dover Pub INC
11 Elementary Number Theory in Nine chapters - James J. Tattersall, Cambridge Uni Press
12 A first course in Theory of Numbers - K. C. Chowdhary, Asian Books Pvt Ltd New Delhi
13 1001 problems in Classical Number Theory - Jean Marie De Konick Armed Mercier, AMS

Syllabus for Semester - V (Mathematics)

MAT306 Practical-1 (Based on MAT301, MAT302)

Practicals

Unit I

1) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + … +1/ N.
2) To find the absolute value of an integer.
3) Enter 100 integers into an array and sort them in anascending order.
4) Bisection Method.
5) Newton Raphson Method.
6) Secant Method.
7) Regulai Falsi Method.
8) LU decomposition Method.
9) Gauss-Jacobi Method.
10) SOR Method or Gauss-Siedel Method.
11) Lagrange Interpolation or Newton Interpolation.
12) Simpson's rule.
13) Countable and Uncountable Sets
14) Completeness property of R - problems related to infimum, supremum of sets.
15) Limits of sequences including inductively defined sequences, limit inferior and superior
16) Cauchy Sequences
17) Types of discontinuities-discussion and examples
18) Uniform continuity.
19) Problems based on Mean Value Theorems
20) L'Hospital's Rule –Theorems + problems.

Syllabus for Semester - V (Mathematics)

MAT 306: Practical-2 (Based on MAT303, MAT304)

Hours: 6 /week **Credits: 2.5**

List of Practicals:

Unit I

1. Application of De-Moivere's theorem (to find the roots of an equation and simplify common statements)
2. Verification of Cauchy-Riemann equaations (Cartesian & polar form).
3. Find the harmonic conjugate of a function and hence find corresponding analytic function.
4. If $f(z) = u + iv$ is an analytic function then find $f(z)$ when $u, v, u - v$ or $u + v$ is given.

Unit II

5. Problems on transformation under function $w = \frac{1}{z}$.
6. Problems on verification of conformality.
7. Find the Fourier series of functions - I.
8. Find the Fourier of functions-II.

Unit III

9. Solve Linear programming problem by graphical method for two variable problem (3 problems)
10. Solve Linear Programming Problem by simplex method-I (3 problems)
11. Solve Linear Programming Problem by big-M method (3 problems)
12. Solve Linear Programming Problem by Two-Phase method (3 problems)

Unit IV

13. Using duality solve Linear Programming Problem (3 problems)
14. Using Modi method to solve Transportation problem (Balanced) (3 problems)
15. Using Modi method to solve Transportation problem (Unbalanced) (3 problems)
16. Using "Hungarian method" to solve Assignment problem (Balanced and Unbalanced) (3 Problems)

Syllabus for Semester - VI (Mathematics)

MAT 307: Co-ordinate Geometry (Theory)

UNIT I

Introduction to Lines and Planes in R^3: Co-ordinates, equation of line, equation of plane in R^3, Angle between two lines, Direction cosines of a line, Relation between Direction Cosines, Projection on a straight line, Theorem, Converse of the Preceding theorem, Transformation to the normal form, Direction Cosines of the normal to a plane, Angle between two planes, Determination of a Plane under given conditions, System of Planes, Two sides of a Plane, Length of the Perpendicular from a point to a Plane, Joint equation of two Planes, Orthogonal Projection on a Plane, Volume of Tetrahedron

UNIT II

Sphere in R3: Definitions, Equation of the sphere through four given points, Sphere, Equations of a Circle in R3, Intersection of a Sphere and a Line, Equation of a Tangent Plane, Angle of Intersection of two Spheres, Radical Plane, A simplified form of the equation of two given Spheres

UNIT III

Cones and Cylinders in R3: Definitions, Condition that the General equation of the second degree represent a Cone, Cone and a Plane through its vertex, Intersection of a Line with a Cone, Intersection of two Cones with a common vertex, The right circular cone and examples, The Cylinder, Right circular cylinder and its examples, Enveloping Cone and Cylinder

UNIT IV

Conicoid: The general equation of the second degree, Shapes of some Surfaces, Intersection of a Line with a Conicoid, Plane of contact, The Polar Plane of a point, Chord, Conjugate diameters and diametric Planes, Paraboloids, Plane section of a Conicoid

Text Book

Analytical Solid Geometry by Shanti Narayan, Dr. P. K. Mittal (S. Chand)

Syllabus for Semester - VI (Mathematics)

MAT308 Analysis-II (Theory)

Unit I

Introduction to Riemann integral, Properties of the Riemann integral, Fundamental theorems of calculus, First and second mean value theorems, Improper integrals of the first and second kind.
Articles 8.1, 8.3, 8.4, 8.5 up to theorem 7 of text book 1.

Unit II

Limit superior and inferior, Complex sequences, Convergence of series, Series of positive terms and tests for convergence
Articles 4.8 to 4.11 of text book 2.

Unit III

Absolute convergence, Rearrangement of series, Conditionally convergent series, Power Series and its convergence, Multiplication of series
Articles 4.12 to 4.15 of text book 2.

Unit IV

Taylor's Theorem with Lagrange and Cauchy form of remainders, Binomial series theorem, Expansions of exponential, logarithmic and trigonometric functions, Power series solutions of differential equations
Article 9.2 of text book 1 and 4.4 to be supplemented from the reference book 1 (Article 8.3).

Text Books

1) A First Course in Mathematical Analysis, D. Somasundaram and B. Choudhary (Corrected Edition), Narosa Publication.
2) Fundamentals of Mathematical Analysis, G. Das and S. Pattanayak, Tata McGrow Hills.

Reference Books

1) An Introduction to Analysis, Gerald G. Bilodeau, Paul R. Thie and G. E. Keough, Jones and Bartlett Student edition
2) Introduction to Real Analysis, Robert G. Bartle and Donald R. Sherbert, Wiley Student Edition, 2010.
3) Principles of Mathematical Analysis, W. Rudin, McGraw-Hill.
4) Mathematical Analysis, Tom M. Apostol, Narosa Publ. House India.
5) Elementary Analysis: the theory of calculus, K. Ross, Springer, India.
6) A Course in Calculus and Real Analysis, S. R. Ghorpade and B. V. Limaye.
7) Mathematical Analysis, Andrew Browder, Springer.

Syllabus for Semester - VI (Mathematics)

MAT309 Analysis-III (Theory)

UNIT I

Metric Spaces: Definition and Examples, Open Sets, Closed Sets, Convergence, Completeness and Baire's Theorem
Articles 9, 10, 11 and 12 (Baire's Theorem without Proof) of Text Book (1)

UNIT II

Continuity, Compactness and Connectedness: Compact sets, Connected sets, Continuous functions, Continuity and compactness, Continuity and connectedness
Articles 2.1 (2.31 - 2.38), 2.2 (2.45 - 2.47), 2.3 (4.5 - 4.8), 2.4 (4.13 - 4.18), 2.5 (4.22, 4.23) covered from Text Book (2)

Unit III

Uniform Convergence: Pointwise Convergence, Uniform Convergence, Uniform Convergence and Continuity, Uniform Convergence and Differentiation, Term by Term Integration of Series, Term by Term Differentiation of Series
Articles 9.1-9.5 of Text Book (3)

Unit IV

Applications of Uniform Convergence: Power Series, Abel's Limit Theorem, Multiplication of Power Series (Except Stirling's Formula), Taylor's Series, Weierstrass Approximation Theorem, Exponential, Logarithmic and Trigonometric Functions
Articles 9.6-9.8 and only topics of Article 4.5 from 9.9 of Text Book (3)

Text Books

1) Topology and Modern Analysis - G. F. Simmons.
2) Principles of Mathematical Analysis, Third edition- Walter Rudin, McGraw-Hill International Editions, McGraw-Hill Book Company.
3) Fundamentals of Mathematical Analysis - Das and Pattanayak, TMH.

Reference Books

1) Mathematical Analysis -Tom Apostol, Addison Wesley
2) Introduction to Real Analysis - Robert G. Bartle and Donald R. Sherbert, Wiley Student Edition, 2010.
3) A First Course in Mathematical Analysis – D. Somasundaram & B. Choudhary, Narosa Publishing House, New Delhi.
4) A Course in Calculus & Real Analysis - S. R. Ghorpade& B. V. Limaye
5) Elementary Analysis: the theory of calculus - K. Ross, Springer. India.
6) Topology of Metric Spaces - S. Kumaresan, Narosa
7) Metric Spaces - Shirali, Springer, India.

Syllabus for Semester - VI (Mathematics)

MAT310 Graph Theory (Theory)

UNIT I

An Introduction to Graphs: The Definition of Graph, Graph as a model, More definitions, Vertex Degrees, Sub graphs

UNIT II

Trees and Connectivity: Paths and Cycles, The Matrix Representation of Graphs, Definitions and Simple Properties, Bridges

UNIT III

Connector Problems: Spanning Trees, Cut Vertices and Connectivity, Whitney's Theorem, Weighted Graph, Minimal Spanning Tree

UNIT IV

Euler Tours and Hamiltonian Cycles: Euler Tours, The Chinese Postman Problem, Hamiltonian Graphs, The Travelling Salesman Problem

Text Book

1) A First Look At Graph Theory by John Clark & Derek Allan Holton, Published by Allied Publishers Ltd.
   UNIT I (1.1 to 1.5)
   UNIT II (1.6, 1.7, 2.1, 2.2)
   UNIT III (2.3, 2.4, 2.6)
   UNIT IV (3.1 to 3.4)
   (Omit Theorem 2.16 to 2.18)

Reference Books

1) An introduction to Graph Theory by S. Pirzada, Universities Press
2) Introduction to Graph Theory by R. J. Wilson, Logman
3) Graph Theory with application to Engineering and computer science by Narshinghdeo, PHI
4) A First Course in Graph Theory by S. A. Choudum, Macmillan India Ltd.
5) Graph Theory by G. Suresh Singh, Prentice Hall of India.
6) Introduction to Graph Theory by Douglas B. West, PHI second addition
7) Invitation to Graph Theory by S. Arumugam, S. Ramchandran, Scitech Publication (India)

Syllabus for Semester - VI (Mathematics)

MAT311 (Elective Course) Cryptography (Theory)

UNIT I

Rings, Modular Arithmetic, Prime Numbers, Primitive Elements, Discrete Logarithm.

UNIT II

Conventions in Representation, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, A Case for Modern Cryptography.

UNIT III

Trapdoor Function, Diffie-Hellman (DH) Algorithms for Key Exchange, Algorithms for Discrete Logarithms, ElGamal Public-Key Cryptosystem, RSA Cryptosystem, Digital Signature.

Text Book

1) Cryptography and Security - C K Shyamala, N Harini and Dr T R Padmanabhan Wiley-India.

   Ch-1 (omit1.5.6), Ch-2(omit 2.9), Ch-5(up to 5.5), Ch-7.5(up to 7.5.2).

Reference Books

1) Cryptography & Network Security - Behrouz A Forouzan and Debdeep Mukhopadhyay, McGraw Hill.
2) Cryptography - Atul Kahate.
3) Cryptography and information Security - V K Pachgrare, PHI, EEE.
4) Public-Key Cryptography Theory and Practice - Abhijit Das, Madhvan and C E Veni, Pearson.

Syllabus for Semester - VI (Mathematics)

MAT311 (Elective Course) Operations Research (Theory)

Unit I

Inventory Problems: Introduction, types of inventory, cost involved in inventory problems, notations, EOQ model, limitations of EOQ formula, EOQ model with finite replenishment rate, EOQ model with shortages, Order – level Lot – size model, Order – level Lot – size model with finite replenishment rate.

Unit II

PERT and CPM: Introduction, origin of PERT & CPM, applications of PERT & CPM, framework of PERT & CPM, construction of project network, dummy activities and events, rules for network construction, finding the critical path, concepts of float, total float and free float and its interpretations.

Unit III

Game Theory: Introduction, Two person zero-sum games, Maximin and Minimax Principles, Mixed strategies, expected pay-off, solution of 2×2 mixed strategy game, solution of mixed strategy game by the method of oddments, Dominance Principle, solution of mixed game by matrix method, solution of a two person zero-sum $2 \times n$ game, Algebraic method for solving a game, solution of 3×3 games with mixed strategy by the method of oddments, Iterative method for approximate solution.

Text Book

1) Operations Research - Nita H. Shah, Ravi M. Gor and Hardik Soni, PHI learning.

   Chapter 11 (11.1 – 11.10), Chapter 15 (15.1 – 15.9) and Chapter 18 (18.1 – 18.14).

Reference Books

1) Operations Research by J. K. Sharma.
2) Operations Research by S. D. Sharma.
3) Operations Research by Man Mohan, Kanti Swaroop and P. K. Gupta

Syllabus for Semester - VI (Mathematics)

MAT311 (Elective Course) Bio-Mathematics (Theory)

Unit I

Mathematical Models in epidemiology: Basic concepts, SI model, SIS model with constant coefficient, SIS model with coefficient as a function of time t, SIS model with constant number of carriers, SIS model when the carriers is a function of time t, SIR model, Epidemics with vaccination.

Unit II

Single-species population models – Age structured: Continuous-time continuous-Age-Scale population models, Lotka's model for population growth, Discrete-Time Discrete-Age-Scale population model, Bernardelli, Lewis and Leslie (BLL) model, Density Dependence model, Two-sec models, Continuous-time Discrete-Age population model.

Unit III

Single-species population models – non-age structured: Exponential Growth model, its formulation, solution and interpretation, Effects of immigration and Emigration on population, Logistic Growth model, its formulation, solution and interpretation.

Text Book

1) Bio-Mathematics - S. K. Aggarwal, ALP Books.

Syllabus for Semester - VI (Mathematics)

MAT311 (Elective Course) Mechanics (Theory)

Unit I

Foundation of Mechanics- The ingredients of mechanics (particles, mass, rigid bodies, events, frame of reference, time, units, rest of motion, force), Introduction of vectors, velocity and acceleration, Fundamental laws of Newtonian mechanics, The theory of dimensions.

Unit II

Methods of Plane Statics- Equilibrium of a particle, Equilibrium of a system of particles, the moment of a vector about a line, the theorem of verignon, necessary condition for equilibrium equipollent system of forces, couples, reduction of a general plane force system, work, the principle of virtual work, sufficient condition for the equilibrium of a rigid body movable parallel to a fixed plane, Potential energy.

Unit III

Mass centers and centre of gravity, Theorem of Pappus, gravitation, centre of gravity, Friction, laws of Static and kinetic friction, thin beams, flexible cables, differential equation of flexible cables, the suspension bridge, the common catenary, cables in contact with smooth curves, cables in contact with rough curves.

Text Book

1) Principles of Mechanics - John L. Synge and Byron A. Grifith. Mc Graw Hill Book Comp.-New Delhi.

Reference Books

1) Introduction to classical Mechanics - R. G. Takwale & P. S. Puranik. Mc Graw Hill Book Comp.-New Delhi.

2) A Text Book on Mechanics - P. N. Sinha l& S. Sareen, Anmol Publications Pvt. Ltd., New Delhi

3) Classical Mechanics - Herbert Goldstein, Addison –Wesley Publishing Company, INC.

4) Classical Mechanics – T. W. B. Kibble, Longman scientific & Technical Co-published in US with John Wiley & Sons Inc., New-York.

5) Mechanics - S. L. Kalani, C. Hemrajani, Shubhara Kalani, Viva Books Pvt. Ltd., New Delhi ISBN-10: 81-309-0058-0.

Syllabus for Semester - VI (Mathematics)

MAT311 (Elective Course)

Convex Analysis and Probability Theory (Theory)

Unit I

Convex Analysis: Convex and concave sets, Affine sets & Hyperplanes, Convex combination, Convex cones, Algebra of convex sets: Convex functions and discussion of its continuity, graphs, sequences, limits, maxima & minima, monotonicity, linearity on an interval & convex sets, Convexity & connectedness and discussion of differentiability of convex functions. Examples, counter examples and theorems based on them.

Unit II

Jensen inequality and its consequences & related results. AM, GM, Quadratic Mean (QM) inequality, logarithmic mean and convexity. Problems, Lagrange Mean Value Theorem (LMVT) & Convexity. Probability as a stochastic (uncertainty) mathematical model. Axiomatic & classical definition of probability, Sample space, events, probabilistic 2-set, 3-set, n-set. Inclusion & Exclusion and examples: Box office queue, Birthday problems, Bertrand's paradox. Independent, Conditional & geometric probability. Law of total probability.

Unit III

Random walk & Random variable, Baye's Rule. Classical problems: Shakespeare's monkey Eccentric Warden, 3-prisoner's Dilemma, D'Alembert's Confusion Gambler's Ruin etc. Expected values & variance Binomial poison & normal Distributions Banach match-box problem & some classical problems.

Text Books

1) Convex Analysis, R. Tyrrell Rockafellor, Princeton Uni. Press.
2) A course in Calculus & Real Analysis, Sudhir R. Ghorpade & Balmohan V. Limaye, Springer India. Pages:23, 24, 25, 34, 36, (ex.27 to 35), 42, (ex.71, 72), 74 to 77, 100, 102, 125 to 130 (ex.15), 174 (ex.12)
3) Probability: An Introduction, David A. Santos Viva Books Ch.3 & 4

Reference Books:

1) All the mathematics you missed but Need to Know - Thomas A. Garrity, Camb. Univ. Press.
2) An Introduction to Probability Theory & its Applications - Feller Vol. I John Wiley & sons, NY.
3) Introduction to Probability Models -Sheldom M. Ross, Academic Press, 9th Edition.
4) Probability & Probability Distributions (MS-8, Block:3), IGNOU, New Delhi.
5) Elementary Probability Theory - Chung, Springer, India.

6) What is Mathematics? - Courant & Robbins, Revised by Ian Stewart Pg.108 - 116.
7) Calculus, once again (for convex function & monotonicity) - David A. Santos.
8) Convex functions - A. W. Roberts and D. E. Varberg. Academic press.
9) Lecture slides on Convex Analysis & Optimization - Dimitri P. Bertsekas, MIT Cambridge MASS.
10) Convex Analysis by Jose' De Dona; The Uni. of New Castle.
11) A course in Multivariable Calculus & Analysis - S. R. Ghorpade& B. V. Limaye Springer (India) pp:8, 9, 25, 26, 35(ex 5, 6, 7, 8), 37 (ex 23, 24, 25, 58 - 60 (for continuity & Convexity))pp:125 & 126, 129 - 137.
12) Convex Analysis: An Introductory Text - J. Van Tid, John Wiley, New York.

Syllabus for Semester - VI (Mathematics)

MAT 312: Practical-1(Based on MAT307, MAT308)

Hours: 6 /week **Credits: 2.5**

List of Practicals

Unit I

1. The mutual relation between polar and Cartesian co-ordinate system in R^2. Transformation of equations from one system to another system.
2. The mutual relation among Cartesian, cylindrical and spherical co-ordinate system in R^3. Transformation of equations from one system to another system.
3. Problems on Sphere.

Unit II

1. Problems on Cone.
2. Problems on Cylinder.

Unit III

1. Definition and evaluation of Riemann integrals by various methods
2. Verifying MVTs and problems based on Fundamental Theorem of Integration
3. Convergence of infinite series of positive terms
4. Absolute convergence, root and ratio tests using limit inferior and superior

Unit IV

5. Power Series, radius of convergence
6. Improper integrals
7. Power series expansion of functions.
8. Power series solutions of differential equations

Syllabus for Semester - VI (Mathematics)

MAT 312: Practical (Based on MAT309, MAT310)

Practicals

Unit I

1) Metric spaces, examples
2) Uniform convergence of sequences
3) Uniform convergence of series, term by term differentiation and integration
4) Multiplication of power series

Unit II

5) Properties of exponential, logarithmic and trigonometric functions
6) Problems based on Compact and connected spaces

The following two practicals are not from Unit II

7) Well-known examples of parametric surfaces such as Sphere, Cylinder, Cone, Torus and special case of parametrized surface that is given as a graph of function of two variables f(u,v) along with their special cases. Understand these surfaces and calculate their first fundamental forms.
8) Find surface area of some regions of well-known parametrized surfaces studied in Practical 7.

Unit III

9) Using the adjacency matrix, determine whether the given graph is connected or not.
10) Determine whether the given graph is connected or not using fusion algorithm.
11) Find a minimal spanning tree of a given connected weighted graph using Kruskal's algorithm.
12) Find a minimal spanning tree of a given connected weighted graph using Prim's algorithm.

Unit IV

13) Find a shortest path between two vertices of a given connected graph using the Breadth First Search algorithm.
14) Find a shortest path between two vertices of a given connected graph using the Back-tracking algorithm.
15) Find a shortest path between two vertices of a given connected weighted graph using the Dijkstra's algorithm.
16) Construct an Euler tour in a Euler graph using Fleury's algorithm.

References

1) www.mathworld.com.
2) Elements of Differential Geometry - Richard S. Millman & George D. Parke, Prentice-Hall Inc.
3) Elementary Differential Geometry - Andrew Pressley, Springer.
4) Handwritten notes by Mr. H. D. Kamat especially for practical 7 & 8.