SYLLABUS

FOR

B.A/B.Sc. MATHEMATICS (Honours)

Under the

CHOICE BASED CREDIT SYSTEM

DEPARTMENT OF MATHEMATICS
ORIENTAL COLLEGE (AUTONOMOUS),
TAKYEL, IMPHAL
2020

1. Programme objectives:

The Objectives of the B.A/B.Sc. Mathematics (Honours) Programme under the Choice Based Credit System (CBCS) are to develop the ability of

- Simplicity and lucidity of pre-presentation
- Critical analysis
- Logical and analytical thinking
- Convenient and powerful way of examining

The program covers the full range of mathematics. The course has a structured foundation of Algebra, Metric Space, Calculus, Geometry, Differential Equation, Discrete Mathematics, Vector Analysis, Sets and Logic, Tensor, Complex Analysis, Numerical Analysis, Probability Theory, Theory of Relativity, Computer Science and Programming, Graph Theory, Cryptography, Information Security, Higher Mechanics, Astronomy, Mathematical Modelling, Computational Mathematics Laboratory.

There are opportunities for the students who have passed B.A./B.Sc. Mathematics. They can pursue their higher studies in different areas. They can also look for jobs in different fields in private and public sector. There are wide scope of Mathematics in teaching and research fields.

2.Programme learning outcomes:

After completion of the programme, a student shall enable to

- Numerical, analytical and logical skills.
- Better problem solving skills.
- Real world applications.
- Understand the world better.
- Understand hypothesis, theories and proofs.

3. Program Structure:

The B.A./B.Sc. Math(H) program is a three year course divided into six semesters. A student is required t**o** complete 148 credits for the completion of course and the award of degree.

		Semester	Semester
Part-I	First year	Semester I: 22	Semester II: 22
Part-II	Second year	Semester II: 28	Semester III: 28
Part-III	Third Year	Semester IV: 24	Semester V: 24

Outlines of Course Structures for Choice Based Credit System

The main components of this syllabus are as follows:

1. **Core Course**
2. **Elective Course**
3. **Ability Enhancement Course**

1. **Core Course (CC)**
   A course that should compulsorily be studied by a candidate as a core requirement is termed as a core course.

2. **Elective Course**
   2.1 **Discipline Specific Elective Course (DSE):** A course, which may be offered by the main discipline/subject of study, is referred to as Discipline Specific Elective.
   2.2 **Generic Elective Course (GE**): An elective course, chosen generally from an unrelated discipline/subject of study with intention to seek an exposure, is called a Generic Elective Course.

3. **Ability Enhancement Course(AEC)**
   The ability Enhancement Course may be of two kinds:
   3.1 Ability Enhancement Compulsory Course (AECC).
   3.2 Skill Enhancement Course (SEC).

4. **Dissertation/Project Work** is considered as a special course involving application of knowledge in solving/analyzing/exploring a real life situation/difficult problem. A project/Dissertation work would be of 6 credits. A project/Dissertation work may be given in lieu of a discipline specific elective paper.

CBCS Honours Degree Programme Course Structure for Mathematics

Semester ⇩	Course Names & Credits				
	Honours Core Course (HC)	***Discipline Specific Elective (DSE)***	***Generic Elective (GE) #***	***Skill Enhancement Course (SEC)***	***Ability Enhancement Compulsory Course (AECC)***
	14 papers x 6 credit each = 84 credits	**4 papers x 6 credit each = 24 credits**	**4 papers x 6 credit each = 24 credits**	2 papers x 4 credit each = 8 credits	2 papers x 4 credit each = 8 credits
	Paper	**Paper**	**Paper**	**Paper**	**Paper**
I	**Mat-HC - 1016** **Mat-HC - 1026**		**GE-1** **Mat-HG- 1016/** **Mat-HG-1026**		**Gen-AE - 1014/** **Gma-AE - 1014**
II	**Mat-HC-2016** **Mat-HC-2026**		**GE-2** **Mat-HG-2016/** **Mat-HG-2026**		**Env-AE-2014**
III	**Mat-HC-3016** **Mat-HC-3026** **Mat-HC-3036**		**GE-3** **Mat-HG-3016/** **Mat-HG-3026**	**SEC-1** **Mat-SE-3014/** **Mat-SE-3024**	
IV	**Mat-HC-4016** **Mat-HC-4026** **Mat-HC-4036**		**GE-4** **Mat-HG-4016/** **Mat-HG-4026**	**SEC-2** **Mat-SE-4014/** **Mat-SE-4024**	
V	**Mat-HC-5016** **Mat-HC-5026**	**DSE-1** **Mat-HE-5016/** **Mat-HE-5026** **DSE- 2** **Mat-HE-5036/** **Mat-HE-5046/** **Mat-HE-5056**			
VI	**Mat-HC-6016** **Mat-HC-6026**	**DSE-3** **Mat-HE-6016/** **MatT-HE-6026** **DSE-4** **Mat-HE-6036** **Mat-HE-6046/** **Mat-HE-6056**			
TOTAL:	**14x6 = 84 credits**	**4x6=24 credits**	**4x6 = 24 credits**	**2x4 =8 credits**	**2x4=8 credits**
26 PAPERS & 148 CREDITS					

Abbreviations:
Core=Honours discipline specific Core Course (14 Papers of 6 Credits each) – **Course Code: HC** ;
AECC = Ability Enhancement Compulsory Course (2 Papers of 4 Credits each) - **Course Code: AE** ;
SEC = Skill Ability Enhancement Course (2 Papers of 4 Credits each) - **Course Code: SE ;**
DSE = Discipline Specific Elective Course (4 Papers of 6 Credits each) - **Course Code: HE** ;
GE = Generic Elective Course (4 Papers of 6 Credits each) - **Course Code: HG** ;

Note:
1. Optional Dissertation or Project Work in Place of one Discipline Specific Elective Paper (6 credits) in 6^{th} Semester.
2. # For the Students of other discipline.

Details of Semester wise Course structure & Credits for Choice Based Credit System in B.A./B.Sc. Mathematics (Honours)

Semester	Course	Course Code	Title	Credits	Remarks
I	Core	Mat-HC – 1016	Algebra I, and Complex Trigonometry	5+1 = 6	Compulsory
		Mat-HC – 1026	Calculus	5+1 = 6	Compulsory
	Generic Elective #	Mat-HG- 1016 Mat-HG-1026	Group theory, Matrices &Trigonometry Analytical Geometry(Two & Three Dimensions)	5+1 = 6	(Choose any one) #For the Students of other discipline.
	Ability Enhancement	Gen-AE – 1014 Gma-AE – 1014	General English General Manipuri (MIL)	3+1 = 4	(Choose any one) & Compulsory
			Sub Total : 4 papers	22 credits	
II	Core	Mat-HC-2016	Differential Equations	5+1 = 6	Compulsory
		Mat-HC-2026	Algebra II Abstract Algebra	5+1 = 6	Compulsory
	Generic Elective #	Mat-HG-2016 Mat-HG-2026	Calculus Discrete Mathematics	5+1 = 6	Choose any one) #For the Students of other discipline.
	Ability Enhancement	Env-AE-2014	Environmental Science	3+1 = 4	Compulsory
			Sub Total: 4 Papers	22Credits	
III	Core	Mat-HC-3016	Mechanics – I (Dynamics & Statics)	5+1 = 6	Compulsory
		Mat-HC-3026	Real Analysis - I	5+1 = 6	Compulsory
		Mat-HC-3036	Laplace Transform & Vector Analysis	5+1 = 6	Compulsory
	Generic Elective #	Mat-HG-3016 Mat-HG-3026	Ordinary Differential Equations, Partial Differential Equations & Vectors Elements of Probability	5+1 = 6	(Choose any one) #For the Students of other discipline.
	Skill Enhancement	Mat-SE-3014 Mat-SE-3024	Sets & Logic Computer Science & Programming I (in C or any software)	3+1= 4 2+2= 4	(Choose any one) & Compulsory
			Sub Total: 5 papers	28Credit	

IV	Core	Mat-HC-4016	Real Analysis-II	5+1 = 6	Compulsory
		Mat-HC-4026	Linear Algebra	5+1=6	Compulsory
		Mat-HC-4036	Computer Science & Programming II (in C or using any software)	4+2=6	Compulsory
	Generic Elective #	Mat-HG-4016 Mat-HG-4026	Mechanics – II Information Security	5+1= 6 4+2=6	(Choose any one) #For the Students of other discipline
	Skill Enhancement	Mat-SE-4014 Mat-SE-4024	Graph Theory Cryptography	3+1=4 2+2=4	(Choose any one) & Compulsory
V			Sub Total: 5 Papers	28Credits	
	Core	Mat-HC-5016	Partial Differential Equations & Calculus of variation	5+1= 6	Compulsory
		Mat-HC-5026	Analysis III Numerical Analysis	4+2=6	Compulsory
	Discipline Specific Elective	Mat-HE-5016 Mat-HE-5026	Geometry (Two & Three Dimensions) Fluid Mechanics	5+1= 6	(Choose any one) & Compulsory
		Mat-HE-5036 Mat-HE-5046 Mat-HE-5056	Rigid Dynamics & Tensor Higher Mechanics Linear Programming	6	(Choose any one) & Compulsory
			Sub Total: 4 Papers	24 Credits	
VI	Core	Mat-HC-6016	Metric Space	5+1= 6	Compulsory
		Mat-HC-6026	Complex Analysis	5+1= 6	Compulsory
	Discipline Specific Elective	Mat-HE-6016 Mat-HE-6026	Spherical Trigonometry & Astronomy Special theory of Relativity	5+1=6	(Choose any one) & Compulsory
		Mat-HE-6036 Mat-HE-6046 Mat-HE-6056	Probability Theory Computational Mathematics Laboratory Mathematical Modelling	5+1=6 4+2= 6 5+1=6	(Choose any one) & Compulsory
			Sub Total: 4 Papers	24 Credits	
			Total: 26 Papers	148 Credits	

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SEMESTER - I

Detailed Syllabus

Honours Core Course (HC)
Mat-HC-1016
Algebra - I & Complex Trigonometry
Total Marks: 100
Credits 6: Theory-05, Tutorial-01

Course Objectives: The course is designed to improve students' abstract and logical thinking capabilities applying mathematical ability to handle proofs, to give the applications of the concept of binary operations and groups, basic properties of groups and subgroups, to explore different types of subgroups, cyclic groups, permutation groups, symmetric groups., to give relation between roots and coefficients, to give knowledge of complex functions in complex variable.

Course Outcomes: On successful completion of this course, the student should be able

- To prove some group theoretic statements including groups, cyclic groups, permutation Groups, normal subgroups.
- Prove Lagrange's theorem, Fermat's & Wilson's theorem.
- To find solutions of cubic equations by Cardan's method & biquadratic equations by Ferrari's method.
- To understand De Moivre's theorem, Gregory's theorem & Hyperbolic functions of complex functions.

Unit –I (25 Marks)

Inequalities

Geometric Mean and Arithmetic mean, Cauchy-Schwarz, Holder's and Minkowski's inequalities.

Theory of Equations

Polynomial, Descartes rule of signs, Fundamental theorem of Algebra (Statement only), Relation between roots and Coefficient, Symmetric functions of roots, Transformation of equations, Solution of cubic equations by Cardan's method and biquadratic equations by Ferrari's method and Euler's method.

Unit – II (25 Marks)

Matrices

Some types of Matrices, Elementary operations on matrices, Inverse of a matrix, Linear independence of row and column matrices, Row rank, Column rank and rank of a matrix, Equivalence of column and row ranks, Eigen values, eigenvectors and the characteristic equation of a matrix, Cayley Hamilton theorem and its use in finding inverse of a matrix.

Unit – III (25 Marks)

Abstract Algebra

Mappings, Equivalence relations and partitions, equivalence classes, Congruence modulo n Group and its elementary properties, Examples of Abelian and Non- Abelian groups, Subgroups, Condition for being a subgroup, integral power of an element ,Order of a group and order of an element of a group, Cyclic groups and generators. Permutation group, product of two permutations.
Symmetric groups $S_1, S_2, S_3, \ldots, S_n$ is abelian for $n \leq 2$ and non – abelian for $n = 3$. Cycle notation, Even and odd permutation, Alternating groups, Coset decomposition, Lagrange' theorem, Fermat's and Wilson's Theorem(Group Theoretic approach).

Definition and properties of normal sub-group.

Unit-IV (25 Marks)

Complex Trigonometry

De Moivre's theorem and its applications, Expansion of trigonometric functions, Exponential values for circular functions, complex argument, Gregory's series, Hyperbolic functions, summation of series including C + iS method, Infinite product, (Sin x and Cos x).

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RECOMMENDED:

1. Das and Mukherjee - *Higher Trigonometry,* U.N. Dhur & Sons Pvt. Ltd., Kolkata.
2. Chandrika Prasad - *Algebra and Theory of Equations*, Pothisala Pvt.
3. I.N. Herstein - *Topics in Algebra,* John Wiley & Sons, New Delhi.
4. J,G, Chakravorty & P.R. Ghosh : *Advance Higher Algebra,* U.N. Dhur & Sons Pvt. Ltd., Kolkata.
5. Joseph A. Gallan: *Contemporary Abstract Algebra,* Narosa.

REFERENCES:

1. John B. Fraleigh - *A First course in Abstract Algebra,* Narosa, Publishing House, New Delhi.
2. Surjeet Singh and Quazi Zameerudin - *Modern Algebra, VIKAS.*
3. K.B. Dutta - *Matrix and Linear Algebra,* Prentice Hall of India Pvt. Ltd., New Delhi.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul - *Basic Abstract Algebra,* CUP, Indian Edition
5. P.B Bhattacharya, S.K. Jain and S.R. Nagpaul - *First Course in Linear Algebra,* Wiley Eastern, N New Delhi
6. H.S. Hall and S.R. Knight - *Higher Algebra,* A.I.T.B.S. Publishers & Distributors, New Delhi.
7. S.L. Loney - *Plane Trigonometry Part I and II,* Macmillan.
8. R.S. Varma and K.S. Shukla - *Text Book on Trigonometry, Pothisala Pvt. Ltd.*

Honours Core Course (HC)

Mat-HC-1026

Calculus

Total Marks: 100

Credits 6: Theory-05, Tutorial-01

Course Objectives: To focus on general concepts of

- Limit continuity and differentiability.
- successive and partial differentiations and their physical interpretation
- Introduce the idea of double integrals and its applications.

Course Outcomes: Students should be able to

- Express the physical problems containing more variables.
- Find volume and surface areas of solid of revolution and ready to solve problems arise in mathematical physics.

Unit – I (25 Marks)

Differentiation: Limit and Continuity (using $\varepsilon - \delta$ definition) of the functions, Successive differentiation, Leibniz's theorem and its application.

Rolle's Theorem, Lagrange's and Cauchy's Mean Value theorems, Taylor's and Maclarin's theorem with Lagrange's and Cauchy's form of remainders, Indeterminate forms, L-Hospital's rule, Expansion of standard functions:

e^x , sin x, cos x, log (1+x), $(1+x)^m$, $\sin^{-1}x$, $\cos^{-1}x$, $\tan^{-1}x$.

Unit – II (25 Marks)

Partial Differentiation:

Function of Two and three variables, Limit and Continuity for functions of two and three variables, Partial differentiation, successive partial differentiations, Euler's theorem on Homogenous functions of two and three variables, Maxima and Minima of functions of two variables.

Applications:

Curvature, radius of curvature for the Cartesian, Parametric, implicit and polar equations, Asymptotes. Length of tangent and normal, sub tangent and sub normal.

Unit-III (25 Marks)

Integration : Integration as the limit of a sum, Fundamental theorem of integral calculus, Definite integrals, Reduction formulae for indefinite and definite integrals, Definition of improper integral, simple properties of Beta and Gamma functions.

Applications: Quadrature and Rectification.

Unit –IV (25 Marks)

Double Integrals

Working knowledge of double integrals, Jacobian, change of variable in double integrals, Application of double integral.

Applications: *Volume and surface areas of solid of revolution*

RECOMMEMDED BOOKS

1. Das and Mukherjee - *Differential Calculus*, U.N. Dhur & Sons, Kolkata.

2. Das and Mukherjee - *Integral Calculus*, U.N. Dhur & Sons Pvt. Ltd., Kolkata.

REFFERENCES

1. Maity and Bagchi - *Integral Calculus, An introduction to Analysis,* New CentralBook Agency, Calcutta.

2. T.M. Apostol - *Calculus, Vulume I and II,* Willey Eastern Ltd., New Delhi.

3. Shanti Narayan - *Integral Calculus,* S. Chand & Co.Pvt. Ltd., New Delhi.

4. Gorakh Prasad - *Integral Calculus,* Pothisala Pvt.Ltd., Allahabad.

5. Gorakh Prasad - *Differential Calculus,* Pothisala Pvt.Ltd. Allahabad.

6. Erwin Kreyszig - *Advanced Engineering Mathematics,* John Wiley & Sons

7. N.Piskunov - *Differential and Integral Calculus,* Peace Publishers, Moscow.

8. Murray R. Spiegel - *Theory and Problems of Advanced Calculus* Schaum's Outline series, Schaum Publishing Co., New York

9. Maity and Gosh - *Integral Calculus,* New Central Book Agency, Kolkata.

Generic Elective Course (GE-1)
Mat- HG -1016
Group Theory, Matrices & Trigonometry
Total Marks: 100
Credits 6: Theory-05, Tutorial-01

Course Objectives: The course gives

- The definitions of the basic concepts of abstract algebra, analysis of the concept of permutation groups, definition of Isomorphism of groups, properties of ring.
- It will help to find solutions of linear equations.
- It gives knowledge of complex functions in complex variables.

Course Outcomes: The student should be able to

- Apply Lagrange's theorem, Fermat's & Wilson's theorem to some exercise.
- explore the groups of permutations and the alternating groups
- Prove Cayley's theorem & its generalization.

Unit I (25 Marks)

Group Theory

Groupoid, Monoid, Semi group, Abelian group and their elementary properties; permutation group, cycle, Transposition, Even and Odd permutation, Alternating group, Subgroup, conditions for being a subgroup (finite cases), Examples of Abelian and Nonabelian groups.

Unit II (25 Marks)

Cosets, Lgrange's theorem, Fernat's and Wilson's theorem. Theorem: If H and K are subgroups, then HK is a subgroup if HK = KH Theorem on – Union and Intersection of subgroups, Order of finite group, index of a group.

Cyclic group and its examples, Isomorphism of groups. Ring, sub rings, Integral of domains , Division ring, (Definition and examples), Elementary properties of a ring.

Unit III (25 Marks)

Matrix

Definition, Operations on Matrices, Matrix Algebra, Types of Matrices, Transpose, Adjoint and Inverse of a matrix, Rank of a matrix, Determination of rank of a matrix, Solutions of System of linear equations.

Unit IV (25 Marks)

Trigonometry

De Moivre's theorem for a rational index, Expansion of sin x, cos x, in power of x, exponential values for circular functions, Complex argument, Gregory's series, Hyperbolic functions, summation of series including

C + iS method.

RECOMENDED BOOKS

1. Das and Mukherjee – Higher Trigonometry, U.N. Dhur & Sons Pvt. Ltd, Cal.-73.
2. Chandrika Prasad – Algebra and Theory of Equations, Pothisala Pvt.Ltd, 2Lajpat Road.
3. Surjeet Singh and Quazi Zameerudin – Modern Algebra, V. Kas

Generic Elective Course (GE-1)
Mat-HG - 1026
Analytical Geometry of Two &Three Dimensions
Total Marks: 100
Credits 6: Theory-05, Tutorial-01

Course Objectives: The primary objective of the first part is to introduce the basic tools of plane geometry and geometric properties of different conic sections which are helpful in understanding their applications to the real world problems.
The second part of the course is to introduce the basic tools of space geometry.

Course Outcomes: The course will enable the student to

- Understand the basic knowledge about transformation of rectangular axes, pair of straight lines, elementary properties of conic sections in the Cartesian and polar co-ordinates systems.

Analytical Geometry of Two Dimensions

Unit I (10 Marks)

Transformations of Rectangular axes: translation, rotation and their combinations. General equation of second degree in x and y, Reduction to canonical forms. Classification of conics.

Unit II (20 Marks)

Pair of straight lines: condition that the general equation of second degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of pair of straight lines joining the origin to the points in which a line meets a conic.

Unit III (20 Marks)

Equations of pair of tangents from an external point, chord of contact, poles and polars in case of general conic, in particular for Circle, Parabola, Ellipse, Hyperbola. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal.

Analytical Geometry of Three Dimensions:

Unit IV (10 Marks)

Rectangular Cartesian co-ordinates. Distance between two points. Division of a line segment in a given ratio. Direction cosines and direction ratios of a straight line.

Unit V (20 Marks)

Equation of plane: General equation of a plane. Intercept and normal forms. Angle between two planes. Distance of a point from a plane and distance between two parallel planes. Bisectors of angles between two intersecting planes.

Unit VI (20 Marks)

Equation of a straight line: General and symmetric form. Angle between two straight lines. Distance of a point from a line. Coplanarity of two straight lines. Shortest distance between two skew lines, Sphere and its tangent plane.

RECOMENDED BOOKS

1. **B. Das**-Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. **Shanti Narayan and P.K. Mittal**-Analytical Solid Geometry, S. Chand.

REFERENCES

1. **S.L. Loney**: Co-ordinate geometry of two dimensions, Macmillan and Sons Pvt. Ltd.
2. **R.J.T. Bell**: Co-ordinate geometry of three dimensions, Macmillan and Sons Pvt. Ltd.

Ability Enhancement Compulsory Course (AECC)

1) Gen-AE-1014: GeneralEnglish

(From the Department of English)

2) Gma-AE-1014: General Manipuri (MIL)

(***From the Department of Manipuri))***

SEMESTER II

Honours Core Course (HC)
Mat – HC - 2016
Differential Equations
Total Marks: 100
Credits 6: (Theory - 05 , Tutorial-01)

Course Objectives: The main objectives of this course are to introduce the students to the existing world of Differential Equations, Mathematical Modelling and their applications.

Course Outcomes: on successful completion of this course, Students should be able to solve linear non-homogeneous equations, simultaneous differential equations, Total differential equations using various techniques.

Unit –I (30 Marks)

Equations of First order and First Degree

First order exact differential equations and integrating factors, Rules to find an integrating factor, Linear equations, equations reducible to linear form and Bernoulli equations. Solutions of simultaneous equations of the form, $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, total differential equations of the form Pdx+Qdy+Rdz = 0, method of solutions and their geometrical interpretations, orthogonal trajectory.

Unit-II (20 Marks)

Equations of the First order but not of First Degree

Equations solvable for x, y, p and Clairaut's equation, Singular solutions.

Unit-III (50 Marks)

Second Order Linear Differential Equation

Second order linear differential equations with constant coefficients, Homogeneous linear equations, Linear non-homogenous equations.

Complementary functions and particular integrals, Method of variation of parameters and by change of independent variable. The Cauchy-Euler equation. Power Series solutions at ordinary and regular singular points. Simultaneous differential equations. Total differential equation in three independent variables.

RECOMMEMDED BOOKS

1. Piaggio - *An Elementary* Treatise on Differential Equation and Their Applications, C.B.S. Publishers & Distributors, New Delhi..

REFFERENCES

1. Maity and Bagchi - Integral Calculus, An introduction to Analysis, New CentralBookAgency, Calcutta

2. Boyce and Diprima - *Elementary Differential Equations and Boundary Value Problems*, John Wiley & Sons

3. Coddington - *An Introduction to Ordinary Differential Equations and there, Applications, Prentice Hall of India, New Delhi*

4 . G.F.Simmons - *Differential Equations,* Tata Mc Graw Hill

5. D.A.Murray,- *Introductory Course in Differential Equations*, Orient Longman(India).

6.. Gabriel Klambaucer - *Mathematical Analysis*, Marcel Dekkar, Inc New York

7. *.Degree Mathematics*, Book II, Asian Books Pvt., Ltd., New Delhi.

8.. Bhamra KS & Ratna Bala - *Ordinary Differential Equations*, Allied Publishers Delhi.

Honours Core Course (HC)
Mat – HC – 2026:
Algebra II
Abstract Algebra
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: This is second course in modern Algebra which deals with ring theory, the course aims to introduce students the application of the concepts of ring theory to important examples of rings. We will have classes of rings that have some additional nice problems.

Course Outcomes:

Students should be able to understand the standard computations of ring theory.

Unit – I (50 Marks)

GROUPS

Normal subgroups, Quotient Groups, Homomorphism and Isomorphism of groups, Kernel of a homomorphism, Isomorphism Theorems, Auto-morphisms, Inner Auto-morphism, Auto-morphism groups, Cayley's Theorem, Conjugacy Relation, Conjugate class, Counting Principle and Class Equation of a finite group, Centre of a group, Normalizer, Centralizer and related Theorems, Cauchy's Theorem, Sylow Theorems, p-Sylow subgroups.

(Ref. Chapter 2[1])

Unit – II (50 Marks)

RINGS

Rings, Elementary Properties of Rings, Integral Domains, Division Rings, Fields and related Theorems, Ideals and Quotient Rings, Ideals generated by a subset, Sum of two ideals, Homomorphism and Isomorphism of Rings, Kernel of a homomorphism, Isomorphism Theorems, Maximal Ideal, Principal Ideal, Prime Ideal, Euclidean Rings, polynomial Rings, polynomial over the rational Field, Eisenstein's Irreducibility criterion, polynomial Rings over Commutative Rings, Unique Factorization Domain.

- **RECOMMENDED BOOKS**

1 **I.N.Herstein**: Topics in Algebra, John Wiley & Sons, New Delhi.

2. **Kenneth Hoffman and Ray Kunze**: Linear Algebra, Pearson.

3. **V.K. Khanna & S.K. Bhambri**: A Course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.

REFERENCES

1. **S. Kumaresan**: Linear Algebra, Prentice Hall of India.
2. **Vivek Sahai and Vikas Bist**: Linear Algebra, Narosa Publishing House, New Delhi.
3. **Shanti Narayan & P.K. Mittal**: A Text Book of Matrices, S. Chand & Co., New Delhi.
4. **Joseph A. Gallan**: Contemporary Algebra, Narosa Publishing House, New Delhi.
5. **Surjeet Singh** and **Qazi Zameerudin**: Modern Algebra, Vikas.
6. **P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul**: Basic Abstract Algebra, CUP.
7. **John F. Fraleigh**: A First Course in Abstract Algebra, Addison Wesley. 8. **J.G. Chakravorty and P.R. Ghosh**: Advanced Higher Algebra, U.N.Dhur & Sons Pvt. Ltd., Kolkata.

Generic Elective Course (GE-2)
Mat- HG -2016
Calculus
Total Marks:100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives:

Deals with rate of change of motion.

- To focus on general concepts of limit, continuity & differentiaon.
- To focus on related theorems.

Course Outcomes:

-Extensive applications in business & real life

Unit I (10 Marks)

Graphs of simple concrete functions such as polynomial, Trigonometric, Inverse trigonometric, Exponential and logarithmic functions

Unit II (10 Marks)

Limits and continuity of a function including approach, Properties of continuous functions including Intermediate value theorem.

Unit III (20 Marks)

Differentiability, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivatives.

Unit IV (20 Marks)

Rolle's theorem, Lagrange's mean value theorem with geometrical interpretations and simple applications, Taylor's theorem, Taylor's series and Maclaurin's series, Maclaurin's series expansion of functions such as their use in polynomial approximation and error estimation.

Unit V (20 Marks)

Functions of two or more variables, Graphs and level curves of functions of two variables, Partial differentiation up to second order.

Unit IV (20 Marks)

Fundamental theorem of integral calculus, Definite integration, working knowledge of double integrals, Application of double integral

RECOMMENDED BOOKS

1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13thed). Pearson Education, Delhi. Indian Reprint 2017
2. Das and Mukherjee – Differential Calculus, U.N.Dhur & Sons Pvt. Ltd., KolKata
3. Das and Mukherjee Integral Calculus, U.N.Dhur & Sons Pvt. Ltd., Kolkata

Generic Elective Course (GE-2)
Mat-HG- 2026:
Discrete Mathematics
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives:

This course is designed to provide knowledge about Lattices, Boolean Algebra and Switching circuits.

Course Outcomes:

Students will understand
- the concept of Lattices with applications
- Applications of switching circuit.

Unit I (30 Marks)

Ordered Sets
Definitions, Examples and basic properties of ordered sets, order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principal, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.

Unit II (35 Marks)

Lattices

Lattices as ordered sets, Lattices as algebraic structures, sublattices, Products and homomorphism; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattices, Relatively complemented lattice, Sectionally complemented lattice, homomorphism.

Unit III (35 Marks)

Boolean Algebras and Switching Circuits

Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.

RECOMMENDED BOOKS:

1.Davey, B. A., & Priestley, H. A. (2002). Introduction to Lattices and Order (2nd ed.). Cambridge University press, Cambridge

2.Goodaire, Edgar G., & Parmenter, Michael M. (2011). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.

3.Lidl, Rudolf & Pliz, Gunter. (2004). Applied Abstract Algebra (2nd ed.), Undergraduate Text in Mathematics. Springer (SIE), Indian Reprint.

Ability Enhancement Course (AECC)
Env-AE-2014: Environmental Science
(From the Department of Environmental Science, Botany)

SEMESTER III

Honours Core Course (HC)
Mat – HC – 3016
Mechanics I (Dynamics and Statics)
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: This course aims to provide knowledge how a physical system might develop or alter over time and study the causes of those changes.

Course Outcomes: Students should be able

- To analyse the problems involving tension in a string
- to illustrate laws of motion, kinemetics of motion and their interrelationship
- To explain the concepts of motion of particles

Unit-I (50 Marks)

DYNAMICS

Components of velocities and accelerations along, radial and transverse, along tangential and normal (Art[1] 8,49, 87, 88) Simple Harmonic motions (Art[1] 22-25, Art[2]17.1-17.4. 17.6, 17.7)

Dynamics of a particle:

Motion on smooth and rough plane curves (Art[1] 14.1, 14.2, 15.1, 15.2, 16.1, 16.2) Motion in resisting medium including projectile, Motion of varying mass (Art[1] 104-112) central orbit, Kepler's Law (Art[1] 53-55, 57, 60, 64-67, 69-70)

Acceleration in different Coordinates system (Art[1] 125-127)

Unit-II (50 Marks)

Statics

Parallel forces: Resultant of two parallel forces (3-Art 4.2), unlike parallel forces (3-Art. 4.3), moment of a force, Definition (3-Art. 5.1), and couples: Definition of moment of couple (3-Art. 6.1), Theorem on moment of forces (3-Art. 6.2), Resultant of a couple and a force (3-Art. 6.8). Equilibrium of three coplanar forces (3-Art 8.1), any system of coplanar forces (3-Art 8.3). Centenary: Freely suspended thin, perfectly flexible string lines (3-Art 14.2). Geometrical properties of common Catenary (3-Art 14.3), Tension of the Catenary (3-Art 14.4), Finding the parameter of a Catenary for a uniform string (3-Art 14.5).

Forces in 3-dimension (5-Art 14.1), Conditions of equilibrium (5-Art 14.2), Pointsot's central axis (5-Art 14.3), Null points, lines and planes (5-Art. 14.6), Stable, Unstable and Neutral equilibrium (3-Art 11.4).

RECOMMENDED BOOKS

1. **S.L. LONEY:** An elementary treatise on dynamics of particle and of rigid bodies. Cambridge University press 1956, reprinted by S. Chand & Company (P) Ltd. 1988.
2. **DAS & MUKHERJEE**: Dynamics published by S. Chand & company (P) Ltd, 2010 ISBN-81-85624-96-8.
3. **DAS & MUKHERJEE:** Statics published by S. Chand & company (P) Ltd. 2010, ISBN-81-85624-18-6.
4. **S.L. LONEY:** An Elementary treatise on Statics published by A.I.T.B.S., New Delhi, 2004 ISBN-81-7473-123-7.
5. **A.S. RAMSEY**: Statics, CBS Publishers and Distribution, Shahdara, New Delhi-110032, India.

REFERENCES

1. **M.RAY and G.C. SHARMA**: A Textbook of dynamics published by S. Chand & company (p) Ltd., 2008 (Chapter 1, 2, 6, 8, 9, 11, 12), ISBN-81-219-0342-4.
2. **R.S. VERNA**: A Text Book on Statics Pothishala Pvt Ltd., Allahabad.
3. **A.S. RAMSEY**: Dynamics Part-I, Cambridge University Press, 1973.

Honours Core Course (HC)
Mat- HC-3026
Real Analysis – I
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives:

The course will develop a deep and rigorous understanding of real line R and of defining terms to prove results about convergence and divergence of sequences and series of real numbers**.**

Course Outcomes:

Will understand many properties of the real line, recognize bounded convergent, divergent, Cauchy and monotonic sequences, applications of the ratio, root, alternating series and limit comparison test for convergence and absolute convergence of an infinite series of real numbers**.**

Unit-I (25 Marks)

Fundamental Properties of Real Numbers and Elements of Point Set Topology on

Interval and its different kinds, Bounded and unbounded sets, Supremum and infimum, Field axioms, Order axioms, Order completeness in R, Archimedean property, Neighbourhood of a point, Interior points, Open sets and related properties/theorems, Limits points and derived set, Bolzano-Weierstrass Theorem, Adherent point and Closure of a set, Closed sets and related properties/theorems, Concept of compactness; Heine-Borel theorem.

Unit-II (25 Marks)

Sequence of Real Numbers

Concept of sequence, Bounds of sequence, Limit points of a sequence, Bolzano Weierstrass theorem for sequence, Limit inferior and superior, Convergent and their properties, divergent and oscillate sequences, Cauchy sequences, Cauchy's general principle of convergence, Algebra of sequences, monotonic sequence and their properties, Subsequences, Nested interval theorem.

Unit-III (25 Marks)

Sequence of Real Numbers

Introduction to series of real numbers, Sequence of partial sums and convergence of infinite series, Necessary condition for the convergence of an infinite series, Cauchy's general principle for convergence, Geometric series, some useful theorems on series of positive terms, Comparison test of convergence, convergence and divergence of p-series, Cauchy's root test, D'Alembert's ratio test, Raabe's test, Logarithmic test, D'Morgan & Bertrand test, Leibnitz's test for alternating series. Conditional and Absolute convergence.

Unit-IV (25 Marks)

Limits and Continuity

Limit and Continuity (using $\varepsilon - \delta$ definition) of a function, Algebra of limits and continuous functions, Sequential criterion for limits and continuity, Types of discontinuities, Properties of continous functions on a closed interval, Uniform continuity.

RECOMMENDED BOOKS

1. **S.C. Malik and Savita Arora** - Mathematical Analysis, New Age International (P) Limited; Publishers, New Delhi.

2. **K.C. Maity & R.K. Ghosh** - An Introduction to Analysis, Differential Calculus Part I & II, Integral Calculus, Books and Allied (P) Ltd., Kolkata 700009.

3. **Shanti Narayan and P.K. Mittal** - A Course of Mathematical Analysis, S. Chand & Company Ltd. Ram Nagar, New Delhi - 110055.

REFERENCES

1. **Shanti Narayan and Md. Raisinghania** - Elements of Real Analysis, S. Chand & Company Ltd., Ram Nagar, New Delhi - 110055.
2. **S.L. Gupta & N.R. Gupta** - Principles of Real Analysis, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 F.I.E. Patparaganj N.D. - 110092.
3. **S.K. Jain & S.K. Kaushik** - Introduction to Real Analysis, S. Chand & Company Ltd., Ram Nagar, N.D. - 110055.
4. **S.K. Sinha** - Real Analysis, P.C. Dwadash Shreni & Co (P) Ltd. Publisher & Book Seller's, Bara Bazar, Aligarh - 202001.
5. **V.K. krishnan** - Fundamentals of Real Analysis, Pearson Education (Singapore) Pte. Ltd., Indian Branch.
6. **K.K. Jha** - Honours Course in Real Analysis and Convergence, Navbharat Prakashan Patna - 4, Delhi - 6.
7. **D. Somasundarum & B. Choudhury** - A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
8. **R.G. Bartle & D.R. Sharbert** - Introduction to Real Analysis, John Wiley and Sons (Asia)

Honours Core Course (HC)
Mat-HC-3036
Laplace Transform & Vector Analysis
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: This course aims to introduce students to the following concepts and cognitive skills. In this course the students

- Understand Laplace Transformation, their properties and applications
- Understand the concepts of Differential and Integration of vectors.

Course Outcomes: After studying this course the students will be able to

- State and prove Heaviside's shifting theorem
- Apply Laplace Transformation in solving PDE
- Solve the related problems of Gauss's, Green's and Stoke's theorems

Laplace Transformation

Unit – I (20 Marks)

Concept & definition of Laplace Transform,. Kernel of the Integral transformation [Ref. Ch - 6 (3)]. Existence of Laplace Transformation [Ref. Ch - 8.1 (4)]. Transformation of some elementary functions such as f (t) = e^{-at}, Cos at, Sin at, Cosh at, Sinh at, t^n etc. [Ref. Ch 6 (3)].

Unit-II (20 Marks)

Properties of Laplace Transformation [Ref. Ch - 6 (3)]. First Translation or Shifting Theorem. Second Translation or Heaviside's shifting Theorem [Ref. Ch - 8.5 (4)].

Unit – III (20 Marks)

Differentiation property [Ref. Ch - 6 (3)]. Change of scale property with examples [Ref. Ch - 8.5 (4)]. Laplace Transformation of Derivatives of order n with Theorems [Ref. Ch - 13.6 (5)].

Unit-IV (20 Marks)

Inverse Laplace transformations. Theorems on multiplication by s and 1/s. First and Second Shifting properties with examples [Ref. Ch - 13.20 (5)]. Convolution Theorem. Properties of Convolution, examples of Convolution [Ref. Ch - 8.16 (4)].

Application of Laplace Transformation in solving PDE [Ref. Ch - 8.19 (4)]

Unit-V (20 Marks)

Vector Analysis

Scalar and vector product of three and four vectors, reciprocal vectors, Differetiation of vectors, Gradient, Divergence and Curl of a vector, vector integration, ordinary integrals of vectors, Line, Surface and Volume integrals, theorems of Gauss, Green, Stokes and related problems.

RECOMMENDED BOOKS

1. **B. Das**-Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. **M.R. Spiegel-**Vector analysis and an introduction to tensor analysis-Schaum series.
3. Vector Analysis by Maity & Ghosh.
4. **Spiegel**: *Laplace Transform,* Schuam Outlines Series.

REFERENCES

1. **L.N. Sneddon** : *The use of Integral Transform,* Mc-Graw Hill, New York 1972.
2. *An Introduction to Transform Theory,* Academic Press, New York by D.V. Widder.

Generic Elective Course (GE-3)
Mat-HG -3016
Ordinary Differential Equations,
Partial Differential Equations &Vector
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The course aims to provide knowledge about existing world of Differential equations, Mathematical Modelling and their applications.

Course Outcomes: On completion of this course, Students should be able to solve different mathematical problems with variation of parameters.

Unit I (30 Marks)
ODE

Ordinary differential equations of 1^{st} order and 1^{st} degree (variables separable, homogeneous, exact and linear), equations of 1^{st} order but higher degree. Second Order Linear Equations with constant Coefficients, Homogeneous forms, second order Equations with variable Coefficients, Variation of Parameters.

Unit II (35 Marks)

PDE

Basic concepts and Definitions, Mathematical Problems, First Order Equations, Classification, Construction and Geometrcal Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations, Canonical forms of First –b order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.

Unit III (35 Marks)

Vector

Scalar and vector product of three and four vectors, reciprocal vectors, Differentiation of vectors, Gradients, Divergence and Curl of a vector, vector integration, ordinary integrals of vectors, Line, Surface and Volume integrals, theorems of Gauss, Green, Stokes and related problems.

RECOMMENDED BOOKS:

1. Piaggio – An Elementary Treatise on Differential Equation and Their Applications, C.B.S.Publishers & Distributors, New Delhi.
2. Bhamra KS & Ratna Bala – Ordinary Differential Equations, Allied Publishers Delhi
3. IAN SNEDDON – Elements of partial differential equations, Mc- Graw Hill International edition.
4.H.T.H.PIAGGIO- An elementary treatise on differential equations and their application.
5.Maity & Ghosh – Vector Analysis
6. M.R. Spiegel- Vector analysis and an introduction to tensor analysis, Schaum series.

Generic Elective Course (GE-3)
Mat-HG – 3026
Elements of Probability
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The course is designed to understand the notion of probability and applications.

Course Outcomes: The course will help to understand concept of probability like different types of distribution and applications, Bernoulli's number, Moment generating functions

Unit I (20 Marks)

Probability

Concepts: Classical and Axiomatic, Conditional Probability, Bayes's Theorem, Independent Events, Random Variable, discrete and continuous random variable, Distribution function, probability density function, Expectations, moments moment generating functions.

Unit II (15 Marks)

Discrete Probability

Binomial, Poisson, Hypergeometrial distributions, their comparison, applications.

Unit III (35 Marks)

Continuous Probability Distribution

Stirring's Approximation, Bernoulli Numbers, Uniform Distribution, Negative Binomial Exponential, Gamma and Betta Distributions, Normal Distributions. Limiting forms of Binomial and Poisson distributions, Chebyshev's Inequality.

Unit IV (30 Marks)

Bernounoulli's theorem

Evaluation of Distribution function, Filling of Normal Curve of a frequency distribution. Applications of Normal Distribution, Moment Generating Function, Approximation for the Mean and Variance.

RECOMMENDED BOOKS

1. J.N.Kapoor and M.N. Saxena – Mathematical Statistics, S.Chand & Co. New Delhi.
2. N.A.Rahman – A Course in Theoretical Statistics. Griffin, London.
3. K.L.Chung – Elementary Probability Theory with Stochastic Process, Narosa Publishing House, New Delhi, 1985.
4. Goon Gupta and Das Gupta Ground work of Statistics.

Skill Enhancement Course (SEC-I)
Mat-SE-3014
Sets and Logic
Total Marks: 100
Credits 4: (Theory-03, Tutorial-01)

Course Objectives: The primary objective of this course is to understand Truth Tables, Logical equivalences, importance of Tautology.

Course Outcomes: On completion of this course, students should be able to construct truth tables of different statements. These are of great use in concluding some statements from some given statements.

Unit I (25 Marks)

Sets, Subsets, Set Operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets.

Finite sets and counting principle. Empty set, properties of empty set. Standard set Operations. Classes of Sets. Power set of a set.

Unit II (25 Marks)

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections, Relation, Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations , nary relations.

Unit III (50 Marks)

Sentences and statements, Negation of a statement, Truth values of Statements, Truth Tables, conjunction, disjunction, Implications, biconditional propositions, converse, contra positive and inverse propositions, precedence of logical operators, Propositional equivalence. Logical equivalences, Predicates and quantifiers Tautology, Importance of Tautology, Contradiction. Logically true statement, logically equivalent statement.

RECOMMENDED BOOKS:

1. Gupta and Malik, Set theory and Number systems, Rastogi Publications, Meerut
2. E. Kamke, Theory of sets, Dover Publishers, 1950
3. Samar Ballav Bhoi, A text Book of Logic and Sets, Education Publishing.

Skill Enhancement Course (SEC-I)
Mat-SE-3024
Computer Science & Programming I (in C or any software)
Total Marks: 100
Credits 4: (Theory-02, Practical-02)

Course Objectives: The objective of the course is to generate qualified manpower in the area of Information Technology which will enable such person to work at any offices or for future entrepreneur in the field of IT.

Course Outcomes: Students should be able

- Ability to find importance of software for lab Experimentation, in research by simulation work,
- To write basic mathematical problems in any software.
-

Computer fundamentals:

Unit I (10 Marks)

Basics: Historical evolution, computer generations, a standard model of Computer, functional description, types of Computer, operating systems, hardware and software.

Unit II (20 Marks)

Positional number systems: Representation of integers and real numbers, effect of finite representations
Of number of an arithmetic operations like underflow and overflow, associativity and normalisation, method of overcoming these limitations. Binary, Octal, Decimal, Hexadecimal system. Conversion of a number from one system to another. Binary arithmetic.
Storing of data in a computer: BIT, BYTE, NIBBLE, WORD, coding of data- ASCII, EBCDIC, etc.

Unit III (25 Marks)

Algorithm, Important features, ideas about the complexities of algorithm. Application in simple problems.
Flow-charts, their execution traces.

Programming Languages: Machine language, Assembly language, High level languages. Compiler and Interpreter. Object and Source Program. Ideas about some major High level languages.
Introduction to ANSIC: Character set in ANSIC.

Unit IV (20 Marks)

Introduction to ANSIC:

i) Data Type: character, integer, oating point, etc. Variables, operators: =;==; !!; <; >; etc. (arithmetic, assignment, relational, logical, increment,

ii) Expressions: eg. (a = b)!!(b = c).
iii) Statements: eg. If (a < b) small = a; else small = b;
iv) Standard input / output.

v) Use of while, if else, for, do while, switch, continue, etc.
vi) Arrays, strings, library function and user defined function. Header file.

Unit- V Practical (25 Marks)

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

Construction of simple C programs: Solution of quadratic equations, Approximate sum of convergent infinite series, LCM, GCD, Factorial, Fibonacci series, etc.

RECOMMENDED BOOKS

1. **Byron Gottfried,** Programming with C, Tata McGraw Hill.
2. **E. Balaguruswami,** Programming with ANSIC, Tata McGraw Hill.
3. **RG Dromey,** How to solve it by computer, Prentice Hall of India.
4. **Venugopal & Prasad,** Programming with C, Tata McGraw Hill.

REFERENCES

1. **Kamtham -** Programming with ANSI & Turbo C, Pearson Education.
2. **B.W. Kernighan and D.M. Ritchie,** the Programming Language, Prentice Hall of India.
3. **V. Rajaraman,** Programming in C, Prentice Hall of India.
4. **Robert C Hutchison** and **Steven B. Just,** Programming using C language, Tata McGraw Hill.

SEMESTER IV

Honours Core Course (HC)
Mat-HC-4016
Analysis II (Real Analysis)
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives:

The study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concept of Calculus.

Course Outcomes:

Students should be able to have

- a rigorous understanding of the families and properties of Rieman integral functions
- Concept of multiple integral, line and surface integrals and connection among all integrals (Green's and Stoke's theorem)

Unit-I (25 Marks)
Improper Integrals

Improper integrals, Different types of improper integrals, Evaluation, convergence of improper integrals, various forms of comparison tests, absolute and conditional convergence, Abel's test and Dirichlet's test, Beta function, Gamma function, Frullani's Integral.

Unit-II (25 Marks)

Riemann Integration

Upper and lower Riemann Integrals (R.I.), Darboux's theorems, Integrability conditions, R.I. as a limit of a sum, properties, Inequalities for Integrals, Integral function, Mean value theorems

Unit-III (25 Marks)

Functions of Several Variables

Differentiability and differential, Partial derivatives of higher order, Young's and Schwarz's theorems, Differentials of higher order, Functions of Functions, Differentials of higher order of a function of functions; Derivation of composite functions (the chain rules); Change of variables.

Unit-IV (25 Marks)

Multiple Integrals
Concept of line integrals; Double and repeated integrals; Green's theorem in the plane, evaluation of area, Change of order of integration.
Surface areas; surface integrals; Stoke's Theorem; Volume integrals, Triple integrals; Gauss divergence Theorem and its
application

RECOMMENDED BOOKS

1. **S.C. Malik and Savita Arora** - Mathematical Analysis, New Age International (P) Limited; Publishers, New Delhi.
2. **K.C. Maity & R.K. Ghosh** - An Introduction to Analysis, Differential Calculus Part I & II, Integral Calculus, Books and Allied (P) Ltd., Kolkata 700009.
3. **Shanti Narayan and P.K. Mittal** - A Course of Mathematical Analysis, S. Chand & Company Ltd. Ram Nagar, New Delhi - 110055.

REFERENCES

1. **Shanti Narayan and Md. Raisinghania** - Elements of Real Analysis, S. Chand & Company Ltd., Ram Nagar, New Delhi - 110055.
2. **S.L. Gupta & N.R. Gupta** - Principles of Real Analysis, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 F.I.E. Patparaganj N.D. - 110092.
3. **Shanti Narayan and P.K. Mittal** - A Course of Mathematical Analysis, S Chand & Company Ltd. Ram Nagar, New Delhi - 110055.

REFERENCES

1. **Shanti Narayan and Md. Raisinghania** - Elements of Real Analysis, S. Chand & Company Ltd., Ram Nagar, New Delhi - 110055.
2. **S.L. Gupta & N.R. Gupta** - Principles of Real Analysis, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 F.I.E. Patparaganj N.D. - 110092.
3. **S.K. Jain & S.K. Kaushik** - Introduction to Real Analysis, S. Chand & Company Ltd., Ram Nagar, N.D. - 110055.
4. **S.K. Sinha** - Real Analysis, P.C. Dwadash Shreni & Co (P) Ltd. Publisher & Book Seller's, Bara Bazar, Aligarh - 202001.
5. **V.K. Krishnan** - Fundamentals of Real Analysis, Pearson Education (Singapore) Pte. Ltd., Indian Branch.
6. **K.K. Jha** - Honours Course in Real Analysis and Convergence, Navbharat Prakashan Patna - 4, Delhi - 6.
7. **D. Somasundarum & B. Choudhury** - A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
8. **R.G. Bartle & D.R. Sharbert** - Introduction to Real Analysis, John Wiley and Sons (Asia)

Pte. Ltd., Singapore.

9. **R.R. Goldberg** - Method of Real Analysis, Oxford and INH Publishing Co.
10. **Murray R Spiegel** - Theory and Problems of Advanced Calculus, Schaum Out Line Series Mc Graw Hill Book Company.
11. **Frak Aryer Jr.** - Theory & Problem of Calculus, Schaum Out Line Series Mc Graw Hill Book Company.

Honours Core Course (HC)
Mat – HC - 4026
Linear Algebra
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives:

To focus on real vector spaces, subspaces and aplications. It gives details of linear independence and dependence, linear transformation, Inner product spaces. Students also expected to gain an appreciation for the application of linear algebra to areas such as computer science, engineering, biology and economics.

Course Outcomes: Students should be able to

- Explain the concepts of vector space, subspace and their properties
- Express vector spaces in different dimensions
- Solve Rank and Nullity of linear transformation.

UNIT – I (35 Marks)

VECTOR SPACES:

Concept of Vector Space over a Field K, n-tuple space, Subspaces, Necessary and sufficient condition for being a Subspace, Subspace generated by a Subset, Sum as Direct sum of Subspace, Linear Span, Linear Dependence, Linear Independence and their basic properties, Basis, Dimensions, Finite Dimensional Vector Spaces, Existence Theorem for Basis, Complement of a Subspace and Existence of a Complement of a Subspace of a Finite Dimensional Vector Space, Dimension of sum of Subspaces, Quotient Space and its Dimension.

UNIT – II (35 Marks)

Linear Transformation

Kernel of a Linear Transformation, Isomorphism, Isomorphism Theorem, Representation of Linear Transformation as matrices, Algebra of Linear Transformations, Rank and Nullity of a Linear Transformation, Rank-Nullity Theorem,

Change of Basis, Dual Space, Annihilator of a Subspace, Quadratic and Hermitian Forms. (Ref Chapter 4[1], Chapter 9 and 10[3], Chapter 8 and 9[2])

UNIT – III (30 Marks)

INNER PRODUCT SPACES

Inner Product Spaces, Cauchy-Schwarz Inequality, Orthogonal Vectors, Orthogonal Complements, Orthonormal sets and Orthonormal Basis, Bessel's inequality for Finite Dimesnsional Vector Spaces, Gram-Schmidth Orthogonalization process.

Ref. Chapter 9[3]

RECOMMENDED BOOKS

1. **I.N.Herstein**: Topics in Algebra, John Wiley & Sons, New Delhi.
2. **Kenneth Hoffman and Ray Kunze**: Linear Algebra, Pearson.
3. **V.K. Khanna & S.K. Bhambri**: A Course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.

REFERENCES

1. **S. Kumaresan**: Linear Algebra, Prentice Hall of India.
2. **Vivek Sahai and Vikas Bist**: Linear Algebra, Narosa Publishing House, New Delhi.
3. **Shanti Narayan & P.K. Mittal**: A Text Book of Matrices, S. Chand & Co., New Delhi.
4. **Joseph A. Gallan**: Contemporary Algebra, Narosa Publishing House, New Delhi.
5. **Surjeet Singh** and **Qazi Zameerudin**: Modern Algebra, Vikas.
6. **P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul**: Basic Abstract Algebra, CUP.
7. **John F. Fraleigh**: A First Course in Abstract Algebra, Addison Wesley.
8. **J.G. Chakravorty and P.R. Ghosh**: Advanced Higher Algebra, U.N.Dhur & Sons Pvt. Ltd., Kolkata.
9. **Michael Artin:** Algebra, Prentice Hall of India Ltd.
10. **N. Jacobson**: Basic Algebra Vol. I & II, Hindustan Publishing Corporation, New Delhi.
11. **K.B. Dutta:** Matrix and Linear Algebra, Prentice Hall of India Pvt. Lt.
12. **I.S. Luther, I.B. Passi:** Algebra Vol-I(Groups), Vol-II(Rings) and Vol-III(Modules), Narosa Publishing House, New Delhi.
13. **D.S. Malik, J.N.Moderson & M.K. Sen**: Fundamentals of Abstract Algebra, Mc-Graw Hill International Edition.
14. **David S. Dummit, Richard M. Foote:** Abstract Algebra, John Wiley and Sons (Asia) Pvt., Ltd, Singapore.
15. **S.Lipschutz**: Theory And Problems of Linear Algebra, SI (metric) edn. Schuam's Out Series, Mc Graw Hill.
16. **Frank ayres:** Modern Algebra, Schaum Outline Series, Mc Graw Hill.

Honours Core Course (HC)
MAT- HC- 4036:
Computer Science & Programming II
(in C or using any software)
Total Marks: 100
Credits6: (Theory-04, Practical-02)

Course Objectives:

- To familiarize students the concept of programming in C and exploring software like MATLAB, PYTHON etc.
- To provide a foundation in use of this software for real time applications and
- To prepare the students to use any software in their project works.

Course Outcomes: Students should be able to
- ability to write basic mathematical problems in C, MALAB, Python etc.
- find importance of mathematical soft ware for Lab Experiment

Unit –I (15 Marks)

Basic model of a computer, Algorithm, Flow Chart, programming language, Compilers and operating system, character set, identifiers and keyword, Constant, variables and data type, operations and expressions, operator precedence and associativity, Basic input/output statements, introduction to simple C-programs.

Unit-II (20 Marks)

Conditional statements and loops: Decision making with a program, logical and conditional operators, if statement, nested if else statement, loops, while loop, do-while loop, for loop, nested loops, break statement, switch statement, continue statement, goto statement, the comma operator.

Unit – III (20 Marks)

Arrays: One dimensional arrays, declaration and initialization of one dimensional arrays, searching, insertion and delation of an element from an array, sorting an array. Two dimensional arrays.

Unit- IV (20 Marks)

Function: Defining a function, accessing a function, function declaration/prototype, function parameters, return values, passing arguments to a function, call by a reference, call by value, function calls, recursion, passing arrays to function.

Unit- V Practical (25 Marks)

Instructions for Practical **[<u>Two Programs Only</u> a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

Duration Two Hours

List of practical (in C or using any soft ware)

1. To calculate the compound interest accepting the necessary data from the keyboard.
2. To find the value of $\frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots\cdots\cdots\cdots\cdots$
3. To find the roots of a quadratic equation.
4. To find the factorial of a positive integer.
5. To reverse the order of some numbers.
6. That will read a positive number from the keyboard and check the number is prime or not.
7. To convert octal to decimal number.
8. To generate prime numbers up to n terms.
9. To find GCD of two given numbers.
10. To find GCD of two given numbers using recursion.
11. To arrange numbers in ascending order and decreasing order.
12.. To generate Fibonacci series of numbers up to n terms.
13. To write program to test a word is palindrome or not.
14. To implement selection sort.
15. To implement insertion sort.
16. To write program for union of two sets
17. To write program for intersection of two sets.

RECOMMENDED BOOKS.

1. **Byron Gottfried,** Programming with C, Tata McGraw Hill.
2. **E. Balaguruswami,** Programming with ANSIC, Tata McGraw Hill.
3. **RG Dromey,** How to solve it by computer, Prentice Hall of India.
4. **Venugopal & Prasad,** Programming with C, Tata McGraw Hill.

REFERENCES

1. **A. Kamtham -** Programming with ANSI & Turbo C, Pearson Education.
2. **B.W. Kernighan and D.M. Ritchie,** The Programming Language, Prentice Hall of India.
3. **V. Rajaraman,** Programming in C, Prentice Hall of India.
4. **Robert C Hutchison** and **Steven B. Just,** Programming using C language, Tata McGraw Hill.

Generic Elective Course (GE – 4)
Mat-HG-4016
Mechanics II
Total marks:100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The course aim to
- understanding the components of velocity and acceleration
- develop an understanding of the fundamentals and principles of motion of particles
- develop an ability to grasp the concepts of equilibrium and tension.

Course Outcomes: Students should be able to
- illustrate laws of motion, kinematics of motion and to learn the cause-effect related to these
- explain the concepts of motion of particles; get a hold of S.H.M. of compounding two S.H.M. of simple pendulum.

UNIT I (50 Marks)

DYNAMICS

Kinematics in two dimensions: Tangential, normal, radial, transverse velocities and accelerations. Angular velocity and acceleration. Rectilinear motion and simple pendulum. S.H.M., compounding of two S.H.M. Repulsive motion. Motion under inverse square law.

Rectilinear Motion (Kinetics): Newton's law, Work, K.E., work energy principle, Impulse, Torque and angular momentum, conservation of energy, momentum and angular momentum, Hooke's law, extension of an elastic string: Horizontal & vertical case**.**

UNIT II (50 Marks)

STATICS

Reduction of system of coplanar forces, equation of resultant, condition for equilibrium, astatic centre. Laws, angles and cone of friction, equilibrium on a rough inclined plane, particle constrained to move on a rough curve under any given forces.

RECOMMENDED BOOKS:

1. Statics – S. L. Loney
2. Dynamics – S. L. Loney
3. Mechanics – Singh & Sen, Bharti Bhawan Publication
4. Dynamics – Das & Mukherjee, published by S.Chand & Company (P) Ltd.2010 ISBN-81-85624-96-8
5. Statics - Das & Mukherjee, published by S.Chand & Company (P) Ltd.2010 ISBN-81-856224-18-

Generic Elective Course (GE – 4)
Information Security
Mat-HG-4026
Total Marks: 100
Credits 6: (Theory-04, Practical-02)

Course Objectives: This course is aims to introduce students the concept of Secrecy, Program threats, Authentication, Integrity, Access control, public key encryption.
Course Outcomes: This course will enable the students to keep confidential and protect the Messages exchanged over worldwide through computer networks.

Unit I (15 Marks)

Overview of Security:
Protection versus security; aspects of security–data integrity, data availability,; security problems, user authentication, Orange Book.

Unit II (15 Marks)

Security Threats:
Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats-intruders; communication threats- tapping and piracy.

Unit III (15 Marks)
Cryptography:
Substitution, transposition ciphers, symmetric-key algorithms- Data . Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

Unit IV (15 Marks)
Digital signatures:
Symmetric key signatures, public key signatures, message digests, public key infrastructures.

Unit V (15 Marks)
Security Mechanisms:
Intrusion detection, auditing and logging, tripwire, system-call monitoring

Practical – 25 Marks

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

RECOMMENDED BOOKS

1. W. Stallings, *Cryptography and Network Security Principles and Practices*, 4th Ed., Prentice-Hall of India, 2006
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing* , 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security*, Springer-Verlag Berlin , 2003.
5. J.M. Kizza, *Computer Network Security*, Springer, 2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices*, Pearson

Skill Enhancement Course (SEC-2)

MAT-SE- 4014

Graph Theory

Total Marks: 100

Credits 4: (Theory-03, Tutorial-01)

Course Objectives:

This course gives details about the different types of graph and its properties. It will help students to develop Mathematical modelling in terms of different Type of graph.

Course Outcomes: Students should be able

- to apply different types of Graph as a mathematical model for many real life Situation such as communication network, signal flow.
  to develop Euler's subordinate relationship
- solve Map-colouring problems

Unit I (10 Marks)

Definition, examples and basic properties of graphs, types of graphs, complete, directed graph, signed graph, weighted digraph, weighted signed digraphs.

Unit II (20 Marks)

Mathematical Models in terms of directed graphs. One way traffic problems, Genetic graphs, Senior-Subordinate Relationship, Food Webs, and Communication Networks. Tree, Basic properties, Spanning tree, Minimal Spanning tree, Kruskal's algorithm, Prime's Algorithm, Rooted tree, Binary tree.

Unit III (20 Marks)

Matrices associated with a Directed graph, Application of Directed graphs to Detection of Cliques, Mathematical models in terms of Signed graphs, Structure theorem and its Implications, Antibalance and Duobalance of a graph, the degree of Unbalanced of a graph.

Unit IV (30 Marks)

Mathematical modelling in terms of Weighted Digraphs, Weighted Digraphs and Markov chains, General communication networks, Signal Flow graphs, Weighted Bipartitic Digraphs and Difference Equations, Mathematical Modelling in terms of Unoriented Graphs, Map-Colouring problems, Planer graphs, Face-size equation , Euler's formula for a planar graph, To show the graphs K_5 and $K_{3,3}$ are non planar, Euler 'Subordinate relationship, Necessary and sufficient condition for a graph to be Euler graph. Konigsberg Bridge problem.
Food Webs, Communication Networks. Skill Enhancement

Unit V (20 Marks)

Matrices associated with a Directed graph, Application of Directed graphs to Detection of Cliques, Mathematical models in terms of Signed graphs, Structure theorem and its Implications, Antibalance and Duobalance of a graph, the degree of Unbalanced of a graph.

RECOMMENDED BOOKS

1. J.N, Kapur, Mathematical Modelling; Wiley Estern Limited
2. E. G. Goodaire & M.M Prementer, Discrete Mathematics (with graph); Prentice Hall

Skill Enhancement Course (SEC-2)

Mat-SE-4024

Cryptography

Total marks: 100

Credits 4: (Theory-02, Practical-02)

Course Objectives: Objective of studying cryptography is to provide students knowledge of symmetric encryption, substitution symmetric encryption (letters/block of letters are substituted by other letters/block letters), Transposition symmetric encryption application of permutation to the plaintext), public key Encryption, etc.

Course Outcomes: Students should be able to find importance of cryptography. They will have knowledge how to keep the information used by the common people secure, should be able to protect confidential messages exchanged over worldwide through computer network against manipulation.

Unit – I (15 Marks)

Prerequisites of Number theory

Prime numbers, format's theorem (without proof), Euler's theorem; Primality test- Methods of Native, Fermat, Miller- Rabin Leonard Adleman and Huang, probability, fast deterministic, number theoretic tests. Chinese Remainder Theorem, discrete logarithms.

Unit – II (15 Marks)

Cryptography & Information Security

Information security, security attacks, services and mechanisms, conventional encryption techniques, substitution ciphers and transportation ciphers, cryptanalysis, sterography, stream and block ciphers.

Unit – III (15 Marks)

Block Ciphers and DES

Block cipher principles, Data Encryption Standards (DES), strength of DES, differential and linear cryptanalysis of DES, block ciphers models of operation, triple DES, IDEA encryption and decryption, traffic confidentially, key distribution, random number generation.

Unit –IV (15 Marks)

Public Key Cryptography

Principles of public key cryptography, prime and related prime numbers, modular arithmetic, key management, authentication, key length and encryption strength, RSA algorithm, security of RSA key management.

Unit – V (15 Marks)

DSS & IP Security

Authentication functions, and message authentication codes, digital signatures, authentication protocols, digital signature standards (DSS) digital signature algorithm. IP security and its overview, intruders, viruses and related threads, firewell design principles.

PRACTICAL – 25 Marks

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

RECOMMENDED BOOKS

1. **William Stallings,** Cryptography and Network Security, Principles and Practice, Prentice Hall of India, New Delhi, 2007

2. **V.K Pachghare,** Cryptography and Information Security, PHI Learning (P) Ltd, New Delhi, 2009

REFERENCES:

1. **Johannes A. Buchman,** Introduction to cyptography, Spiringer Verlag
2. , **Bruce Schiener,** Applied Cryptography, Addition Wesley, 2001

SEMESTER V

HONOURS CORE COURSE (HC)
Mat-HC-5016
Partial Differential Equations & Calculus of Variation
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The main objective of the course is to teach students to form and solve partial differential equations and use them in solving some physical problems.

Course Outcomes: Students should be able

- to formulate and classify partial differential equations
- To solve linear and non linear partial differential equations using various methods and apply these methods in solving some physical problems.

Unit – I (25 Marks)

First order PDE

Origin of 1st order PDE, Formation of PDE by eliminating arbitrary constants and arbitrary functions. Cauchy's problem of First order equation [Ref. Ch-2 (1)]. Definitions of (i) Complete Integral (ii) Particular Integral solvable for y (iii) Singular Integral (iv) General Integral. Equations of 1st order but not of 1st degree (i) Solvable for P (ii) Solvable for y (iii) Solvable for x [Ref. Ch - V (2)].

Language's method of solving the linear PDE of order one namely Pp + Qq = R, where P, Q, R are functions of x, y, z. Its Geometrical interpretation. Linear equation with n independent variables [Ref. Ch - XII (2)]

Unit – II (25 Marks)

Non-linear PDE of order one

Different Standard Forms (i) Only p and q present (ii) Only p, q and z present (iii) f(x,p) = F (y, q) (iv) Analogous to Clairaut's form. [Ref. Ch - XII (2)].

Partial differential equations of 1st order but of any degree (i) Two independent variables. Charpit's Method (ii) Three or more independent variables, Jacobi's method [Ref. Ch - XIII (2)].

Unit – III (25 Marks)

PDE of second order

Introduction to Higher order PDEs (constant coefficients only): Origin of second order equations [Ref. Ch - 3 (1)]. Solution of Linear Homogenous PDE with constant coeffiecients. To find the complete solution of the equations namely (i) f (D, D^1) z = 0 and (ii) f (D, D^1)z = F(x, y). Equations reducible to linear form with constant coefficients [Ref. Ch - 2.9 (4)]. Monge's method of integrating (i) Rr + Ss + Tt = V (ii) Rr + Ss + Tt + U($rt - S^2$) = V [Ref. Ch - XIV (2)].

Unit – IV (25 Marks)

Calculus of Variation

Fundamental Theorem on Calculus of Variation Definition, Euler's equations, particular cases of Euler's equation [Ref. Ch - 17 (5)]. Necessary condition for extremums. Sufficient condition for extremums of higher order variations [Ref. Ch - 10 (4)]. Legendre condition for extremum (Sufficient condition for extremum with problems) [Ref. Ch - 10.7 (4)].

Brachistochron problems. Extension of the variational case (several dependent variables) with examples.

RECOMMENDED BOOKS

1. *Elements of partial differential equations by* **IAN SNEDDON:** Mc-Graw Hill International editions.
2. *An elementary treatise on differential equations and their application* by **H.T.H.PIAGGIO.**
3. *Introduction to partial differential equations* by **K. Krishna Rao.**
4. *Advanced partial differential equations (with Boundary value problems)* by Pundir & Pundir.
5. *Advanced engineering Mathematics* by **H.K. Dass.**
6. *Partial Differential Equations* by **KS Bhamra**, PHI Learning Pvt. Ltd, New Delhi, 2010.

REFERENCES

1. **W.E. Williams:** *Partial differential equations,* Oxford.
2. **Phoolan Prasad:** *Partial differential equations,* Wiley Eastern, New Delhi (and Renuka Ravindran).
3. **I.N. Sneddon** : *Partial differential equations,* Mc-Graw Hill, New York.
4. **KS Bharma & Ratna Bala:** *Ordinary Differential Equations, Allied Publishers,* Delhi, 2003

HONOURS CORE COURSE (HC)
ANALYSIS III
Mat-HC-5026
Numerical Analysis (including practical)
Credit 6: (Theory-04, Practical-02)

Course Objectives: To make the students familiarize with the ways of solving complicated mathematical problems using numerical approximations

- To describe and understand the several errors and approximations in numerical methods
- To obtain numerical solutions to problems of mathematics such as finding roots of equations, numerical differentiations and Integration, solutions of differential equations.
- To study curve fitting and interpolation

Course Outcomes: To explore complex systems mathematicians, engineers, physicist and others require computational methods since mathematical models are only rarely solvable algebraically. Numerical methods based upon sound computational mathematics are the basic algorithms in modern systems. These methods include technique for simple optimization, interpolation from the known to the unknown, to study the solutions of linear algebra, differential equations to simulate systems and Stochastic simulation under random influences.

Unit 1 (10 Marks)

Calculus of finite difference: The operators $\Delta, \nabla, E,$ factorial notation, their properties and interrelation between the operators, Fundamental theorem of difference calculus, ordinary and divided differences.

Unit II (10 Marks)

Interpolation: Newton's forward and Backward difference interpolation formulae, Newton's divided difference formulae and their properties.

Unit III (15 Marks)

Lagrange's and Hermite's interpolation (Osculating) formulae, Central difference interpolation, Gauss's forward, backward and central difference interpolation formula. Least square polynomial approximation.

Unit – IV (20 Marks)

Numerical differentiation: Derivative using forward, backward and central difference interpolation formulae.

Numerical integration: General quadrature formulae, Trapezoidal rule, Simpson's one- third rule and three-eighth rule, Weddle's rule, Newton-Cote's method.

Numerical solution of ODEs using Picard, Euler, and Euler's modified Runge-Kutta methods.

Unit-V (20 Marks)

Solution of algebraic and transcendential equations, Bisection method, Regula-Falsi method and Newton-Raphson method.

System of linear algebraic equation using Gauss elimination method.

NB. Use of Scientific Calculator is allowed.

Unit-VI (Practical) (25 Marks)

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks]**

Duration Two Hours

List of practical (in C or using any soft ware)

1. Calculate the Sum $\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\cdots\cdots\cdots\cdots\cdots+\frac{1}{N}$
2. To find the Absolute value of an Integer.
3. Enter 100 Integers into an array and Sort them in an Ascending order.
4. Program for Newton's Forward difference interpolation formula.
5. Program for Newton's backward difference interpolation formula.
6. Program for Lagrange's interpolation formula
7. Program for Newton's divided difference interpolation formula.
8. To find the solution of non-linear equation by
   (i) Bisection
   (ii) Secant and
   (iii) Newton- Raphson method.
9. To find the solution of linear equation by Gauss Elimination method.
10. Numerical Integration
    (i) Trapezoidal rule
    (ii) Simpson's 1/3 rule.
11. Ordinary differential equation
    (i) Euler's method
    (ii) Runge - Kutta method.

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RECOMMENDED BOOKS

1. **M.K. JAIN, S.R.K Iyenger, R.K. Jain -** Numerical methods for scientific and engineering computation, New Age international (P) Ltd.
2. **James B. Scarborough –** Numerica

l mathematical analysis, Oxford and IBH publishing Co. pvt. Ltd.

3. **H.C. Saxena** - Finite differences and numerical analysis, S Chand & Co. Ltd., New Delhi.

REFERENCES

1. **K.E. Atkinson** - An introduction to numerical analysis, John Wiley and Sons.
2. **M.K. Jain, S.R.K. Iyenger, R.K. Jain -** Numerical method for problems and Solutions, New Age international (p) Ltd.
3. **R.Y. Robistein** - Simulation and Montecarlo method, John Wiley.
4. **C.E. Froberg** - Introduction to numerical analysis, Addison Wesley, 1979.

Discipline Specific Elective (DSE -1)

Mat-HE-5016
Geometry (Two & Three dimensions)
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The primary aim of this course is to introduce the basic tools of plane geometry and geometric properties of different conic sections which are helpful in understanding their applications to the real world problems. The main aim is to introduce the basic tools of space geometry.

Course Outcomes: This course will enable the students to

- Understand basic knowledge about pair of straight lines, properties of conic sections in the Cartesian and polar co-ordinates, to trace parabola, ellipse, hyperbola in a plane using its mathematical properties.
- Understand about lines in 3D, projections, basic knowledge about different types of conicoids such as spheres, cone, cylinder, ellipsoid, hyperboloid and paraboloid.

Two dimensional Geometry

Unit – I (25 Marks)

Change of axes: Change of origin without changing the direction of axes. Change of direction of axes of co-ordinates without changing the origin.

Pair of Straight lines: Pair of straight lines, homogeneous equation of second degree, Angle between the pair of lines given by the homogeneous equation, Bisectors of the angles between the pair of lines, Condition for the general equation of second degree represents a pair of straight lines, Point of intersection, Equation of the pair of lines joining the origin to the points of intersection of the line and a curve.

Unit-II (25 Marks)

System of Conics: Every general equation of second degree in two variables always represents a conic section, The centre of a conic, Reduction of the general second degree equation into a central and non-central conics, Condition that a line is a tangent to a conic, Chord of contact, pole and polar, Diameter, conjugate diameters, feet of normals, Intersection of two conics, Pair of tangents.

Confocal Conics and their Properties

Polar equation of conics: Polar equation of a conic with respect to focus as pole, equation of a chord, tangent and normal.

Three Dimensional Geometry

Unit-III (25 Marks)

Sphere: Equations of sphere, condition for the general equation of second degree to represent a sphere, plane section of sphere, intersection of a plane and a sphere, intersection of two spheres, power of a point, equation of a tangent plane, condition for a plane to be a tangent plane to a sphere, plane of contact, polar plane, pole of a plane.

Cone: Equation of a cone with a conic as guiding curve, enveloping cone of a sphere, quadratic cones with vertex at origin, condition for the general equation of second degree to represent a cone, reciprocal cone, right circular cone.

Unit – IV (25 Marks)

Cylinder: Equation of cylinder, enveloping cylinder, right circular cylinder.

Central coincoids: Equations and properties of coincide, intersection of a line with a conicoid, Tangent line and plane, normal, number of normals from a given point, plane of contact. Polar plane of a point, enveloping cone and cylinder, chord, conjugate diameters.

Paraboloids: Equations and simple properties.

Confocal conicoids: Equations and simple properties.

RECOMENDED BOOKS:

1. **B. Das**-Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. **Shanti Narayan and P.K. Mittal-**Analytical Solid Geometry, S. Chand.

REFERENCES

1. **S.L. Loney**: Co-ordinate geometry of two dimensions, Macmillan and Sons Pvt. Ltd.
2. **R.J.T. Bell**: Co-ordinate geometry of three dimensions, Macmillan and Sons Pvt. Ltd.

Discipline Specific Elective (DSE -1)

Mat-HE-5026
Fluid Mechanics
Total Marks: 100
Credits 6 : *(Theory-05, Tutorial-01)*

Course Objectives:
- To introduce description of different types of fluid motion
- To study equations of continuity indifferent forms
- To study geometric properties of different fluid rotation, flow fluids which are helpful in understanding their applications to the real problem.

Course Outcomes: Students will be able to
- Understand pressure equations and can solve Bernoulli's equations and its applications
- Learn about kinematic and dynamic similarities, potential functions, flows, flows fluids.

Unit I (25 Marks)

Kinetics

Eulerian and Lagrangian description of fluid motion. Concept of local and connective accelerations. Steady and Non-Steady flows. Stream lines and path lines. Equation of continuity in different forms. Irrational and Rotational flows. Controlled volume analysis for mass, momentum and energy. Velocity potential.

Unit II (25 Marks)

Equation of Motion

Equations of motion-Eulerian and Lagragian. Pressure equation, Bernoulli's equation and its applications, Cauchy's integrals. Motion under the action of impulsive forces. Sources, Sinks, Doublets and their Images.

Unit III (25 Marks)

Dimensional Analysis

Concept of Geometric, Kinematic and Dynamic Similarities, Concept of Fluid rotation, Velocity, Stream function and Potential function, Potential flows, Elementary flow fields and Principle of superposition.

Unit IV (25 Marks)

Vortex Motion

General theorem (vortex motion and its properties), Rectilinear vortices, Motion under circular and rectilinear vortices.

RECOMMEDED BOOKS

1. **G.K. Batchelor,** An introduction to Fluid Mechanics, Cambridge Univ. Press 1967.
2. **F. Chorlton**, Text Book of Fluid Dynamics, CBS Publication, Delhi 1985.

REFERENCES

1. **AJ Chorin & JF Mursden**, mathematical introduction to Fluid dynamics 1993.
2. **L.D. Landu and F.M. Lifshitz,** Fluid Mechanics, Pregmon Press 1985.
3. **O'Neil and F. Chorlton,** Ideal and incompressible Fluid Dynamics, Ellis Horwood,Ltd.1986

Discipline Specific Elective (DSE -2)

Mat-HE- 5036
Rigid Dynamics& Tensor
Total Marks: 100

Credits 6: ***(Theory-05, Tutorial-01)***

Course Objectives: The first part of the course is to
- develop an ability to grasp the concepts of equilibrium and tension.
- develop an understanding of the fundamentals and principles of motion of any rigid body

The second part aim
- at understanding the various relations which remain valid on change of systems.
- help the learners of relativity, differential geometry, and engineering mathematics.

Course Outcomes: Students should be able to
- analyse the problems of the motion of rigid bodies and simultaneously solve them
- get a hold of motion of compound pendulum
- study and learn the cause effect related to the relations between other papers of mathematics
- the applications in observing and relating real situations.

Unit I (50 Marks)

DYNAMICS OF RIGID BODIES:

Moments and products of inertia (Art[1] 144-149), Momental Ellipsoid (Art[1] 151) Equimomental systems, Principal Axis (Art[1] 154, 155)

D'Alembert's Principle, Equations of motion of rigid bodies, Motion of centre of inertia, Motion relative to centre of Inertia (Art[1] 162)

Motion about a fixed axis (Art[1] 168-171), Compound Pendulum (Art[1] 173-175), Motion in 2 dimension under finite and impulsive forces (Art[1] 187-190), Conservation of momentum and Energy. (Art[1] 235, 236, 238, 239, 242)

Unit II (50 Marks)

Tensors:

Space of N-dimension, Transformation of co-ordinates, contravariant and covariant vectors (Tensor of first order), Tensor of second order (or of rank two), Tensor of higher rank (or higher orders), Mixed tensors, Kronecker delta symbol, Invariant or scalar, Algebraic operations with tensors, Addition & subtraction of tensors, contraction, product of tensors, Inner Product, symmetric and Skew symmetric tensor.

RECOMMENDED BOOKS

1. **S.L. LONEY** : An elementary treatise on dynamics of particle and of rigid bodies. Cambridge university press 1956, reprinted by S. Chand & Company (P) Ltd. 1988.

Discipline Specific Elective (DSE -2)
MAT-HE-5046:
Higher Mechanics
Total Marks: 100
Credits 6: *(Theory-05, Tutorial-01)*

Course Objectives: This course aims to

- Provide knowledge about K.E. due to rotation, as quadratic functions of generalized velocities, Euler's geometrical equations.
- Understand applications to S.H.M., pendulum, projectile motion.

Course Outcomes: A student will understand the importance of advantages

- Of Hamiltonian approach over Lagrangian approach.
- Conditions for a transformation to be canonical.

UNIT – I (10 Marks)

System of Particles

Centre of mass, centre of gravity, momentum, conservation of Linear momentum, Angular momentum, kinetic Energy, conservation of Energy for a system of particles.

UNIT – II (25 Marks)

Motion of rigid *bodies*

Generalized coordinates for rigid body, translational and rotational motion Angular momentum, moments and products of Inertia, Kinetic Energy due to rotation, kinetic energy in terms of inertia tensor, principle axes, Principle moments of inertia, Euler's angle, Euler's geometrical equations, rate of change of vector, coriolis forces, and Euler's equation of motions.

UNIT –III (25 Marks)

Lagrangian Mechanics

Generalized Coordinates, degrees of freedom, generalized force, generalized momenta, Holonomic, non-holonomic, Seleronomic and Rheonomic systems, virtual works, D' Alembert's principal, Kinetic Energy as quadratic functions of generalized velocities, Lagrangian of a force system, Lagrange's Equations of motion. Applications to S.H.M. Compound pendulum, projectile, central orbit, motion of a particle on the Earth's surface.

UNIT – IV (25 Marks)

Hamiltonian Mechanics

Configuration space, system point, Hamiltonian of a force system, relation between Lagrangian and Hmiltonian of a system. Hamilton's Principle, Physical significiances of Hamiltonian, Derivation of Hamilton's Principle from Lagrange's Equations and Vice-Versa, Derivation from D' Alembert's Principle, Hamilton's Canonical Equation of motion, advantages of Hamiltonian approach over Lagrangian approach, meaning of Action in Hamiltonian sense, Least action Principle.

UNIT – V (15 Marks)

Canonical Transformation

Meaning and conditions for a transformation to be canonical, Examples, Lagrange's bracket, Poisson's bracket and their properties, equations of motion in Poisson's bracket.

RECOMMENDED BOOKS

1. **S.L. Loney** : An Elementary treatise on Dynamics of a particles and rigid bodies.
2. **G. Aruldhas** : Classical Mechanics, Prentice Hall of India, Private Limited, New-Delhi-2008.
3. **H. Goldstein** : Classical Mechanics Narosa Publishing House, New Delhi-1985.
4. C.R. Mondal : Classical Mechanics, Prentice hall of India New Delhi.

REFERENCES

1. **Murray R. Spiegel**: Theoretical Mechanics Mc Graw Hill Book Company, New Delhi.
2. **K. Shankara Rao** : Classical Mechanics Prentice Hall of India.
3. **R.G. Takwale and P.S. Puranik** : Introduction to Classical Mechanics, Tata Mc Graw Hill Publishing Company, New Delhi.

Discipline Specific Elective (DSE -2)
Mat-HE-5056
Linear Programming
Total Marks: 100
Credits 6:: *(Theory-05, Tutorial-01)*

Course Objectives: The course begins with the formulation of linear programming problem and then different methods to solve them will be discussed. Duality in LPP will be introduced; Introduction to Transportation problem and some solving methods will be covered. At the end Games and strategies will be discussed.
Course Outcomes: Students will understand the concept of LPP, TP and will be able to
Solve real life problems using optimization techniques.

Unit-I (25 Marks)

Introduction to linear programming problems (LPP), Mathematical formulation of the LPP with illustrations, Graphical method, general Linear programming problems, canonical and standard form of LPP, Theory of Simplex method, optimality and unboundeness, the simplex algorithm, simplex method in tableau format, Introduction to artificial variables, two-phase method, big M method and their comparison.

Unit- II (25 Marks)

Duality in LPP: Introduction, General Prime-Dual Pair, Formulation of the Dual Problem, Prime Dual Relationship duality theorems, complementary slackness theorem, duality and simplex method, Economics.
Interpretation of the duality.

Unit-III (25 Marks)

Transportation Problems (TP): LP formulation of TP, Existence of solution and duality in TP. Solution of transportation problems, North-West corner method, Least-cost method and Vogel approximation method for determination of strategy basic solution, algorithm of solving transportation problem, assignment problem and its mathematical formulation. Solution methods of assignment problem, special cases in assignment problems.

Unit-IV (25 Marks)

Games and strategies: Introduction, Formulation of two person zero sum games, solving two person zero sum Games, maximum-minimax principle, Games without saddle points, games with mixed strategies, Graphical solution procedure to (2xn) and (mx2) games.

Recommended Books:
1.Kantiswarup, P.K Gupta and Man Mohan – Operation Research, S. Chand and Co.

Reference Books:

1. G.Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002
2. R.Veerachamy and V. Ravi Kumar- Operation Research, I.K International Publishing House Pvt. Ltd., New Delhi, Bangalore.

SEMESTER VI

Honours Core Corse
Mat-HC-6016
Metric Space
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: This course will help the students to develop social competences since this branch of mathematics is a convenient and very powerful way of examining the behaviour of various mathematical models. In real life, Metric space methods have been employed for decades in various applications such as in internet search engines, image classification, or protein classification.

Course Outcomes: Students will understand the idea of distance between two elements in a set and to extend the concepts namely, open sets, closed sets, convergence of sequences, compact sets, continuity of functions etc. from real line to a metric space and extend several theorems and concepts about the real numbers and real valued functions, such as convergence and continuity, to the more general setting of these spaces.

Unit—I (30 Marks)

Metric Spaces

Definition and example of a metric space, Diameter and boundedness of sets, Distance between two subsets of a Metric space, Fundamental inequalities (Holder and Minkowski).

Some function spaces, Subspace of a metric space. Open spheres/balls, Open sets and properties, closed sets, neighbourhood of a point, limit points, adherent Point, Interior, Exterior and Frontier points, closure of a set, Dense subsets. **[Ref: CH.2 [1]]**

UNIT – II (35 Marks)

Complete Metric Spaces

Sequences in metric space, Convergent sequences, Cauchy sequences, Convergence of a Cauchy Sequence,

Complete metric spaces, Examples of complete and in-complete metric spaces, Cantor's intersection theorem.

Continuous functions: Characterization of continuous functions, Uniform Continuity Homeomorphism. **[Ref: CH 3, 4 [1]]**

UNIT – III (35 Marks)

Compactness

Compact metric spaces, Sequential Compactness, Bolzano Weirstrass property, totally boundedness, Finite intersection property, equivalence among the kinds of compactness.

Continuous functions and compact sets. **[CH: 5 [1]]**

RECOMMENDED BOOKS

1. **P.K. Jain and K. Ahmed**: metric spaces, Narosa Publishing House, New Delhi.

REFERENCES

1. **G.F. Simmons**: Introduction to Topology and Modern analysis, Tata Mc Graw Hill Education Private Limited, New Delhi.
2. **S. Lipchutz**: General Topology, Schaum's Outline Series, Mc Graw Hill Company.
3. **S.C. Malik, Savita Arora**: Mathematical Analysis, New Age International (P) Ltd., (Chapter 19)
4. **E.T. Copson**: Metric Spaces, Universal Book Stall, 5 Ansari Road, New Delhi-11..
5. **R.K. Ghosh & K.C. Maity**: Differential Calculus (an introduction to analysis) Part-II(including Metric Spaces and Complex Analysis) New Central Books Agency (p) Ltd. Kolkata.

Honours Core Course (HC)
Mat-HC-6026
Complex Analysis
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

***Course Objectives*:** The aim of this course is to provide knowledge about the analytical aspects of complex functions in complex variables. The course also emphasizes on construction of regular functions, Cauchy's theorems, series expansions and transformations.

***Course Outcomes*:** Students should be able to understand the significance of differentiability and continuity of functions of complex variables leading to the understanding of Cauchy-Riemann equations, evaluation of the contour integral, to find critical and fixed points of different transformation.

Unit-I (15 Marks)

Complex numbers, Properties of Complex numbers, regions in the complex plane, functions of complex variables. Limits, Continuity and differentiability of functions of complex variable.

Unit-II (20 Marks)

Analytic functions, examples of analytic functions, exponential functions, Logarithmic functions, Trigonometric functions. The necessary and sufficient condition for a function f(z) to be analytic.

Unit-III (20 Marks)

Method of constructing a regular function, Cauchy-Riemann differential equations in Cartesian and polar forms, Complex equations of a straight line and circle. **[CH: 2, 5 [2]]**

Unit-IV (20 Marks)

Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy integral formula, Liouville's theorem and the fundamental theorem of Algebra.

UNIT – V (25 Marks)

Conformal Mappings

Definition, Transformation, Jacobian of transformation, Conformal transformation, Some general transformations, Necessary and sufficient condition for w = f (z) to represent conformal mapping, Bilinear transformation, critical points and fixed points. Cross ratio, preservance of cross ratio, Types of bilinear transformation, fixed points of bilinear transformation, Family of circles and straight lines under bilinear transformation. **[CH:7.8 [2]]**

RECOMMENDED BOOKS

1. **R.V. Churchill & J.W. Brown**: Complex variables and Application (5th Edition) Mc Graw Hill International Editions.

REFERENCES

5. **H.S. Kasana**: Complex Variables (Theory and Applications), Prentice Hall of India, Private Ltd., New Delhi
6. **John B. Conway**: Functions of One Complex Variable, Narosa Publishing House.
7. **L.V. Ahlfors**: Complex Analysis, Mc Graw Hill Book Company.
8. **Murray R. Spiegel**: Complex Variables, Schaum's Outline Series, Mc Graw Hill Book Company.
9. **Shanti Narayan and P.K. Mittal**: Theory of Complex Variables: S Chand And Company Ltd., Ram Nagar, New Delhi.
10. **R.K. Ghosh & K.C. Maity**: Differential Calculus (an introduction to analysis) Part-II(including Metric Spaces and Complex Analysis) New Central Books Agency (p) Ltd. Kolkata.

Discipline Specific Elective (DSE-3)
Mat-HE-6016
Spherical Trigonometry and Astronomy
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The main objective of this course is

- to introduce Trigonometry to The Celestial bodies
- To study different systems of Celestial co-ordinates,
- To study effect of sunrise and sunset
- To study declination of a star

Course Outcomes: Students should be able to

- Determine declination of a star in the distance between two neighbouring stars
- Understand different kinds of time
- Understand planetary motion
-

Unit I (30 Marks)

Spherical Trigonometry

Spherical triangle, Polar triangle, properties of Polar and Spherical triangles. Sine formula, Cosine formula, four parts formula, Sine cosine formula, Cotangent formula, Napier's analogies, Delambre's analogies.

Right angled spherical triangle, Formulae relating to the right spherical triangles, Area of a spherical triangle. Area of a spherical polygon.

Unit II (20 Marks)

Celestial sphere

Three systems of celestial coordinates. Rectangular coordinates. Sidereal time. Rising and setting of stars. Circumpolar stars. Rate of change of zenith distance and azimuth. Twilight. Motion of the Sun. Vernal and Autumnal Equinox. Summer and Winter Solstice. Different kinds of time. Seasons.

Unit III (20 Marks)

Refraction, Precession and Nutation

Laws of Refraction. Cassini's hypothesis. Simpson's hypothesis. Bradely's formula. Effect of refraction on (1) sunrise and sunset (2) the right ascension and declination of a star (3) in the distance between two neighbouring stars (4) on the shape of the disc of the sun.

Precession on the right ascensions and declination of a star. Nutation in the right ascension and declination of a star. Precession and nutation both on the right ascension declination of a star.

Unit IV (20 Marks)

Aberration, Parallax

Annual and diurnal aberration. Annual aberration in (1) ecliptic longitude and latitude (2) right ascension and declination of a star. Diurnal aberration in (1) hour angle and declination (2) zenith distance and azimuth.

Geocentric parallax and Annual parallax. Geocentric parallax in (1) right ascension and declination (2) the distance between two planets (3) azimuth and zenith distance. Annual parallax in (1) latitude and longtitude (2) right ascension and declination.

Unit V (10 Marks)

Planetary motion

Synodic and orbital Period. Kepler's laws. Deduction of Kepler's laws from Newton's laws of Gravitation.

RECOMMENDED BOOKS

1. **M. Ray:** *Spherical Trigonometry*
2. **M. Ray:** *Spherical Astronomy*
3. **K.K. De:** *Text Book of Astronomy, Books Syndicate Pvt. Ltd., Kolkata.*

REFERENCES

1. **W.M. Smart:** *Text Book of Spherical Astronomy,* CUP-VIKAS Student's Edition
2. **W.M. Smart** *: Foundation of Astronomy,* CUP-VIKAS Student's Edition.
3. **Gorakh Prasad:** *Text Book on Spherical Astronomy,* Pothisala Pvt. Ltd., Allahabad
4. **Standy P. Wyatt:** *Principles of Astronomy:* Allyn and Bacon, Inc

Discipline Specific Elective (DSE-3)
Mat-HE-6026
Special theory of Relativity
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The objective of this course is

- To introduce the concept of space and time
- To grew out of a desire to understand consequences of Lorentz transformation, properties of mass energy and force

Course Objectives: The course will help students to expressed physical laws in mathematical terms. It will help to study related problems of Einstein's time distillation, the relativistic force of law and equivalence of mass and energy.

Unit – 1 (25 Marks)

Basic Aspects of STR

Inertial frames, Galilean tranformation, Michelson - Morley' experiment. The relavistic concept of space and time, Postulates of special theory of relativity.

Unit – II (30 Marks)

Relativistic Kinematics

Lorentz transformation equations, the general Lorentz transformation equations, Consequences of Lorentz transformation equations like Relativity of simultaneity, Einstein's time distillation or apparent retardation of clocks, Relativity of space - Lorentz - Firzgerald contraction and related problems.

Unit – III (30 Marks)

Relativistic Dynamics

Redefined momentum, the relativistic force Law and the Dynamics of a single particle, Equivalence of Mass and Energy, $E=mc^2$ and its consequences.

Unit - IV

Realitivistic Mechanics **(15 Marks)**

Transformation properties of Momentum, Energy, Mass and Force.

RECOMMENDED BOOKS

1. **M. Ray:** Special Theory of Relativity.
2. **A. Das:** The Special Theory of relativity.
3. **Banerjee and Banerjee**: The Special Theory of relativity, Prentice Hall of India, New Delhi.
4. **Resnick** : Special Theory of relativity, John Wiley.

REFERENCES

1. **Dirac:** General Theory of Relativity, Prentice Hall of India, New Delhi.
2. **S.K. Bose**: General Theory of Relativity, Wiley Eastern Ltd.

Discipline Specific Elective (DSE-4)
Mat-HE-6036
Probability Theory
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: The main objective of this course is to introduce the students to the existing world of probability theory.

Course Outcomes: Students should be able

- To solve problems of probability generating functions, problems of weak and strong convergence of random variables, problems of probability under normal curve, problems of application of central limit theorem.

Unit – I (20 Marks)

Continous Probability distributions

Continous probability distributions - uniform, exponential, rectangular, beta gamma distributions, probability generating functions.

Unit – II (20 Marks)

Generating functions & Convergence

Moment inequalities-Holder, Minkowsky, Schwarz: Weak and strong convergence of random variables, almost sure convergence, Convergence in r'th mean.

Unit – III (20 Marks)

Convergence of distribution functions

Weak and complete convergence of distribution functions: probability inequalities: Chebychev, Markov and Jensen.

Unit – IV (20 Marks)

Normal distribution

Normal distribution as limiting case of binomial distribution, properties of normal distribution, normal **probability** curve, area under normal curve, Characteristic functions and its properties.

Unit - V (20 Marks)

Central Limit Theorem

Univariate distribution, Transformation, Bivariate normal distribution and its properties. De Moivre Laplace limit theorem, Liapunov theorem (without proof) and applications of central limit theorem.

RECOMMENDED BOOKS

1. **B.R. Bhatt,** Modern Probability Theory, Wiley Eastern Ltd., 1989
2. **P. Mukhopadhyay** Theory of Probability, New Central Book, Agency, Kolkata, 2002
3. **Kai Lai Chung,** A Course in Probability Theory, 3/e. Academic Press, 2001

REFERENCES

4. **M.H. Degroot, M.J. Schervish** : Probability and Statistics, Addison Wesley, 2001
5. **Sheldon Ross,** A First Course in Probability, Prentice Hall, New Jersey, 2002
6. **William Feller,** An Introduction to Probability Theory and Its Applications, Volume 1, John Wiley and Sons, Inc., New York, 1971.
7. **A.N. Kolmogorov,** Foundations of the Theory of Probability, 2nd ed., AMS, 1997

Discipline Specific Elective (DSE-4)
Mat-HE-6046
Computational Mathematics Laboratory
Total Marks: 100
Credits 6: (Theory-04, Practical-02)

Course Objectives: The main aim of this course is

- to introduce common mathematical functions, 2 & 3 dimensional graphics
- To develop mathematical programmes for data analysis

Course Outcomes: The course will enable the students to

- Understand 2-D & 3- D graphics
- Understand colour map & colour functions
- Solve problems of different equations and numerical Integration.

THEORY - 75 (DURATION - TWO HOURS)]

[PRACTICAL - 25 (DURATION - TWO HOURS)]

UNIT –I (15 Marks)

Simple arithmetical operations, variables, round-off errors, formatting printing, common mathematical functions, script M-files, File Input-Output. Two-dimensional graphics, three-dimensional graphics

UNIT – II (20 Marks)

Generating matrices, colon operator, manipulating matrices, simple arithmetical operations, operator procedure, common mathematical functions, data manipulation commands, sparse matrices.

UNIT - III (20 Marks)

Solving linear system of equations-square linear system, catastrophic round-off error, over determined and undetermined linear system, Initial-valued ordinary differential equations.

UNIT – IV (20 Marks)

Programming in MATHLAB-Flow control and logic variables, matrix relational operators and logical operators, function M-files.

UNIT – V

PRACTICAL - 25 MARKS (List of practical topics based on MATLAB or any software)

1. Plotting of functions
2. Matrix operations, vector and matrix manipulation, matrix function
3. Data analysis and curve fitting
4. Use of FFT algorithm
5. Numerical Integration
6. Differential equations
7. 2-D graphics and 3-D graphics-general purpose graphic functions, colour maps and colour functions.
8. Sparse matrices-Iterative methods for sparse linear equations, eigenvalues of sparse matrices.

Instructions for Practical **[Two Programs Only a) Program writing 10 marks, b) Output - 10 marks c) Viva Voce 3 marks d) Note book 2 marks , Time – 2 hrs]**

RECOMMENDED BOOKS:

1. **MATHLAB**-High performance numeric computation and visualization software: User's guide
2. **A MATHLAB** Tutorial-Ed Doverman Dept. Of Math., Ohio State University.

Discipline Specific Elective (DSE-4)
Mat-HE-6056
Mathematical Modelling
Total Marks: 100
Credits 6: (Theory-05, Tutorial-01)

Course Objectives: This course is designed to understand need, Techniques, classification of Mathematical modelling through different branches of mathematics.

Course Outcomes: On completion of this course, students should be able to design mathematical models for Traffic flow on a highway, model of planetary motion, population dynamics and genetics through difference equation, through linear, Non-linear programming, through calculus of variation.

Mathematical Modelling:

Unit I (20 Marks)

Need, Techniques, Classification. Mathematical Modelling through Geometry, Algebra, Trigonometry, Calculus.

Unit II (30 Marks)

Mathematical Modelling in Dynamics through Ordinary Differential Equations of First Order. Mathematical Modelling in Population Dynamics, Mathematical Modelling of Epidemics through Systems of Ordinary Differential Equations of First Order.

Unit III (20 Marks)

Mathematical Modelling of Planetary Motions, Circular Motion and Motion of Satellites, Mathematical Modelling through Difference Equations in Population Dynamics and Genetics.

Unit IV (30 Marks)

Model for Traffic Flow on a Highway. Mathematical Modelling through Calculus of variations . Mathematical

Modelling through Linear Programming, Mathematical Modelling through non – linear Programming.

Recommended Books

1. J.N. Kapur, Mathematical Modelling, Willy Extern Limited 1988
2. Giordano, Frank R., Fox, William P., & Horton, Steven B. (2014). A First Course in Mathematical Modelling (5^{th} ed.). Brooks/Cole, Cengage Learing.