# B.SC MATHEMATICS

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13. **Dr. Ullas Thomas**
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    **Department of Mathematics**
    **SB College**
    **Changanacherry**

**AIM**

This syllabus aims to equip BSc Mathematics students with a solid foundation in basic areas of Mathematics like Geometry, Analysis and Algebra. It makes students to cop up with the standards of national and international institutions.

**COURSE STRUCTURE:**

The BSc. Programme in Mathematics includes (a) Common courses, (b) Core courses, (c) Complementary Courses, (d) Open Courses (e) Choice Based course and (f) Project.

**CORE COURSES**

The following table shows the structure of the programme which indicates Code of the courses, title of the courses, instructional hours, credits, End semester examination style and the components for internal and external evaluation.

| Semester | Title of the Course | Number of hours per week | Total Credits | Total hours/ semester | End Sem Exam Duration in Hours | Weightage | |
|---|---|---|---|---|---|---|---|
| | | | | | | IE | EE |
| 1 | SB MM1B01: FOUNDATIONS OF MATHEMATICS | 4 | 3 | 72 | 3 | 1 | 4 |
| 2 | SB MM2 B01 :GEOMETRY OF THREE DIMENSIONS , TRIGONOMETRY AND NUMBER THEORY | 4 | 3 | 72 | 3 | 1 | 4 |
| 3 | SB MM3 B01 MATHEMATICAL ANALYSIS -I | 5 | 4 | 90 | 3 | 1 | 4 |
| 4 | SBMM4B01: MATHEMATICAL ANALYSIS -II | 5 | 4 | 90 | 3 | 1 | 4 |
| 5 | SB MM5B01 –MATHEMATICAL ANALYSIS -III | 5 | 4 | 90 | 3 | 1 | 4 |
| | SB MM5B02 – LINEAR ALGEBRA | 5 | 4 | 90 | 3 | 1 | 4 |
| | SB MM5B03 – DIFFERENTIAL EQUATIONS | 5 | 4 | 90 | 3 | 1 | 4 |
| | SB MM5B04 – ABSTRACT ALGEBRA | 5 | 4 | 90 | 3 | 1 | 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | SB MM5D – OPEN COURSE | 4 | 4 | 72 | 3 | 1 | 4 |
| | SB MM6D05-PROJECT | 1 | 1 | 18 | - | 1 | 4 |
| 6 | SB MM6B01 – MATHEMATICAL ANALYSIS -IV | 5 | 4 | 90 | 3 | 1 | 4 |
| | SBMM6B02 – COMPLEX ANALYSIS | 5 | 4 | 90 | 3 | 1 | 4 |
| | SB MM6B03 – DISCRETE MATHEMATICS | 5 | 4 | 90 | 3 | 1 | 4 |
| | SBMM6B04 – METRIC SPACES | 5 | 4 | 90 | 3 | 1 | 4 |
| | SBMM6D01 – CHOICE BASED COURSE | 4 | 3 | 72 | 3 | 1 | 4 |

**OPEN COURSES**

| Code | Title of the Course | No. of contact hrs/week | No. of Credit | Duration of Exam |
|---|---|---|---|---|
| SBMM5D01 | MATHEMATICAL MODELING | 4 | 4 | 3 hrs |
| SBMM5D02 | APPLICABLE MATHEMATICS | 4 | 4 | 3 hrs |
| SBMM5D03 | FINANCIAL MATHEMATICS | 4 | 4 | 3 hrs |
| SBMM5D04 | MATHEMATICAL ECONOMICS | 4 | 4 | 3 hrs |

**CHOICE BASED COURSES**

| Code | Title of the Course | No. of contact hrs/week | No. of Credit | Duration of Exam |
|---|---|---|---|---|
| SBMM6D01 | OPERATIONS RESEARCH | 4 | 3 | 3 hrs |
| SBMM6D02 | PROGRAMMING IN C | 4 | 3 | 3 hrs |
| SBMM6D03 | TOPOLOGY | 4 | 3 | 3 hrs |
| SBMM6D04 | THEORY OF COMPUTATIONS | 4 | 3 | 3 hrs |

**PROJECT**

All students must do a project. The project can be done individually or as a group of maximum 3 students. The viva on this project will be conducted individually. The projects are to be identified during the IV$^{th}$ semester of the programme with the help of the supervising teacher. The report of the project in duplicate is to be submitted to the department and are to be produced before the examiners appointed by the controller of examinations for valuation.

## COMPLEMENTARY COURSES

## COMPLEMENARY MATHEMATICS FOR B.Sc PHYSICS / CHEMISTRY

| Semester | Title of the paper | Number of hours per week | Total Credits | Total hours/ semester | End Semester Exam | Weightage | |
|---|---|---|---|---|---|---|---|
| | | | | | | IA | EA |
| 1 | SBMP1C01 TRIGONOMETRY,DIFFERENTIAL CALCULUS & MATRICES | 4 | 3 | 72 | 3 hrs | 1 | 4 |
| 2 | SBMP2C01:INTEGRAL CALCULUS AND FOURIER SERIES | 4 | 3 | 72 | 3 | 1 | 4 |
| 3 | SBMP3C01 – VECTOR CALCULUS ANALYTIC GEOMETRY AND ABSTRACT ALGEBRA | 5 | 4 | 90 | 3 | 1 | 4 |
| 4 | SBMP4C01- DIFFERENTIAL EQUATIONS, NUMERICAL ANALYSIS AND COMPLEX ANALYSIS | 5 | 4 | 90 | 3 | 1 | 4 |

## COMPLEMENARY STATISTICS FOR MATHEMATICS

| Semester | Title of the paper | Number of hours per week | Total Credits | Total hours/ semester | End Semester Exam Durati | Weightage | |
|---|---|---|---|---|---|---|---|
| | | | | | | IA | EA |
| 1 | BASIC STATISTICS | 4 | 3 | 72 | 3 hrs | 1 | 4 |
| 2 | THEORY OF PROBABILITY AND RANDOM VARIABLES | 4 | 3 | 72 | 3 | 1 | 4 |
| 3 | PROBABILITY DISTRIBUTIONS | 5 | 4 | 90 | 3 | 1 | 4 |
| 4 | STATISTICAL INFERENCE | 5 | 4 | 90 | 3 | 1 | 4 |

## COMPLEMENTARY MATHEMATICS FOR BCA

| Semester | Title of the paper | Number of hours per week | Total Credits | Total hours/ semester | End Sem Exam Duration | Weightage | |
|---|---|---|---|---|---|---|---|
| | | | | | | IA | EA |
| 1 | M1C01 MATRICES , CALCULUS AND LAPLACE TRANSFORMS | 4 | 4 | 72 | 3 | 1 | 4 |
| 2 | M2C01 : DISCRETE MATHEMATICS | 4 | 4 | 72 | 3 | 1 | 4 |
| 4 | M4C01 : OPTIMIZATION TECHNIQUES | 4 | 4 | 72 | 3 | 1 | 4 |

# COMPLEMENTARY STATISTICS FOR BCA

| Semester | Title of the paper | Number of hours per week | Total Credits | Total hours/ semester | End Sem Exam Duration | Weightage | |
|---|---|---|---|---|---|---|---|
| | | | | | | IA | EA |
| 1 | INTRODUCTORY STATISTICS | 4 | 4 | 72 | 3 | 1 | 4 |
| 3 | ADVANCED STATISTICS | 4 | 4 | 72 | 3 | 1 | 4 |

## EVALUATION SYSTEM

### CRITERIA FOR GRADING

| MARK | GRADE | |
|---|---|---|
| 90 and above | A+ | Out standing |
| 80 to 89 | A | Excellent |
| 70 to 79 | B | Very Good |
| 60 to 69 | C | Good |
| 50 to 59 | D | Satisfactory |
| 40 to 49 | E | Adequate |
| Below 40 | F | Failure |

**INTERNAL AND EXTERNAL MARKS FOR ALL THEORY PAPERS FOR EACH SEMESTER**

| Internal | External |
|---|---|
| 20 | 80 |

**DISTRIBUTION OF MARKS FOR PROJECT**

| | |
|---|---|
| Internal | 20 |
| Viva-Voce | 20 |
| Dissertation | 60 |

**DISTRIBUTION OF INTERNALS**

| Division | Marks |
|---|---|
| Attendance | 5 |
| Assignment/Seminar/Viva | 5 |
| Test Papers | 10 |

**ATTENDENCE**

| % of Attendance | Marks |
|---|---|
| $\geq 90$ | 5 |
| $\geq 85$ and $< 90$ | 4 |
| $\geq 80$ and $< 85$ | 3 |
| $\geq 75$ and $< 80$ | 2 |
| $< 75$ | 1 |

**END-SEMESTER ASSESSMENT (EA)**

The End - semester examination of all semesters are conducted by the Controller of Examinations on the close of each semester.

## PATTERN OF QUESTION PAPER

A question paper shall be a judicious mix of objective type, short answer type, short essay type/ problem solving type and long essay type questions. Different types of questions shall be given different weights to qualify their range.

| PART | Total no. of questions | Number of questions to be answered | Marks of each question | Total marks |
|---|---|---|---|---|
| A | 10 | 10 | 1 | 10 |
| B | 12 | 8 | 2 | 16 |
| C | 9 | 6 | 4 | 24 |
| D | 4 | 2 | 15 | 30 |
| | **35** | **26** | | **80** |

**Semester 1**

| Course Code | Course Title | Inst. Hours/ week. | Credits |
|---|---|---|---|
| CEN101 | Common English Paper I | 5 | 4 |
| CEN102 | Common English Paper II | 4 | 3 |
| | Additional Language PI | 4 | 4 |
| BMM 101 | Core I - FOUNDATIONS OF MATHEMATICS | 4 | 3 |
| DSM101 | Complementary I - STATISTICS | 4 | 3 |
| DMM101 | Complementary II- PHYSICS | 4 | 3 |

**Semester 2**

| Course Code | Course Title | hours /week. | Credits |
|---|---|---|---|
| CEN203 | Common English Paper III | 5 | 4 |
| CEN204 | Common English Paper IV | 4 | 3 |
| | Additional Language P II | 4 | 4 |
| BMM202 | Core - II -GEOMETRY OF THREE DIMENSIONS, TRIGONOMETRY AND NUMBER THEORY | 4 | 3 |
| DSM202 | Complementary III- STATISTIS | 4 | 3 |
| DMM202 | Complementary IV - PHYSICS | 4 | 3 |

**Semester 3**

| Course Code | Course Title | hours /week. | Credits |
|---|---|---|---|
| CEN305 | Common English Paper V | 5 | 4 |
| | Additional Language PIII | 5 | 4 |
| BMM203 | Core- 3 MATHEMATICAL ANALYSIS -I | 5 | 4 |
| DSM303 | Complementary V- STATISTIS | 5 | 4 |
| DMM303 | Complementary VI- (PHYSICS) | 5 | 4 |

**Semester 4**

| Course Code | Course Title | Hours /week. | Credits |
|---|---|---|---|
| CEN406 | Common English Paper VI | 5 | 4 |
| | Additional Language P IV | 5 | 4 |
| BMM404 | Core 4- MATHEMATICAL ANALYSIS -II | 5 | 4 |
| DSM404 | Complementary VII- STATISTIS | 5 | 4 |
| DMM404 | Complementary VIII-PHYSICS | 5 | 4 |

**Semester 5**

| Course Code | Course Title | Hours /week. | Credits |
|---|---|---|---|
| BMM505 | Core 5- MATHEMATICAL ANALYSIS -III | 5 | 4 |
| BMM506 | Core 6- LINEAR ALGEBRA | 5 | 4 |
| BMM507 | Core 7 -DIFFERENTIAL EQUATIONS | 5 | 4 |
| BMM508 | Core 8 -ABSTRACT ALGEBRA | 6 | 4 |
| OMM501 | Open course | 4 | 3 |
| BMM6PJ | Project | 4 | 1 |

**Semester 6**

| Course Code | Course Title | hours /week. | Credits |
|---|---|---|---|
| BMM609 | Core 9 -MATHEMATICAL ANALYSIS -IV | 5 | 4 |
| BMM610 | Core 10 -COMPLEX ANALYSIS | 5 | 4 |
| BMM611 | Core 11- DISCRETE MATEMATICS | 5 | 4 |
| BMM612 | Core 12 -METRIC SPACES | 5 | 4 |
| BMM613 | Choice Based Course | 5 | 4 |

## FIRST SEMESTER
## FOUNDATIONS OF MATHEMATICS (72 hours)

**MODULE1: BASIC LOGIC -16 Hours**

Propositions and Logical Operations, Conditional Statements, Methods of proofs, Mathematical Induction

Text Book 1- Chapter 2

**MODULE2: MATRICES – 20 Hours**

Elementary Transformations, Rank of a Matrix, Simultaneous Linear Equations, Characteristic Roots and Characteristic vectors, Cayley Hamilton Theorem

Text Book 2 - Sections 3.1-3.9; 4.1- 4.9; 5.1-5.5; 7.1-7.8; 8.1-8.3

**MODULE3: GEOMETRY OF TWO DIMENSIONS: CONIC SECTIONS – 20 Hours**

Circle, Parabola, Ellipse, Hyperbola, Classifying Conic Sections by Eccentricity, Quadratic Equations and Rotations, Parametrization of Plane Curves

Text Book 3 Sections 9.1-9.4

**MODULE 4 : GEOMETRY OF TWO DIMENSIONS: POLAR EQUATIONS – 16 Hours**

Polar Coordinates, Graphing in Polar Coordinates, Polar Equation for Conic Sections

Textbook 3 Sections 9.6 - 9.8

### Text books

1. Kolman, Bontry etal ; Discrete Math Structures, Pearson,New Delhi,2007
2. V.N. Kala, R. Rana, Matrices, University Science Press,New Delhi,2011
3. Thomas, Finney, Calculus and Analytic Geometry, Addison-Wessly

### REFERENCES

1. Manicavachagom pillay, Natarajan – Analytic Geometry (part i, two dimensions)
2. S.L. Loney – Plane Trigonometry part – II, S. CHAND and company ltd.
3. Frank Ayres Jr - Matrices, Schaum's Outline Series, TMH edition.
4. K.H. Rosen: Discrete Mathematics and its Applications (sixth edition), tata mcgraw hill publishing company, New delhi.

### QUESTION PAPER PATTERN

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 3 | 1 | 1 |
| **II** | 3 | 3 | 3 | 1 |
| **III** | 3 | 3 | 3 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SECOND SEMESTER
## GEOMETRY OF THREE DIMENSIONS, TRIGONOMETRY AND NUMBER THEORY
## (72 Hours)

**MODULE 1: GEOMETRY OF THREE DIMENSIONS - 18 Hours**

Rectangular Coordinates in Space, Cylindrical Polar Coordinates, Spherical Polar Coordinates, Direction Cosines and Angle between Two Lines, Equation of a Plane, The Straight Line, Shortest Distance between two skew Lines, The Sphere, The Cylinder, The Cone, Quadratic Surfaces

Text Book 1, Sections 2.1.5 – 2.1.7; 2.3.1 - 2.3.8

**MODULE 2: TRIGONOMETRY – 18 Hours**

Circular and Hyperbolic Functions of a Complex Variable, Separation into Real and Imaginary Parts, Factorization of $x^n - 1$, $x^n + 1$, $x^{2n} - 2x^n a^n \cos\theta + a^{2n}$, Summation of Infinite series by C + iS Method

Text Book 2, Chapter 5; 7; 9 (Relevant Sections)

**MODULE 3: ELEMENTARY NUMBER THEORY – 18 Hours**

Early Number Theory, The Division Algorithm, Greatest Common Divisor, Euclidean algorithm, Fundamental Theorem of arithmetic, Sieve of Eratosthenes

Text Book 3, Sections 2.1-2.4; 3.1, 3.2

**MODULE 4: THE THEORY OF CONGRUENCES – 18 Hours**

Basic Properties of Congruence, Binary and Decimal Representations of Integers, Linear Congruence and Chinese Remainder Theorem, Fermat's Little Theorem and Pseudo primes, Wilsons theorem, The sum and number of divisors, Euler phi Function, Euler Theorem.

Text Book 3, Sections 4.2-4.4; 5.2, 5.3, 6.1, 7.1-7.3

**Text Books**

1. S.S Sastry, Engineering Mathematics Volume 1, Forth Edition, PHI Learning Private Limited New delhi,2008
2. S.L Loney, Plane Trigonometry Part II, S. Chand and Company Limited.
3. David M. Burton, Elementary Number Theory, Sixth Edition, Tata Mcgraw-Hill, New delhi

**REFERENCES**

1. S.K. Stein – Calculus and Analytic Geometry, (Mcgraw Hill)
2. N. Das – Analytic Geometry of Two and Three Dimension (New Central books)
3. Thomas and Finney - Calculus and Analytical Geometry (Addison-Wesley)
4. S. Bernard and J.M Child: Higher algebra, Aitbs Publishers, India, 2009
5. Graham Everest, Thomas Ward: an Introduction to Number Theory, Springer
6. Fernando rodriguez villegas: experimental number theory, Oxford university press
7. Richard johnsonbaugh – discrete mathematics (pearsons )
8. C.y hsiung - elementary theory of numbers, allied publishers

**QUESTION PAPER PATTER**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 3 | 2 | 1 |
| **III** | 3 | 3 | 3 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## THIRD SEMESTER
## MATHEMATICAL ANALYSIS-I (90 Hours)

**MODULE 1: REAL NUMBER SYSTEM – 25 Hours**

Natural numbers , integers, rational numbers, real numbers, ordering of real numbers, absolute value, intervals, bounded set, Archimedean property, maximum minimum of set, completeness of R, factorials and binomial coefficients, Cartesian product, functions, range and pre-image, surjective and injective function, inverse function, bijection, monotone function, composition of functions, translations, rescaling, reflections, elementary properties of functions, powers, rational functions, trigonometric functions

Sections 1.3 To 1.5; 2.1-2-6 of Text 1.

**MODULE 2: LIMITS AND CONTINUITY I – 20 HOURS**

Neighborhood, limit of sequences, Euler number, limit of function, continuity, removable discontinuity, types of discontinuity

Sections 3.1-3.3 of Text 1.

**MODULE 3 : LIMITS AND CONTINUITY II – 20 Hours**

Uniqueness and sign of the limit, comparison theorems, more fundamental limits, indeterminate forms of exponential type, global features of continuous maps, intermediate value theorem

Sections 4.1-4.3 of Text 1.

**MODULE 4 : NUMERICAL SEQUENCES AND SERIES – 25 Hours**

Landau symbols, infinitesimal and infinite functions, further properties of sequences, series, positive term series, alternating series, comparison test, ratio test, root test, Leibniz test, absolute convergence test.

Sections 5.1-5.4 of Text 1; Section 1.1-1.5 of Text 2

**TEXT BOOKS**

1. CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS I, SPRINGER 2008
2. CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS II, SPRINGER 2010

**REFERENCES**

1. T. M. APOSTOL – CALCULUS VOLUME I & II (WILEY INDIA)
2. DAVID V.WIDDER – ADVANCED CALCULUS, 2ND EDITION
3. ROBERT G BARTLE AND DONALD R SHERBERT –INTRODUCTION TO REAL ANALYSIS 3RD EDITION.WILEY
4. RICHARD R GOLDBERG – METHODS OF REAL ANALYSIS 3RD EDITION, OXFORD AND IBM PUBLISHING CO (1964)

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 1 | 1 |
| **II** | 2 | 3 | 3 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 3 | 3 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## FOURTH SEMESTER
## MATHEMATICAL ANALYSIS II (90 Hours)

**MODULE 1: DIFFERENTIAL CALCULUS -25 Hours**

Derivative, derivatives of elementary functions, Rules of differentiation, algebraic operations, chain rule, derivative of inverse function, non differential points, extrema and critical points, Rolle's theorem, mean value theorem, first and second increment formulas, monotone maps, convexity and inflection points, domain and symmetries, L'Hopital's theorem, Applications of L'Hopital's theorem.

Sections 6.1-6.11.

**MODULE 2 : DIFFERENTIAL CALCULUS -20 Hours**

Taylor expansions, Maclaurins expansion, operations on Taylor expansions, local behavior of a map via its Taylor expansion

Sections 7.1-7.4.

**MODULE 3 : INTEGRAL CALCULUS – 25 Hours**

Primitive functions and indefinite integrals, rules of indefinite integration, integration by parts, integration by substitution, integrating rational maps, definite integrals, Cauchy integral, Riemann integral, Properties of Definite integrals, integral mean value, mean value theorem, rules of definite integration, computation of areas.

Sections 9.1-9.9

**MODULE 4 : IMPROPER INTEGRALS – 20 Hours**

Unbounded domains of integration, comparison test, absolute convergence test, asymptotic comparison test, integral test, more improper integrals, curves, integrals along curves, length of curve and arc length.

Sections 8.4; 10.1-10.3

**TEXT BOOK**

CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS I, SPRINGER 2008

**REFERENCES**

1. T. M. APOSTOL – CALCULUS VOLUME I & II (WILEY INDIA)
2. DAVID V.WIDDER – ADVANCED CALCULUS, 2ND EDITION
3. K. C. MAITY& R. K. GHOSH – DIFFERENTIAL CALCULUS (NEW CENTRAL BOOKS AGENCY)
4. K. C. MAITY& R. K. GHOSH – INTEGRAL CALCULUS (NEW CENTRAL BOOKS AGENCY)

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 4 | 3 | 2 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 4 | 3 | 1 |
| **IV** | 1 | 2 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## FIFTH SEMESTER
## MATHEMATICAL ANALYSIS III (90 Hours)

**MODULE 1 : SEQUENCE AND SERIES OF FUNCTIONS – 25 Hours**

Sequence of functions, Properties uniform convergence of sequences, interchanging limits and integrals, interchanging limits and derivatives, series of functions, power series, Algebraic operations, differentiation and integration, analytic functions

Section 2.1-2.5.

**MODULE 2: FOURIER SERIES – 20 Hours**

Trigonometric polynomial, period, Fourier coefficients and Fourier series, exponential form, differentiation, convergence of Fourier series, quadratic convergence, point wise convergence, uniform convergence, decay of Fourier coefficients, periodic function with period $T > 0$

Section 3.1 – 3.6

**MODULE 3 : FUNCTIONS IN EUCLIDEAN SPACES – 20 Hours**

Vectors in $R^n$, Matrices, set in $R^n$ and their properties, functions; definition and first examples, continuity and limits, properties of limits and continuity, curves in $R^m$, surfaces in $R^3$.

Section 4.1-4.7

**MODULE 4: DIFFERENTIAL CALCULUS FOR SCALAR FUNCTIONS – 25 hours**

First partial derivative and gradient, Differentiability and differentials, Mean value theorem and Lipschitz functions, higher order partial derivatives, Taylor expansions, convexity, Extremal points of a function, stationary points, saddle points.

Sections 5.1-5.6.1.

**TEXT BOOK**

CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ALYSIS II, SPRINGER 2010

**REFERENCES**

1. HORST R BAYER - CALCULUS AND ANALYSIS: A COMBINED APPROACH (WILEY).
2. T. M. APOSTOL – CALCULUS VOLUME I & II (WILEY).

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 3 | 1 |
| **II** | 2 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 3 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## FIFTH SEMESTER
## LINEAR ALGEBRA (90 Hours)

**MODULE 1 : VECTOR SPACES – 26 Hours**
Definition of Vector Space, Properties of Vector Spaces, Subspaces, Sums and Direct Sums, Span and Linear Independence, Bases Dimension
(Chapter 1 & 2 Relevant Sections)

**MODULE 2 : LINEAR MAPS – 24 Hours**
Definitions and Examples, Null Spaces and Ranges, the Matrix of a Linear Map, Invertibility
(Chapter 3)

**MODULE 3 : EIGENVALUES AND EIGENVECTORS – 22 Hours**
Invariant Subspaces, Polynomials Applied to Operators, Upper-Triangular Matrices, Diagonal Matrices, Invariant Subspaces on Real Vector Spaces
(Chapter 5)

**MODULE 4 : INNER-PRODUCT SPACES – 18 Hours**
Inner Products, Norms, Orthonormal Bases
(Chapter 6, Relevant Sections)

**TEXT BOOK**
SHELDON AXLER- LINEAR ALGEBRA DONE RIGHT SECOND EDITION, SPRINGER

**REFERENCES**
1. GILBERT STRANG – LINEAR ALGEBRA AND ITS APPLICATIONS, THIRD EDITION (BOOK WORLD ENTERPRISES)
2. J H KWAK, S HONG- LINEAR ALGEBRA, SECOND EDITION, SPRINGER

### QUESTION PAPER PATTERN

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 4 | 3 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 2 | 2 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## FIFTH SEMESTER
## DIFFERENTIAL EQUATIONS (90 Hours)
### ORDINARY DIFFERENTIAL EQUATIONS

**MODULE 1– 30 Hours**

Introductory remarks ,The nature of solutions, Separable Equations, , First order Equations , Exact Equations ,Families of curves and Orthogonal Trajectories , Homogeneous equations, Integrating Factors, Reduction of order.

Sections 1.1-1.9 of Chapter 1 of Text 1

**MODULE 2 - 25 Hours**

Second order linear equations with constant coefficients, The method of Undetermined Coefficients, The method of Variation of Parameters, The use of a known solution to find another, A bit of theory, Picards existence and uniqueness theorem.

Sections 2.1-2.4 of Chapter 2 and Section 3.2 Of Chapter 3 of Text 1.

**MODULE 3 – 20 Hours**

Introduction and review of Power series , Power Series solutions of First order equations , Second order Linear Equations , Ordinary points and Regular Singular Points , Frobenius Method , Le gender polynomials, Bessel's functions .

Sections 4.1- 4.5 of Chapter 4 of Text 1.

### PARTIAL DIFFERENTIAL EQUATIONS

**MODULE 4 – 15 Hours** Surfaces and curves in three dimensions, Methods of solutions of equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ Integral curves of the equations, Partial Differential Equations, Origin of first order Partial Differential equations, linear partial Differential Equations of First order and Lagrange's Partial Differential Equations.

Sections 1 & 2 of Chapter 1 and Sections 1, 2 & 4 of Chapter 2 of Text 2.

**TEXT BOOKS**

1. GEORGE F SIMMONS -DIFFERENTIAL EQUATIONS –THEORY, TECHNIQUE AND PRACTICE (TATA MCGRAW HILL)
2. IAN SNEDDON -ELEMENTS OF PARTIAL DIFFERENTIALEQUATIONS (TATA MC GRAW HILL)

**REFERENCES**

1. SHEPLEY L ROSS-DIFFERENTIAL EQUATIONS 3RD EDITION (WILEY INDIA)
2. FRANK AYRES JR – THEORY AND PROBLEMS IN DIFFERENTIAL EQUATIONS (SCHAUMS OUTLINE SERIES).
3. A H SIDIQI, P MANCHANDA – DIFFERENTIAL EQUATIONS WITH APPLICATION

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 4 | 3 | 1 |
| **II** | 3 | 4 | 3 | 1 |
| **III** | 2 | 2 | 2 | 1 |
| **IV** | 2 | 2 | 1 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## FIFTH SEMESTER
## ABSTRACT ALGEBRA (90 Hours)

**MODULE 1 – 20 Hours**

Introduction and examples, Binary operations, Isomorphic binary structures, How to show that binary structures are isomorphic (not isomorphic), Groups, Elementary properties of groups, subgroups, cyclic sub groups.

Chapters 1 – 5 of the Text

**MODULE 2– 25 Hours**

Cyclic groups, The structure of cyclic groups, Sub groups of finite cyclic groups, Permutations, Permutation groups, Symmetric group $S_3$, $4^{th}$ Dihedral group $D_4$, Cayley's theorem. Orbits, Cycles, Even and Odd permutations, Alternating groups.

Chapters 6, 8, 9 of the Text

**MODULE 3 – 25 Hours**

Cosets, Lagrange's theorem, Homomorphism, Properties of homomorphism, Normal sub groups, Factor groups from homomorphisms, Factor groups from normal subgroups, The Fundamental Homomorphism Theorem, Normal subgroups and inner automorphisms.

Chapters 10, 13, 14 of the Text

**MODULE 4 – 20 Hours**

Rings, Basic properties of Rings, Homomorphism and isomorphism, Fields, Divisors of zero and Cancellations, Integral domains, Characteristic of a Ring.

Chapters 18, 19 of the Text

**TEXT BOOK**:

JOHN B FRALEIGH; A FIRST COURSE IN ABSTRACT ALGEBRA, $7^{TH}$ EDITION, PEARSON EDUCATION 2007

**REFERENCES**

1. I N HERSTEIN; TOPICS IN ALGEBRA, $2^{ND}$ EDITION, JOHN WILEY 1975.
2. JOSEPH A GALLIAN; CONTEMPORARY ABSTRACT ALGEBRA, $7^{TH}$ EDITION, BROOKS & COLE, 2010.
3. RONALD SOLOMON; ABSTRACT ALGEBRA (PURE AND APPLIED GRADUATE TEXTS) VOLUME 9, AMS 2003.
4. DAVID S DUMMIT& RICHARD M FOOTE; ABSTRACT ALGEBRA, $3^{RD}$ EDITION, JOHN WILEY, 2004

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 3 | 2 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 3 | 1 |
| **IV** | 3 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SIXTH SEMESTER
## MATHEMATICAL ANALYSIS IV (90 Hours)

**MODULE 1 : DIFFERENTIAL CALCULUS FOR VECTOR VALUED FUNCTIONS (25 Hours)**
Partial derivatives and Jacobian matrix, Differentiability and Lipchitz functions, Basic differential operators, First Order operators, second order operators, differentiating composite functions, Functions defined by integrals. Inverse and Implicit Function Theorems (Statement only)
Section 6.1-6.4.1

**MODULE 2 : INTEGRAL CALCULUS IN SEVERAL VARIABLES (25 Hours)**
Double integral over rectangles, Double integrals over measurable sets, properties of double integrals, changing variables in double integrals, Multiple integrals, Changing variables in triple integrals, applications and generalizations, mass, centre of mass and moments of a solid body, volume of solids of revolution, integrals of vector valued functions, improper multiple integrals.
Section 8.1-8.5.4

**MODULE 3 : INTEGRAL CALCULUS ON CURVES AND SURFACES (20 Hours)**
Integrating along curves, centre of mass and moments of a curve, path integrals, integrals over surfaces, area of a surface, centre of mass and moments of a surface, flux integrals.
Section 9.1-9.4

**MODULE 4: THEOREMS OF GAUSS, GREEN AND STOKES (20 Hours)**
Open sets, admissible surfaces and boundaries, divergence theorem, Greens theorem, Stokes theorem, Conservative fields and potentials, computing potentials explicitly.
Section 9.5-9.6.1

## TEXT BOOK
CLAUDIO CANUTO, ANITA TABACCO, MATHEMATICAL ANALYSIS II, SPRINGER 2010

**REFERENCES**.
1. HORST R BAYER- CALCULUS AND ANALYSIS: A COMBINED APPROACH.(WILEY)2. T. M. APOSTOL – CALCULUS VOLUME I & II (WILEY)
3. A. D. ALEXANDROV ET AL- MATHEMATICS, ITS CONTENT, METHODS AND MEANING, DOVER
4. W. RUDIN, PRINCIPLES OF MATHEMATICAL ANALYSIS, SECOND EDITION, MCGRAW-HILL
5. A. E. TAYLOR, GENERAL THEORY OF FUNCTIONS AND INTEGRATION, DOVER

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 4 | 2 | 1 |
| **II** | 3 | 4 | 3 | 1 |
| **III** | 2 | 2 | 2 | 1 |
| **IV** | 2 | 2 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SIXTH SEMESTER
## COMPLEX ANALYSIS (90 Hours)

**MODULE 1 : ANALYTIC FUNCTIONS AND ELEMENTARY FUNCTIONS– 25 hours**

Functions of a complex variable-limits-Theorems on limits-Continuity-Derivatives-Differentiation-Formulas-Cauchy Riemann Equation-Sufficient condition for differentiability-Polar Co-ordinates-Analytic Functions-Examples-Harmonic Functions-The exponential Function-The Logarithmic Function-Branches and derivatives of Logarithms-Complex Exponents-Trigonometric Functions-Hyperbolic Functions-Inverse Trigonometric Functions

**MODULE 2 : INTEGRALS – 25 Hours**

Derivatives of Functions-Definite integrals of Functions-Contours-Contour Integrals-Some examples-Upper bounds for moduli of Contour Integrals,Antiderivatives(proof excluded)Cauchy-Goursat Theorem, Simply Connected Domains-Multiply Connected domains-Cauchy Integral Formula-An extension of Cauchy Integral Formula-Liouville's Theorem and the Fundamental Theorem of Algebra-Maximum modulus Principle

**MODULE 3 : SERIES AND RESIDUES – 15 Hours**

Convergence of Sequences- Convergence of Series-Taylor Series-Proof of Taylor's Theorem-Examples-Laurent Series-Examples-Isolated Singular Points-Residues-Cauchy Residue Theorem

**MODULE 4 : POLES AND APPLICATIONS OF RESIDUES – 25 hours**

Three types of isolated singular points-Residues at Poles-Examples-Zeros of Analytic Functions-Zeros and Poles-Behavior of functions near isolated singular points-Evaluation of Improper integrals-Examples-Improper Integrals from Fourier Analysis-Jordan's Lemma(statement only),Definite integrals involving sines and cosines-Argument Principle-Roche's Theorem(statement only).

**TEXT BOOK**

JAMES WARD BROWN AND RUEL V CHURCHILL-COMPLEX VARIABLES AND APPLICATIONS (8TH EDITION)

**REFERENCES**

LARS V. ALFORS- COMPLEX ANALYSIS- AN INTRODUCTION TO THE THEORY OF ANALYTIC FUNCTIONS OF ONE COMPLEX VARIABLE ($4^{TH}$ ED.), MCGRAW-HILL.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 5 | 5 | 3 | 1 |
| **II** | 2 | 2 | 2 | 1 |
| **III** | 1 | 2 | 2 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SIXTH SEMESTER
## DISCRETE MATHEMATICS (90 Hours)

**MODULE 1: GRAPH THEORY – 30 Hours**

Definition to graphs , Graphs as models , Matrices and Isomorphism , Decomposition and Special graphs , Trails, Cycles and Paths, Connection in graphs , Bipartite graphs , Eulerian circuits ,Hamiltonian circuits , Vertex degrees and counting , Graphic sequences.

Chapter 1 – Sections 1.1., 1.2, 1.3.1 - 1.3.10, 1.3.27 – 1.3.30.Chapter 2 – Sections 2.1.1 - 2.1.13, 2.2.1-2.2.10 of Text 1

**MODULE 2 : TREES AND MATCHINGS – 25 Hours**

Trees- Properties, Distance in Graphs, Spanning Trees and Enumeration, Matching's and Covers, Maximum Matching's, Hall's matching condition.

Chapter 3 – Sections 3.1.1 – 3.1.13 of text 1

**MODULE 3 : BOOLEAN ALGEBRAS – 20 Hours**

Partial order relations, Chains and Antichains, Lattices and Algebraic Systems, Principle of duality, Basic properties of Algebraic systems defined by lattices, Modular, Distributive complete and Complemented lattices, Boolean lattices and Boolean Algebras.

Chapter 4 - Sections 4.1, 4.3, 4.4, 4.5, 4.6 & Chapter 12 - Sections 12.1, 12.2, 12.3, 12.4, 12.5, 12.6 of Text 2.

**MODULE 4: COMBINATORICS – 15 Hours**

Two basic counting principles, Permutations ,Circular permutations, Combinations, The injection and bijection principles, Arrangements and selection with repetitions, Introduction to principle of inclusion and exclusion, The principle- a generalization.

Chapter1- sections 1.1-1.6; 3.1, 3.2 of Text 3

**TEXT BOOKS**

1. DOUGLAS B. WEST-INTRODUCTION TO GRAPH THEORY, SECOND EDITION (PEARSON EDUCATION)
2. C.L LIU-ELEMENTS OF DISCRETE MATHEMATICS (MC GRAW -HILL).
3. CHEN CHUAN CHONG, KOH KHEE MENG, PRINCIPLES AND TECHNIQUES IN COMBINATORICS (WORLD SCIENTIFIC)

**REFERENCES**

1. JOHN CLARK &DEREK ALLEN HOLTEN –A FIRST LOOK AT GRAPH THEORY-ADLLIE PUBLISHERS.
2. R BALAKRISHNAN& K RANGANATHAN – A TEXT BOOK OF GRAPH THEORY-SPRINGER EDITION
3. VIJAY K KHANNA –LATTICES AND BOOLEAN ALGEBRAS-FIRST CONCEPTS –VIKAS PUBLISHING HOUSE
4. J K SHARMA –DISCRETE MATHEMATICS-2ND EDITION-MAC MILLION

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| I | 3 | 4 | 3 | 2 |
| II | 3 | 4 | 3 | 1 |
| III | 2 | 2 | 2 | 1 |
| IV | 2 | 2 | 1 | 0 |
| Total | 16 | 12 | 9 | 4 |

## SIXTH SEMESTER
## METRIC SPACES (90 Hours)

**MODULE 1 - 20 Hours**

Metric Spaces, Point Functions and Point like Functions, Metric Subspaces and Metric Super spaces, Isometries, Extending a Metric Space, Metrics and Norms on Linear Spaces
(Chapter1 excluding section 1.6)

**MODULE 2 – 20 Hours**

Diameter, Distances from Points to Sets, Inequalities for Distances, Distances to Unions and Intersections, Isolated Points, Accumulation Points, Distances from Sets to Sets, Nearest Points
(Chapter 2)

**MODULE 3 - 25 Hours**

Boundary Points, Sets with Empty Boundary, Boundary Inclusion, Boundaries in Subspaces and Super spaces, Boundaries of Unions and Intersections, Closure and Interior, Inclusion of Closures and Interiors, Closure and Interior of Unions and Intersections, Open and Closed Subsets, Dense Subsets, Universal Openness and Universal Closure, Nests of Closed Subsets
(Chapter 3 & Chapter 4 excluding sections 4.3, 4.4 and 4.5)

**MODULE 4 – 25 Hours**

Open and Closed Balls, Theorems using Balls, Balls in Subspaces (excluding product space), Balls in Normed Linear Spaces, Definition of Convergence for Sequences, Limits, Superior and Inferior Limits of Real Sequences, Convergence in Subspaces and Super spaces, Convergence Criteria for Interior and Closure, Convergence of Subsequences, Cauchy Sequences, Cauchy Sequences in Subspaces, Forcing Convergence of Cauchy Sequences
(Chapters 5 and 6 excluding sections 6.5 and 6.10)

**TEXT BOOK**

MICHEAL O SEARCOID - METRIC SPACES, SPRINGER 2007

**REFERENCES**

1. G. F. SIMMONS - AN INTRODUCTION TO TOPOLOGY AND MODERN ANALYSIS
2. W. A. SUTHERLAND - INTRODUCTION TO METRIC AND TOPOLOGICAL SPACES
3. E. KREYSZIG INTRODUCTORY FUNCTIONAL ANALYSIS WITH APPLICATIONS
4. SATISHSHIRALI, HARKRISHANLALVASUDEVA, METRIC SPACES SPRINGER SCIENCE & BUSINESS MEDIA, 2006

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 1 | 1 |
| **II** | 2 | 3 | 2 | 1 |
| **III** | 3 | 3 | 3 | 1 |
| **IV** | 2 | 3 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

# OPEN COURSES IN MATHEMATICS

## FIFTH SEMESTER
## MATHEMATICAL MODELLING (72 Hours)

**MODULE 1: INTRODUCTION – 18 hours**

Mathematical modelling-what and why? Classification of mathematical models, Characteristics of mathematical models, Mathematical modelling through geometry, algebra, trigonometry & calculus, Limitations of mathematical modelling.

[Chapter-1: Sections 1.1 to 1.9 of book [1]; Page Nos. 1-29]

**MODULE 2 : MODELLING THROUGH FIRST ORDER -18 Hours**

Linear growth and decay models, Non-linear growth and decay models, Compartment models, Modelling in dynamics and Modelling of geometrical problems.

[Chapter-2: Sections 2.1 to2.6 of book [1]; Page Nos.30 -52.]

**MODULE 3 : SYSTEM SIMULATION – 18 hours**

Introduction, Examples, Nature of simulation, Simulation of a chemical reactor, Euler and Runge-Kutta integration formulae, Simulation of a water reservoir system, Simulation of a servo system. (Write and execute all the computer programs throughout this course using C)

[Chapter-1: Sections 1.1 to 1.7 & Chapter-2: Sections 2.1 to 2.6 and 2.9 of book [2]; Page Nos. 1-39.]

**MODULE 4: DISCRETE SYSTEM SIMULATION – 18 Hours**

Fixed time-step vs. event-to-event model, on simulating randomness, Monte-Carlo computation vs. stochastic simulation, Rudiments of queuing theory, Simulation of a single-server queue.

[Chapter-3: Sections 3.1 to 3.7 and Chapter-4: Sections 4.1 & 4.2 of book [2]; Page Nos. 40-76.]

**TEXTS BOOKS**

1. MATHEMATICAL MODELLING- J.N.KAPOOR, NEW AGE INTERNATIONAL, 2001 REPRINT.
2. SYSTEM SIMULATION WITH DIGITAL COMPUTER- NARSINGDEO, PRENTICE HALL OF INDIA, SIXTH PRINTING, 1996.

**REFERENCES**

1. SYSTEM SIMULATION – GEOFFREY GORDON, PRENTICE HALL OF INDIA, SECOND EDITION.
2. MATHEMATICAL MODELING FOR INDUSTRY AND ENGINEERING- THOMAS SVOBODNY, PRENTICE HALL.
3. MATHEMATICAL MODELING- F.R.GIORDANO, M.D.WEIR&WILLIAMP.FOX, THIRD EDITION.
4. A PRACTICAL COURSE IN DIFFERENTIAL AND MATHEMATICAL MODELING- IBRAGIMOV N.H, ALGA

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 3 | 1 |
| **II** | 2 | 3 | 2 | 1 |
| **III** | 3 | 3 | 2 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## OPEN COURSE-APPLICABLE MATHEMATICS
## FIFTH SEMESTER
## APPLICABLE MATHEMATICS (72 Hours)

**MODULE 1:– 18 Hours**

Types of numbers, Quadratic equations (Solution of quadratic equations with real roots only), Logarithms – All rules with out proof, Multiplication and division of numbers, Evaluating expressions of the form $x^{p/q}$, x any real number, p & q are integers, Permutations and combinations – simple applications, Trigonometry introduction, Values of trigonometric ratios of $0^0$, $30^0$, $45^0$, $60^0$& $90^0$, Heights and distances – Simple cases - (application of sinx, cosx, tanx, and their reciprocals only). Two dimensional geometry- Introduction, plotting points and drawing graph of the lines of the form ax + by + c = 0.

**MODULE 2 - 18 Hours**

Probability – Introduction – Sample spaces and events, Simple examples like tossing coin, tossing die etc.., Logical Reasoning- Number series, Letter series, Distance and directions, Odd man out, Number puzzles, Blood relations, Logical and analytical reasoning.
No core text book is needed for Modules 1 & 2

**MODULE 3 – 18 Hours**

HCF and LCM of numbers, Fractions, Squares and square roots, cube and cube roots, simplifications, Ratio and Proportion, Percentage, Profit and loss, Simple average (No Weighed average)
(Sections – 2, 3, 5, 6, 7, 9, 10, 11, 13)

**MODULE 4 - 18 Hours**

Simple interest, Compound interest, Time and work, Work and wages, (Exclude Pipes and Systems from the core reference), Time and distance, Elementary mensuration – Area and perimeter of polygons, Elementary Algebra, (Simplifications of algebraic expressions)
(Sections - 14, 15, 17, 18, 21, 22, 23)

**CORE REFERENCE**

M. TYRA, & K. KUNDAN- CONCEPTS OF ARITHMETIC,
BSC PUBLISHING COMPANY PVT.LTD. C – 37, GANESH NAGAR, PANDAV NAGAR COMPLEX, DELHI - 110092

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 3 | 3 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 3 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

# OPEN COURSE-FINANCIAL MATHEMATICS
## FIFTH SEMESTER
## FINANCIAL MATHEMATICS (72 HOURS)

**MODULE 1 - 20 Hours**

Theory of interest rates: Rate of interest – Accumulation factors – Force of interest and Stoodley's formula for the force of interest. Basic Compound interest relations: Relationships between s, i, v, and d – The equation of value and yield on a transaction.

Annuity certain: Present values and accumulations – Loan schedule for a level annuity – Continuously payable annuities and varying (increasing and decreasing) annuities.

Nominal rates of interest: Annuities payable p –thly- present values and accumulations- Loan schedule for p-thly annuities.

**MODULE 2 – 20 Hours**

Discounted cash flow: Net percent values and yields – The comparison two investment projects – The effects of inflation – The yield on a fund and measurement of investment performance. Capital Redemption Policies: Premium calculations- Policy values, Surrnder values, paid-up policy values and policy alterations, Stood ley's logistic model for the force of interest, reinvestment rates.

**MODULE 3 – 20 Hours**

Valuation of securities: Fixed interest securities – Ordinary shares, prices and yields, perpetuities – Mak ham's formula, optional redemption dates – Effect of the term to redemption on the yield – Real returns and index linked stocks. Capital Gains Tax: Valuing a loan with allowance for capital gains tax - capital tax when the redemption price of the rate of tax is not constant - Finding the yield when there is capital gains tax - optional redemption dates – Offsetting capital losses against capital gains.

**MODULE 4 - 12 Hours**

Cumulative Sinking Funds (Restricted coverage): The relationships between successive capital repayments – the term of the loan when the redemption price is constant.

**TEXT BOOK:**

MC CUTCH EON AND SCOT HEINEMANN, AN INTRODUCTION TO THE MATHEMATICS OF FINANCE, PROFESSIONAL PUBLISHING

**REFERENCES**

1. SHELDON M.ROSS - AN INTRODUCTION TO MATHEMATICAL FINANCE, CAMBRIDGE UNIVERSITY PRESS.
2. JOHN C. HULL - OPTIONS, FUTURES, AND OTHER DERIVATIVES, PRENTICE HALL OF INDIA PVT LTD.
3. SALIH N. NEFTCI -AN INTRODUCTION TO THE MATHEMATICS OF FINANCIAL DERIVATIVES, ACADEMIC PRESS.

4. ROBERT J ELLIOT AND P EKKEHARD KOPP - MATHEMATICS OF FINANCIAL MARKET, SPRINGER- VERLAG, NEW YORK INC.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 4 | 3 | 1 |
| **II** | 3 | 4 | 2 | 1 |
| **III** | 3 | 2 | 2 | 1 |
| **IV** | 1 | 2 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

# OPEN COURSE-MATHEMATICAL ECONOMICS
# FIFTH SEMESTER
# MATHEMATICAL ECONOMICS (72 HOURS)

**MODULE I: -DEMAND AND SUPPLY ANALYSIS – 18 Hours**

Utility and demand – the meaning of demand and quantity demanded – the law of demand – demand curve – market demand curve – reasons for the law of demand – slope of a demand curve – shifts in demand – demand function and demand curve – the meaning of supply – supply function – law of supply – slope of a supply curve – shifts in supply – market equilibrium – price elasticity of demand – measurement of price elasticity – arc elasticity of demand – cross elasticity of demand.

(Relevant sections chapters 5 and 7 of Text -1)

**MODULE II: -COST AND REVENUE FUNCTIONS – 18 Hours**

Cost function: Average and marginal costs, Short run and long run costs, Shapes of average cost curves in the short run and long run and its explanation, Revenue function, Marginal revenue (MR) and Average Revenue (AR) functions, Relation between MR, AR and Elasticity of demand.

(Relevant sections of chapter 19 & 21 of Text - 1)

**MODULE III: -THEORY OF CONSUMER BEHAVIOUR – 18 Hours**

Cardinal utility analysis – the Law of diminishing marginal utility – the Law of equi-marginal utility – Indifference curves – Ordinal utility – Indifference map – Marginal rate of substitution – Properties of indifference curves.

(Relevant sections of chapters 9 and 11 of Text -1)

**MODULE IV:-ECONOMIC APPLICATIONS OF DERIVATIVES – 18 Hours**

Economic Applications of Derivatives. Marginal, average and total concepts optimizing economic functions - Functions of several variables and partial derivatives, Rules of partial differentiation, Second order partial derivatives, Optimization of multivariable functions, Constrained optimization with Lagrange multipliers, Significance of the Lagrange multiplier, Total and partial derivatives – total derivatives.

Marginal productivity, Income determination, multipliers and comparative statics, Income and cross elasticity of demand, Optimization of multivariable function in Economics constrained optimization of multivariable functions in Economics.

(Chapter 4, Sections 4.7 and 4.8; chapter 5 and chapter 6 sections 6. 1 to 6.5 of text 2).

**TEXT BOOKS:**

1. H.L. AHUJA: PRINCIPLES OF MICRO ECONOMICS, 15TH REVISED EDITION, S. CHAND
2. EDWARD T. DOWLING: INTRODUCTION TO MATHEMATICAL ECONOMICS, SCHAUM'S OUTLINE SERIES, THIRD EDITION, TMH.

**REFERENCES**

1. SINGH, PARASHAR, SINGH --ECONOMETRICS & MATHEMATICAL ECONOMICS, S. CHAND & CO. 1997.
2. R.G.D. ALLEN - MATHEMATICAL ANALYSIS FOR ECONOMISTS, MACMILLAN, ELBS.
3. EDWARD T. DOWLING - INTRODUCTION TO MATHEMATICAL ECONOMICS, THIRD EDITION, SCHAUM'S OUTLINE SERIES, TMH.
4. HENDERSON &QUANDT - MICROECONOMIC THEORY: A MATHEMATICAL APPROACH, 3RD EDITION, TMH.
5. TARO YAMANE - MATHEMATICS FOR ECONOMISTS: AN ELEMENTARY SURVEY. SECOND EDITION, PHI.
6. SRINATHBARUAH - BASIC MATHEMATICS AND ITS APPLICATION IN ECONOMICS, MACMILLAN.

**QUESTION PAPER PTTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 3 | 3 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

# CHOICE BASED COURSES IN MATHEMATICS

## SIXTH SEMESTER
## OPERATIONS RESEARCH (72 Hours)

**MODULE 1: MATHEMATICAL PRELIMINARIES – 20 Hours**

**Euclidean Space**: Vectors and vector space Linear dependence, dimensions of a vector space, basis. Convex sets : Open and closed sets in $E_n$, convex linear combinations, convex sets, intersection of convex sets, convex hull of a set, vertices of a convex set, convex polyhedron, hyper planes, half spaces and polytopes, separating and supporting hyper planes, ( All Theorems without proof)

**Linear Programming**

Introduction, LP in two dimensional space, general LPP, Feasible solution, Basic and basic feasible solution, optimal solution.

Ch. 1 (Section 1 – 5 and 11 – 18 of text 1)

**MODULE 2 : LINEAR PROGRAMMING CONTD – 20 Hours**

Simplex method ( numerical example ) Simplex tableau, Finding the first b.f. s., artificial variables, Degeneracy, simplex multipliers, Duality in LPP, Duality theorems, Application of duality, Dual simplex method.

Ch. 3 (Section 1 – 20 except 16 of text 1)

**MODULE 3 :TRANSPORTATION AND ASSIGNMENT PROBLEMS -17 Hours** Introduction, transportation problem, Transportation array, Transportation matrix, triangular basis, finding a basic feasible solution, testing of optimality, loop in a transportation problem, change the basis, Degeneracy, Unbalanced problem, Assignment problem.

Ch. 4 (Section 1 – 11 & 14 of text 1)

**MODULE 4 : QUEUING THEORY - 15 Hours**

Introduction, Essential features of queuing system, Calling population, Characteristic Queuing Process, Queue discipline, Service Process ( or Mechanisms ) , Performance measure of Queuing system. Transient- state and Steady – state, Relationship among Performance measure. Probability distribution in Queuing system, Distribution of arrival (Pure Birth Process), Distribution of inter-arrival times (Exponential process) Distribution of departure (Pure Death Process) Distribution of Service Times.

Ch. 16 (Section 16.1 – 16.4 of text 2)

**TEXT BOOKS:**

1. K. V MITAL AND C. MOHAN - OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEM ANALYSIS ( 3RD EDITION) (NEW AGE INTERNATIONAL )
2. J. K. SHARMA: OPERATION RESEARCH THEORY AND APPLICATION ( 3RD EDITION )

**REFERENCES:**

1. OPERATION RESEARCH BY KANTI SWARUP, P. K. GUPTA AND MAN MOHAN (SULTAN CHAND AND SONS)
2. PROBLEMS IN OPERATIONS RESEARCH BY GUPTA P. K. AND HIRA D. S. (S. CHAND)
3. OPERATIONS RESEARCH BY RAVINDRAN A., PHILIP D. T. AND SOLBERG J. J. (JOHN WILEY AND SONS)

4. B. K. MISHRA , B. SHARMA – OPTIMIZATION LINEAR PROGRAMMING (ANE BOOKS)
5. MOKHTAR S. BAZARAA, J. J. JARVIS, H.D. SHERALI – LINEAR PROGRAMMING AND NETWORK FLOWS (WILEY INDIA )

## QUESTION PAPER PATTERN

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 3 | 3 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 3 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SIXTH SEMESTER
## PROGRAMMING IN C (72 Hours)

**MODULE 1 : CONSTANTS VARIABLES AND DATA TYPES - 25 Hours**

Introduction, Character set, C Tokens, Key words and Identifiers, Constants, Variables, Data Types, Declaration of Variables, Declaration of Storage Class, Assigning Values to Variables, Defining Symbolic Constants, Declaring a Variable as Constant, Declaring a Variable as Volatile, Over flow and Under flow of Data,

**Operators and Expressions.**

Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Some Computational Problems, Type Conversions in Expressions, Operator Precedence and Associativity, Mathematical Functions

**Managing In Put and Out Put Operations.**

Introduction, Reading a Character, Writing a Character, Formatted Input, Formatted Output.
(Chapters 2, 3, 4)

**MODULE 2 : DECISION MAKING AND BRANCHING -15 Hours**

Introduction, Decision Making with IF Statement, Simple IF Statement, the IF……Else Statement, Nesting of IF……Else Statement, the Else……IF Ladder, The switch Statement, The? **:** Operator the GOTO Statement

**Decision Making and Looping**

Introduction, the WHILE Statement, the DO Statement, the FOR Statement, Jumps in LOOPS, Concise Test Expressions
(Chapters 5 and 6)

**MODULE 3 - 15 hours**

**Arrays**

Introduction, One Dimensional Arrays, Declaration of One Dimensional Arrays, Initialization of One Dimensional Arrays, Two Dimensional Arrays, Initialization of Two Dimensional Arrays, Multidimensional Arrays, Dynamic Arrays, More about Arrays.

**Character Arrays and Strings**

Introduction, Declaring and Initializing String Variables, Reading Strings from Terminal, Writing Strings to Screens. Arithmetic Operations on Characters, Putting Strings together, Comparison of two Strings, String Handling Functions. Table of Strings, Other Features of Strings

**MODULE 4: USER DEFINED FUNCTIONS. – 17 Hours**

Introduction, Need for User Defined Functions, A Multi Function Programme, Elements of User Defined Functions, Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions, No Arguments and No Return Values, Arguments but No Return Values, Arguments with return Values, No Arguments but Returns a Value, Functions That Return Multiple Values, Nesting of Functions, Recursions, Passing Arrays to Functions, Passing Strings to Functions, The scope, Visibility and Life Time of Variables, Multi File Programmes
(Chapters 7, 8 and 9)

**TEXT BOOK**

E. BALAGURUSAMY - PROGRAMMING IN ANSI C, FOURTH EDITION, THE TATA MC GRAW - HILL PUBLISHING COMPANY, CHAPTERS 2 TO 9

**REFERENCES**

1. V. RAJARAMAN-COMPUTER PROGRAMMING IN C, PRENTICE HALL OF INDIA, PVT LTD
2. BYRON S GOTTRIED - THEORY AND PROBLEMS OF PROGRAMMING WITH C, (SCHAUMS) TATA MC GRAW – HILL.
3. YASHWANTH P KANETHKAR - LET US C, BPB PUBLICATIONS,

## QUESTION PAPER PATTERN

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 3 | 3 | 1 |
| **III** | 3 | 3 | 2 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SIXTH SEMESTER
## TOPOLOGY (72 Hours)

**MODULE 1 -17 Hours**

Topological Spaces, Basis for a Topology, The product Topology on X × Y, The Subspace Topology.

**MODULE 2 – 33 Hours**

Closed sets and Limit Points, Continuous functions, The Metric Topology

**MODULE 3 - 12 Hours**

Connected Spaces, Connected subspaces in the Real Line

**MODULE 4 -10 Hours**

Compact Spaces

Chapter – 2 Sections 12, 13, 15, 16, 17, 18, 20 Chapter – 3, Sections 23, 24, 26

**TEXT BOOKS**

JAMES R MUNKRES -TOPOLOGY - SECOND EDITION,
PEARSON PRENTICE HALL, AN IMPRINT OF PEARSON EDUCATION
(FIRST IMPRESSION, 2006)

**REFERENCE**

INTRODUCTION TO TOPOLOGY AND MODERN ANALYSIS – G. F. SIMMONS

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 3 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SIXTH SEMESTER
## THEORY OF COMPUTATION (72 HOURS)

**MODULE 1- 22 Hours**

The Theory of Automata: Definition of Automaton – Description of Finite Automaton – Transition Systems – Properties of Transition Functions – Acceptability of a String by a Finite Automaton – Nondeterministic Finite State Machines – The Equivalence of DFA and NDFSA. Examples.

**MODULE 2 - 15 Hours**

Formal Languages: Basic Definitions – Definition of a Grammar – Derivations and Language Generated by a Grammar – Examples

**MODULE 3 - 15 Hours**

Chomsky Classification of Languages – Languages and their relation – Operation on Languages – Languages and Automata - Examples

**MODULE 4 - 20 Hours**

Regular expressions – Identities for Regular Expressions – Finite Automata and Regular Expressions – Transition system Containing □- moves- NDFAs with □- moves and Regular Expressions – Conversion of Nondeterministic Systems to Deterministic Systems – Algebraic Method Using Arden's Theorem - Construction of Finite Automata Equivalent to a Regular Expression – Equivalence of Two Finite Automata – Equivalence of Two Regular Expressions. Examples

Chapters – 3, 3.1- 3.7, 4.1, 4.2, 4.3, 4.6, 5.1 and 5.2 (Proof of theorems 5.1, 5.2, 5.3 and 5.4 are omitted)

**TEXT BOOK:**

K.L.P. MISHRA AND N.CHANDRASEKARAN - THEORY OF COMPUTER SCIENCE, AUTOMATA, LANGUAGES AND COMPUTATION (THIRD EDITION), PRENTICE- HALL OF INDIA PVT. LTD, NEW DELHI

**REFERENCES**

1. JOHN E. HOPCROFT, JEFREY D. ULLMAN - INTRODUCTION TO AUTOMATA THEORY LANGUAGES, AND COMPUTATION, NAROSA PUBLISHING HOUSE 1999
2. PETER LINZ - AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA (SECOND EDITION) NAROSA PUBLISHING HOUSE 1997.

**QUESTION PAPER PATTER**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 3 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **3** |

## SIXTH SEMESTER
## NUMERICAL METHODS (72 Hours)

**MODULE 1 - (18 Hours)**

**Approximations and errors in computing** – significant digits – Inherent errors – Numerical errors – Truncation errors – Modelling errors – Blunders – Absolute and Relative errors. Error Propagation - conditioning and Stability – Convergence of an iterative process – Error estimation – Minimizing the total error.

**Theory of equations** Statement of fundamental Theorem of algebra. Deduction that every polynomial of degree n has only n roots. Relation between roots and coefficients. Transformation of equations. Reciprocal equations. Cardan's method, Ferrari's method. Symmetric functions of roots.

(Chapter 6 and Descartes Rule of signs also, 11, 12 of Text 2)

**MODULE 2 - (18 Hours)**

**Roots of non – Linear equations** – methods of solution – Iterative methods – Starting and stopping an iterative process. – Bisection Method – Convergence of bisection method – False position method – convergence – Newton – Raphson method – convergence – Limitations - Secant Method – convergence

**Solutions to simultaneous linear equations** – Existence of solution – Solution by elimination – Basic Gauss Elimination Method – Gauss Elimination with Pivoting - Guass Jordan method – Triangular Factorization Methods – Matrix Inversion method.

**Iterative solutions of Linear Equations** - Gauss Jocobis Iteration method – Gauss - Seidal iterative method – Method of Relaxation – convergence of iteration methods.

**MODULE 3 - 18 hours**

**Curve Fitting: Interpolation** – Polynomial forms – Linear Interpolation – Lagrange Interpolation polynomial – Newton Interpolation polynomial – Divided difference table – Interpolation with equidistant points – Forward and Backward difference table

**Curve Fitting: Regression –**Fitting Linear equations –Least squares regression – Fitting Transcendental Equations – Fitting a polynomial function

**MODULE 4 – 18 Hours**

**Numerical Differentiation** – Differentiating Continuous functions – Forward and central difference quotient – Error Analysis – Differentiating Tabulated functions - Higher – order derivatives.

**Numerical Integration** – Newton – Cotes methods – Trapezoidal Rule – Error analysis – Composite Trapezoidal rule - Simpsons 1/3 rule – Error analysis – Composite Simpsons 1/3 rule – Error analysis – Simpsons 3/8 rule – Boole's rule

**Numerical Solution of Ordinary Differential equations** – Taylor Series method – Picard's method – Euler's Method – Accuracy of Euler's method – Polygon method – Runge –Kutta Methods.

**TEXT BOOKS:**

1. E. BALAGURUSAMY – TREATMENT AS IN NUMERICAL METHODS, TATA MCGRAW HILL.
2. BERNARD CHILD - HIGHER ALGEBRA, AITBS PUBLISHERS, INDIA
3. P. KANDASAMYK.THILAGAVATHY AND K.GUNAVATHY – NUMERICAL, S.CHAND AND COMPANY LTD

**REFERENCE**:

M.K.VENKATARAMAN– NUMERICAL METHODS IN SCIENCE AND ENGG, NATIONAL PUBLISHING COMPANY 1990 EDITION.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 3 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## COMPLEMENTARY COURSE IN MATHEMATICS TO PHYSICS/CHEMISTRY
## FIRST SEMESTER
## COURSE 1- TRIGONOMETRY, DIFFERENTIAL CALCULUS AND MATRICES.

**MODULE 1: TRIGONOMETRY (18 Hours)**

Expansions of $\sin n\theta$, $\cos n\theta$, $\tan n\theta$, $\sin^n\theta$, $\cos^n\theta$, $\sin^n\theta.\cos^m\theta$, Circular and hyperbolic functions, inverse circular and hyperbolic function. Separation into real and imaginary parts. Summation of infinite series based on C+iS method. (Geometric, Binomial, Exponential, Logarithmic and Trigonometric series)

(Relevant Sections in Chapter 3 – 5 and Chapter 8 of Text 2)

**MODULE 2:**

**DIFFERENTIALCALCULUS & APPLICATIONS OF DERIVATIVES (20 Hours)**

Derivative of a function, differentiation rules, the derivative as rate of change, derivatives of trigonometric functions, the chain rule and parametric equations, implicit differentiation, Extreme values of functions, The Mean Value Theorem

(Sections, 3.1 – 3.6 & 4.1 - 4.2 of Text 1)

**MODULE 3: PARTIAL DERIVATIVES (16 Hours)**

Functions of several variables (Definition only), Partial derivatives, The Chain Rule

(Sections 14.3 - 14.4 of Text 1)

**MODULE 4: MATRICES (18 Hours)**

Singular and Non-singular Matrices, Elementary transformations, Equivalent matrices ,Elementary matrices , Inverse of a matrix by elementary transformations , Rank of a Matrix, Row Canonical form, Normal form, Elementary matrices ,System of linear equations , Solution by Matrix Method , Cramers rule and elementary transformations , Characteristic equation of a matrix; Characteristic roots and characteristic vectors, Cayley-Hamilton theorem (statement only) and simple applications,

(Text 3, Chapters – 5, 10, 19, 23).

**TEXT BOOKS**

1. GEORGE B. THOMAS, JR: THOMAS' CALCULUS ELEVENTH EDITION, PEARSON, 2008.
2. S.L. LONEY – PLANE TRIGONOMETRY PART – II, AITBS PUBLISHERS INDIA, 2009.
3. DAVID W. LEWIS - MATRIX THEORY (ALLIED)

**REFERENCES**

1. SHANTI NARAYAN : DIFFERENTIAL CALCULUS ( S CHAND)
2. GEORGE B. THOMAS JR. AND ROSS L. FINNEY: CALCULUS, LPE, NINTH EDITION, PEARSON EDUCATI
3. S.S. SASTRY, ENGINEERING MATHEMATICS, VOLUME 1, 4TH EDITION PHI.
4. MURAY R SPIEGEL ADVANCED CALCULUS, SCHAUM'S OUTLINE SERIES.

## QUESTION PAPER PATTERN

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 2 | 2 | 1 |
| **II** | 3 | 2 | 2 | 1 |
| **III** | 3 | 4 | 2 | 1 |
| **IV** | 2 | 4 | 3 | 1 |
| **Total** | **10** | **12** | **9** | 4 |

## SECOND SEMESTER
## COURSE 2- INTEGRAL CALCULUS AND FOURIER SERIES

**MODULE 1 : INTEGRAL CALCULUS (10 Hours)**

A quick review of indefinite integral as anti derivative. The Definite integral. The fundamental theorem of Calculus
(Section 5.3 and 5.4 of Text -1).

**MODULE 2 : APPLICATION OF INTEGRALS (25 Hours)**

Substitution and area between curves, Volumes by slicing and rotation about an axis (disc method only), Lengths of plane curves, Areas of surfaces of revolution and the theorem of Pappus (excluding proof)
(Section 5.6, 6.1, 6.3, 6.5 of Text - 1),

**MODULE 3 : MULTIPLE INTEGRALS (20 Hours)**

Double Integrals, area of bounded region in plane only, Double Integrals in Polar form, Triple integrals in rectangular co-ordinates, Volume of a region in space
(As in Sections 15.1, 15.2, 15.3, 15.4 of Text - 1)

**MODULE 4 : FOURIER SERIES (17 Hours)**

Periodic Functions, Trigonometric Series, Functions of any period p = 2L Fourier series, Even and Odd functions, Half-range Expansions.
(Sections 10.1, 10.2, 10.3, 10.4 of Text 2 – Excluding Proofs).

**TEXT BOOKS**

1. GEORGE B. THOMAS, JR: THOMAS' CALCULUS ELEVENTH EDITION, PEARSON, 2008.
2. ERWIN KREYSZIG: ADVANCED ENGINEERING MATHEMATICS, EIGHTH EDITION, WILEY, INDIA.

**REFERENCE BOOKS:**

1. SHANTI NARAYAN, P .K. MITTAL: INTEGRAL CALCULUS (S. CHAND & COMPANY)
2. SHANTHI NARAYANAN & P.K. MITTAL, A TEXT BOOK OF MATRICES, S. CHAND.
3. DAVID W. LEWIS - MATRIX THEORY (ALLIED)
4. M.R SPIEGEL – COMPLEX VARIABLES, SCHAUM'S SERIES

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 2 | 1 | 0 |
| **II** | 3 | 4 | 3 | 2 |
| **III** | 2 | 4 | 3 | 1 |
| **IV** | 2 | 2 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## THIRD SEMESTER

## COURSE 3- VECTOR CALCULUS, ANALYTIC GEOMETRY AND ABSTRACT ALGEBRA (90 Hours)

**MODULE 1: VECTOR VALUED FUNCTIONS -20 Hours**

Vector Functions, Arc length and unit Tangent vector **T**, Curvature and unit Normal Vector **N**, Torsion and unit Binomial vector **B,** Directional Derivatives and Gradient Vectors**.**
**(Sections**13.1, 13.3, 13.4, 13.5 and 14.5 of text 1)

**MODULE 2: INTEGRATION IN VECTOR FIELDS -22 Hours**

Line Integrals, Vector fields and Work, Circulation and Flux, Path independence, Potential Function and Conservation Fields, Green's theorem in Plane ( Statement and problems only), Surface area and Surface integral, Parameterised Surface, Stoke's theorem( Statement and Problems only), the Divergence theorem and a Unified theory ( Statement and simple problems only).
(Sections 16.1 to 16.8 of text 1)

**MODULE 3: ANALYTIC GEOMETRY-20 Hours**

Conic sections and Quadratic equations, Classifying Conic Sections by Eccentricity, Conics and Parametric equations, The Cycloid, polar co-ordinates, Conic Sections in Polar coordinates.
(Sections 10.1, 10.2, 10.4, 10.5, 10.8 of Text 1)(Exclude the Pedal Method and Newtonian Method)

**MODULE 4 : ABSTRACT ALGEBRA -28 Hours**

Groups, Subgroups, Cyclic groups, Groups of Permutations, Rings, Fields & Vector Spaces. (Definitions, examples and simple properties only)
(Section 1.4, 1.5, 1.6, 2.8, 3.13, 4.18, 6.30 of text 2)

**TEXT BOOK**

1. GEORGE B. THOMAS, JR: THOMAS' CALCULUS ELEVENTH EDITION, PEARSON, 2008.
2. JOHN B FRALEIGH- A FIRST COURSE IN ABSTRACT ALGEBRA ($7^{TH}$ EDITION, PEARSON EDUCATION 2007)

**REFERENCES**

1. SHANTI NARAYAN, P .K. MITTAL: VECTOR CALCULUS (S. CHAND & COMPANY)
2. P.P.G DYKE: AN INTRODUCTION TO LAPLACE TRANSFORMS AND FOURIER SERIES (SPRINGER 2005)
3. HARRY F. DAVIS & ARTHUR DAVID SNIDER: INTRODUCTION TO VECTOR ANALYSIS, $6^{TH}$ ED., UNIVERSAL BOOK STALL, NEW DELHI.
4. MURRAY R. SPIEGEL: VECTOR ANALYSIS, SCHAUM'S OUTLINE SERIES, ASIAN STUDENT EDITION.
5. MERLE C. POTTER – ADVANCED ENGINEERING MATHEMATICS, OXFORD UNIVERSITY PRESS.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 4 | 3 | 1 |
| **II** | 2 | 2 | 1 | 1 |
| **III** | 2 | 2 | 2 | 1 |
| **IV** | 3 | 4 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## FOURTH SEMESTER
## COURSE 4- DIFFERENTIAL EQUATIONS, NUMERICAL ANALYSIS AND COMPLEX ANALYSIS (90 Hours)

**MODULE 1: ORDINARY DIFFERENTIAL EQUATIONS - 20 Hours**

Exact Differential Equation, Linear Equations , Solutions by Substitutions, Equations of first order and not of first degree , First order equations of higher degree solvable for $p$, Equations solvable for $y$ , Equations solvable for $x$, Equations of first degree in $x$ and $y$ , Lagrange's and Clairaut's Equations.

(Sections 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 3.4, 3.5 of text 1)

**MODULE 2: SPECIAL FUNCTIONS & NUMERICAL ANALYSIS - 24 Hours**

Power series method of solving differential equations. Legendre equation and Legendre Polynomials, Rodrigues Formula, Bessel's Equation and Bessel Functions

Numerical Methods -Bisection Method, Method of false position, Newton -Raphson Method

(Sections 2.1, 2.2, 2.3, 2.4, 2.5 and 2.11 of Text 2 and relevant sections of text 4)

**MODULE 3: PARTIAL DIFFERENTIAL EQUATIONS -16 Hours**

Surfaces and Curves in three dimensions, Solution of equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ ,Integral curves of equations, Origin of first order partial differential equations, Linear equations of the first order- Lagrange's equations

(Chapter 1, Section 1 and 3 & Chapter 2 Section 1, 2 and 4 of text 3)

**MODULE 4: COMPLEX ANALYSIS- 30 Hours**

Complex numbers –a quick overview , Functions of a complex variable: Definition of analytic functions and singular points- C.R. equations in Cartesian and polar co-ordinates(proof excluded), determination of analytic functions if real or imaginary parts are given, line integral ,Cauchy's integral theorem- Cauchy's integral formula, zeros and singularities, residues- residue, theorem (Relevant topics from Text 2)

**TEXT BOOK**

1. A. H SIDDIQI, P MANCHANADA: A FIRST COURSE IN DIFFERENTIAL EQUATIONS WITH APPLICATIONS (MACMILLAN INDIA LTD 2006)
2. ERWIN KREYSZIG-ADVANCED ENGINEERING MATHEMATICS – 8TH EDITION WILEY INDIA
3. IAN SNEDDON – ELEMENTS OF PARTIAL DIFFERENTIAL EQUATION (TATA MCGRAW HILL)
4. S.S. SASTRY: INTRODUCTORY METHODS OF NUMERICAL ANALYSIS, 4TH EDITION (PRENTICE HALL)

**REFERENCE**

1. R. K. GHOSH, K. C. MAITY – AN INTRODUCTION TO DIFFERENTIAL EQUATIONS, NEW CENTRAL BOOKS
2. SHEPLEY L. ROSS – DIFFERENTIAL EQUATION , WILEY INDIA
3. SRIMANTA PAL – NUMERICAL METHODS, OXFORDUNIVERSITY PRESS
4. QAZI SHOEBAHAMAD, ZUBIR KHAN – NUMERICAL AND STATISTICAL TECHNIQUES, ANE BOOKS M R SPIEGEL-COMPLEX VARIABLES, SCHAUM'S SERIES.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 3 | 2 | 1 |
| **II** | 3 | 3 | 2 | 2 |
| **III** | 2 | 2 | 2 | 0 |
| **IV** | 3 | 4 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## COMPLEMENTARY COURSE IN STATISTICS FOR B.Sc MATHEMATICS
## COURSE I BASIC STATISTICS (72 HOURS)

**MODULE 1 - 12 Hours**

Introduction to Statistics – Definitions, Uses and applications of statistics, Misuse of statistics. Definition of Population and Sample, Census and Sampling, primary and secondary data. Methods of collecting primary data, Methods of Sampling (Definitions only) - Simple Random Sampling (with and without replacement), stratified sampling, systematic sampling. Types of data – quantitative and qualitative data, Levels of measurement – nominal, ordinal, interval and ratio scales, Classification and Tabulation, Diagrammatic representation - Bar diagrams, pie diagram Graphical representation -histogram; frequency polygon; frequency curve; ogives and stem and leaf chart.

**MODULE 2 - 30 Hours**

Measures of Central Tendency - Mean; Median; Mode; Geometric Mean; Harmonic Mean and Properties. Absolute and Relative measures of Dispersion - Range, Quartile Deviation, Percentiles, Deciles, Box Plot, Mean Deviation, Standard Deviation, Coefficient of Variation.

**MODULE 3- 18 Hours**

Moments - Raw and Central Moments, Absolute Moments, Inter Relationships (First Four Moments. Skewness – Types of Skewness, Measures - Pearson, Bowley and Moment Measure .Kurtosis- Types of Kurtosis, Measures of Kurtosis - Measure based on moments

**MODULE 4- 72 Hours**

Index Numbers - definition, uses, types of index numbers – simple and weighted indices, Simple Index Numbers- AM, GM and HM indices and aggregate index number, Weighted Index Numbers – Laspeyer's, Paasche's and Fisher's Index Numbers. Test of Index Numbers and Construction of Index Numbers, Cost of Living Index Numbers - Family Budget Method, Aggregate Expenditure Method.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS

**REFERENCES**

1. S.P. GUPTA: STATISTICAL METHODS (SULTAN CHAND & SONS DELHI).
2. B.L. AGARWAL: BASIC STATISTICS, NEW AGE INTERNATIONAL (P) LTD.

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 2 | 1 | **0** |
| **II** | 3 | 4 | 3 | **2** |
| **III** | 2 | 3 | 3 | **1** |
| **IV** | 3 | 3 | **2** | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## II SEMESTER

## COURSE II - THEORY OF PROBABILITY AND RANDOM VARIABLES (72 Hours)

**MODULE 1 - 16 Hours**

Probability Concepts, Random Experiment, Sample Space, Events – Mutually exclusive, exhaustive, equally likely events. Approaches to Probability- Classical, Statistical and Axiomatic. Addition Theorem of probability for two, three and n events (with proof), Boole's inequality. Conditional Probability, Independence of events, Multiplication theorem (upto 3 events).Total Probability Law, Baye's Theorem.

**MODULE 2 - 18 Hours**

Random Variables - Discrete and Continuous, Probability Distributions. Probability Mass Function; Probability Density Function and Cumulative (distribution) function and their properties. Change of variables (Univariate only)

**MODULE 3 - 16 Hours**

Bivariate random variables - Definition of Discrete and Continuous cases. Joint Probability Density Functions, Marginal and Conditional Distributions, Independence of Random Variables.

**MODULE 4 - 22 Hours**

Bivariate data, Method of Least Squares for fitting a curve and normal equations. Fitting of Straight Lines, Second Degree Equation, Exponential Curve, Power Curve. Linear Correlation, Methods of Correlation, Scatter Diagram, Covariance Method, Rank Correlation (with equal ranks). Linear Regression - Regression Equations, Fitting and identification, properties.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS

**REFERENCES**

1. S.P. GUPTA: STATISTICAL METHODS, , SULTAN CHAND AND SONS, NEW DELHI
2. B.L. AGARWAL: BASIC STATISTICS, NEW AGE INTERNATIONAL (P) LTD.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 3 | 2 | 0 |
| **III** | 2 | 2 | 1 | 1 |
| **IV** | 3 | 4 | 4 | 2 |
| **Total** | **10** | **12** | **9** | **4** |

## III SEMESTER

## COURSE III - PROBABILITY DISTRIBUTIONS (90 hours)

**MODULE 1 - 22 hours**

Mathematical Expectations - Expectation of a Random Variable, Moments in terms of Expectations, Moment Generating Functions (m.g.f.) and its properties. Characteristic Functions and its Simple Properties, Conditional Expectation

**MODULE II - 30 hours**

Discrete Distributions – Uniform, Bernoulli; Binomial. Poisson, Geometric distributions.
Mean, Variance, moment generating function. Additive property and Fitting of Distributions (Binomial and Poisson only). Recurrence relation for moments of binomial and Poisson distributions. Mode of Binomial and Poisson distributions. Poisson distribution as a limiting form of Binomial distribution. Lack of Memory property of Geometric distribution (with proof)

**MODULE 3 - 20 Hours**

Continuous distributions – Definition, Mean, variance and M G F of Uniform; Exponential; Gamma; Beta (type I and II) distributions. Lack Memory property of exponential distribution
Normal; Standard Normal - definitions, Mean, Variance, m.g.f., Additive property, Fitting of Normal, Use of Standard Normal Tables for Computation of Various Probabilities. Normal distribution as a limiting form of Binomial and Poisson distributions.

**MODULE 4 -: 18 Hours**

Law of large Numbers, Tchebycheff's Inequality, Weak Law of Large Numbers, Bernoulli's Law of Large Numbers, Central Limit Theorem (Lindberg-Levy form) without proof.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS

**REFERENCE**

HOGG, R.V. AND CRAIG A.T - (1970). INTRODUCTION TO MATHEMATICAL STATISTICS, AMERIND PUBLISHING CO, PVT.

**ADDITIONAL REFERENCES**

1. V.K. ROHATGI: AN INTRODUCTION TO PROBABILITY THEORY AND MATHEMATICAL STATISTICS, WILEY EASTERN.
2. MOOD A.M., GRAYBILL F.A. AND BOES D.C. INTRODUCTION TO THEORY OF STATISTICS, MCGRAW HILL.

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 2 | 2 | 0 |
| **II** | 3 | 4 | 3 | 2 |
| **III** | 3 | 4 | 2 | 2 |
| **IV** | 2 | 2 | 2 | 0 |
| **Total** | **10** | **12** | **9** | **4** |

## IV SEMESTER

## COURSE IV -STATISTICAL INFERENCE (90 Hours)

**MODULE 1 - 20 hours**

Sampling Distributions - definition of Statistic, Parameter, Standard Error. Sampling Distributions of Mean and Variance $c^2$, t and F distributions (without derivation), properties, Inter relationships. Statistics following $c^2$, t and F distributions

**MODULE 2 - 25 Hours**

Concepts of Estimation, Types of Estimation - Point Estimation; Interval Estimation. Properties of Estimates - Unbiasedness, Efficiency; Consistency; Sufficiency. Methods of Estimation MLE, Methods of Moments, Method of Minimum Variance, Cramer- Rao Inequality (without proof). Interval Estimation for Mean, Variance and Proportion.

**MODULE 3 - 25 Hours**

Testing of hypothesis- Statistical hypothesis, Simple and composite hypothesis, Null and Alternate hypothesis, Type I and Type II errors, Critical Region, Size of the test, P value, Power, Neyman Pearson approach.

**MODULE 4 - 20 hours**

Large Sample tests - Z test, Chi-Square test-goodness of fit, test of independence. Small sample tests - Normal, t test, Chi-square test, F test.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS

**REFERENCES**

1. S.C GUPTA: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS.
2. V.K. ROHATGI: AN INTRODUCTION TO PROBABILITY THEORY AND MATHEMATICAL STATISTICS, WILEY EASTERN.
3. MOOD A.M., GRAYBILL F.A. AND BOES D.C. INTRODUCTION TO THEORY OF STATISTICS, MCGRAW HILL.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 2 | 2 | 0 |
| **II** | 2 | 4 | 2 | 1 |
| **III** | 3 | 3 | 3 | 0 |
| **IV** | 2 | 3 | 2 | 3 |
| **Total** | **10** | **12** | **9** | **4** |

## COMPLEMENTATARY COURSE IN MATHEMATICS FOR BCA
## FIRST SEMESTER
## COURSE 1 : MATRICES , CALCULUS AND LAPLACE TRANSFORMS (72 Hours)

**MODULE 1 : MATRICES - 17 hours**

A quick review of the fundamental concepts, Rank of a Matrix, Non-Singular and Singular matrices, Elementary Transformations, Inverse of a Non-Singular Matrix, Canonical form, Normal form. Systems of Linear equations: Homogeneous and Non Homogeneous Equations, Characteristic equation of a matrix. (Relevant sections of Text 1).
(Proof of all the theorems are to be excluded.)

**MODULE 2 : DIFFERENTIAL CALCULUS - 20 hours**

A quick review of limits of function, rules for finding limits, extensions of limit concepts, derivative of a function, differentiation rules, chain rule, rate of change and simple applications of the rules. Extreme values of a function Rolle's Theorem, Mean Value Theorem. (Sections 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2 of Text 2)

**MODULE 3 : PARTIAL DIFFERENTIAL EQUATIONS - 15 hours**

Introduction, formulation of Partial Differential Equation by elimination of arbitrary constants and by elimination of arbitrary function. Solution of first order equations using Lagrange's method.
(Relevant sections of Text 3)

**MODULE 4 : LAPLACE TRANSFORMS - 20 hours**

Definitions- transforms of elementary functions, properties of Laplace transforms, inverse transforms- convolution theorem (no proof). (Relevant sections of Text 3).

**TEXT BOOKS:**

1. MATRICES, FRANK AYRES JR SCHAUM'S OUTLINE SERIES, TMH EDITION
2. THOMAS AND FINNEY - CALCULUS AND ANALYTICAL GEOMETRY (ADDISON-WESLEY )
3. DR. B. S. GREWAL – HIGHER ENGINEERING MATHEMATICS

**REFERENCE BOOKS**

1. S.K. STEIN – CALCULUS AND ANALYTIC GEOMETRY, (MCGRAW HILL)
2. ZUBAIR KHAN, SHADAB AHMAD KHAN - MATHEMATICS – 1 AND MATHEMATICS – II (ANE BOOKS)
3. SHANTI NARAYAN - MATRICES (S. CHAND & COMPANY)
4. N.P.BALI, DR.N.CH.NARAYANA IYENGAR-ENGINEERING MATHEMATICS - LAXMI PUBLICATIONS
5. ERWIN KREYSZIG: ADVANCED ENGINEERING MATHEMATICS, EIGHTH EDITION, WILEY, INDIA.

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 3 | 2 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 2 | 1 |
| **IV** | 3 | 3 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## SECOND SEMESTER
## COURSE 2 : DISCRETE MATHEMATICS (72 Hours)

**MODULE 1 : PRELIMINARIES -14 Hours**

Basic set Theory, terminology and notation, Venn diagrams, truth table and proof. Functions and relations, partial orderings and equivalence relations, mathematical induction. An application of hamming codes.

**MODULE 2 : COMBINATORICS – 16 Hours**

The theory counting. The multiplication rule, ordered sample and permutations, unordered samples without repetition, permutations involving indistinguishable objects, multinomial co-efficient, unordered samples with repetition, permutation involving indistinguishable objects.

**MODULE 3: PROPOSITIONAL CALCULUS -20 Hours**

Proposition, compound proposition, truth table for basic operators, connectives, theorems from Boolean algebra, De-Morgan's law, normal forms, rules of inference, chain rule and modusponens, chains of inference, tautology, proof by adopting a premise. Reduction- ad-absurdum, proof by resolution.

**MODULE 4 : GRAPHS AND ALGORITHMS -22 Hours**

Leonhard Euler and the seven bridges of Konigsberg, trees and spanning trees, minimal spanning trees, binary trees and tree searching. Planar graphs and Euler's theorem, the shortest path problem, Dijkstras Algorithm, two "all-pairs" Algorithm, Floyd's Algorithm and Marshal's Algorithm.

**TEXT BOOKS:**

1. PETERGRAY – LOGIC, ALGEBRA AND DATABASES (CHAPTER 3), AFFILIATED EAST WEST PRESS PVT LTD.
2. ROBERT J MCELIECE, ROBERT B ASH AND CAROL ASH – INTRODUCTION TO DISCRETE MATHEMATICS (CHAPTER 1, 2 AND 4), MC.GRAW HILL.

**REFERENCES:**

1. S. LIPSCHUTZ: SET THEORY AND RELATED TOPICS (SECOND EDITION), SCHAUM OUTLINE SERIES, TATA MCGRAW-HILL PUBLISHING COMPANY, NEW DELHI.
2. R.G...STOLL - SET THEORY AND LOGIC
3. P.R. HALMOS - NAIVE SET THEORY, SPRINGER
4. JOHN CLARK & DEREK ALLEN HOLTON - A FIRST BOOK AT GRAPH THEORY (ALLIED PUBLISHERS)
5. DOUGLAS B WEST – INTRODUCTION TO GRAPH THEORY , PEARSON EDUCATION

**QUESTION PAPER PATTERN**

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 2 | 2 | 1 |
| **II** | 2 | 2 | 2 | 1 |
| **III** | 3 | 4 | 2 | 1 |
| **IV** | 3 | 4 | 3 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## III SEMESTER
## COURSE 3: ADVANCED STATISTICS OPTIMIZATION TECHNIQUES

**MODULE 1 – 14 Hours**

Stochastic and deterministic models, Basics of operations research, The nature and uses of OR - Main concepts and approaches of OR-models in OR-Advantages of a model phases of OR

**MODULE 2 – 22 Hours**

Linear programming problems; Mathematical formulation of a L.P.P General linear programming problems, solution of a L.P.P, graphical method for solving a L.P.P.,

Simplex Method: slack and surplus variables- reduction of any feasible solution to a basic feasible solution, dual problems, artificial variable techniques-Big M method.

Duality in liner programming, Properties of duality, Formulation of Dual from Primal.

**MODULE 3 – 16 Hours**

Transportation problems: transportation model – Mathematical formulation, Solution by North West corner method, lowest cost entry method, Vogel's and MODI method-Degeneracy and its solution.

Assignment problems. Assignment model, mathematical formulation, Solution of assignment problem for maximization and minimization of objective.

**MODULE 4 – 20 Hours**

Two person Zero sum game, pure and mixed strategy with saddle point, Solution of pure strategy games, solution of mixed strategy games, Problems by arithmetic method, Principle of dominance, Solution by graphical method.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR - FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS.

**REFERENCES**

SHELDON M.ROSS - STOCHASTIC PROCESSES
KANTI SWAROOP - OPERATIONS RESEARCH

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 2 | 2 | 2 | 0 |
| **II** | 3 | 4 | 3 | 1 |
| **III** | 3 | 4 | 3 | 2 |
| **IV** | 2 | 2 | 1 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

# COMPLEMENTARY COURSE IN STATISTICS FOR BCA
## I SEMESTER
## COURSE - INTRODUCTORY STATISTICS

**MODULE 1 -14 Hours**

Introduction to Statistics – Definitions, Uses and applications of statistics, Misuse of statistics. Definition of Population and Sample, Census and Sampling, primary and secondary data.
Methods of collecting primary data, Methods of Sampling (Definitions only) - Simple Random Sampling (with and without replacement) , stratified sampling , systematic sampling, Types of data – quantitative and qualitative data, Levels of measurement – nominal, ordinal, interval and ratio scales , Classification and Tabulation, Diagrammatic representation - Bar diagrams, pie diagram Graphical representation -histogram; frequency polygon; frequency curve; ogives and stem and leaf chart.

**MODULE 2 - 18 Hours**

Measures of Central Tendency - Mean; Median; Mode; Geometric Mean; Harmonic Mean and Properties. Absolute and Relative measures of Dispersion - Range, Quartile Deviation, Percentiles, Deciles, Box Plot, Mean Deviation, Standard Deviation, Coefficient of Variation.

**MODULE 3 – 20 Hours**

Probability Concepts, Random Experiment, Sample Space, Events – Mutually exlusive, exhaustive, equally likely events. Approaches to Probability- Classical, Statistical and Axiomatic. Addition Theorem of probability for two, three and n events ( with proof), Boole's inequality. Conditional Probability, Independence of events, Multiplication theorem (upto 3 events). Total Probability Law, Baye's Theorem.

**MODULE 4 – 20 Hours**

Random Variables - Discrete and Continuous, Probability Distributions.
Probability Mass Function of discrete and Probability Density Function of continuous Random variables, and Cumulative (distribution) function and their properties.
Mathematical Expectations - Expectation of a Random Variable, Moments in terms of Expectations, Moment Generating Functions (m.g.f.) and its properties.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS.

**REFERENCES**

1. S.P. GUPTA: STATISTICAL METHODS (SULTAN CHAND & SONS DELHI).
2. B.L. AGARWAL: BASIC STATISTICS, NEW AGE INTERNATIONAL (P) LTD.

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 3 | 3 | 2 | 1 |
| **III** | 2 | 3 | 3 | 1 |
| **IV** | 2 | 3 | 2 | 1 |
| **Total** | **10** | **12** | **9** | **4** |

## III SEMESTER
## COURSE II - ADVANCED STATISTICS

**MODULE 1 – 14 Hours**

Bivariate data , Method of Least Squares for Fitting a curve and normal equations.
Fitting of Straight Lines, Second Degree Equation, Exponential Curve, Power Curve.
Linear Correlation ,Methods of Correlation, Scatter Diagram, Covariance Method, Rank Correlation (with equal ranks).
Linear Regression - Regression Equations , Fitting and identification, properties.

**MODULE 2 – 22 Hours**

Discrete Distributions – Binomial. Poisson, Geometric distributions.
Mean, Variance, moment generating function. Additive property and Fitting of Distributions (Binomial and Poisson only). Recurrence relation for moments of binomial and Poisson distributions. Mode of Binomial and Poisson distributions. Poisson distribution as a limiting form of Binomial distribution. Lack of Memory property of Geometric distribution(with proof)
Continuous distribution – Definition, Mean, variance and M G F of Normal; Standard Normal - definitions, Mean, Variance, m.g.f., Additive property, Fitting of Normal, Use of Standard Normal Tables for Computation of Various Probabilities.

**MODULE 3 – 16 Hours**

Sampling Distributions - definition of Statistic, Parameter, Standard Error. Sampling Distributions of Mean and Variance. $\chi^2$, t and F distributions (without derivation), properties, Inter relationships. Statistics following $\chi^2$, t and F distributions

**MODULE 4 – 20 Hours**

Concepts of Estimation, Types of Estimation - Point Estimation; Interval Estimation. Properties of Estimates - Unbiasedness, Efficiency; Consistency; Sufficiency. Interval Estimation for Mean, Variance and Proportion.
Testing of hypothesis- Statistical hypothesis, Simple and composite hypothesis, Null and Alternate hypothesis, Type I and Type II errors, Critical Region, Size of the test, P value, Power, Neyman Pearson approach. Large Sample tests - Z test, Chi-Square test-goodness of fit, test of independence. Small sample tests - Normal, t test, Chi-square test, F test.

**TEXT BOOK**

S.C. GUPTA AND V.K. KAPOOR: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND AND SONS.

**REFERENCES**

1. S.C GUPTA: FUNDAMENTALS OF MATHEMATICAL STATISTICS, SULTAN CHAND & SONS.
2. V.K. ROHATGI: AN INTRODUCTION TO PROBABILITY THEORY AND MATHEMATICAL STATISTICS, WILEY EASTERN.
3. MOOD A.M., GRAYBILL F.A. AND BOES D.C. INTRODUCTION TO THEORY OF STATISTICS, MCGRAW HILL.

| Module | Part A | Part B | Part C | Part D |
|---|---|---|---|---|
| **I** | 3 | 3 | 2 | 1 |
| **II** | 2 | 4 | 3 | 1 |
| **III** | 2 | 2 | 2 | 0 |
| **IV** | 3 | 3 | 2 | 2 |
| **Total** | **10** | **12** | **9** | **4** |