

**DEPARTMENT OF APPLIED MATHEMATICS  
FACULTY OF SCIENCE  
NOAKHALI SCIENCE & TECHNOLOGY UNIVERSITY  
NOAKHALI-3814, BANGLADESH.**

# **SYLLABUS FOR**

**B.Sc. (HONOURS)  
INTEGRATED PROGRAMME IN APPLIED MATHEMATICS**

## **DETAILED SYLLABUS**

**DEPARTMENT OF APPLIED MATHEMATICS  
FACULTY OF SCIENCE  
NOAKHALI SCIENCE & TECHNOLOGY UNIVERSITY  
NOAKHALI-3814, BANGLADESH**

## Detailed Syllabus

### Year – I, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH- 1101	Basic Algebra	3	3	4
A.MTH -1103	Set Theory	3	3	4
A.MTH -1105	Calculus-I	3	3	4
A.MTH- 1107	Basic Statistics	3	3	4
A.MTH 1109	Properties of Matter, Wave and Sound	3	3	4
CSTE - 1101	Basic Computer	2	2	3
FENG - 1101	Basic English Skills and Commercial Correspondence	3	3	4
Total		20		

### Year – I, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -1201	Calculus-II	3	3	4
A.MTH -1203	Linear Algebra	3	3	4
A.MTH -1205	Vector Analysis	3	3	4
A.MTH -1207	Probability theory & Distribution Function	3	3	4
A.MTH-1209	Electricity and Magnetism	3	3	4
A.MTH-1202	Math Practical-I	1	2	4
A.MTH -1204	Viva-Voce	2		
Total		18		

### Year – II, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -2101	Calculus-III	3	3	4
A.MTH -2103	Co-ordinate Geometry of Two Dimensions	3	3	4
A.MTH -2105	Co-ordinate Geometry of Three Dimensions	3	3	4
A.MTH -2107	Ordinary Differential Equations	3	3	4
A.MTH -2109	Statistical Methods & Demography	3	3	4
A.MTH -2111	Tensor Analysis	3	3	4
A.MTH -2102	Stat Lab	2	2	4
Total		20		

### Year – II, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -2201	Trigonometry (Plane & Spherical)	3	3	4
A.MTH -2203	Partial Differential Equations	3	3	4
A.MTH -2205	Heat and Thermodynamics	3	3	4
A.MTH -2207	Discrete Mathematics	3	3	4
A.MTH -2209	FORTTRAN Programming	3	3	4
A.MTH - 2202	Math Practical - II	3	3	4
A.MTH -2204	Viva-Voce	2		
Total		20		

Year – III, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH - 3101	Real Analysis	3	3	4
A.MTH - 3103	Numerical Analysis	3	3	4
A.MTH - 3105	Optimization Techniques-I	3	3	4
A.MTH - 3107	Programming with C/C ++	3	3	4
A.MTH - 3109	Differential Geometry	3	3	4
A.MTH- 3111	Mathematics for Business	3	3	4
A.MTH - 3102	Math Practical - III	3	3	4
Total		21		

Year – III, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -3201	Optimization Techniques - II	3	3	4
A.MTH -3203	Method of Applied Mathematics	3	3	4
A.MTH -3205	Complex Analysis	3	3	4
A.MTH -3207	Mechanics(Statics and Dynamics)	3	3	4
A.MTH -3209	Integral Equations	3	3	4
A.MTH -3202	Math Practical-IV	3	3	4
A.MTH -3204	Viva-Voce	2		
Total		20		

Year – IV, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH - 4101	Quantum Mechanics	3	3	4
A.MTH – 4103	Classical Mechanics	3	3	4
A.MTH – 4105	Fluid Mechanics	3	3	4
A.MTH – 4107	Thermodynamics and Statistical Mechanics	3	3	4
A.MTH - 4109	Theory of Relativity	3	3	4
A.MTH - 4111	Bio-Mathematics	3	3	4
A.MTH - 4102	Math Practical - V	3	3	4
Total		21		

Year – IV, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH - 4201	Mathematical Cosmology	3	3	4
A.MTH - 4203	Mathematical Astronomy	3	3	4
A.MTH - 4205	Honours Project	3	3	4
A.MTH - 4202	Math Practical-VI	3	3	4
A.MTH - 4204	Viva-Voce	2		
Total		14		

Two subjects to be offered by the academic committee of the department from the following courses:

Year – IV, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH – 4207	Bio-Mechanics	3	3	4
A.MTH – 4209	Mathematical Modeling in Finance and Business	3	3	4
A.MTH – 4211	Electromagnetic Theory	3	3	4
A.MTH – 4213	Mathematical Methods for Feed forward Artificial Neural	3	3	4

	Networks			
A.MTH – 4215	Graph Theory	3	3	4
A.MTH – 4217	Mathematical Modeling in Biology	3	3	4
A.MTH – 4219	Micro and Macro Economics	3	3	4
Total		21		

Grand Total- (20 + 18 + 20+ 20+ 21+ 20+21 + 20) = 160 Credits

Year – I, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH- 1101	Basic Algebra	3	3	4
A.MTH -1103	Set Theory	3	3	4
A.MTH -1105	Calculus-I	3	3	4
A.MTH- 1107	Basic Statistics	3	3	4
A.MTH 1109	Properties of Matter, Wave and Sound	3	3	4
CSTE - 1101	Basic Computer	2	2	3
FENG - 1101	Basic English Skills and Commercial Correspondence	3	3	4
Total		20		

**A.MTH 1101: Basic Algebra  
(4 Hours, 100 Marks, 3 Credits)**

**1. Inequalities:** Order properties of Real Numbers, Average, Mean, Arithmetic Mean, Geometric Mean, Weierstras's Inequality. Cauchy-Schwarz Inequality, Tchebychef's Inequality and Holder's inequality.

**2. Theory of Equations:** Equations and Identities, Basic Ideas of Solutions of Equations with Graphical Representations, Relations between Roots and Co-efficient of the nth Degree Equations, Synthetic division. Descartes' Rule of Signs, Newton's Method, Reciprocal Equations and Sturm's Theorem, Position of Roots.

**3. Series:**

Basic definitions of series, Techniques of summing up series, Test for Convergence and Divergence of Series (Less emphasis on proofs of Theorems).

**4. Determinants and Matrices:**

Elementary properties of Determinants and Matrices, Techniques of Solving linear non-homogeneous and homogeneous Equations, Cramer's Rule, Ranks of Matrices, Echelon Matrices.

**Books Recommended:**

1. Bernard and Child : Higher Algebra
2. S. Barnad & J.M Child : Higher Algebra
3. P.K Bhattacharjee : Basic Algebra

**A.MTH 1103 : Set Theory  
(4 Hours, 100 Marks, 3 Credits)**

**1. Basic concept of set. Set operations, power set, Van diagram, Universal Set etc.**

**2. Relations and functions:**

Equivalence Relations, Distinction between Relations and Functions and Fundamental Theorem of Equivalence Relations, Partition. Functions: Surjective, Injective, bijective functions, Inverse function, one-one function, onto function, Characteristic function, Set function, Restriction function, Extension function real valued function.

**3. Natural numbers and the axiom of infinity.**

**4. Cardinality:**

Countability Cardinal Numbers, Cantor's Theorem, Partially Ordered Sets, Well-Ordered Sets and Ordinal Numbers.

**5. Logic and Language:**

Arguments containing compound statements, Method of Deduction, Quantification theory, The logic of relation, Propositional calculus.

**Books Recommended:**

1. Lipschutz. : Set Theory and Related Topics
2. F. Hausdorff. : Set Theory

**A.MTH 1105 : Calculus - I**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Functions:**

Basic ideas of the Real and Complex Number Systems. Functions of a Single Variable and Its Domain and Ranges, Graphical Representation of Standard Functions (E.g. Polynomials, Trigonometric and Exponential Functions).

**2. Limit and Continuity:**

Existence of Limits, Definition and Elementary Properties of Continuous Functions of a Single Variable, Statement and Verifications of Standard Theorems by suitable Examples (No proofs).

**3. Differentiation:**

Techniques of Finding Derivatives of functions of a Single Variable, Geometrical Interpretation of Derivatives, Fundamental Theorems (Rolle's Theorem, Mean Value–Theorem, Taylor's Theorem, etc). Successive Differentiations, Leibnitz Theorem, L'Hospitals Rule for Indeterminate Forms (No proof of Theorem), Basic Ideas of Functions of Two and Three Variables: Partial and Total Derivatives.

**4. Integration (Indefinite and Definite Integrals):**

Integrations of Functions of a Single Variable, Integrals as Anti derivatives, Techniques of Integrations of Standard Forms. Integrals as Limits of Sums, Geometrical Meaning of Definite Integrals.

**5. Definite Integrals:**

Elementary Properties of Definite Integrals, Basic Ideas of Double and Triple Integration.,Gamma and Beta Function. Fundamental Theorems of Calculus Reduction Formula.

**Books Recommended:**

- |                                      |  |
|--------------------------------------|--|
| 1. George B. Thomas                  | : Calculus and Analytic Geometry       |
| 2. Earl W. Swlpowski                 | : Calculus and Analytic Geometry       |
| 3. Marvin J. Forrey                  | : Calculus with Analytic Geometry      |
| 4. Glyn James                        | : Advanced Engineering Mathematics     |
| 5. Mohammad, Bhattacharjee and Latif | : A Text Book on Differential Calculus |
| 6. Md. Abu Yousuf                    | : Differential Calculus                |

**A.MTH 1107 : Basic Statistics**  
**(4 Hours, 100 Marks, 3 Credits)**

Introduction, Definitions, background and scope. Meaning Characteristic feature, uses of Statistics, presentation of statistical data (Graphs, Charts and Diagrams) Qualitative and Quantitative data.Measure of location (Important averages and their comparative study), Central tendency, Measure of dispersion.Moments of frequency distribution, Skewness and Kurtosis and their measurements.

Bivariate universe, Co-efficient of simple correlation, Bivariate frequency distribution, Simple Regression line and correlation Co-efficient, Rank correlation, Comparison of regression analysis with correlation analysis useful theorem in regression and correlation analysis, Correlation ratio. Multiple regressions, partial correlation, multiple correlations, Estimation of multiple regression co-efficient, Co-efficient determination.

**Books Recommended:**

- |   |   |
|---|---|
| 1. Yule, U & Kendal. M.G.                       | : Introduction to the theory of Statistics.       |
| 2. Weathervurn, C.E.                            | : A first course in Mathematical Statistics.      |
| 3. Goodman, E.                                  | : Teach your self-Statistics.                     |
| 4. Kenny, J.F. & Keeping, E.S.                  | : Mathematics of Statistics, Part- 1.             |
| 5. Mostafa, M.G.                                | : Methods of Statistics.                          |
| 6. All, M.A.                                    | : Theory of Statistics, Vol.1.                    |
| 7. Mosteller, Rourks & Theorems                 | : Probability and its applications to Statistics. |
| 8. Mood, A. M.                                  | : Introduction to the theory of Statistics.       |
| 9. Simpson & Kafa                               | : Basic Statistics.                               |
| 10. Rabindra Nath Shil & Subash Chandra Debnath | : An Introduction To The Theory of Statistics     |

**A.MTH -1109 : Properties of Matter ,Wave and Sound  
(4 Hours, 100 Marks, 3 Credits)**

**Group A: Properties of Matter**

**Gravitation and Gravity:**

Law of universal gravitation; Inertial and gravitational masses; Gravitational intensity and potential; Gravitational potential energy; Gravitational effects of Symmetrical distribution of matter; Motion of planets and satellites; Variation of acceleration due to gravity.

**Elasticity:**

Introduction; stress; strain: Hooks law: Elastic modulli; relations between elastic constants and their determination; Bending of beams: Cantilever.

**Surface Tension:**

Surface energy; surface tension and molecular forces, pressure within a curved film; capillarity; surface tension and temperature; measurements of surface tension.

**Group B: Acoustics**

**Wave in elastic media;** Plane compressional waves in a fluid; superposition principle; wave velocity; Power and Intensity in wave motion; Stationary waves; Doppler effects and its applications in Sound and Light.

**Vibrations:** Strings, bars and air-columns, Laws of Transverse vibrations: Sonometer, Melde's experiments; resonance; organ pipes; Measurement of Velocity of Sound: Resonance air column method; Kundt's tube method; Acoustical Instruments.

**Books Recommended:**

- |                                  |  |
|----------------------------------|--|
| 1. S. Mathur                     | : Properties of Matter.                    |
| 2. Halliday and Resnick          | : Physics for Sei. & Engineering students. |
| 3. P.Chkrabarti and S. Chowdhury | : A Text Book of Sound.                    |
| 4. Giasuddin Ahmed               | : Outlines of Physics.                     |
| 5. Wood A.B.                     | : Text Book of sound.                      |
| 6. Stephenson                    | : Acounstic & Vibrational Physics.         |

**CSTE-1101 : Basic Computer  
(3 Hours, 100 Marks, 2 Credits)**

**Introduction:** Brief history and types of computers, application areas; Working principle of a computer system, Single and multi-user systems.

**Organization and Architecture:** Motherboards & Microprocessor; Memory units; Primary memory, Secondary memory; I:O Devices: peripheral devices, AT:XT, ISA, EISA, PCI bus architecture;

**Computer network:** Basic concepts of Internet systems, LAN and WAN; Gateway, bridge, router, Internet protocol; Multimedia systems.

**Maintenance:** Power supply stability, grounding effects of surge, sag current and its protection.

Classification of Stabilizer and UPS, Effect of static charge on computer devices; Handling of computers cards, chips, computer viruses and protections, software troubleshooting and maintenance.

**Books Recommended:**

1. C. S. Frence : Computer science
2. L. Rosch : Hardware Bible
3. Peter Norton : Inside the PC



**FENG- 1101 : Basic English Skills and Commercial Correspondence  
(4 Hours, 100 Marks, 3 Credits)**

**1. Grammar:** Tense ; Voice change; subject-verb agreement; conditionals; article; direct and indirect speech; transformation of sentences; use of conjunction; adjective and preposition; use of phrase and clause; basic sentence patterns; sentence correction; causative verbs and problem verbs.

**2. Comprehension practice**

**3. Writing :** Standard paragraph and essay writing.

**4. Correspondence :** CV/ Resume writing; Job applications; business report writing; sales letters; claim and adjustment letters; memoranda; credit and collection letters; quotations and orders; notice, agenda and minutes.

**Books Recommended:**

1. Billah, Q.M., G.S. Chowdhury and M. Alam : Foundation English for Undergraduates.
2. Eastwood, J. : Oxford Practice Grammar.
3. Hornby, A.S. : Guide to Patterns and Usage in English.
4. Wren and Martin. : High School English Grammar and Composition.
5. Thompson and Martinet. : Practical English Grammar.
6. Murphy, R. : English Grammar in Use.
7. Imhoof and Hudson. : From Paragraph to Essay.
8. Mosback, G. and V. Mosback. : Practical Faster Reading.
9. Ashley, A. : Oxford Handbook of Commercial Correspondence.
10. Sharma , R.C. and K. Mohan. : Business Correspondence and Report Writing.

Year – I, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -1201	Calculus-II	3	3	4
A.MTH -1203	Linear Algebra	3	3	4
A.MTH -1205	Vector Analysis	3	3	4
A.MTH -1207	Probability theory & Distribution Function	3	3	4
A.MTH-1209	Electricity and Magnetism	3	3	4
A.MTH-1202	Math Practical-I	1	2	4
A.MTH -1204	Viva-Voce	2		
Total		18		

**A.MTH 1201 : Calculus II**  
(4 Hours, 100 Marks, 3 Credits)

**1. Applications of Differentiation:**

Extrema (Maxima or Minima) of Subsets of the Real Number System, Real Valued Functions of Single Variable and Its extrema. Narrative extrema Problems and Related Rates Based on Elementary Theory.

**2. Further Applications of Differentiation:**

Tangent Line Approximation, Differentials, Tangents, Normals, Curvature and Asymptotes, Point of Inflection, Increasing and Decreasing, Convexity and Concavity of functions, Curve Tracing, Polynomials and Rational Functions.

**3. Applications of Integration:**

Reduction formula, Lengths of Curves, Areas of Plane Regions, Areas of Surface of Solids of Revolution and Volumes of Solids of Revolution. Moments and Centroids of Plane regions and solids of Revolution.

**Books Recommended:**

1. George B. Thomas, Jr : Calculus and Analytic Geometry.
2. Marvin J. Forray : Calculus with Analytic Geometry.
3. Mohammad, Bhattacharjee & Latif : Differential and Integral Calculus.

**A.MTH 1203 : Linear Algebra**  
(4 Hours, 100 Marks, 3 Credits)

**1. Concept of Vector Spaces:**

Basic ideas of Groups and Fields (No theorem) (Real Numbers, Complex Number and Rational Numbers). Definition of vector spaces, subspaces and basic theorems.

**2. Basis and Dimension:**

Linear Combinations of vectors, spanning set, Linear dependence and Independence of vectors, Basis and Dimension of a vector space. Finite Dimensional vector spaces, sums and direct sums of subspaces.

**3. Linear Transformations:**

Linear Transformation, The Matrix of a linear Transformation, The Kernel and Image of a linear. Transformation, Rank and Nullity of a linear Transformation, Non-singular linear Transformation, Linear functionals. Dual spaces and dual bases.

**4. Diagonalization of Matrices:**

Introduction, Eigen values and Eigen vectors, Diagonalization of matrices, The minimal polynomial of a matrix and the Cayley-Hamilton theorem, The diagonalization of symmetric matrices.

**5. Inner Product spaces, Norms:**

Inner products, Norms, Orthogonality and Gram-Schmidt Orthogonalisation Process, Bilinear Forms, Symmetric, Antisymmetric and Quadratic Forms and related theorems.

**Books Recommended:**

1. A.O. Morris : Linear Algebra
2. C.Dixon : Linear Algebra
3. S.Lang : Linear Algebra
4. R.Stoll : Linear Algebra and Matrix Theory
5. F.Ayres : Linear Algebra (Schaum's Series)
6. S.N.Goel : Linear Algebra
7. S.Narayan : Abstract Algebra
8. N.C. Mazumder : Elementary linear Algebra
9. K.C. Roy and A.G.Das : Elements of Linear and Abstract Algebra.

**A.MTH 1205 : Vector Analysis**  
**(4 Hours, 100 Marks,3 Credits)**

**1. Vector Algebra and Vector Calculus:**

Vector Algebra, Scalar and Vector Fields, Differentiation of Vector functions.

**2. Gradient Divergence and curl:** Definitions, Geometrical meanings, applications.

**3. Vector integration:** Definition, integration along a line, closed curve, surface and volume.

**4. Vector integral theorems:** Green's Gauss and Stokes' Theorems, Applications and verifications.

**5. Curvilinear Co-ordinates:**

General Curvilinear Co-ordinates, Orthogonal Curvilinear Co-ordinates, Spherical Polar Co-ordinates, Cylindrical Co-ordinates etc.,

**6. Differential Operators in General Curvilinear Co-ordinates and Orthogonal Curvilinear Co-ordinates;** Line, Surface and Volume Elements in Curvilinear Co-ordinates.

**Books Recommended:**

1. Fred A. Binchey : Vectors and Tensors for Engineers and Scientists.
2. M.R. Spiegel : Vector Analysis (Sheum's Outline Series).
3. Hazra : Vector Analysis with Application.
4. MD. Raisinghania : Vector Analysis.

**A.MTH 1207 : Probability Theory and Distribution Function**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Meaning of probability.** Mathematical and statistical definition of probability, Sample space, Event (simple and compound). Additive & multiplicative law of probability. Marginal and conditional probability. Bayes Theorem and its applications. Additive and simple laws of probability and their applications. Random variable and its probability distribution, probability function, probability density function, Distribution function, Marginal and conditional distribution function, joint probability density function, Marginal probability density function, Conditional probability density function.

**2. Some Theoretical Distribution:**

Mathematical expectation, theorem of expectation, Covariance, Variance of a linear combination of variates, Relation between moments and cumulants. Basic probability distribution (Binomial, Poisson and Normal etc.)

**3.Sampling distributions:**

(F, t and  $\chi^2$  : Definition, Uses and Properties). Test Based on F, t and  $\chi^2$  and normal Distributions. Contingency Table and its applications

**Books Recommended:**

- |   |   |
|---|---|
| 1. Yule, U & Kendal. M.G.                       | : Introduction to the theory of Statistics.               |
| 2. Weathervurn, C.E.                            | : A first course in Mathematical Statistics.              |
| 3. Goodman, E.                                  | : Teach your self-Statistics.                             |
| 4. Kenny, J.F. & Keeping, E.S.                  | : Mathematics of Statistics, Part- 1.                     |
| 5. Mostafa, M.G.                                | : Methods of Statistics.                                  |
| 6. All, M.A.                                    | : Theory of Statistics, Vol.1.                            |
| 7. Mosteller, Rourks & Theorems                 | : Probability and its applications to Statistics.         |
| 8. Mood, A. M.                                  | : Introduction to the theory of Statistics.               |
| 9. Simpson & Kafa                               | : Basic Statistics.                                       |
| 10. Rabindra Nath Shil & Subash Chandra Debnath | : An Introduction To The Theory of Statistics             |
| 11. Manindra Kumar Roy                          | : Fundamentals of Probability & Probability Distributions |

**A.MTH 1209 : Electricity and Magnetism  
(4 Hours, 100 Marks, 3 Credits)**

- 1. Electrostatics:** Electric dipole; electric field due to a dipole; dipole on external electric field; Gauss's law and its applications.
- 2. Capacitors:** Parallel plate capacitors with dielectrics; dielectrics and Gauss's law; susceptibility, permittivity and Dielectric constant; energy stored in an electric field.
- 3. Electric Current:** Electron theory of conductivity: Conductor, semiconductors and insulators; superconductors: current and current density; Kirchhoffs law and its applications.
- 4. Magnetism:** Magnetic dipole; mutual potential energy of two small-magnets: magnetic shell; energy in a magnetic field ; magnetometers.
- 5. Electromagnetic Induction:** Faradays experiment; Faraday's; Ampere's law, motional e.m.f; self and mutual Inductance; galvanometers- moving cell ballistic and deadbeat types.
- 6. Thermoelectricity:** Thermal e. m. f; Seebeck, Peltier and Thomson Effects; laws of thermal e. m. f .s. Thermoelectric power.
- 7. D.C and A.C circuits:** D.C circuits with R, RC, LC and LCR in series; A.C circuits with LR, RC, LC and LCR in series.

**Books Recommended:**

1. Acharyya : Electricity and Magnetism
2. Adams and Page : Principles of Electricity
3. Bopadhyays and Ghose : Padarthavidya (Bengali)
4. Constant : Theoretical Physics (Electromagnetism)
5. Din : Electricity and Magnetism
6. Emran, et al : Text book of Magnetism, Electricity and Modern Physics.
7. Halliday & Resnick : Physics (I and II)
8. Huz, et al : Concepts of Electricity and Magnetism
9. Islam, et al : Tarit Chumbak Tatwa O Adhunik Padartha vijnan (Bengali)
10. Kip : Fundamentals of Electricity and Magnetism

**A.MTH 1202 : Math Practical-I  
(4 Hours, 100 Marks, 1 Credit)**

1. Representation of numbers in line (rational & irrational number),  $\mathbb{R}$  as a totally ordered set, maxima, minima of subset of  $\mathbb{R}$ .
2. Codomain, Domain and Ranges; (Injective, surjective and bijective functions), Inverse functions.
3. Cartesian Coordinate System in  $E_2$ ,  $\mathbb{R}$  and L-handed Cartesian Coordinate System. Cartesian Coordinates in  $E_3$ , Three dimensional figures;
4. Representation of  $\mathbb{R}^2$  on the plane, Use of Argand diagram for Complex numbers.
5. Venn Diagram.
6. Relation and function (Graphical representation), Equivalence Relations, Equivalent sets and Partitions.
7. Calculate the three different legs or sides of the right angle by using the Pythagorean rule. The area of circles, of rings, of segments. Volume of prism, lateral area of a prism, volume of a irregular solid. Volume of a cylinder, lateral area of a cylinder and hollow cylinder. Volume of a pyramid, volume of a cone, lateral area of a cone. Surface area of a sphere, volume and radius of a sphere.
8. Finding extrema of cont. functions defined on closed intervals, Narrative problems Asymptotes, Extrema of Polys. and Rational Functions. Sketching Graphs using Calculus (CPs.Ips), MVT Taylor's series (Approx. Poly).
9. Conics, Sin, Cos and Tan curves drawing.
10. Geometrical Meaning of Partial Derivatives and Definite Integrals.
11. DEs: Solve LDEs: E.g.  $dx + dy = 0$ ,  $xdx + ydy = 0$  and other standard DEs. Show graphically the solutions of DEs. Solving DEs by matrix method.
12. Calculus of several variables : Dom & Range of F, Extrema of F, Surface Integrals & Line Integrals (F: )
- 13(a) Well-known Curves: cycloid, logarithmic, curve( $y=\log x$ ), exponential curve, Equiangular spirals, Cardioid, etc.
- (b) Sphere, Ellipsoids, hyperboloid of one sheet, hyperboloid of two sheets, Elliptic paraboloids etc.

**IMPORTANT NOTE**

At least 20(Twenty) experiments shall have to be done in the class. 5(Five) experiments 50(Fifty) marks, Viva-Voce 20(Twenty) marks, Class Performance 25(Twenty Five) marks, Attendance 05(Five) marks.Total 100(One Hundred) marks.

**A.MTH 1204 : Viva-Voce  
( Marks 100, 2 Credits)**

Basis on the subjects which are taught in the Year-I, Term-I and Year-I, Term-II.

Year – II, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -2101	Calculus-III	3	3	4
A.MTH -2103	Co-ordinate Geometry of Two Dimensions	3	3	4
A.MTH -2105	Co-ordinate Geometry of Three Dimensions	3	3	4
A.MTH -2107	Ordinary Differential Equations	3	3	4
A.MTH -2109	Statistical Methods & Demography	3	3	4
A.MTH -2111	Tensor Analysis	3	3	4
A.MTH -2102	Stat Lab	2	2	4
Total		20		

**A.MTH 2101 : Calculus III  
(4 Hours, 100 Marks, 3 Credits)**

**1. Functions of Several Variables:**

Functions of Two and Three Variables, Real Valued and Vector Valued Functions, Scalar Fields and Vector Fields. Limit and Continuity of Functions of Two and Three Variables.

**2. Differentiations of Functions of Several variables:**

Partial Differentiation, Total differentiation, Geometrical Meaning of Partial Derivative, Extrema of Functions of Several Variables: First Derivative Test, Second Derivative Test and Lagrange's Multiplier Method and Taylor's Theorem.

**3. Integration of Functions of Several Variables:**

Line Integrals, Double and Triple Integration, Green's Theorem, Gauss's Divergence Theorem and Stokes' Theorem.

**4. Improper Integrals:**

Definition and Classification of Improper Integrals, Tests for Convergence and Divergence of Improper Integrals, Gamma and Beta Functions.

**Books Recommended:**

1. Mann and Taylor : Advanced Calculus
2. Spiegel : Advanced Calculus.
3. Thomas : Calculus
4. Glyn James : Advanced Engineering Mathematics

**A.MTH 2103 : Co-ordinate Geometry of Two Dimensions.  
(4 Hours, 100 Marks, 3 Credits)**

**1.** Cartesian Coordinates, Polar coordinates, Parameters, Changes of Axes, Standard Equations in Different Coordinates Systems and their Parametric Representations.

**2.** General Equations of Second Degree:

Standard Forms, Reduction of General Equation of Second Degree into Standard Forms.

**3.** Pair of Straight Lines:

General Equation of Second Degree representing a Pair of Straight Lines, General Properties of Pair of Straight lines.

**4.** Circles and system of circles.

**5.** Properties of Parabola, Ellipse, Hyperbola and Rectangular Hyperbola.

**6.** Parabola: Properties and standard form.

**7.** Ellipse: Properties and standard form.

**8.** Hyperbola: Properties and standard form.

**9.** Rectangular Hyperbola: properties.

**Books Recommended:**

1. Rahman and Bhattacharjee : Coordinate Geometry of Two and Three Dimensions and Vector Analysis.
2. Askwith : An Elementary Treatise on Coordinate Geometry of Two Dimensions.
3. Lony : Geometry.

**A.MTH 2105 : Co-ordinate Geometry of Three Dimensions.**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Coordinate Systems in Three Dimensions:** Display of Solid Figures, Rectangular Coordinates: Direction Cosines & Direction Ratios, Projections, Angle between two Lines.

**2. Planes and Straight lines:**

Planes: Constants in the Equations of Plane, Different Forms of the Equation of a Plane and Conversions, Angle between two planes, Lines: Different Forms of Equations of Lines and Conversions, Skew Lines, Constants in the Equation of a Line, Angle between a Line and a Plane. A Line in a Plane Through a Line, Coplaner Lines, Shortest Distance.

**3. Spheres:**

Equations of Spheres, A Plane and Sphere, A Line and Sphere, Circle in three dimensions. Plane of Contact, Tangent Planes, Polar Planes, Angle of Intersection of Two Spheres, Condition of Orthogonality, Radical Line, Plane and Centres, Coaxial Spheres.

**4. Cones and Cylinders:**

Generators, Necessary Condition for a General Eq. of Second Degree to represent a cone, Right Circular Cones, Equations of Cylinders, Circular Cylinders, Enveloping Cylinders and Enveloping Cones.

**5. The General Equation of Second Degree:** Conicoids, Reduction to Standard Forms, Conicoids of Revolution Ellipsoids, Paraboloids & Hyperboloids.

**Books Recommended:**

1. Rahman and Bhattacharjee : Coordinate Geometry of Two and Three Dimensions and Vector Analysis.
2. R.J.T.Bell : An Elementary Treatise on Coordinate Geometry of Three Dimensions.
3. Lony : Geometry in Three Dimensions.

**A.MTH 2107 : Ordinary Differential Equations**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Introductory concepts:**

Definitions of ordinary differential equations(ODE) Construction of ODEs, Geometrical meanings of ODEs and their solutions, classification of ODEs Initial value problems.

**2. Techniques of Solving ODE's:**

First order and 1<sup>st</sup> degree differential equations, Trajectories, Linear differential equation with constant co-efficients, Homogenous linear differential equations and their applications. Equation of 1<sup>st</sup> order but not of 1<sup>st</sup> degree, Singular solutions.

**3. Further Techniques:**

Method of variation of parameters, Method of undetermined co-efficients. Reduction of Linear differential equations to a first order system.

**4. Higher order Linear Differential equations:**

Initial value problem (IVP), Boundary value problem (BVP). The Wronkians and its Properties. Reduction of order. A formula for the Wronkian. Exact differential equations.

**Books Recommended:**

1. H.T.H Piaggio : Elementary Treatise of Differential Equations.
2. B. D. Sharma : Differential equations.
3. Frank Ayres : Differential equations (SOS).
4. Ross : Differential equations

**A.MTH 2109 : Statistical Methods & Demography**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Economical Statistics:**

Index number : The concept of a index number, The problems in the construction of index number. Type of indices, (Price, Quantity and Value) simple price index. Simple aggregative-index; weight indices and cost of living indices and their use. Test of index number formulae.

Time series: Concept of time series analysis. Components of time-series and their relationship. Measurement of trend by different methods (Method of free hand curve. Method of moving average. Method of least square. Determination of seasonal fluctuation. Simple averages Ratio to moving average methods. Ratio to link relative method.

**2. Vital Statistics:**

Sources of demographic data; Population census, Vital registration, surveys, Population composition by age, sex, marital status, Economic activity etc. and their usefulness in demographic analysis. Rates and ratio. Examples of above statistics in relation to Bangladesh population.

**3. Fertility:**

Crude and age-sex specific birth rates. Central and total fertility rates. Standardised rates and their relative merits and demerits GRR and NRR.

**4. Mortality:**

Crude and age-sex specific death rates. Standardised death rate. Infant mortality rate. Census of deaths. Life table (Complete and abridged) and their uses.

**5. Educational Statistics & Quality Control:**

Concept of statistical quality control. The importance of statistical quality control. Shewart control chart technique. Control chart (X proportion and range) and uses. Merits and demerits of control chart. Soeing (T score and Z score) validity, Reliability, I.Q. etc.

**Books Recommended:**

1. Barclay, J. : Techniques of Population Analysis.
2. Guilford : Statistical methods in Psychology.
3. Croxton and Cowden : Applied General Statistics.
4. Ghosh & Chowdhury : Statistics in theory and practice.
5. Scarborough : Numerical Mathematics.
6. Garres : Statistics in Psychology.
7. Simpson & Kapka : Basic Statistics.
8. Mostafa, M.G. : Methods of Statistics.

**A.MTH 2111 : Tensor Analysis**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Linear Transformation:**

General Linear Transformations, Orthogonal Transformation and Admissible Transformations.

**2. Tensor Algebra:**

Riemannian space, Invariant, Contravariant and Covariant Vectors, Tensors of Different Ranks and Types, Symmetric and Skew Symmetric Tensors in Euclidean Space and in Riemannian Space, Addition and Subtraction of Tensors, Outer Product and Inner Product of Tensors, Contraction and Quotient law, Metric Tensor, Index Raising and Lowering.

**3. Tensor Calculus and Riemannian metric:**

Christoffel Symbols of First & Second kind, Parallel Displacement, Covariant Differentiation of Tensors, Metric Affinity and the Christoffel symbols in terms of the Metric Tensor, Basic Concepts of Riemann-Christoffel Curvature Tensor, Ricci Tensor, Bianchi identity, Geodesics and Equations of Geodesics.

**4. Applications of Tensor analysis to electromagnetic theory and relativity.**

**Books Recommended:**

1. Fred A. Binechey : Vectors and Tensors for Engineers and Scientists.
2. L.P. Eisenhart : Riemannian Geometry.
3. D.F.Lawden : An Introduction to Tensor Calculus and Relativity.

**A.MTH-2102: STAT LAB**  
**(4 Hours, 100 Marks, 2 Credits)**

1. Graphical Representation of data .
2. Measures of Central Tendency .
3. Measures of Dispersion.
4. Correlation and Regression.
5. Different Problems of Probability and Probability distributions.
6. Test of Significance.
7. Statistical Quality Control.
8. Index Number .
9. Demography .

**IMPORTANT NOTE**

At least 20(Twenty) experiments shall have to be done in the class. 5(Five) experiments 50(Fifty) marks, Viva-Voce 20(Twenty) marks, Class Performance 25 (Twenty Five) marks, Attendance 05(Five) marks. Total 100(One Hundred) marks.



## Year – II, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -2201	Trigonometry(Plane& Spherical)	3	3	4
A.MTH -2203	Partial Differential Equations	3	3	4
A.MTH -2205	Heat and Thermodynamics	3	3	4
A.MTH -2207	Discrete Mathematics	3	3	4
A.MTH -2209	FORTTRAN Programming	3	3	4
A.MTH - 2202	Math Practical - II	3	3	4
A.MTH -2204	Viva-Voce	2		
Total		20		

**A.MTH 2201 : Trigonometry (Plane and Spherical)**  
(4 Hours, 100 Marks, 3 Credits)

**Group A: Plane Trigonometry****Marks: 40****1. DeMoivre's Theorem and it's applications:**

Complex Quantities, DeMoivre's Theorem and its applications, Function of Complex Quantities. Inverse circular function of complex quantities, Exponential Series for Complex quantities.

**2. Hyperbolic Functions:**

Circular Functions for Complex Angles, Euler's Exponential Values, Hyperbolic Functions, and Inverse Circular and Hyperbolic Functions.

**3. Trigonometric Series:**

Power Series, Logarithmic Series, Gregory's Series, Summation of Series, Expansions in Series.

**Group B: Spherical Trigonometry****Marks:30****Introductory Concepts of Spherical Trigonometry (ST):**

Importance of ST, Geometry of sphere, Axis & Poles. Spherical Triangle, Polar Triangle, Properties of Polar Triangle. Relation between sides and angles of a Spherical triangle: Cosine and Sine formula; Sine of Angles in terms of sides; Relation between two sides, Included angle and another angle; Formulae of half angle and half side; Cosine of sides; Napier's Analogies; D'Alembert's Analogies.

**Books Recommended:**

1. S. L. Loney. : Trigonometry
2. A. Sattar : Higher Trigonometry
3. Chowdhury M.G.Zakaria : Elements of Spherical Trigonometry
4. Bhu Dev Sharma : Spherical Trigonometry
5. B.C.Das and B.N. Mukharjee : Plane Trigonometry

**A.MTH 2203 : Partial Differential Equations  
(4 Hours, 100 Marks, 3 Credits)**

**1. Introductory concepts:**

Definition of partial differential equations (PDEs), Origin of the PDEs. Geometrical meaning of PDEs and their solutions. Classification of PDEs.

**2. Technique of solving PDEs:**

Methods of solutions of simultaneous differential equations. Integrability conditions and solution of equations. Linear Partial differential equations of order one: Lagrange's method, Jacobis method. Non-linear PDEs of order one: Charpits method. Linear PDEs of order more than one (Homogeneous and non-homogeneous ) Constant co-efficients.

**3. Classification of 2<sup>nd</sup> order PDE. Canonical forms:** Hyperbolic equation, Parabolic equations, Elliptic equation Adjoint operators, Riemann's Method.

**4. Second order Partial differential equations with variable Co-efficients:** Mong's method, Reduction to canonical form.

**5. Solution of different types of** (i) Elliptic (ii) Parabolic (iii) Hyperbolic differential equations of more than one dimension.

**Books Recommended:**

1. D. Sharma : Differential equations
2. N. Sharma & Dehar Singh : Partial Differential Equations for Engineers and Scientists
3. K. Sankara Rao : Introduction to Partial Differential Equations.
4. Snadon : Partial Differential Equations.

**A.MTH 2205 : Heat and Thermodynamics  
(4 Hours, 100 Marks, 3Credits)**

**1. Thermometry:**

Gas thermometers and their corrections, measurement of low and high temperatures, Platinum resistance thermometer; thermocouple.

**2. Kinetic theory of gases:** Kinetic theory of gas, Deduction of Boyle's, Charle's and Avogardo's laws, determination of gas constants, mean force path.

**3. Equation of states for gases:** Equation of state for a perfect gas its experimental study, vander waal's equation deduction: physical significance of 'a' and 'b' defects.

**4. Liquefaction of gases:** Different methods of liquefaction of air nitrogen, refrigeration.

**5. Thermal conduction:** Thermal conductivity, Fourier's equations of heat flow thermal conductivities of good and bad conductors.

**6. Radiation:** Radiation pressure, Kirchoffs law black body radiation, Stefan Boltzmann's law Rayleigh jean's law, planck's Quantum law.

**7. First law of Thermodynamics:** Internal energy, work done by expanding fluid, Specific heats of perfect gases, Ratio of  $C_p$  to  $C_v$ , Isothermal and adiabatic expansions.

**8. Second law of Thermodynamics and entropy:** Reversible and irreversible processes, carnot cycle, efficiency of heat engines, absolute scale of temperature Clausius and claperon's theorem. Change of entropy in reversible and irreversible processes. Thermodynamics Potentials at constant volume and pressure, maxwell's thermodynamics relations, specific heat equation, Joule Thomson effect, production of low temperature.

**Books Recommended:**

1. Bhuiyan & Rahman : A Text Book of Heat, Thermodynamics & Radiation.
2. Halliday & Resnick : Physics (I and II).
3. Saha & Srivastava : A treatise on Heat.
4. Leo and Sears : Thermodynamics
5. Zemansky : Heat and hermodynamics
6. T. Hossain : Text Book of Heat
7. Haque : Text Book of Heat, Thermodynamics & Radiation

**A.MTH 2207 : Discrete Mathematics  
(4 Hours, 100 Marks, 3Credits)**

**1. Proposition, Relations and Functions:** Propositions, A relational model for data bank, Properties of binary relations, Equivalence relations and Partitions, Partial ordering relations and lattices, chains and antichains. Functions and the Pigeonhole Principle.

**2. Graphs and planar Graphs:** Introduction, Basic terminology, Multigraphs and weighted graphs, Paths and circuits, Shortest Paths in weighted graphs, eulerian Paths and circuits, Hamiltonian Paths and circuits.

**3. Trees and Cut Sets:** Trees, Rooted trees, Path lengths in rooted trees, Binary search trees spanning trees and cutsets, Minimum spanning trees.

**4. Boolean Algebra:** Lattices and Algebraic systems, Principle of duality, Basic Properties of Algebraic system defined by lattices, Distributive and complemented lattices, Boolean lattices and Boolean algebras, Boolean lattices and Boolean expressions Propositional calculus, Design and implementation of digital Networks, Switching circuits.

**Books Recommended:**

- |   |                                      |
|---|--------------------------------------|
| 1. Prof. Dr. M.F. Rahman                        | : Discrete Mathematics               |
| 2. JERRY BANKS, JOHNS CARSON,II, BARRY L.NELSON | : Discrete- Event System Simulation  |
| 3. Kolman , Busby, Ross                         | : Discrete Mathematical Structures   |
| 4. Rosen  | : Discrete Mathematics               |
| 5. Olympia Nicodemi                             | : Discrete Mathematics               |
| 6. Swapan Kumar Sarkar                          | : A Textbook of Discrete Mathematics |

**A.MTH 2209 : FORTRAN Programming  
(4 Hours, 100 Marks, 3Credits)**

**Programming in FORTRAN**

Introduction to FORTRAN, First Steps in Fortran 90 programming, number system (binary, octal, hexadecimal), conversion and algebra, Program structure, FORTRAN language-constants, variables, arithmetic statements, I/O operations, Basic ideas of Algorithm, Flow chart, control statements, looping, Introduction to Arrays, Using files to preserve data, functions and subroutines.

**Books Recommended:**

- |                                    |  |
|------------------------------------|--|
| 1. Rosen                           | : Discrete Mathematics   |
| 2. Olympia Nicodemi                | : Discrete Mathematics   |
| 3. Swapan Kumar Sarkar             | : A textbook of Discrete Mathematics                           |
| 4. Schaum's outline series         | : Programming with FORTRAN                                     |
| 5. S.Balachandra Rao, C.K. Shantha | : Numerical Methods with Programs in BASIC, FORTRAN and Pascal |
| 6. Cooper Redwine                  | : Upgrading to Forfran 90                                      |
| 7. Rajaraman, V.                   | : Computer programming in Fortran 90 and 95                    |

**A.MTH 2202: Math Practical-II  
(4 Hours, 100 Marks, 3 Credits)**

[Four hours practical examination using MATHEMATICA]

1. Introduction to the computer algebra package MATHEMATICA.
2. Basic Concepts: Basic Arithmetic Operations, Strings, Logical Relations, Introduction to Graphing, Operations on Functions.
3. Lists: Generating Lists, List Manipulation, Tables and Matrices.
4. Two-Dimensional Graphics: Plotting Functions of a Single Variable, Special Two-Dimensional Plots.
5. Three-Dimensional Graphics: Plotting Functions of Two Variables, Special Three-Dimensional Plots, Standard Shapes 3D Graphics Primitives
6. Equations: Algebraic and Transcendental equations solving.
7. Calculus: Limits, Derivatives, Anti-derivatives, Definite Integrals, Functions Defined by Integrals.
8. Ordinary Differential Equations: Analytical Solutions, Numerical Solutions.

**IMPORTANT NOTE**

At least 15 (Fifteen) Lab assignments shall have to be done in the class. Solving 7 (Seven) problems 70 (Seventy) marks, Class performance 20 (Twenty) marks, Class assignments 05 (Five) marks, Attendance 05 (Five) marks. Total 100 (One Hundred) marks.

**A.MTH 2204 : Viva-Voce  
(100 marks, 2 Credits)**

Basis on the subjects which are taught in the Year-II, Term-I and Year-II, Term-II.

Year – III, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH - 3101	Real Analysis	3	3	4
A.MTH - 3103	Numerical Analysis	3	3	4
A.MTH - 3105	Optimization Techniques-I	3	3	4
A.MTH - 3107	Programming with C/C ++	3	3	4
A.MTH - 3109	Differential Geometry	3	3	4
A.MTH- 3111	Mathematics for Business	3	3	4
A.MTH - 3102	Math Practical - III	3	3	4
Total		21		

**A.MTH 3101 : Real Analysis**  
(4 Hours,100 Marks,3 Credits)

**1. Real number system:** Rational number, field, ordered set, ordered field, least upper bound and greatest lower bound, the least upper bound, property and its applications.

**2. Basic Topology of the Real Number System:** Definitions of Distance Functions, Metric Space, Neighbourhood, Limit Point, Closed Sets, Interior Points, Open Sets, Connectedness, Compactness in the Context of Real Number Systems and Standard Theorems.

**3. Set Theory:** Finite and infinite sets, equivalence of sets, denumerable and countable sets, uncountable sets.

**4. Metric spaces:** Metric spaces, open and closed sets, compact sets. Perfect set. Cantor set.

**5. Sequence and Series:** Convergence sequence, bounded sequence, subsequence, Cauchy sequence and completeness of  $\mathbb{R}$ ., Convergent series, Cauchy's criteria for convergent series, comparison test, Cauchy's condensation test, Root and Ratio test, Integral test, Raabi's test, Leibnitz's test, Absolutely convergence.

**6. Limit and Continuity:** Geometrical Meanings of Limit and Continuity of Real Valued Functions of a Single Real Variable, Uniform Continuity, Intermediate Value Theorem and Global Extrema Theorems.

**7. Differentiability:** Derivatives of real valued functions of a single Real Variable, Intermediate Value Theorem for Derivatives, Rolle's Theorem, Mean Value Theorem for Derivatives and their Geometrical Interpretations. L'Hospital's Theorem; Maclurin series and Taylor Series with Remainder. (More emphasis on proofs) and Taylor's Polynomials.

**Books Recommended:**

- |                            |                                       |
|----------------------------|---------------------------------------|
| 1. Rudin, W.               | : Principles of Mathematical Analysis |
| 2. Procter and Morey, C.R. | : Modern Mathematical Analysis        |
| 3. Borle                   | : Real Analysis                       |
| 4. Royden                  | : Mathematical Analysis               |
| 5. T.Apostal               | : Mathematical Analysis.              |
| 6. Spiegel                 | : Real Variables.                     |
| 7. P.N. Chatterjee         | : Real Analysis.                      |

**A. MTH 3103 : Numerical Analysis**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. The Calculus of Finite Differences:**

Difference tables, Forward, Backward and General Differences fundamental theorem of difference Calculus.

**2. Interpolation with equally spaced data:**

Newton's forward and backward formulas Gauss and Bessel's interpolation formulas. Interpolation with unequally spaced data; Existence and uniqueness of the interpolating polynomials Lagrangian interpolation, and divided difference interpolation formulas. Error of the interpolating polynomials. Lagrangian interpolation, and divided difference interpolation formulas. Error of the interpolating polynomials.

**3. Solution of Non-Linear Equations:**

Bisection method, iterative methods, secant and regula falsi methods. Graphical method Fixed point iteration, convergence criterion for a fixed point iteration, Newton-Raphson method.

**4. System of Linear Equations:**

Gauss elimination method triangular factorization, Crout method. Iterative methods; Jacobi method, Gauss-Seidel method.

**5. Numerical Differentiation:**

Numerical differentiation formulae based on interpolation polynomials, error estimates.

**6. Numerical Integration:**

Newton-Cotes formulae: trapezoidal rule, Simpson's formulae, Weddle's rule, composite rules. Romberg improvement, Richardson extrapolation. Error estimation of integration formulae. Gaussian integration. Solution of Ordinary Differential Equations: Picard's method, Euler's method, Taylor's Series method, Runge-Kutta method, Predictor-corrector methods. Single step methods, Systems of differential equation.

**Books Recommended:**

1. F.Schild : Numerical Analysis (Schaum's Outline Series)
2. A.R. Vasishgtha & V. Vasishtha : Numerical Analysis
3. S.S.Sastry : Introductory Methods of Numerical Analysis (Prentice-Hall of India, Private Ltd.)
4. F.B.Hildebrand : Introduction to Numerical Analysis.
5. Phillips & Taylor : Theory and Applications of Numerical Analysis.

**A.MTH 3105 : Optimization Techniques - I**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Basic Concepts:** Introduction, The nature, Meaning, Scope and role of operation Research. Main phases of operation Research. Study, Modeling in operation Research, General Methods for solving operation Research Models. Decision making in operation Research.

**2. Mathematical programming:** Concept and Basic elements of Linear Programming (LP) Formulation of Linear Programming Problems.

**3. Solution of Linear Programming Problems:** (i) Graphical Method (ii) Simplex Method.

**4. Revised Simplex Method.**

**5. Duality in Linear Programming.**

**6. Sensitivity Analysis, Parametric Analysis. Transportation and Assignment problems.**

**7. Integer Linear programming Dynamic Programming.**

**8. Decision Theory: Decision under Risk, Decision Trees, Decision under Uncertainty. Game Theory: Basic Concept of Game Theory, Two Persons and n-persons Zero-Sum Game.**

**Books Recommended:**

1. Vajda S. : Game Theory.
2. Charles, A : Decision Making under Uncertainty Models
3. Gass, S. I. : Linear Programming.
4. Hudly, G : Linear Programming.
5. Lindly, D. V : Making Decision.
6. Taha, H.A. : Operation Research : An Introduction.
7. Berger J. O. : Statistical Decision Theory

**A.MTH 3107: Programming with C/C++**  
**(4 Hours, 100 Marks, 3 Credits)**

**Programming in C and C++:**

History of C, C Fundamentals, Operators & Expressions, Data Input & Output, Program control statements, Function, Arrays, Pointers, Structures and unions, Data Files. Introduction to C++, Basic structure of C++, Concepts of Object Oriented Programming (OOP) (Polymorphism, Inheritance, and Encapsulation etc), Objects, Classes parameterized constructors, Functions in C++, Pointers & References, Overloading Operators, String Class, Composition and Inheritance.

**Books Recommended:**

1. S.K. Bottle : Mastering Turbo C.
2. H Schidt : Advanced Turbo C.
3. H Schildt : Mastering Turbo C ++
4. H Schildt : Teach yourself C ++
5. H.Schildt : C Complete reference
6. Stephen, G. Kochan : Programming with C
7. Kumar Agrawal : Programming in ANSIC
8. Herbert Schildt : Turbo C/C++, The complete reference

**A.MTH 3109 : Differential Geometry**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Introductory Concepts of Differential Geometry Vector Algebra and Calculus of Vectors;** Functions of Class Cm; Regular and Implicit Representation of Curves in R<sup>3</sup>; Tangent Plane, Normal Plane and Osculating Plane; Curvature and Torsion.

**2. Theory of Curves and Surfaces:**

The Fundamental Existence and Uniqueness Theorems; Involutives and Evolutes, Theory of Contact, Osculating Curves and Surfaces, Coordinate patches, Simple surfaces and Topological Properties of Simple Surfaces.

**3. Fundamental Forms:**

First and Second Fundamental Forms: Normal Curvature, Principal Curvature, Gaussian and Mean Curvature; Rodrigues Formula and Conjugate Families of Curves.

**4. Further Theory of Surfaces:**

Gauss-Weingarten Equations, Gauss Theorem and the Fundamental Theorem of Surfaces: Elementary Manifolds, Application of Tensors in Surface Theory; Mapping of Surfaces, Intrinsic Geometry,

**5. Geodesics :** Definitions, differential equation of geodesics, canonical geodesic equation, geodesic on a surface of revolution, Clairaut's theorem, normal property, geodesic curvature, Bonnet's theorem, Gauss-Bonnet theorem.

**Books Recommended:**

1. Ciampin and Pirani : Applicable Differential Geometry.
2. Dirk J. Struik : Lectures on Classical Differential Geometry.
3. Hicks, N : Notes on Differential Geometry.
4. M.M.Lipschutz : Differential Geometry.
5. Khanna, M.L. : Differential Geometry
6. Weatherbum, C. : Differential Geometry Dimensions

**A.MTH 3111 : Mathematics for Business**  
**(4 Hours, 100 Marks, 3 Credits)**

1. Set Theory and its applications to business problems. Applications of Matrices and system of linear equations.
2. Straight lines and its applications to business Break Even interpretations.
3. Mathematics of finance : Simple and compound interest. Present and future value. Simple and compound discount. Depreciation. Annuity.
4. Supply and demand function. Application of supply and demand functions. Elasticity Relation between average and marginal cost.
5. Application of differential calculus: Maxima and Minima of a function and its applications. Marginal Propensity of consume and the multiplier. Applications of partial derivatives.
6. Application of integral calculus: Interpretive application of area consumer's and producer's surplus. Applications of differential equation. Dynamic modeling and difference equations.

**Books Recommended:**

1. D. Prichet and John. C. Saber : Mathematics with applications in Management and Economics
2. K. Holden and A.W. Pearson : Introductory Mathematics for Economics and Business
3. D.C. Sanchetiz V.K. Kapoor : Business Mathematics
4. Zambeer uddin, Khanna and Hambri : Business Mathematics

**A.MTH 3102 : Math Practical-III**  
**(4 Hours, 100 Marks, 3 Credits)**

[Four hours practical examination using Fortran 90.]

1. **Elementary Programs:** Solving a quadratic equation. identification of conics, circumference and area of circles and triangles, testing a leap year.
2. **Programs using do loops:** Summation of series. Product of factors, testing of prime numbers.
3. **Programs using select case:** Printing number month in given, printing result of students if courses are given, printing weather condition if the temperature is given, etc.
4. **Programs of arrays:** Printing Fibonacci numbers. Sorting in ascending / descending order of a given array, Searching the highest and lowest number in a given array, Addition and multiplication of matrices, transposing of matrices.
5. **Using Functions and subroutine:** Defining a given function and printing its values at a set of equally, spaced points. Calculation of A.M, G.M, H.M, S.D, M.D etc. of an array of numbers. Elementary row operations of matrices, solving a system of linear, equations.
6. **File Processing:** Printing an array of numbers in a file. Reading two matrices from a file and printing the addition/ subtraction / multiplication in another file. Creating, editing. Appending files of student's records.

**IMPORTANT NOTE**

At least 15 (Fifteen) Lab assignments shall have to be done in the class. Solving 7 (Seven) problems 70 (Seventy) marks, Class performance 20 (Twenty) marks, Class assignments 05 (Five) marks, Attendance 05 (Five) marks. Total 100 (One Hundred) marks.



Year – III, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH -3201	Optimization Techniques - II	3	3	4
A.MTH -3203	Method of applied Mathematics	3	3	4
A.MTH -3205	Complex Analysis	3	3	4
A.MTH -3207	Mechanics(Statics and Dynamics)	3	3	4
A.MTH -3209	Integral Equations	3	3	4
A.MTH -3202	Math Practical-IV	3	3	4
A.MTH -3204	Viva-Voce	2		
Total		20		

**A.MTH 3201 :Optimization Techniques - II  
(4 Hours, 100 Marks, 3 Credits)**

**1. Convex and Concave Functions:**

Definitions and basic properties; Fundamental theorems for convex function; Maxima and Minima of Convex Function; Generalizations of Convex Function. Properties and relations of generalized convex function.

**2. The Fritz John and the Kuhn Tucker Optimality Conditions:**

- a. Unconstrained Problems,
- b. Problem with inequality constraints,
- c. Problem with equality and inequality constraints,
- d. Second order Necessary and Sufficient optimality conditions for constrained problems.

**3. Constraint qualifications:**

- a. The cone on Tangents,
- b. Various constraint qualifications,
- c. Problems with inequality and equality constraints.

**4. Lagrangian Duality and Saddle Point Optimality conditions:**

- a. The Lagrangian Dual Problem,
- b. Duality theorems and Saddle Point Optimality Conditions,

**5. Flow and potential in networks:** Introduction, Graphs, Definitions and notations, minimum path and Maximum flow problem.

**Books Recommended:**

1. O.L. Mangasarian, : Nonlinear Programming, McGraw Hill, New York, New York, 1969
2. M.S. Bazaraa, H.D.Sherali, and C.M. Shetty, : Nonlinear Programming School Edition, John Wiley and Sons, New York, (1993).
3. McCORMICK G.P. : Nonlinear Programming, John Wiley and Sons, New York, 1983.
4. K.V. Mital, C. Mohan : Optimization Methods in operations research and system analysis
5. Hamdy A.Taha : Operations Research

**A.MTH 3203 : Method of Applied Mathematics**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. The Laplace Transform :** (i) Definition existence and basic properties (ii) Differentiation and integration (iii) Inverse Laplace transform and convolution (iv) Solution of linear differential equations with constant coefficients and linear systems.

**2. Bessel's Equations:** Solution, Generating function, Recurrence relation, values of Bessel's function, Orthogonality.

**3. Legendre's Equation:** Solution" Generating function, Recurrence relation, Rodrigue's formula and Orthogonality of Legendre polynomials.

**4. Hermite's Equation:** Solution' Integral and Recurrence formula, Orthogonality, Differential formula.

**5. Leguerre's Equation:** Solution, Integral and Recurrence formula, Differential forms, Orthogonality,

**6. Hyper geometric Equation :** Solution, Hyper geometric function and its properties, Integral formula and transformations of hyper geometric functions.

**7. Fourier series:** Fourier coefficients, sine and cosine series, Dirichlet's theorem, Properties and applications.

**8. Sturm-Liouville problem:** Self adjoint differential equation, Characteristic values and characteristic function. Orthogonality; Green's function.

**9. Fourier transforms:** Fourier sine and cosine transforms' Complex Fourier transform, convolution theorem.

**10. Applications to boundary value problems.**

**Books Recommended:**

- |                          |                                   |
|--------------------------|-----------------------------------|
| 1. Jeffreys and Jeffreys | : Methods of Mathematical Physics |
| 2. Courant and Hilbert   | : Methods of Mathematical Physics |
| 3. Rajput, B.S.          | : Mathematical Physics            |
| 4. Spiegel, M R          | : Laplace Transforms              |
| 5. Lighthill, M J        | : Asymptotic Expansion            |

**A.MTH 3205 : Complex Analysis**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. Complex Numbers:**

Definition, Algebraic properties, Geometric interpretations, Property of moduli, Polar form, Exponential form, Power and roots, Regions in the Complex plane.

**2. Functions, Limit, Continuity, and Differentiation:**

Functions of a complex variable, Mappings, Limits, Theorems on Limits, Continuity, Derivatives, Cauchy-Riemann Equations, Analytic functions and Harmonic functions.

**3. Complex Series:**

Convergence and Divergence of sequence and series, Taylor Series and Laurent Series.

**4. Conformal Representation:**

Conformal mapping, Simple functions, Homographic transformation Schwarz's Lemmas, Riemann's Theorem for a circle, Schwarz's Principle of symmetry. Conformal representation of a polygon on a half-plane.

**5. Complex Integration:**

Definite Integrals of Functions of a Complex Variable expressed as Functions of a single Parameter, Contours, Line Integrals, properties of integrals. Change of variables. Simply and Multiply Connected Domains, Derivatives of Analytic Functions. Cauchy's integral Theorem, Extension of Cauchy's Theorem. Jordan curve theorem, Green's theorem in plane. Complex form of the Green's theorem.

**6. Cauchy's integral Formula and Related Theorems:**

Cauchy's integral formulae. Some important theorems. Morera's theorem. Cauchy's inequality. (Liouville's theorem. Fundamental theorem of algebra. Gauss' mean value theorem. Maximum modulus theorem. Minimum modulus theorem.

**7. The Calculus of Residues:**

Residue at pole, Residue at infinity, Calculation of residues, Cauchy's residues theorem, Computation of residue at a finite pole. Jordan's lemma, Integration round unit circle. Evaluation of the definite integrals, Special theorems used in evaluating integrals, Cauchy's principal value of integrals, Quadrant and sector contours, Rectangular contours.

**8. Singularities:**

Zeros of a function, Singular point, Different types of singularities, Poles and zeros are isolated, Limiting point of zeros and poles, Some theorems.

**Books Recommended:**

- |                              |   |
|------------------------------|---|
| 1. E. T. Copson              | : An Introduction to the theory of functions of complex variable. |
| 2. Churchill and Brown       | : Complex Variable and Applications.                              |
| 3. Spiegel                   | : Complex Variables (Schaum's Outline Series)                     |
| 4. P. K. Bhattacharjee       | : Complex Variables.  |
| 5. E.G. Phillips             | : Complex Variables.  |
| 6. J.K. Goyal and K.P. Gupta | : Functions of a complex variable.                                |
| 7. Glyn James                | : Advanced Engineering Mathematics.                               |

**A.MTH 3207 : Mechanics(Statics and Dynamics)**  
**(4 Hours, 100 Marks, 3 Credits)**

**Statics**

1. **Introduction:** Composition and Resolution of Forces acting at One Point Equilibrium of a particle on a smooth Curve.
2. Parallel Forces, Moments, Couples.
3. Equilibrium of a Rigid Body acted on by Forces in the Plane; Astatic Equilibrium.
4. **Work:** Virtual Work, Principle of Virtual Work for a coplanar system.
5. **Centre of Gravity (CG):** CG of an arc, CG of a Plane Area, CG of a Solid and Surface of Revolutions, CG of any Volume, CG of a Spherical Triangle, Theorems of pappus.
6. Stable and Unstable Equilibrium.

**Dynamics**

1. Fundamental Definitions and Principles.
2. Motion in Straight Line: Simple Harmonic Motion (SHM)
3. Motion under the Earth's Attraction.  
Uniplanar Motion where the Accelerations Parallel to Fixed
4. Axes are given, Composition of SHMS.
5. Uniplanar Motion referred to polar Coordinates: Revolving
6. Axes. Central Forces, Apses and Apsidal Distances, Stability of Orbits.

**Books Recommended:**

1. S.L. Loney : An Elementary Treatise on the Dynamics of a Particle and of Rigid bodies.
2. P.K.Bhattacharjee : Mechanics – Higher Statics and dynamics.
3. A. S. Ramsey : Dynamics.
4. G. S. Malik : Dynamics.
5. P. P. Gupta : Statics

**A.MTH 3209 : Integral Equations**  
**(4Hours, 100 Marks, 3 Credits)**

1. Introduction, Types of IEs, Differentiation under an integral sign, Relation between differential and integral equations.
2. Solution of the VIEs and FIEs of the first and second kinds.
3. Fredholm's First, Second and Third fundamental theorems. Fundamental function, IEs with degenerate kernels, Eigenvalues and eigen functions.
4. Symmetric kernel, Orthogonal & Normalised systems, Schmidt's solution of non-homogeneous IEs, Hilbert Schmidt theorem.
5. Construction of green's function, Influence function, IE & Green's function for BVPs.
6. Singular IEs, Cauchy principal integral, Hilbert kernel & Hilbert formula. Solution of Hilbert type IEs of the first & second kinds.

**Books Recommended:**

1. Shanti Swarup : Integral Equations
2. M.D. Raishinghania : Linear Integral Equations
3. R.P. Kanwal : Linear Integral Equations
4. T.G. Tricomi : Integral Equations
5. A.R. Vashishtha : Integral Equations

**A.MTH 3202 : Math Practical - IV**  
( 4 Hours, 100 Marks, 3 Credits)  
[Four hours practical examination using C / C++]

- 1. Array And string:** Arithmetic mean, geometric mean, harmonic mean, Variance of some numbers, Sorting of a list of numbers and strings, searching, finding out Put.
- 2. Matrices and determinations :** Addition, subtraction and multiplication of matrices, determinnant of a square matrices, echelon form, row canonical form, elementary transformation of matrices,
- 3. File :** Out put of a file and read from the file and drawing of graphs of some function using the data.
- 4.** solution of transcendental and algebraic equations by i) iterative and ii) Newton- Raphson methods.
- 5. Interpolation:** i) Newton forward, ii) Newton backward ii) Lagrange interpolation formulae.
- 6. Numerical differentiation:** By using Newton forward and backward interpolation formula and numerical integration by simple  $1/3$ ,  $3/8$  and trapezoidal rules.

**IMPORTANT NOTE**

At least 15 (Fifteen) Lab assignments shall have to be done in the class. Solving 7 (Seven) problems 70 (Seventy) marks, Class performance 20 (Twenty) marks, Class assignments 05 (Five) marks, Attendance 05 (Five) marks. Total 100 (One Hundred) marks.

**A.MTH 3204 : Viva-Voce**  
(100 marks, 2 Credits)

Basis on the subjects which are taught in the Year-III, Term-I and Year-III, Term-II.

Year – IV, Term – I

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH - 4101	Quantum Mechanics	3	3	4
A.MTH – 4103	Classical Mechanics	3	3	4
A.MTH – 4105	Fluid Mechanics	3	3	4
A.MTH – 4107	Thermodynamics and Statistical Mechanics	3	3	4
A.MTH - 4109	Theory of Relativity	3	3	4
A.MTH - 4111	Bio-Mathematics	3	3	4
A.MTH - 4102	Math Practical - V	3	3	4
Total		21		

**A.MTH 4101 : Quantum Mechanics**  
(4 Hours, 100 Marks, 3 Credits)

1. Basic Concept, Planck's hypothesis, Classical law's, Planck's radiation law, Black body radiation, Photo-electricity, Einstein's Photon theory, Compton effect.
2. Wave Particle Dualism for light and matter. De Broglie Model of the Atom. De Broglie wave, phase and group velocities. Wave packets, Uncertainty principle.
3. Thomson Model of the Atom, Rutherford Atom model. Rutherford scattering of a particles, Bohr Model of the atom. Bohr's theory of the Hydrogen Spectrum, Spectral Series of Hydrogen Atom, Energy level of Hydrogen atom. Correspondence principle.
4. Wave Mechanical concepts, Schrodinger wave equation, Interpretation of wave function; Expectation value and Ehrenfest's theorem.
5. Energy eigenfunctions, One dimensional square well potential, Interpretative Postulates and energy eigenfunctions.
6. Momentum eigenfunctions. Box normalization, Dirac  $\delta$  function; Motion of a free wave packet. Minimum uncertainty product and minimum packet.
7. Linear harmonic oscillator.
8. Spherically Symmetric potential in three dimension, Angular momentum Hydrogen atom. Collision theory: One Dimension square potential barrier.

**Books Recommended:**

1. Arther Beiser : Concepts of Modern Physics.
2. L. I Schiff : Quantum Mechanics.
3. P. T. Mathews : Introduction of Quantum Mechanics
4. Powell and Crassmann : Quantum Mechanics.
5. Gupta, Kumar and Sharma : Quantum Mechanics.
6. Donald Rao : Quantum Mechanics.

**A.MTH 4103 : Classical Mechanics**  
(4 Hours, 100 Marks, 3 Credits)

1. Basic Concepts of Mechanics  
Mechanics of a particle, Mechanics of a system of particles, constraints
2. Variational principles and Lagrange's Equation.  
Hamilton's principle, Some Techniques of the calculus of Variations, Derivation of Lagranges Equations from Hamilton's Principle, Conservation Theorems and Symmetry properties.
3. The Two-body Central Force Problem.  
Reduction to the Equivalent one-body problem, The equations of Motion and First Integrals, Scattering in a Central Force Field.
4. The Kinematics of Rigid Body Motion.  
The independent coordinates of a rigid body, Orthogonal transformations, Formal properties of the transformation matrix, Euler's theorem of the motion of a rigid body. The Coriolis force.
5. The Rigid Body Equations of Motion.  
Angular momentum and kinetic energy of motion about a point, Tensors and dyadics, The inertia tensor and the moment of inertia, Methods of solving rigid body problems and the Euler equations of motion.
6. Special Relativity in Classical Mechanics.  
The basic program of special relativity, The Lorentz transformations, Covariant four formulations, The force and energy equations in relativistic mechanics, The Lagrangian formulation of relativistics mechanics, Covariant Lagrangian formulations.
7. Legendre transformations and the Hamilton equations of motion, Cyclic coordinates and Routh's procedure, Conservation theorems and the physical significance of the Hamiltonian, Derivation from a variational principle, The principles of Least Action.

## 8. Canonical Transformations.

The equations of canonical transformation, Lagrange and Poisson brackets as canonical invariants. The equations of motion in Poisson bracket notation, infinitesimal contact transformations, constants of the motion, and symmetry properties.

### Books Recommended:

1. H. Goldstein : Classical Mechanics (Addison Wesley)
2. E.T. Whittaker : Analytical Dynamics (Dover)
3. Synge & Griffith : Principle mechanics (Mc Graw –Hill)
4. Backer : Theoretical Mechanics.
5. Spiegel : Theoretical Mechanics.

## A.MTH 4105 : Fluid Mechanics (4 Hours, 100 Marks, 3 Credits)

### Group A: Hydrostatics

Pressure of heavy fluids, equilibrium of fluids, in given fields of forces, centre of pressure, Equilibrium and Stability of floating bodies.

### Group B: Hydrodynamics

1. Some basic properties of the fluid. Velocity and acceleration of fluid particles. Lagrange's and Euler's method. Local and particle rates of change. Steady and unsteady flows. Uniform and non-uniform flows.
2. Streamline and pathlines and Vortex lines, velocity potential, vorticity vector, rotational and irrotational flows. One, Two and Three Dimensional flows. Discharge or rate of flow.
3. Signification of the equation of continuity. The equation of continuity. Equation of continuity in curvilinear coordinates. Equation of continuity in spherical and polar coordinates. Equation of continuity of an incompressible fluid through a channel. Boundary surface.
4. Euler's equation of motion, conservative field of force; Lamb's hydrodynamical equations of motion; Bernoulli's equation; Motion under conservative body force, Vorticity equations, Helmholtz's vorticity equation.
5. Motion in two-dimension; Stream function Physical meaning of Stream function velocity in polar coordinates. Relation between stream function and velocity potential.
6. Sources, sinks and doublets, complex potential and complex velocity, stagnation points; complex potential due to a source and a doublet. Uniform stream. Image in two and three dimensions Image of a source and doublet w.r.to circle. Stokes stream function.
7. Flow Circulation; Relation between circulation and vorticity. Kelvin's circulation theorem, Permanence of irrotational motion, Equation of energy; Kelvin's minimum energy theorem.
8. Kutta's theorem, The Theorem of Blasius, the force exerted on a circular cylinder by a source, Motion of a circular cylinder, pressure at points on a circular cylinder, image system for a source outside circular cylinder. Vortex motion, Vortex tube; strength of a vortex, vortex pair, complex potential due to vortex motion, vortex rows, Free vortex, Forced vortex, spiral vortex, compound vortex.

### Books Recommended:

1. L.M. Milne; Thompson : Theoretical Hydrodynamics
2. Bansilal : Theoretical Hydrodynamics.
3. J.M.Kar : Hydro statics
4. M.Roy and Sharma : Elements of Hydrostatics.
5. Raisinghania : Fluid Dynamics
6. Kundu Pijush K. and Cohen Ira M. : Fluid Mechanics.
7. Massey B. S. : Mechanics of Fluid.
8. Chorlton : Text Book of Fluid Dynamics.

## A.MTH 4107 : Thermodynamics and Statistical Mechanics (4 Hours, 100 Marks, 3 Credits)

1. Basic concept: Thermodynamic system, State of a system, Thermal equilibrium and concept of temperature, Scope of thermodynamics, Meaning of partial derivatives, More relations between partial derivatives. Equation of state: Intensive and intensive variables, Equation of state, Equation of state of an ideal gas, Other equation of state.
2. The first law of thermodynamics: The first law of thermodynamics. Heat depends on path, Work depend on path, Heat capacity, Specific heat capacity, Difference in two specific heats Isothermal and isobaric process, Gas equation during an adiabatic process, Work done during an isothermal process, Work done during an adiabatic process.
3. The 2<sup>nd</sup> law of thermodynamics: Reversible and irreversible process, 2<sup>nd</sup> law of thermodynamics. Efficiencies of reversible engines, Carnot cycle, Carnot's Engine and Refrigerator, Thermodynamic scale of temperature, Absolute zero on work scale, Work scale and Ideal gas scale, The Clausius-Clapeyron equation, Clausius inequality'

4. Entropy, Mathematical expression for change of entropy, Change of entropy between two states, Entropy changes in reversible and irreversible process, Entropy of an ideal gas, Temperature entropy diagrams, The helmholtz function and Gibbs function, Adiabatic and isothermal elasticities.
5. (a) Maxwell's equations, Maxwell's thermodynamics relations, Thermodynamics functions. Deductions from the thermodynamics relations, and functions. (b) Enthalpy: Enthalpy, Joule-kelvin co-efficient, 1st order phase transition, Second-order phase transition.
6. Kinetic theory of an ideal gas: Introduction, Basic assumptions, collisions with the walls, Equation of state of an ideal gas, collisions with a moving wall. The clausius equation of state. The Vander waals equation of state.
7. The Distribution of molecular velocities and transport Phenomena : The distribution of molecular velocities, Evaluation of  $\alpha$  and  $\beta$ , the error function, The energy, Classical theory of specific heat capacity, Specific heat capacity of solid, Mean free path, The distribution of free paths, Coefficient of viscosity, Thermal Conductivity, Diffusion.
8. The Maxwell- Boltzman statistics : Introduction phase space, Microstates and macrostates, Thermodynamic probability, Entropy and probability. Quantum Statistical Mechanics: Difficulties with the Maxwell Boltzmann statistics, The Bose-Einstein statistics, The Maxwell Boltzman statistics, Statistics of a photon gas, The Fermi Dirac statistics, Velocity, Speed and energy distribution functions.

**Books Recommended:**

1. F. W. Sears : Thermodynamics and Statistical Mechanics
2. T. Hossain : Heat and Thermodynamics
3. Brijlal : Heat and Thermodynamics

**A.MTH 4109 : Theory of Relativity  
(4 Hours, 100 Marks, 3 Credits)**

Attempt to locate absolute frame; the speed of light relative to earth. Aberrations of star-light. Fresnel's co-efficient of ether-drag. Fizeau's experiment. Inertial and non-inertial frame. Validity of theory of relativity. Michelson-Morley's experiment; Einstein's definition of simultaneity, the two postulates of Relativity, Lorentz's Transformation, Fitzgerald contraction, Dilation of time, Proper time interval, Minkowski's four dimensional world, transformation of velocity & acceleration, force, variation of mass and energy, Four dimensional representation of velocity, momentum etc. Energy momentum tensors. Electromagnetic vectors as the component of tensor, electromagnetic field tensor, Maxwell's equations for electromagnetic field, in relativistic form, in four potential form, Lorentz transformation of the components of electromagnetic field tensor, four vector current, Invariants of fields, Lorentz force, Energy momentum tensor, Poynting vector and its physical interpretations. Principle of covariance, principle of equivalence; principle of Mech-Einstein's law of gravitational potentials, properties of metric tensor. Derivation of Einstein's equations, curvature tensor, Discussion of Schwarzschild, spherically symmetric, cylindrically symmetric and Robertson-Walker line element, Lie derivatives and Killing vectors.

**Books Recommended:**

1. R.C. Tolman : Relativity, Thermodynamics & Cosmology.
2. S. Weinberg: Gravitation & Cosmology: General Theory of Relativity.
3. H.P. Robertson W. Nauman : Relativity Cosmology
4. J.L. Synge : The special theory of Relativity.
5. C. Moller : The Theory of Relativity
6. G.C. Mc Vittle : General Relativity and Cosmology
7. M. Bauli : Theory of Relativity
8. H.H. Dicker : Relativity, Groups & Topology.
9. A.A. Michelson and E.W. Moreley : Relativity Physics.
10. J.L. Anderson : Principles of Relativity Physics.
11. S. Prakash : Relativistic Mechanics

**A.MTH 4111 : Bio-Mathematics  
(4 Hours, 100 Marks, 3 Credits)**

1. Continuous population models for single species: continuous Growth Models and its linear analysis. Periodic solutions. Harvesting a single Natural population.
2. Discrete population Model for a single species: Simple Models, Discrete Logistic Model's. Discrete Delay Models. Fishery Management Models.
3. Continuous Models for Interacting populations predator-prey Models (Lotka-Volterra systems) complexity and stability. Competition Models. Mutualism or symbiosis.
4. Discrete Growth Models for Interaction populations. Detailed Analysis of predator-prey Models.
5. Biological waves (Single Models) Fisher Equation and Propagation wave solutions. Asymptotic solutions and stability of wave not Diffusion Reactions. Diffusion Models and some Exact Equation.
6. Biological waves: Multispecies Reaction Diffusion Models.

7. Population Interaction Diffusion Mechanisms. Linear stability Analysis and Evolution of spatial pattern. Dispersion relation, Turning space, Scale and Geometry Effects in pattern Formation in Morphogenetic Models. Pattern Generation with single spicing Models.
8. Epidemic Models and the dynamics of intentions Diseases.

**Books Recommended:**

1. J.D. Murry : Mathematical Biology
2. J.N. Kapoor : Mathematical Biology

**A.MTH 4102 : Math Practical - V  
(4Hours, 100 Marks, 3Credits)**

[Four hours practical examination using c and MATLAB]

1. Solution of polynomial and transcendental equations and system of nonlinear equations.
2. Interpolation and polynomial approximation.
3. Matrices and solution of systems of linear equations.
4. Numerical differentiation and integration.
5. Numerical solution of ordinary differential equations and system of ordinary differential equations.
6. Numerical solution of partial differential equations and integral equations.
7. Curve fitting.

**IMPORTANT NOTE**

At least 15 (Fifteen) Lab assignments shall have to be done in the class. Solving 7 (Seven) problems 70 (Seventy) marks, Class performance 20 (Twenty) marks, Class assignments 05 (Five) marks, Attendance 05 (Five) marks. Total 100 (One Hundred) marks.



Year – IV, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH - 4201	Mathematical Cosmology	3	3	4
A.MTH - 4203	Mathematical Astronomy	3	3	4
A.MTH - 4205	Honours Project	3	3	4
A.MTH - 4202	Math Practical-VI	3	3	4
A.MTH - 4204	Viva-Voce	2		
Total		14		

Two subjects to be offered by the academic committee of the department from the following courses:

Year – IV, Term – II

Course Code	Course Title	Credits	Contact hours per week	Duration of Examination(hrs)
A.MTH – 4207	Bio-Mechanics	3	3	4
A.MTH – 4209	Mathematical Modeling in Finance and Business	3	3	4
A.MTH – 4211	Electromagnetic Theory	3	3	4
A.MTH – 4213	Mathematical Methods for Feed forward Artificial Neural Networks	3	3	4
A.MTH – 4215	Graph Theory	3	3	4
A.MTH – 4217	Mathematical Modeling in Biology	3	3	4
A.MTH – 4219	Micro and Macro Economics	3	3	4
Total		06		

Grand Total- (20 + 18 + 20+ 20+ 21+ 20+21 + 20) = 160 Credits

**A.MTH 4201 : Mathematical Cosmology  
(4 Hours, 100 Marks, 3 Credits)**

1. Large Scale Structure of the Universe

Astronomy and cosmology, Hubble's Law, the background radiation, relativistic cosmology, structural hierarchy.

2. General Relativity

Covariant differentiation, Riemannian geometry, Space-time curvature, Geodesics, The Principle of equivalence, Action principle and the Energy tensor, Gravitational equations. The Schwarzschild solution.

3. From relativity to cosmology

Historical background, The Einstein Universe, The Expanding Universe, Modifying assumptions of cosmology, The redshifts, The Luminosity of distance, Angular size.

4. The Friedmann models

The Robertson-walker Metric and the Einstein's equation. Derivation of the The Robertson-walker Metric. Energy Terms. The solutions of Friedmann equations. Cosmological constant. The space-time Singularity.

5. The Hubble Constant and Deceleration Parameter Measurement of  $H_0$ , Measurement of  $q_0$ , exact solution for zero pressure, Solution for pure radiation.

6. The Steady State Theory

Motivation for a Non big-bang Cosmology. The perfect Cosmological Principle, the Creation field, Observational Parameters of Steady state Theory, Physical and Astrophysical consideration.

7. History of the Universe

Matter Vs. Radiation Dominant Universe, The Hot Universe, The very Early Universe, Early Universe inflation and Higgs Field.

**Books Recommended:**

1. J.N.Islam : An Introduction to Mathematical Cosmology.
2. J.V.Narlikar : Introduction to Cosmology.
3. Martin Rees : Introduction to Cosmology: Willey , N.Y. 1994.
4. S.Weinberg : First Three Minutes.
5. A.K.Raychaudhuri : Theoretical Cosmology: The Expanding Universe.
6. P.J.Peebles : Physical Cosmology.
7. Landau & Lifshitz : Classical Theory of Fields

**A.MTH 4203 : Mathematical Astronomy**  
**(4 Hours, 100 Marks, 3 Credits)**

**1. The Celestial Sphere:**

Introduction, Terrestrial Longitude and Latitude, Definitions, Annual Motion of the sun, the Ecliptic Motion, System of Coordinates, Conversion of Coordinates from one system to another, Rectangular coordinates, Triangles PZX.

**2. Kepler's Laws:**

Planets. Kepler's Law, Newton's Law of Gravitation, Definitions, relations in elliptic motion, Lambert's Theorem and Euler's theorem.

**3. Time:**

Sidereal time, The sun's apparent orbit, The Mean Sun, The equation of the time, Seasons, Length of the seasons.

Planetary Phenomena: Conjugations, Orbit period and Synodic Periodic, Relation between Synodic periodic and orbital period, Direct and retrograde motion. The Geocentric Motion of a planet, Elongation of a planet when Stationary.

**3. Aberration:**

Aberration, Earth's way, Aberration varies as the Sine of the Earth's way, The effect of Aberration on Longitude and Latitude of a star, The Aberrational Eclipse, Effect of Aberration on right Ascension and Declination.

**4. Eclipses:**

Eclipses of the Moon, The Angular Radius of the Earth's Shadow at the Moons Distance. Duration of an Eclipse, Length of the Earth's Shadow, Solar Eclipses, The Angle subtended at the Earth's Centre by the Sun and the Moon at the beginning or end of a Solar Eclipse.

**Books Recommended:**

1. G.S.Malik : Spherical Astronomy
2. J.M.Kar : Mathematical Astronomy.

**A.MTH 4205: Honours Project**  
**( 100 Marks, 3 Credits)**

Each student is required to work on a project and present a project report for evaluation. Such projects should be extensions or applications of materials included in different honours courses and may involve field work and use of modern technology.

**Implementation and Evaluation of the Project :**

The Academic Committee shall appoint a project Implementation and coordination Committee (PICC) before the Year – IV, Term – I begins. The PICC shall consist of a project Coordinator (PC) and such other members as the Academic Committee considers appropriate. The PC shall invite projects from the teachers before the classes start in Year – IV, Term - I. Each teacher should submit five projects proposal and should include a short description of the project. Such projects should be extension of applications of materials included in different honors courses and may involve field work and use of modern technology such as computer language technology.

Projects must be individual. The project may not be changed later on without approval of the PICC. Student shall work independently on the assigned project under the supervision of the concerned teacher. The PICC shall monitor with the supervisors the progress of different projects and arrange weakly discussions on projects and materials.

**Completion:**

The project must be completed before the termination of the classes in Year – IV, Term - II. . Each report should be of around 35 pages typed on one side of A4 size paper. Graphs and figures should be clearly drawn.

The Academic Committee will fix a date for the submission of the projects to the PICC. Each student must submit three typed copies of her/his project report to the PICC on or before the date fixed for such submission.

The PICC, on receiving the reports, will arrange the presentation before the PICC. This presentation should take place soon after the completion of the written examination in Year – IV, Term - II. Any student who fails to submit the report on the due date or to present the project on the fixed date will not get any credit for this course.

**Evaluation**

The distribution of marks for each project shall be as follows:

Project Report	70 marks.
Project Presentation	30 marks.

Each project report shall be examined in normal procedure.

**A.MTH 4207: Bio-Mechanics**  
**(4 Hours, 100 Marks, 3 Credits)**

1. Contribution of Bio-mechanics in Health Science :

- (i) Clinical problems in cardiovascular system (ii) Quantitative physiology (iii) Additional applications.  
 2.(i) Equation of continuity (ii) Equation of motion (iii) Hagen Poiseulee theory of flow through a pipe in the light of N-S equation. (iv) N-S equations for compressible and incompressible fluid. (v) Reynold's number and other non- dimensional parameters (vi) General feature folaminar, turbulent and transitional flows. (vii) Steady and unsteady fully developed flows, Pulsatile flow, Flow in an elastic tube, Flow in an convergent and divergent channels and flow in slowly varying channel.  
 3. Biorheology, Capillary filtration coefficient, Capillary hydrostatic pressure, Tissue hydrostatic pressure, Plasma colloid osmotic pressure, Tissue colloid osmotic pressure. The lymphatic system, Glomerular filtration, Basement membrane, Peristaltic flow, Lipids.  
 4. Viscosity of fluids and suspensions, Osmotic pressure of Plasma, The blood cells and various properties of the blood.  
 5. The structure of the vessels of the micro-circulation, Blood flow in capillaries, Filtration and re-absorption of water within single capillaries and diffusion across the capillary wall.  
 6. Pulmonary circulation, Dynamics of blood in large pulmonary vessel. Flow in the alveolar sheet and effect of lung capillaries.  
 7. Permeability, Starling's hypothesis, Darcy's law. Beavers and Jespeh boundary conditions at a naturally permeable wall.  
 8. The extra-cellular fluid-the internal environment, Etra-cellular and Intra-cellular fluids, Systememic circulation and pulmonary or lung circulation.  
 9. Model of transcapillary fluid exchange  
 (i) Model of oka and Murata (ii) Model of Dinnar (iii) Model of Apelblat (iv) Model of Black and Gross (v) Model of Mahiuddin, MD.  
 10. Pappenheimer equivalent Pore-theory.

**Books Recommended:**

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|---|---|
| 1. Caro C.G., Pedley T.J; Schroter R.C; Seed W.A. | : The mechanics of the circulation.   |
| 2. Fung Y.C.                                      | : Biomechanics (Mechanical properties of living tissues).                       |
| 3. Bergel D.H                                     | : cardiovascular fluid dynamics   |
| 4. Fung Y.C.; Perone N. & An loker M              | : M Biomechanics : Its foundation and objectives.                               |
| 5. Hamilton W.F.                                  | : Hand book of physiology.  |
| 6. Taylor M.G                                     | : Haemodynamics.  |
| 7. Mc Donald D.A                                  | : Blood flow in arteries.   |
| 8. Guyton A.C. & Jones C.E.                       | : Cardiovascular Physiology.  |
| 9. Wolstenholme G.E.W                             | : Circulatory & respiratory mass transport.                                     |
| 10. Caro C.G                                      | : Mechanics of the pulmonary circulation.                                       |
| 11. Harries P & Heath D                           | :The human pulmonary circulation : Its form and function in health and disease. |
| 12. Yuan S.W.                                     | : Foundation of fluid mechanics.  |
| 13. Schlichting H                                 | : Boundary layer theory.  |
| 14. Miln Thompson L.M.                            | : Theoretical Hydrodynamics.  |
| 15. Arthu C, Cuton M.D.                           | : Text books of medical physiology.   |
| 16. Bhu Dev Sharma & B.K. Sachdeva                | : Elementary hydrodynamics.   |
| 17. Carslacs H.S & Jaegar J.C                     | : Conduction of Heat in Solids.   |
| 18. MAHIUDDIN MD.                                 | : Ph.D. Thesis  |

**A.MTH 4209: Mathematical Modeling in finance and Business**  
**(4 Hours, 100 Marks, 3 Credits)**

1. Set Theory and its applications to business problems. Applications of Matrices and system of linear equations.
2. Straight lines and its applications to business Break Even interpretations.
3. Mathematics for data processing Binary number system. Computations in binary system.
4. Simple and compound interest. Present and future value. Simple and compound discount. Depreciation Annuity.
5. Consumer loans. Other consumer computations. Supply and demand function. Application of supply and demand functions. Elasticity Relation between average and marginal cost
6. Marketing Mathematics: Markup and markdown. Merchandise and profit. Trade discounts and cash discounts.
7. Mathematics for management: Analysis of statements. Other business computations.
8. Application of integral calculus: Interpretive application of area consumer's and producer's surplus. Application of differential equation. Dynamic modeling and difference equation

**Books Recommended:**

- |                                   |   |
|-----------------------------------|---|
| 1. D. Prichet and John. C. Saber. | : Mathematics with applications in Management and Economics |
| 2. K. Holden and A. W. Pearson    | : Introductory Mathematics for Economics and Business       |
| 3. D. C. Sanchetiz. V. K. Kapoor. | : Business Mathematics                                      |

4. L.L. Smail, : Mathematics of Finance.  
 5. P.H. Charles Seebeck, : Mathematics of Finance.

**A.MTH 4211 : Electromagnetic Theory  
 (4 Hours, 100 Marks, 3 Credits)**

1. **Electrostatics:** The electrostatic field of force, conductors, condensers and dipole, systems of conductors, electrical images, electrostatic energy.
2. **Dielectrics:** Electro potential and displacement minimum energy of the field, uniqueness theorem, polarization.
3. **Capacitance and electric energy :** Capacitances of a conductors, capacitors in series and parallel, combination of capacitors, electric energy in terms of Q.V. and C.
4. **Steady electric current:** Electromagnetic force or e.m.f, field aspect, network aspect, resistance and conductors, general network theorem and Kirchhoff's law.
5. **Magnetism:** Fundamental of magnetostatics, magnetic field poles and strength volume vector and vector potential, mutual and self inductance, force on a current, Faraday's law.
6. **Steady current in magnetic material :** Equations of magnetic field and energy, magnetic dipole, electromagnetic Induction, amperes circuital theorem, Biot Savat law.
7. **Maxwell's equations:** Derivations, general solutions, and deductions, scalar and vector potentials, electromagnetic potentials, poynting theorem.
8. **Electromagnetic waves:** Plane electromagnetic waves in an isotropic non-conducting media, equation of telegraphy, Fresnel's relation.

**Books Recommended:**

1. Coulson : Electricity
2. Ferraro, V.C.A. : Electromagnetic theory
3. Gupta and Sharma : Mathematical Theory of Electricity and Magnetism
4. Duffin, W.J. : Electricity and Magnetism

**A.MTH 4213: Mathematical Methods for Feedforward Artificial Neural Networks  
 (4 Hours, 100 Marks, 3 Credits)**

- 1.**Fundamentals of Biological and Artificial Neuron Model:** Biological Neuron Model, The Human Nervous System, Definition of a Neuron Types of Neurons Neurons "Connections" Artificial Neuron Model Single-Input Artificial Neuron Model Activation Functions Multiple-Input Artificial Neuron Model, Examples
- 2.**Architecture of Feedforward Artificial Neural Networks:** A Single-Layer Feed forward Artificial Neural Network of S Neurons, Multi-Layer Feedforward Artificial Neural Network1 Multi-Layer Feed forward Artificial Neural Network of S, Neurons, Structure and Geometric visualization for one and two layered feed-forward, The XOR Problem Geometric visualization
- 3.**Learning in Feedforward Artificial Neural Networks:** Supervised and unsupervised learning Multilayer Perceptrons and Back-Propagation, Learning, Radial-Basis Function Networks
- 4.**Implementation of Mathematical Methods:** Statement of the Problem, Implementation of Optimization Methods, Method of Steepest Descent, Newton's Method, Gauss-Newton Method, Levenberg-Marquardt Method, Conjugate Gradient Method, Quasi-Newton Method

**Books Recommended:**

1. Hassoun MH : Fundamentals of Artificial Neural Networks
2. Ben Krose : An Introduction to Neural Network
3. Gallant S : Neural Network learning and Expert Systems
4. Terrence L. Fine : Feed forward Neural Network Methodology

**A.MTH 4215: Graph Theory  
 (4 Hours, 100 Marks, 3 Credits)**

1. **Discovery of graph theory :** Definition and examples of graphs, multigraphs, digraphs, bigraphs, walks and connectedness, intersection graphs, operation of graphs.
2. **Blocks:** Cut points, bridges, and blocks, block graphs and cut point graphs.
3. **Trees**
4. **Connectivity and traverability, Eulerian and Hamiltonian graphs.**
5. **Line graphs, special line graphs, total graphs.**
6. **Plane and planar graphs.**
7. **Color ability:** The chromatic numbers, the five color theorem, statement of the four color theorem.
8. **Matrices :** The adjacency matrix, the incident matrix, the cycle matrix.

**Books Recommended:**

1. Frank Harary : Graph Theory, Narosa Publishing House, New Delhi
2. West : Graph Theory
3. Parthasarathy : Graph Theory
4. Calaude Berge : Introduction to Graph Theory

**A.MTH 4217 : Mathematical Modeling in Biology  
(4 Hours, 100 Marks, 3 Credits)**

1. **Continuous population models for single species** : Simple models, Continuous growth models, Malthusian models, logistic models, delay models harvesting models.
2. **Continuous Models for Interacting Population**: Two species population models, Prey-predator models, Lotka-Volterra models, multi-spaces population models, War models, competition models mutualism.
3. **Discrete population models** : Simple discrete models, logistic discrete models, Stability, discrete delay models, discrete growth models for interacting populations Fishery management models.
4. **Epidemic Models and Dynamics of Infections Diseases**: Simple epidemic models and some practical applications (GIV/AIDS model, etc) control of epidemic model.

**Books Recommended:**

1. J.N. Kapur : Mathematical model in Biology and medicine.
2. H.I. Freedman: Deterministic Mathematical model in Population Ecology.
3. J.D. Murray : Mathematical Biology.

**A.MTH 4219 :Micro and Macro Economics  
(4 Hours, 100 Marks, 3 Credits)****Group A: Micro Economics****1. Subject matter of Economics:**

Scope and methodology of positive economics. Central problem of every economic society, and Scarcity and choices. How the economic problems are solved under alternative economic systems. The price system, Micro vs macro economics. Theory and reality.

**2. Elements of market equilibrium:**

Demand function. Demand schedules and demand curves. Changes in demand and supply – market price, static analysis comparative statics, market dynamics, stable and unstable equilibrium. Excess demand and excess supply condition. Role of time elements in market equilibrium.

**3. Consumer Theory**

**a)Utility Approach:** Meaning of utility, Total utility and Marginal utility, Law of diminishing marginal utility of money, Equilibrium of the consumer, Equimarginal principle, Derivation of demand curves, Applications.

**b) Indifference Curve Approach:** Preference, Choice and indifference, Indifference schedules and indifference curves, Equilibrium of the consumer with budget constraint, Effect of changes in price. Income effect and substitution effect, Inferior goods, Derivation of demand curves, Market demand curves, Applications.

**4. Producer theory:**

Production: Meaning of production function, production with a single inputs variable proportion and diminishing returns. Two variable inputs returns to scale.

**5. Costs:**

Short run and long run cost functions and the nature of costs production costs, Short run conventional cost curves other types of short run cost curves.

**Group B: Macro Economics**

**1.** The subject matter of macro economic its relation to micro economics Methodology circular flow of income stationary economy growing economy.

**2.** National income measurement- Conceptual problems in the estimation of national product.

**3.The Classical Model:** The demand for a supply of labour – equilibrium level of employment and output Savings and investment in the classical model Say's law of markets- Classical theory of prices.

**4. The Keynesian Model:****A. Consumption:**

Aggregate and cross-section consumption functions.

**B. Investment:**

The theory of investment-demand price, supply price and the investment the equilibrium level of investment.

**Books Recommended:**

1. L. Lancaster : Introduction to Micro Economics
2. R. G. Lipsey G. R. Spards and P. O. Steiner : Economics
3. D. W. Watson : Price theory and its uses.
4. Shapiro, Macro : Economics theory.
5. N. N. Stegel : Aggregate Economics and Policy.
6. T. F. Dernburg and D. M. Magdongal : Macro Economics
7. G. Ackley : Macro- Economic theory.

**A.MTH 4202 : Math Practical - VI  
(4Hours, 100 Marks, 3Credits)**

[Four hours practical examination using C++ / FORTRAN]

1. Solution of polynomial and transcendental equations and system of nonlinear equations.
2. Interpolation and polynomial approximation.
3. Matrices and solution of systems of linear equations.
4. Numerical differentiation and integration.
5. Numerical solution of ordinary differential equations and system of ordinary differential equations.
6. Numerical solution of partial differential equations and integral equations.
7. Curve fitting.

**IMPORTANT NOTE**

At least 15 (Fifteen) Lab assignments shall have to be done in the class. Solving 7 (Seven) problems 70 (Seventy) marks, Class performance 20 (Twenty) marks, Class assignments 05 (Five) marks, Attendance 05 (Five) marks. Total 100 (One Hundred) marks.

**A.MTH 4204: Viva-Voce  
( 100 Marks, 2 Credits)**

Comprehensive Viva -Voce basis on the subjects which are taught in the Year-IV, Term-I , Year-IV, Term-II and basic knowledge on Applied Mathematics.