COURSE STRUCTURE

OF

B.Sc. MATHEMATICS (Hons)

DEPARTMENT OF MATHEMATICS

SCHOOL OF SCIENCE

SESSION: 2017-20

ADAMAS UNIVERSITY
PURSUE EXCELLENCE

Course Structure of MATHEMATICS (UG)

Course Distribution

A. Mathematics – Core (THEORY)

Discipline/ Name (Theory)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
1. Algebra-I [**Classical Algebra**]	**SMA31101**	4	3-1-0	(4x15)
2. Algebra-II [**Set and Group theory**]	**SMA31102**	4	3-1-0	(4x15)
3. Algebra-III [**Ring, Field and Integral Domain**]	**SMA32101**	4	3-1-0	(4x15)
4. Differential Calculus	**SMA31103**	4	3-1-0	(4x15)
5. Integral Calculus	**SMA31104**	4	3-1-0	(4x15)
6. Ordinary Differential Equation-I [**First order linear and nonlinear and 2nd order differential equations with constant coefficients**]	**SMA31105**	4	3-1-0	(4x15)
7. Ordinary Differential Equation-II [**2nd order differential equation with variable coefficients and series solutions**]	**SMA31106**	4	3-1-0	(4x15)
8. Real Analysis [**Sets in $\mathbb{R}$, sequence and series of real numbers**]	**SMA32103**	4	3-1-0	(4x15)
9. Linear Algebra-I [**Matrix Algebra**]	**SMA32105**	4	3-1-0	(4x15)
10. Linear Algebra-II [**Vector Space, Application to quadratic form**]	**SMA32102**	4	3-1-0	(4x15)
11. Analytical Geometry	**SMA32106**	4	3-1-0	(4x15)
12. Partial Differential Equations	**SMA32109**	4	3-1-0	(4x15)
13. Theory of Probability	**SMA32104**	4	3-1-0	(4x15)
14. Functions of Several Variables	**SMA33101**	4	3-1-0	(4x15)
15. Functions of Complex Variables	**SMA32108**	4	3-1-0	(4x15)
16. Introduction to Linear Programming and Game Theory	**SMA33102**	4	3-1-0	(4x15)
17. Dynamics of a Particle	**SMA33106**	4	3-1-0	(4x15)
18. Vector Analysis and Tensor Calculus	**SMA33105**	4	3-1-0	(4x15)
19. Introduction to Numerical Analysis	**SMA33103**	4	3-1-0	(4x15)
20. Integral Transforms [**Laplace, Fourier and Z-transforms**]	**SMA33104**	4	3-1-0	(4x15)
21. Statistics	**SMA33107**	4	3-1-0	(4x15)
Total		**84**	**63-21-0**	

B. Generic Elective (s)

Discipline/ Name (Theory)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
1. 1st Elective I	**SCY32107/HEC32171**	4	4-0-0	(4x15)
2. 1st Elective II	**SCY32108/ EC32172**	4	4-0-0	(4x15)
3. 1st Elective Lab I	**SCY32207**	2	0-0-4	(4x15)
4. 1st Elective Lab II	**SCY32208**	2	0-0-4	(4x15)
5. 2nd Elective I	**SPH31105/ECS31103**	4	4-0-0	(4x15)
6. 2nd Elective II	**SPH31106/ CS31104**	4	4-0-0	(4x15)
7. 2nd Elective Lab I	**SPH31205/ECS31203**	2	0-0-4	(4x15)
8. 2nd Elective Lab II	**SPH31206 /ECS31204**	2	0-0-4	(4x15)
Total		**24**	**16-0-16**	

1st Elective: Chemistry / Economics
2nd Elective: Physics / Computer Science

C. Interdisciplinary Elective (s) (Skill Enhancement Course(SEC))

Discipline/ Name (Theory)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
SEC-I		3		
SEC-II		3		
Total		**06**		

Open Elective Papers: Matlab/Scilab/Mathematica/R-Software

D. Ability Enhancement Foundation Paper (Theory)

Discipline/ Name (Theory)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
English I	**HEN31105**	2	3-0-0	3
Environmental Science and Energy Resources	**SGY31106**	2	3-0-0	3
Total		**04**	**6-0-0**	6

E. Core Lab

Discipline/ Name (Practical)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
Core Lab	SMA33201	02	0-0-4	4
Total		**02**	**0-0-4**	**4**

F. Discipline Specific Elective Papers

Discipline/ Name (Theory)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
DSE I	**SMA33105/ SMA33107/ SMA33109**	4	3-1-0	4
DSE II	**SMA33106/ SMA33108**	4	3-1-0	4
DSE III	**SMA33113/ SMA33115**	4	3-1-0	4
DSE IV Core Project /Dissertation	**SMA33702**	6	0-0-12	12
Project Seminar/ Dissertation Seminar and Viva-voce		4		4
Total		**22**	**12-0-10**	**28**

G. Summer Internship (s)

Discipline/ Name (Theory)	Paper Code	Total Credits	L-T-P	Contact Hours/paper
Summer Internship		2		4 weeks
Total		**2**	**8**	

Distribution of Papers Semester-wise:

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS BACHELOR OF SCIENCE (Honours) SEMESTER - I								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SMA31101**	Algebra-I	Classical Algebra	**4**	**3**	**1**	**0**	**4**
CORE	**SMA31103**	Differential Calculus	Functions, limits, derivatives, rules of Differentiation and its applications	**4**	**3**	**1**	**0**	**4**
CORE	**SMA31105**	Ordinary Differential Equation-I	First order linear, nonlinear and 2nd order differential equations with constant coefficients	**4**	**3**	**1**	**0**	**4**
FOUNDATION	**HEN31105**	**Theory**		**2**	**2**	**0**	**0**	**2**
GENERIC ELECTIVE		**Theory**		**4**	**3**	**1**	**0**	**4**
		Practical		**3**	**0**	**0**	**3**	**2**
Total				**21**	**14**	**4**	**3**	**20**

(Options: Elective Chemistry I, Elective Zoology I, Elective Botany I, Elective Economics I*)

* For non-lab based subjects total credit will be 6 for one paper (e.g., Economics, L-T-P: 5-1-0)

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS BACHELOR OF SCIENCE (Honours) SEMESTER - II								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SMA31102**	Algebra-II	Set and Group theory	**4**	**3**	**1**	**0**	**4**
CORE	**SMA31104**	Integral Calculus	Reduction formula, Evaluation of area and volume,	**4**	**3**	**1**	**0**	**4**
CORE	**SMA31106**	Ordinary Differential Equation-II	2nd order differential equation with variable coefficients with series solutions	**4**	**3**	**1**	**0**	**4**
FOUNDATION	**SGY31106**	**Theory**		**2**	**2**	**0**	**0**	**2**
GENERIC ELECTIVE*		**Theory**		**4**	**3**	**1**	**0**	**4**
		Practical		**3**	**0**	**0**	**3**	**2**
Total				**21**	**14**	**4**	**3**	**20**

(Options: Elective Chemistry II, Elective Zoology II, Elective Botany II, Elective Economics II*)

* For non-lab based subjects total credit will be 6 for one paper (e.g., Economics, L-T-P: 5-1-0)

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS BACHELOR OF SCIENCE (Honours) SEMESTER - III								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SMA32101**	Algebra-III	Ring, Field and Integral Domain	**4**	**3**	**1**	**0**	**4**
CORE	**SMA32103**	Real Analysis	Sets in $\mathbb{R}$, sequence and series of real numbers	**4**	**3**	**1**	**0**	**4**
CORE	**SMA32105**	Linear Algebra-I	Matrix Algebra	**4**	**3**	**1**	**0**	**4**
CORE	**SMA32109**	Partial Differential Equations	First order, second order PDE (linear and non-linear Laplace equation: Solution of Laplace equation	**4**	**3**	**1**	**0**	**4**
FOUNDATION (Skill Enhancement Course **SEC**)		Matlab/Scilab		**3**	**3**	**0**	**0**	**3**
GENERIC ELECTIVE III		**Theory**		**4**	**3**	**1**	**0**	**4**
		Practical		**3**	**0**	**0**	**3**	**2**
Total				**26**	**18**	**5**	**3**	**25**

(Options: Elective Physics I, Elective Computer Science I)

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS BACHELOR OF SCIENCE (Honours) SEMESTER - IV								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SMA32102**	Linear Algebra-II	Vector Space, Linear Transformation, Inner product Space, quadratic form	**4**	**3**	**1**	**0**	**4**
CORE	**SMA32104**	Theory of Probability	Bayes' theorem, random variable, probability distributions	**4**	**3**	**1**	**0**	**4**
CORE	**SMA32106**	Analytical Geometry	Two-dimensional and three dimensional Geometry	**4**	**3**	**1**	**0**	**4**
CORE	**SMA32108**	Functions of Complex Variables	Analytic Function, C-R equation, Complex integration, pole and residues	**4**	**3**	**1**	**0**	**4**
FOUNDATION (Skill Enhancement Course **SEC**)		Mathematica/ R-Software		**3**	**3**	**0**	**0**	**3**
GENERIC ELECTIVE IV		**Theory**		**4**	**3**	**1**	**0**	**4**
		Practical		**3**	**0**	**0**	**3**	**2**
Total				**26**	**18**	**5**	**3**	**25**

(Options: Elective Physics II, Elective Computer Science II)

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS BACHELOR OF SCIENCE (Honours) SEMESTER - V								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SMA33101**	Functions of Several Variables	Limit, continuity, total differentiability, and gradient.	**4**	**3**	**1**	**0**	**4**
CORE	**SMA33103**	Introduction to Numerical Analysis	Roots for transcendental and algebraic equations, solution of ode and system of equations.	**4**	**3**	**1**	**0**	**4**
CORE	**SMA33105**	Vector Analysis and Tensor Calculus	Vector Calculus, Vector integration, Green's Theorem, Divergence Theorem, Stroke's Theorem.	**4**	**3**	**1**	**0**	**4**
CORE	**SMA33107**	Statistics	Testing of Hypothesis, Correlation and Regression.	**4**	**3**	**1**	**0**	**4**
Elective (Discipline Specific) DSE I		**DSE I**	Can be chosen from a list of optional papers. List is provided separately	**4**	**3**	**1**	**0**	**4**
Elective (Discipline Specific) DSE II		**DSE II**	Can be chosen from a list of optional papers. List is provided separately	**4**	**3**	**1**	**0**	**4**
CORE		Introduction to Numerical Analysis Lab		**4**	**0**	**0**	**4**	**2**
		Summer Internship						**2**
Total				**28**	**18**	**6**	**4**	**28**

ADAMAS UNIVERSITY SCHOOL OF SCIENCE - DEPARTMENT OF MATHEMATICS BACHELOR OF SCIENCE (Honours) SEMESTER - VI								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SMA33102**	Introduction to Linear Programming and Game Theory	Solution techniques, Simplex method, big M etc. Transportation & assignment problem, Game theory.	**4**	**3**	**1**	**0**	**4**
CORE	**SMA33104**	Integral Transforms	Laplace, Fourier and Z-transforms	**4**	**3**	**1**	**0**	**4**
	SMA33106	Dynamics of a Particle	Simple harmonic motion, Central forces and central orbits, Kepler's Law.	**4**	**3**	**1**	**0**	**4**
Elective (Discipline Specific) DSE III		**DSE III**	Can be chosen from a list of optional papers. List is provided separately	**4**	**3**	**1**	**0**	**4**
Elective (Discipline Specific) DSE IV	**SMA33702**	**Project-II/Dissertation**		**12**	**0**	**0**	**12**	**6**
		Dissertation Seminar and Viva-Voce			**0**	**0**	**0**	**4**
Total				**28**	**12**	**4**	**12**	**26**

LIST OF 'Discipline Specific Elective Papers' OFFERED BY THE DEPT. OF MATHEMATICS*:

DSE – I (Theory)

1. Mathematical Finance [SMA33105]
2. Portfolio Optimization [SMA33107]
3. Nonlinear Dynamics [SMA33109]

DSE – II (Theory)

1. Number Theory [SMA33113]
2. Set theory and Metric Spaces [SMA33115]

DSE – III (Theory)

1. Bio-Mathematics [SMA33106]
2. Mathematical Modeling [SMA33108]

DSE IV: **Dissertation**

***Offering of subjects will vary from year to year subject to choice of students**

Core Courses of B. Sc. (Mathematics)

Algebra-I (Classical Algebra)

Paper Code: SMA31101 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Short review of complex numbers, De Moivre's theorem and its applications, direct and inverse circular and hyperbolic functions, logarithm of a complex number, expansion of trigonometric functions, Gregory's series. **[12L]**

Unit II

Relation between the roots and coefficients of general polynomial equation of one variable, fundamental theorem of classical algebra and its consequences, nature of roots of an equation (surds or complex roots occur in pairs), statements of Descartes rule of signs and of Sturm's theorem and their applications, transformation of equations, multiple roots, symmetric functions of roots, reciprocal equations, special roots, solutions of cubic equations (Cardan's method) and biquadratic equation (Ferrari's method). **[18L]**

Unit III

Cauchy-Schwarz inequality, inequality involving A.M. (including weighted), G.M., H.M. and their applications, m^{th}power theorem. **[10L]**

Unit IV

Integers: Statements of well-ordering principle and principle of mathematical induction, second principle of mathematical induction, proof of some simple mathematical results by induction, divisibility of integers, division algorithm, the greatest common divisor (gcd) of integers a, b, existence and uniqueness of (gcd) of two integers, prime integers, Euclid's first and second theorems, congruence's, Euler's function, Fermat's theorem. **[20L]**

Text Books:

1. S. K. Mapa, Classical algebra, Sarat book house.
2. S. K. Mapa, Higher algebra, Sarat Book House.
3. I N Hernstein, Topics in algebra, Wiley India Pvt Ltd.

Reference Books:

1. Burnside and Panton, The theory of equations, Vol. 1, Hodges Figgisand company.
2. A. Kurosh, Higher algebra, Mir publishers.
3. Ghosh and Chakroborty, Higher algebra, U N Dhur& Sons.
4. Barnard and Child, Higher algebra, Mac Millan.
5. John B Fraleigh, First course in abstract algebra, Pearson.
6. Sen, Ghosh and Mukhopadhyay, Topics in abstract algebra, University press.

Algebra-II

[Set and Group theory]

Paper Code: SMA31102 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Set, relation, mapping and algebraic structure: Basic properties of sets, set operations, De Morgan's laws, cartesian product of sets, relation, equivalence relation, relation between equivalence relation and partition, congruence of integers, congruence classes. Mapping: Injection, surjection, bijection, identity and inverse mappings, composition of mappings and its associativity. Binary operations: Definitions and examples, commutative and associative binary operations, identity and inverse element. Algebraic structure: Concept of algebraic structure, definition (only) of groupoid, semi-group, monoid. **[15L]**

Unit-II

Group, Abelian group, examples of groups from number system, root of unity, matrices, symmetries of squares, triangles etc., groups of congruence classes, Klein's 4 group, properties deducible from definition of group including solvability of equations like $ax = b$, $ya = b$, any finite semi-group having both cancellation laws is a group, integral power of elements and laws of indices in a group, order of an element of a group, order of a group. **[18L]**

Unit-III

Subgroups, necessary and sufficient condition for a subset of group to be a subgroup, intersection and union of subgroups, necessary and sufficient condition for union of two subgroups to a subgroup, permutation groups and quaternion groups, properties of cyclic groups, classification of subgroups of cyclic groups. [**12L**]

Unit-IV

Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. [**15L**]

Text Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi.
2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Algebra-III
[Ring, Field and Integral Domain]

Paper Code: SMA32101 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third isomorphism theorems, automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups,

applications of factor groups to automorphism groups, characteristic subgroups, commutator subgroup and its properties. [**16L**]

Unit II

Rings and fields: rings, domains, integral domains, division rings, fields, Subrings, Zero Divisors, characteristic and other fundamental ring theoretic topics, ideals and ring homomorphisms, kernel and image of a homomorphism, properties of ring homomorphism, ideals of Z, PIDs, factor rings, prime and maximal ideals, applications. [**24L**]

Unit III

Integral domains and fields of quotients: characteristic, field of quotients, Rings of polynomials, factorization in integral domains: polynomials, division algorithm, ideals in polynomial rings, prime and irreducible elements, associates, unique factorization domains, euclidean domains, example of a not unique factorization integral domain (UFD), primes and irreducible in UFDs, examples. [**20L**]

Text Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi.
2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Differential Calculus

Paper Code: SMA31103 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Functions, limits and derivatives: Exponential functions, inverse functions and logarithms. The tangent and velocity problems, the limit of a function, calculating limits using the limit laws, the precise definition of a limit, indeterminate forms and L'Hopital's rule, continuity and differentiation of a function, limits at infinity, asymptotes, the derivative of a function. [**16L**]

Unit II

Differentiation rules: Derivatives of polynomials and exponential functions, the product and quotient rules, derivatives of trigonometric functions, the chain rule, implicit differentiation, derivatives of logarithmic functions, successive differentiation, Leibnitz's rule, rates of change in the natural and social sciences, exponential growth and decay, related rates, linear approximations and differentials, hyperbolic functions. [**18L**]

Unit III

Applications of differentiation: Maximum and minimum values, Rolle's Theorem, Mean-Value theorem**,** Lagrange's method of multipliers**,** how derivatives affect the shape of a graph**,** summary of curve sketching**,** optimization problems**,** anti derivatives. [**12L**]

Unit IV

Infinite Sequences and Series: Sequences, series, the integral test and estimates of sums, the comparison tests, alternating series, absolute convergence and the ratio and root tests, strategy for testing series, power series, representations of functions as power series, Taylor and Maclaurin series. [**14L**]

Text Books:

1. Shanti Narayan, Differential calculus. S. Chand publishers
2. N, Piskunov, Differential and integral calculus, Vol. I, CBS publishers & distributors

Reference Books:

1. B. N. Mukherjee, B. C. Das, Key to differential calculus, U N Dhur& Sons.
2. Vinay Kumar, Differential calculus, Mcgraw-Hill

3. K. C. Maity and R. K. Ghosh, Differential calculus, an introduction to analysis.

Integral Calculus

Paper Code: SMA31104 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Integrals: Areas and distances**,** the definite integral**,** the fundamental theorem of integral calculus (review), indefinite integrals and the net change theorem, the substitution rule, applications of integration, areas between curves, volumes by slicing, rotation and cylindrical shells. [**14L**]

Unit II

Reduction formula, techniques of integration, integration by parts, trigonometric integrals, trigonometric substitution integration of rational functions by partial fractions, approximate integration, differentiation under integral sign. [**12L**]

Unit III

Double and Triple integrals: Double integrals over rectangles, iterated integrals, some practical applications, Fubini's theorem, double integrals over general regions, change of order of integration, evaluation of triple integrals in Cartesian, polar, cylindrical and spherical coordinates, applications of Double and Triple integrals, area by double integration, volume of solids as double integrals, volume of solid of revolution, volume as triple integral. [**22L**]

Unit IV

Improper integrals, types of improper integrals and their convergences, error function, beta and gamma functions, related problems and applications. [**12L**]

Unit V

Curve tracing: cartesian and polar forms, asymptotes, oblique asymptotes.

Text Books:

1. Shanti Narayan, P.K. Mittal, Integral Calculus, S. Chand.
2. N, Piskunov, Differential and Integral Calculus, Vol. II, CBS Publishers & Distributors
3. K. C. Maity, R. K. Ghosh, Integral Calculus, New Central Book Agency.

Reference Books:

1. Serge Lang, Calculus of several variables, Springer.
2. David M. Bressoud, Second year calculus, Springer.
3. Richard Courant and Fritz John, Introduction to calculus and analysis, volume II, Springer.
4. Harold M. Edwards, Advanced calculus: a differential forms approach, Birkhauser.
5. Tom Apostol, Calculus, Volume 2, Wiley.

Ordinary Differential Equation- I

[**First order linear and nonlinear and 2nd order differential equations with constant coefficients**]

Paper Code: SMA31105 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Motivation and importance, order and degree of a differential equation, differences between linear and nonlinear equations, general, particular, explicit, implicit and singular solutions of a differential equation, formation of differential equation by eliminating arbitrary constants, general solution and geometrical significance of differential equation. [**12L**]

Unit II

First Order Linear Equations: Existence and uniqueness of solution of ordinary differential equations, separable equations, exact differential equations and integrating factors, equations reducible to this form, linear equation and Bernoulli's equations, special integrating factors and transformations, application of first order differential equations to acceleration-velocity model, growth and decay model. [**16L**]

Unit-III

Second Order Linear Equations: Homogeneous Equations with Constant Coefficients, general solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian, its properties and applications, linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, and method of undetermined coefficients, method of variation of parameters. [**20L**]

Unit-IV

Higher Order Linear Equations: General theory of *n*th order linear equations, homogeneous equations with constant coefficients, method of undetermined coefficients, method of variation of parameters. [**12L**]

Text Books:

1. H.T.H. Piaggio, Differential Equations, G.Bell & Sons Ltd. 1921
2. S. L. Ross, Differential Equations, John Wiley and Sons, India, 2004.

Reference Books:

1. William E. Boyce and Richard C. Di-Prima, Elementary Differential Equations and Boundary Value Problems, 7th edition, John Wiley & Sons, Inc.
2. C. H. Edwards and D. E. Penny, Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, India, 2005.
3. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple, Taylor and Francis, London and New York, 2002.
4. H.T.H. Piaggio, An elementary treatise on differential equations, G. Bell and sons limited.

Ordinary Differential Equation II

[2nd order differential equation with variable coefficients and series solutions]

Paper Code: SMA31106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Existence and uniqueness of solutions: Lipschitz condition, non-local existence of solutions, uniqueness of solutions, existence and uniqueness theorem for first order equations, statement of existence and uniqueness theorem for the solutions of ordinary differential equation of order *n*.

[**12L**]

Unit-II

Differential equation of first order but not first degree, solvable for *p, y, x,* Clairaut's equation, singular solutions, Geometric meaning, application of first order differential equation, orthogonal trajectories and related problems. Basic theory of systems of first order linear equations, homogeneous linear systems with constant coefficients, non-homogeneous linear systems, predator-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis. [**16L**]

Unit-III

Application of ODE: Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting. [**12L**]

Unit IV

Series solution: Introduction, ordinary point, singular point and regular singular point, power series solution about an ordinary point, solutions about singular points, Frobenius method.

Legendre's equation and Legendre's polynomials, Rodrigue's formula, Bessel's equation, Bessel's function and its application. [**20L**]

Text Books:

1. Shepley L Ross, Introduction to ordinary differential equation, John Wiley & Sons.
2. M.D.Raisinghania: Ordinary and Partial Differential equations, S.Chand.
3. H.T.H. Piaggio, An elementary treatise on differential equations, G. Bell and sons limited.

Reference Books:

1. M.D.Raisinghania: Advanced Differential equations, S.Chand.
2. Iaan Sneddon, Elements of partial differential, McGraw-Hill book.
3. A. R. Forsyth, A treatise on differential equations, Macmillan.

Real Analysis

[**Sets in R, sequence and series of real numbers**]

Paper Code: SMA32103 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Real number system: Intuitive idea of numbers, mathematical operations revisited with their properties (closure, commutative, associative, identity, inverse, distributive).

Sets and functions: definition and properties (union, intersection, complementation, injection, surjection, bijection). Field Axioms: concept of ordered field, bounded set, l.u.b. (supremum) and g.l.b. (infimum) of a set, properties of l.u.b. and g.l.b. of sum of two sets and scalar multiple of a set, least upper bound axiom or completeness axiom. Characterization of IR as a complete ordered field, definition of an Archimedean ordered field, Archimedean property of IR, Q is Archimedean ordered field but not ordered complete. [**18L**]

Unit-II

Intervals, neighbourhood of a point, interior point, open set, union, intersection of open sets, every open set can be expressed as disjoint union of open intervals, limit point and isolated point of a set, criteria for l.u.b. and g.l.b. of a bounded set to be limit point of the set, Bolzano-Weierstrass theorem on limit point. Definition of derived set, closed set, complement of open set and closed set, union and intersection of closed sets as a consequence, no nonempty proper subset of IR is both open andClosed, dense set in IR as a set having non-empty intersection with every open Interval, Q and IR - Q are dense in IR. [**24L**]

Unit-III

Sequences of real numbers: Definition of a sequence as function from IN to IR, bounded sequence, convergence (formalization of the concept of limit as an operation in IR) and non-convergence, examples, every convergent sequence is bounded and limit is unique, algebra of limits, relation between the limit point of a set and the limit of a convergent sequence of distinct elements, monotone sequences and their convergence, sandwich rule, nested interval theorem.

[**18L**]

Text Books:

1. S.K. Mapa, Introduction to Real Analysis, 7th Edition, Sarat Publishers, India.

Reference Books:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
2. S.C. Malik and S Arora, Mathematical Analysis, New Age International Private Limited, Paperback– 1 Jan 2017.
3. R.K. Ghosh and K.C Maity, An Introduction to Analysis: Differential Calculus: Part I.

Linear Algebra-I

[**Matrix Algebra**]

Paper Code: SMA32105 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Matrices and determinants: Matrices of real and complex numbers, algebra of matrices, symmetric and skew-symmetric matrices. hermitian and skew-hermitian matrices, orthogonal matrices, definition & basic properties of determinants, minors and cofactors, Laplace's method, Vandermonde's determinant, symmetric and skew-symmetric determinants. (No proof of theorems), adjoint of a square matrix, invertible matrix, non-singular matrix, inverse of an orthogonal matrix, elementary operations on matrices, echelon matrix, rank of a matrix, determination of rank of a matrix, normal forms, elementary matrices, statements and application of results on elementary matrices. [**18L**]

Unit-II

Systems of linear equations and the invariance of its solution set under row-equivalence, row reduction and echelon forms, vector equations, the matrix equation $AX = B$, solution sets of linear systems, applications of linear systems, linear independence. [**10L**]

Unit-III

Row space and column space of matrix, row rank and column rank of matrix, equality of row rank, column rank and rank of a matrix, linear system of equations, solution space, Solutions of system of equations by Matrix method, Rank-Nullity theorem. [**12L**]

Unit IV

Congruence of matrices: Normal form of a matrix under congruence, real quadratic form involving three variables, reduction to normal form (Statements of relevant theorems and applications).Eigenvalues and eigenvectors of square matrices, Cayley-Hamilton theorem, simple properties of eigenvalues and eigenvectors, AM and GM., Eigen values, Eigen Vectors and Characteristic Equation of a matrix, the dimension of the solution space of a system of independent homogeneous linear equations. [**20L**]

Text Books:

1. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
2. S. K. Mapa, Higher Algebra- Abstract and Linear, revised Ninth Edition, Sarat Book House, 2003.
3. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Education.

Reference Books:

1. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
2. B. S. Vaatsa, Theory of matrix, New age publication.
3. A Kurosh, Higher Algebra, Mir Publisher
4. Hoffman and Kunze, Linear algebra, Pearson.
5. D.T. Finkbeiner, Introduction to matrices and linear transformations, CBS Publishers, New Delhi.
6. John Smith, Modern Engineering Mathematics, 5th Edition, Pearson Education.

Linear Algebra-II

[Vector Space, Application to quadratic form]

Paper Code: SMA32102 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I

Vector / linear space: Definitions and examples of vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, generators of vector space,

finite dimensional vector space, replacement theorem, extension theorem, dimension of a vector space, extraction of basis, linear independence, basis and dimension, dimension of subspaces.

[**16L**]

Unit II

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations, Extension theorem, deletion theorem. [**12L**]

Unit III

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, Invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator. [**14L**]

Unit-IV

General Quadratic form, index, signature, characteristics of quadratic forms (positive definite, positive semi-definite, negative definite, negative semi-definite, indefinite).

Inner product spaces and norms, Gram-Schmidt orthogonalization process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem. [**18L**]

Text Books:

1. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
2. Hoffman and Kunze, Linear algebra, Pearson.

Reference books:

1. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, Narosa Publishing House.

Analytical Geometry

Paper Code: SMA32106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Coordinate Geometry: Transformation of rectangular axes. Invariants associated with the coefficients of general degree equation, necessary and sufficient conditions for the general second degree equation to represent a pair of straight lines, reduction of the general second degree equation to canonical form, classification of conics, and pair of straight lines. [**12L**]

Unit-II

Conjugate diameters of conics, pole and polar with respect to a non -singular conic, asymptotes, coaxial systems of circles, polar equations of straight lines, circle and conics (with a focus as pole) and tangent, normal, chord of contact. [**14L**]

Unit-III

Three- dimensional Geometry: Rectangular Cartesian coordinates in space, direction cosines and direction ratios of a directed line, projection, angle between two lines, equations to a plane in intercept, normal and general forms, the sides of a plane, bisectors of the angles between two planes, parallelism and perpendicularity of two planes, straight lines in the space, skew lines. [**16L**]

Unit-IV

Sphere, cone, cylinder, surfaces of revolution, ruled surface, transformation of rectangular axes in the space, reduction of the general second degree equation in three variables to canonical form, classification of quadrics, standard equations and shapes of ellipsoid, hyperboloid and paraboloid. [**18L**]

Text Books:

1. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.

Reference Books:

1. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.

Partial Differential Equations

Paper Code: SMA32109 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit – I

Formation of first order partial differential equations (PDE), linear and non-linear PDE of first order, special types of first-order equations, solutions of linear first order PDE, equation solvable by direct integration, Lagrange's method of solving Lagrange's linear equations, Lagrange's linear equations with n independent variables, integral surfaces passing through a given curve, nonlinear first order PDE, Charpit's method. **[16L]**

Unit – II

Linear second order homogeneous and non-homogeneous PDE with constant coefficients, method of finding the complementary function and particular integral for homogeneous and non-homogeneous PDE, partial differential equations with variable coefficients, Some standard forms of variable co-efficient, separation of variable (Product Method), Non-linear equation of the second order. **[16L]**

Unit-II:

Mathematical modeling of vibrating string, vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws and Burger's equations, classification of second order PDE, reduction to canonical forms. **[14L]**

Unit – IV

Laplace equation, Solution of Laplace equation by separation of variables, One dimensional wave equation, Solution of the wave equation(method of separation of variables), Diffusion equation, solution of one-dimensional diffusion equation, method of separation of variables.

[14L]

Text Books:

1. M.D. Raisinghania: Advanced Differential equations, S. Chand.

Reference Books:

1. J. Sinha Roy and S. Padhy, A Course on Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi, Ludhiana

2. I.N. Sneddon, Elements of partial differential, McGraw-Hill book.
3. S. L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004

Theory of Probability

Paper Code: SMA32104 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Random experiment, sample point and sample space, event, algebra of events, Definition of Probability - classical, relative frequency and axiomatic approaches to probability, merits and demerits of these approaches (only general ideas to be given), theorems on probability, conditional probability, independent events, Baye's theorem and its applications. [**14L**]

Unit-II

Random variables and distribution functions: Random variables and its types, distribution function, probability mass function, discrete distribution function, probability density function, various measures of central tendency, dispersion, skewness and kurtosis for continuous probability distributions, two dimensional random variables, joint probability mass function, distribution function, marginal distribution functions, joint density function, marginal density function. [**12L**]

Unit – III

Mathematical expectation and generating functions: Expected value of a random variable, expected value of a random variable, properties of expectation, properties of variance, covariance, some inequalities involving expectation, moment generating function and its limitations, properties and uniqueness theorem of moment generating function. [**14L**]

Unit-IV

Discrete probability distributions: Discrete uniform, Bernoulli, Binomial, Poisson, negative binomial, geometric and hyper-geometric distributions and their moment generating functions and properties.

Continuous probability distributions: Uniform, triangular, gamma, exponential, Weibul, logistic distributions, beta distribution of first kind, beta distribution of second kind and their moment generating functions and applications. [**20L**]

Text Books:

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical Statistics, S Chand & Sons
2. Vijay K. Rohatgi, A.K. Md. EhsanesSaleh, An Introduction to Probability and Statistics, Second edition, Wiley.

Reference Books:

1. R. V. Hogg, J Mckean, A T Craig, Introduction to Mathematical Statistics, 7e, Pearson Education India.
2. S. Ross, A First Course in Probability, Pearson Education.
3. S. Ross, Introduction to probability models, Academic Press, Indian Reprint 2007

Functions of Several Variables

Paper Code: SMA33101 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit – I

Functions of several variables, limit and continuity of functions of two variables, partial differentiation, total differentiability, sufficient condition for differentiability, Chain rule for one and two independent parameters. [**12L**]

Unit – II

Directional derivatives, definition of vector field, divergence and curl gradient, maximal and normal property of the gradient, tangent planes.

Extrema of functions of two variables, Taylor's theorem for functions two variables, method of Lagrange multipliers, constrained optimization problems. [**12L**]

Unit - III

Pedal equation of a curve, pedal of a curve, curvature-radius of curvature, centre of curvature, chord of curvature, evolute of a curve, envelopes of families of straight lines and curves

(cartesian and parametric equations). Jacobian of two and three variables, simple properties including function dependence, concept of implicit function: statement and simple application of implicit function theorem for two variables differentiation of implicit function. [**16L**]

Unit – IV

Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, conservative vector fields, independence of path, Greens theorem, surface integrals, integrals over parametrically defined surfaces, Stokes theorem, Divergence theorem. [**20L**]

Text Books:

1. S. C. Mallik and S. Arrora, Mathematical Analysis, S. Chand.
2. G.B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

Reference Books:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007
2. E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
3. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole,Thomson Learning, USA, 2001.
4. Santosh K. Sengar, Advanced Calculus, Cengage Learning India Pvt. Ltd.

Functions of Complex Variables

Paper Code: SMA32108 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week – 4**

Unit - I

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings, Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. [**14L**]

Unit – II

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions, contours, Contour integrals and its examples, upper bounds for moduli of contour integrals, Cauchy- Goursat theorem, Cauchy integral formula. [**16L**]

Unit – III

Liouville's theorem and the fundamental theorem of algebra, Convergence of sequences and series, Taylor series and its examples, Laurent series and its examples, absolute and uniform convergence of power series. [**12L**]

Unit – IV

Classification of singularities: Isolated and non-isolated singularities, removable singularities, poles, isolated singularities at infinity, Meromorphic functions, essential singularities, residues at a finite point, residues at the point at infinity, Cauchy's residue theorem, Rouche's theorem and evaluation of integrals. [**18L**]

Text Books:

1. Murray. R. Spiegel, Theory and Problems of Complex Variables, Schaum outline series.
2. J. B. Conway, Functions of one Complex variable. Springer,Verlag.

Recommended Books:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill International Edition, 2009.
2. H K Kasana, Complex Variables: Theory and Applications: Second Edition, Prentice Hall India Learning Private Limited.
3. P. Duraipandianand K. Pachaiyappa, Complex Analysis, S. Chand Publishing.
4. S. Ponnusamy, Foundations of Complex Analysis, Narosa Pub. House

Introduction to Linear Programming and Game Theory

Paper Code: SMA33102 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit – I

Introduction, definition of linear programming problem (LPP), formation of LPP from daily life involving inequalities, graphical solution of LPP, basic solutions and basic feasible solution (BFS) with reference to LPP, matrix formulation of LPP, degenerate and non-degenerate BFS, Hyperplane, convex set, cone, extreme points, convex hull and convex polyhedron, supporting and separating hyperplane, reduction of a feasible solution (FS) to a BFS, improving a BFS, optimality condition, unboundedness, alternate optima, infeasibility and related examples.[**16L**]

Unit – II

Theory of simplex method, optimality and un-boundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison, Duality, formulation of the dual problem, primal-dual relationships, Duality them economic interpretation of the dual. [**14L**]

Unit – III

Transportation problem and its mathematical formulation, north-west corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, travelling salesman problem. [**18L**]

Unit – IV

Game theory: Concept of game theory, rectangular games, pure strategy and mixed strategy, saddle point and its existence, optimal strategy and value of the game, necessary and sufficient condition for a given strategy to be optimal in a game, concept of dominance, formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games. [**12L**]

Text Books:

1. KantiSwarup, P. K. Gupta and Man Mohan, Operations Research, S. Chand and Co. Pvt. Ltd.

2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.

Reference Books:

1. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice Hall India, 2006. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
2. N.V.R. Naidu, G. Rajendra and T. Krishna Rao-Operations Research, I.K. International Publishing House Pvt. Ltd., New Delhi, Bangalore.

Vector Analysis and Tensor Calculus

Paper Code: SMA33105 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Vector Calculus: Scalar-valued functions over the plane and the space, definition with examples, curves and paths, vector fields, vector differentiation, formulae with problems, directional derivatives, the tangent plane, total differential, gradient, divergence and Curl, solenoidal and irrotational vector functions, derivations of relations between gradient, divergence and curl of a vector, Laplacian operator and its physical interpretation. **[14L]**

Unit-II

Vector integration: Path, line, surface, and volume integrals with examples, line integrals of linear differential forms, integration of total differentials, conservative fields, conditions for line integrals to depend only on the endpoints, the fundamental theorem on exact differentials, Frenet–Serret formulas, Green's theorem, Gauss theorem, Stokes theorem, problems on these three theorems. **[16L]**

Unit-III

A tensor as a generalized concept of a vector in a Euclidean space E^3, to generalize the idea in an n-dimensional space, definition of E^n, transformation of co-ordinates in E^n (n = 2, 3 as example), summation convention, contravariant and covariant vectors, invariants, contravariant, covariant and mixed tensors, the Kronecker delta, algebra of tensors, symmetric and skew-symmetric tensors, addition and scalar multiplication, contraction, outer and inner products of tensors, quotient law, reciprocal tensor. **[18L]**

Unit-IV

Riemannian space, line element and metric tensor, reciprocal metric tensor, raising and lowering of indices with the help of metric tensor, associated tensor, magnitude of a vector, inclination of two vectors, orthogonal vectors, Christoffel symbols and their laws of transformations, covariant differentiation of vectors and tensors. [**12L**]

Text Books:

1. Murray Spiegel and Seymour Lipschutz, Vector Analysis, Schaum's outlines
2. Barry Spain, Tensor Calculus: A Concise Course,Dover Books.

Reference Books:

1. J.G. Chakravorty, P.R. Ghosh, Vector Analysis, U. N. Dhar& sons Pvt. Ltd.
2. J E Marsden and A Tromba, Vector Calculus by, 6th edition, Freeman.
3. David C. Kay, Schaums Outline of Tensor Calculus, Schaums' Outline Series, McGraw-Hill Education.
4. A. A. Shaikh, U.C. De andJ. Sengupta,Tensor Calculus, 2nd edition,Narosa Book Distributors.

Dynamics of a particle

Paper Code: SMA32106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I:

Applications of Newton's laws to elementary problems of simple harmonic motion, inverse square law and composition of two simple harmonic motions, center of mass.

Basic kinematic quantities: momentum, angular momentum and kinetic energy, principle of energy and momentum, work and poser, simple examples on their applications.

Impact of elastic bodies, direct and oblique impact of elastic spheres, losses of kinetic energy, angle of deflection. [**10L**]

Unit II:

Tangent and normal accelerations, circular motion, radial and cross-radial accelerations, damped harmonic oscillator, motion under gravity with resistance proportional to some integral power of velocity, terminal velocity, simple cases of a constrained motion of a particle,

motion of a particle in a plane under different laws of resistance, motion of a projectile in a resisting medium in which the resistance varies as the velocity, trajectories in a resisting medium where resistance varies as some integral power of the velocity. [**12L**]

Unit III:

Central forces and central orbits, typical features of central orbits, stability of nearly circular orbits, planetary motion and Kepler's laws, time of describing an arc of the orbit, orbital energy, relationship between period and semi-major axis, motion of an artificial satellite, motion of a smooth cure under resistance, motion of a rough curve under gravity e.g., circle, parabola, ellipse, cycloid etc.

Momental ellipsoid, equimomental system, principal axis, D'Alembert's principle, D'Alembert's equations of motion, principles of moments, principles of conservations of linear and angular momentum, independence of the motion of centre of inertia and the motion relative to the centre of inertia, principle of energy, principle of conservation of energy. [**14L**]

Unit IV:

Equation of motion of a rigid body about a fixed axis, expression for kinetic energy and moment of momentum of a rigid body moving about a fixed axis, compound pendulum, interchangeability of the points of a suspension and centre of oscillation, minimum time of oscillation, equations of motion of a rigid body moving in two dimensions, expression for kinetic energy and angular momentum about the origin of rigid body moving in two dimensions, necessary and sufficient condition for pure rolling, two dimensional motion of a solid of revolution moving on a rough horizontal plane. [**12L**]

Unit V:

Equations of motion under impulsive forces, equation of motion about a fixed axis under impulsive forces, to show that (i) of there is a definite straight line such that the sum of the moments of the external impulses acting on a system of particles about it vanishes, then the total

angular momentum of the system about that line remains unaltered (ii) the change of K.E. of a system of particles moving in any manner under the application of impulsive forces is equal to the work done by the impulsive forces. [**12L**]

Text Books:

1. S. L. Loney, Dynamics of a Particle and of Rigid Bodies, G. K. Publication Ltd

Reference Books:

1. Anil Rao, Dynamics of Particles and Rigid Bodies: A Systematic Approach.
2. E. T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies.

Introduction to Numerical Analysis

Paper Code: SMA33103 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit – I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation errors, propagation of errors, Transcendental and Polynomial equations: Bisection method, Regular Falsi method, fixed point of a function, fixed point iteration method, Newton's Raphsan method, Secant method, Rate of convergence of these methods, numerical solution system of non-linear equation by Newton-Raphson method. [**14L**]

Unit – II

System of linear algebraic equations: Gaussian Elimination, pivoting, Gauss Jordan methods, LU-Decomposition methods, ill condition system and its solution, Gauss Jacobi method, Gauss Seidel method and their convergence analysis, eigen value and eigen vector problems, power method. [**14L**]

Unit – III

Interpolation: Finite difference operators and its properties and relation between finite difference operators, Newton's forward and backward difference formula, numerical differentiation.

Interpolation with unequal intervals: Lagrange's interpolation formula and Newton's divided difference interpolation formula. [**14L**]

Unit – IV

Numerical Integration: Trapezoidal rule, Simpsons 1/3rd rule, Simpsons 3/8th rule, Midpoint rule, Composite Trapezoidal rule, Composite Simpsons, Guass-Quadrature 2 point & 3 point rule.

Ordinary Differential Equations: Taylor's method, Picard's Method, Euler's method, Modified Euler's method, Runge-Kutta methods of orders two and four. [**18L**]

Text Books:

1. T. Veerarajan, T. Ramachandran , Numerical Methods with Programs in C , Tata McGraw-Hill Publications
2. S. Dey, S. Gupta , Numerical Methods, McGraw Hill Education

Reference Books:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition, 2007
2. B.S. Grewal , Numerical Methods in Engineering & Science with Programs in C & C++, Khanna Publications

Integral Transforms

[Laplace, Fourier and Z- transforms]

Paper Code: SMA33104 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs and PDEs. Finite Laplace Transform: Definition and properties, Shifting and scaling theorem. [**20L**]

Unit-II

Fourier series: Trigonometric Fourier series and its convergence. Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval`s identity, Complex form of Fourier series. [**10L**]

Unit-III

Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems. [**16L**]

Unit-IV

Z-Transform: Z–transform and inverse Z-transform of elementary functions, Region of convergence, Shifting theorems, Convolution theorem, Initial and final value theorem, Application of Z-transforms to solve difference equations. [**14L**]

Text Books:

1. L. Debanth and D. Bhatta, Integral Transforms and Their Applications, Taylor and Francis Group, 2007.

Reference Books:

1. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, Narosa Publishing House.
2. F. B. Hildebrand, Methods of Applied Mathematics, Courier Dover Publications, 1992.
3. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2011.

Statistics

Paper Code: SMA33104 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit – I

Measures of location (or central tendency) and dispersion, moments, measures of skewness and kurtosis, Bivariate data: Scatter diagram, principle of least-square and fitting of polynomials and exponential curves. [**18L**]

Unit – II

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states. [**12L**]

Unit-III

Testing of Hypothesis: Basic concepts, one- and two- tailed tests, test statistic, types of error, p – values for decision making testing hypotheses, pre-selection of a significance level, test for population mean, difference in means, population variance, one- and two- sample tests concerning variances, χ^2 – goodness of fit test. [**14L**]

Unit-IV

Correlation and Regression: Introduction, linear regression and correlation, rank correlation, multiple and partial correlations (for 3 variates only), least square method of fitting regression lines, analysis of variance and nonparametric tests. [**16L**]

Text Books:

1. S. C. Gupta and V.K. Kapoor-Fundamentals of Mathematical Statistics, S. Chand and Company Pvt. Ltd., New Delhi.
2. Vijay K. Rohatgi, A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Second edition, Wiley.

Reference Books:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007

Discipline Specific Elective (DSE) Courses of B. Sc. (Mathematics)

DSE – I (Theory)

1. Mathematical Finance
2. Portfolio Optimization
3. Nonlinear Dynamics

Mathematical Finance

Paper Code: SMA33105 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Financial Management: Financial Management, Goals of Financial Management and main decisions of financial management, Time Value of Money: Interest rate and discount rate. Present value and future value-discrete case as well as continuous compounding case, Annuities and its kinds, Meaning of return. Return as Internal Rate of Return (IRR), Numerical Methods like Newton-Raphson Method to calculate IRR, Measurement of returns under uncertainty situations. **[20L]**

Unit-II

Meaning of risk, Difference between risk and uncertainty, Types of risks, Measurements of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model, Sharpe's Single Index Model Systematic Risk and Unsystematic Risk, Taylor series and Bond Valuation, Calculation of Duration and Convexity of bonds. **[18L]**

Unit-III

Mathematics in Insurance: Insurance Fundamentals, Insurance defined Meaning of loss, Chances of loss, peril, hazard, and proximate cause in insurance, Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures-feature of a loss that is ideal for insurance, Life Insurance Mathematics, Construction of Mortality Tables, Computation of Premium of Life Insurance for a fixed duration and for the whole life. **[22L]**

Text Books:

1. Aswath Damodaran, Corporate Finance - Theory and Practice , John Wiley & Sons.Inc

Reference Books:

1. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of India Private Limited.
2. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.

3. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englwood Cliffs, New Jersey.

Portfolio Optimization

Paper Code: SMA33107 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Financial markets, Investment objectives, Measures of return and risk, Types of risks, Risk free assets, Mutual funds, Portfolio of assets. [**14L**]

Unit-II

Expected risk and return of portfolio, Diversification, Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, risk-free assets and one fund theorem, efficient frontier, Portfolios with short sales. [**14L**]

Unit-III

Capital market theory, Capital assets pricing model- the capital market line, beta of an asset, beta of a portfolio, security market line. Index tracking optimization models, Portfolio performance evaluation measures. [**20L**]

Text Books:

1. F. K. Reilly, Keith C. Brown, Investment Analysis and Portfolio Management, 10th Ed., South-Western Publishers, 2011.

Reference Books:

1. H.M. Markowitz, Mean-Variance Analysis in Portfolio Choice and Capital Markets, Blackwell, New York, 1987.
2. M.J. Best, Portfolio Optimization, Chapman and Hall, CRC Press, 2010.
3. D.G. Luenberger, Investment Science, 2nd Ed., Oxford University Press, 2013.

Nonlinear Dynamics

Paper Code: SMA33109 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Linear Dynamical Continuous Systems: First order equations, existence uniqueness theorem, growth equation, logistic growth, constant harvesting, planar linear systems, equilibrium points, stability, phase space, n-dimensional linear systems, stable, unstable and center spaces. [**12L**]

Unit-II

Nonlinear autonomous Systems: Motion of pendulum, local and global stability, Liapunov method, periodic solution, Bendixson's criterion, Poincare Bendixson theorem, limit cycle, attractors, index theory, Hartman Grobman theorem, non-hyperbolic critical points, center manifolds, normal forms, Gradient and Hamiltonian systems. [**16L**]

Unit-III

Local Bifurcation: Fixed points, saddle node, pitchfork trans-critical bifurcation, Hopf bifurcation, co-dimension. [**08L**]

Unit-IV

Discrete systems: Logistic maps, equilibrium points and their local stability, cycles, period doubling, chaos, tent map, horse shoe map. [**12L**]

Unit-V

Deterministic chaos: Duffing's oscillator, Lorenz System, Liapunov exponents, routes to chaos, necessary conditions for chaos. [**12L**]

Text Books:

1. Strogatz, S. H., "Nonlinear Dynamics and Chaos", Westview Press, 2008.
2. Lakshmanan, M, Rajseeker, S., "Nonlinear Dynamics", Springer, 2003.

Reference Books:

1. Wiggins, S. "Introduction to applied Nonlinear Dynamical Systems and Chaos", Springer-Verlag, 1990.
2. Perko,L., “Differential Equations and Dynamical Systems”, Springer, 1996.

DSE – II

1. **Number Theory [SMA33113]**
2. **Set theory and Metric Spaces [SMA33115]**

Number Theory

Paper Code: SMA33113 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem. **[14L]**

Unit-II

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function, **[16L]**

Unit-III

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. **[14L]**

Unit-IV

Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last theorem. **[12L]**

Text Books:

1. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.

Reference Books:

2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

Set Theory and Metric Spaces

Paper Code: SMA33115 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit I:

Introduction, definition and examples of metric spaces, neighbourhood, open ball, open and closed set, closed set defined as complement of open set, interior point and interior of a set.[**12L**]

Unit II:

Limit point closure and interior, boundary points, properties of interior, closure and boundary of a set, diameter of a set and bounded set, distance between a point and a set. [**14L**]

Unit III:

Subspace of a metric space, convergent sequence, Cauchy sequence, every Cauchy sequence is bounded, completeness, Cantor's intersection theorem, construction of real numbers as the completion of the incomplete metric space of rationals. [**18L**]

Unit IV:

Dense subsets, separable metric spaces, continuous functions, Uniform continuity, isometry and Homeomorphism, equivalent metrics. [**16L**]

Text Books:

1. P.R. Halmos, Naïve Set Theory, Springer, 1974.
2. B. K. Tyagi,First Course in Metric Spaces, Cambridge University Press.

Reference Books:

1. E. T. Copson, Metric Spaces, Cambridge University Press, 1968.
2. P. K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi, 1996.
3. Satish Shirali and H.Vasudeva, Metric Spaces, Springer

DSE – III (Theory)

1. **Bio-Mathematics**
2. **Mathematical Modeling**

Bio Mathematics

Paper Code: SMA33106 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Overview ,Discrete Biological Models, Difference Equations, Systems of Difference Equations, The Golden Mean ,Complex Eigenvalues, Applications , Nonlinear Difference Equations, Steady States and Stability , The Logistic Equation. [**14L**]

Unit-II

Analysis of the Logistic Equation, Cobwebbing, Systems of Nonlinear Difference Equations, Steady States and Stability, Examples, Continuous Models. [**12L**]

Unit-III

Bacterial Growth, Tumors, Dimensional Analysis, Steady States and Stability, Stability in the Chemostat Applications [**10L**]

Unit-IV

Geometry of First Order ODEs, Systems of 2 First Order ODEs, Geometric Analysis, Nullclines, Phase Plane Diagrams, Geometric Analysis of Stability. [**12L**]

Unit-V

Geometric Analysis of the Chemostat , The Predator-Prey System, Michaelis-Menten Kinetics, Limit Cycles, Poincare-Bendixson Theory ,Cubic Nullclines, Hopf bifurcation. [**12L**]

Text Books:

1. Mathematical Models in Biology: An Introduction by Allman and Rhodes. 2003. Cambridge University Press. ISBN-10: 0521525861

Reference Books:

1. Elements of Mathematical Ecology, Mark Kot. Cambridge University Press.

Mathematical Modelling

Paper Code: SMA33108 **L: T: P=3:1:0**

Credits- 4 **Contact hours per week - 4**

Unit-I

Basic steps of mathematical modeling, its needs, types of models, limitations, elementary ideas of dynamical systems, autonomous dynamical systems in the plane-linear theory, equilibrium point, node, saddle point, focus, centre and limit-cycle ideas with simple illustrations and figures, linearization of non-linear plane autonomous systems, mathematical modeling in the biological environment. [**14L**]

Unit-II

Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence, Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis. [**16L**]

Unit-III

Differential equation based models: Numerical solvers of systems of differential equations: stiff equations, delay differential equations, compartment models: population dynamics, infectious disease models. [**12L**]

Unit-IV

Spatial Models: One species model with diffusion, two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population, Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting. [**18L**]

Text Books:

1. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.
2. Barnes B and Fulford GR, Mathematical Modeling with Case Studies. CRC Press.

Reference Books:

1. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
2. Mattheij RMM, Rienstra SW, ten ThijeBoonkamp JHM, Partial differential Equations, Modeling Analysis, Computation. SIAM (Dimensional analysis)
3. Yang X.S,An Introduction to Computational Engineering with Matlab. CISP (Cellular automata)