# DEPARTMENT OF MATHEMATICS

# DR. SHYAMA PRASAD MUKHERJEE UNIVERSITY



# PROPOSED YEAR WISE STRUCTURE & SYLLABUS OF

# FOUR YEAR U.G. PROGRAM IN MATHEMATICS

# UNDER

# NEW EDUCATION POLICY 2020

Implementing from Academic Year 2023-2026 Onwards

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Dean
Faculty of Science
DSPMU, Ranchi

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Dr. A. K. MAHATO       14.06.2023

Dr.(Mrs.) Anita Kumari       14/06/2023

# DEPARTMENT OF MATHEMATICS
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# HIGHLIGHTS AND REGULATIONS OF FOUR YEAR U.G. PROGRAM IN MATHEMATICS

## COURSES OF STUDY:

Courses of the study indicate pursuance of study in a particular discipline. Every discipline shall offer four categories of courses of study, viz. Major Paper (MJ) courses, Minor from Discipline 1 (MN), Skill Enhancement Courses (SECs) and Minor from Discipline 2 (MVC). Besides these four courses, a student will select Ability Enhancement Courses (AECs) and Value-Added Courses (VACs) from the respective pool of courses offered by the University.

a) **Major Paper (MJ)**: Major Paper is a course of study, which should be pursued by a student as a mandatory requirement of his/ her programme of study. In Bachelor of Science (Hons.) Mathematics programme, MJs are the core credit courses of Mathematics which will be appropriately graded and arranged across the semesters of study, being undertaken by the student, with multiple exit options as per NEP 2020.

b) **Minor from Discipline 1 (MN):** The Minor from Discipline 1 (MN1) are a pool of credit courses of Mathematics from which a student will choose to study based on his/ her interest.

c) **Minor from Discipline 2 (MVC):** Generic Electives is a pool of courses offered by various disciplines of study (excluding the GEs offered by the parent discipline) which is meant to provide multidisciplinary or interdisciplinary education to students. In case a student opts for MNs beyond his/ her discipline specific course(s) of study, such MJs shall be treated as MN2s for that student.

d) **Ability Enhancement course (AEC), Skill Enhancement Course (SEC) and Value Addition Course (VAC):** These three courses are a pool of courses offered by all the Departments in groups of odd and even semesters from which a student can choose.

    I.     **AEC:** AEC courses are the courses based upon the content that leads to knowledge enhancement through various areas of study. They are based on Language and Literature, and Environmental Science which are mandatory for all disciplines.

    II.     **SEC:** SECs are skill-based courses in all disciplines and are aimed at providing hands-on training, competencies, proficiency and skills to students. SEC courses may be chosen from a pool of courses designed to provide skill-based instruction.

    III.     **VAC:** VACs are common pool of courses offered by different disciplines and aimed towards personality building, embedding ethical, cultural and constitutional values; promote critical thinking, Indian knowledge systems, scientific temperament, communication skills, creative writing, presentation skills, sports and physical education and team work which will help in all round development of students.

## PROGRAMME OVERVIEW/SCHEME OF PROGRAMME

Undergraduate degree programme of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:

> ➤ A Certificate after completing 1 year (2 Semesters) of study in the chosen field of study.
> ➤ A Diploma after completing 2 years (4 Semesters) of study in the chosen field of study.
> ➤ A Bachelor's Degree after completing 3 years (6 Semesters) of study in the chosen field of study.
> ➤ A bachelor's Degree with Hons. / Research after completing 4 years (8 Semesters) of study in the chosen field of study.

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## DURATION OR VALIDITY OF REGISTRATION

I. The UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.

II. Each academic year shall comprise of two semesters, viz. Odd and Even semesters.

III. Odd Semesters shall be from July to December and Even Semesters from January to June.

IV. Eligibility to get entry in Semester VII is to secure a minimum of 7.5 CGPA up to semester VI along with other criteria imposed by the Institution.

V. The validity of credits earned and kept in the Academic Bank of Credit account will be 7 years. After 7 years, re-entry into a programme of study will be based on the validation of prior learning outcomes.

## CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

➤ Student's final marks and the result will be based on the marks obtained in Semester Internal Examination and End Semester Examination organized taken together.

➤ Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

➤ The pass marks in 160 credit courses will be 40% of the total marks obtained in each Course offered by the student.

➤ To pass in **MIL Non-Hindi** subject, a student must obtain minimum 40 marks as the aggregate of the two subjects taken together. Besides, He/she must also get 40% pass marks in both the papers individually.

## PROMOTION AND SPAN PERIOD

I. The Requisite Marks obtained by a student iii a particular subject will be the criteria for promotion to the next Semester.

II. No student will be detained in odd Semesters (I, III, V & VII).

III. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of Courses in an academic year (a student has to pass in minimum 9 papers out of the total 12 papers. However, it will be necessary to procure pass marks in each of the paper before completion of the course.

IV. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 16 papers out of the total 22 papers.

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## PUBLICATION OF RESULT

- The result if the examination shall be notified by the Controller of Examinations of the University in different newspapers and also on University website.

- If a student is found indulged in any kind of malpractice/unfair means during examinations, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of next coming session and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.

- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination for clearing the backlog. Similarly, the Students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.

- Regulation related with any concern not mentioned above shall be guided by the Regulations of the University for Four Year Under Graduate Program.

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## COURSE STRUCTURE FOR FOUR YEAR UNDER UNDERGRADUATE PROGRAM 'HONOURS/RESEARCH'

### Credit Framework for Four Year Undergraduate Program under State Universities of Jharkhand [Total Credits=160]

| Level of Courses | Semester | MJ: Discipline Specific Courses- Core or Major | MN: Minor from Discipline (16) | MVC: Minor from Vocational (16) | MDC: Multidisciplinary Courses (9) | AEC: Ability Enhancement Courses (Modern Indian Languages and English) (8) | SEC: Skill Enhancement Courses (9) | VAC: Value Added Courses (6) | IAP: Internship / Dissertation (4) | RC: Research Courses (12) | AMJ: Advanced Courses in lieu of Research (12) | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Foundation or Introductory Courses | I | 4 | 4 | 4 | 3 | 2 | 3 | 2+2 | | | | 20 |
| | II | 4+4 | | 4 | 3 | 2 | 3 | | | | | 20 |
| Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 Credits) | | | | | | | | | | | | |
| Intermediate - Level Courses | III | 4+4 | 4 | | 3 | 2 | 3 | | | | | 20 |
| | IV | 4+4+4 | | 4 | | 2 | | 2 | | | | 20 |
| Exit Point: Undergraduate Diploma provided with Summer Internship in $1^{st}$ or $2^{nd}$ / Project (4 Credits) | | | | | | | | | | | | |
| Higher – Level Courses | V | 4+4+4 | 4 | | | | | | 4 | | | 20 |
| | VI | 4+4+4+4 | | 4 | | | | | | | | 20 |
| Exit Point: Bachelor's Degree | | | | | | | | | | | | |
| Advanced Courses | VII | 4+4+4+4 | 4 | | | | | | | | | 20 |
| | VIII | 4 | | 4 | | | | | | 12 | 4+4+4 | 20 |
| Exit Point: Bachelor's Degree with Hons. / Hons. With Research | | | | | | | | | | | | 160 |

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a research Project / Dissertation.

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## DEPARTMENT OF MATHEMATICS
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### COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME
### Semester wise Course Code and Credit Points for Single Major

| Semester | Common, Introductory, Major, Minor, Vocational &Internship Courses | | Credits |
| --- | --- | --- | --- |
| | Code | Papers | |
| I | AEC-101T | Language and Communication Skills ( MIL-1; Modern Indian Language including TRL) | 2 |
| | VAC-101T | Value Added Course-1 | 2 |
| | VAC-101T | Value Added Course-2 | 2 |
| | SEC-101T | Skill Enhancement Course-1 | 2 |
| | SEC-101P | Skill Enhancement Course-1 Practical | 1 |
| | MDC-101T | Multi-Disciplinary Course-1 | 3 |
| | MN-101T | Minor From Discipline-1 | 3 |
| | MN-101T | Minor From Discipline-1 Practical | 1 |
| | MJ-101T | Major Paper-1(Disciplinary Major) | 4 |
| II | AEC-201T | Language and Communication Skills ( English 1) | 2 |
| | SEC-201T | Skill Enhancement Course-2 | 2 |
| | SEC-201P | Skill Enhancement Course-2 Practical | 1 |
| | MDC-201T | Multi-Disciplinary Course-2 | 3 |
| | MVC-101T | Minor From Discipline-2(Vocational Studies) | 3 |
| | MVC-101P | Minor From Discipline-2(Vocational Studies) Practical | 1 |
| | MJ-201T | Major Paper-2(Disciplinary Major) | 4 |
| | MJ-202T | Major Paper-3(Disciplinary Major) | 4 |
| III | AEC-3 | Language and Communication Skills ( MIL-2; Modern Indian Language including TRL) | 2 |
| | SEC-301T | Skill Enhancement Course-3 | 2 |
| | SEC-301T | Skill Enhancement Course-3 Practical | 1 |
| | MDC-301T | Multi-Disciplinary Course-3 | 3 |
| | MN-201T | Minor From Discipline-1 | 4 |
| | MJ-301T | Major Paper-4(Disciplinary Major) | 4 |
| | MJ-302T | Major Paper-5(Disciplinary Major) | 4 |
| IV | AEC-401T | Language and Communication Skills ( English 2) | 2 |
| | VAC-401T | Value Added Course-2 | 2 |
| | MVC-401T | Minor From Discipline-2 (Vocational Studies) | 3 |
| | MVC-401T | Minor From Discipline-2 (Vocational Studies) Practical | 1 |
| | MJ-401T | Major Paper-6(Disciplinary Major) | 4 |
| | MJ-402T | Major Paper-7(Disciplinary Major) | 4 |
| | MJ-403T | Major Paper-8(Disciplinary Major) | 4 |

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|---|---|---|---|
| V | MN-501T | Minor From Discipline-1 | 4 |
| | MJ-501T | Major Paper-9 (Disciplinary Major) | 4 |
| | MJ-502T | Major Paper-10(Disciplinary Major) | 4 |
| | MJ-503T | Major Paper-11(Disciplinary Major) | 4 |
| | INT-501P | Internship/Dissertation/ Project (Compulsory for all students) | 4 |
| VI | MVC-601T | Minor From Discipline-2 (Vocational Studies) | 3 |
| | MVC-601T | Minor From Discipline-2 (Vocational Studies) Practical | 1 |
| | MJ-601T | Major Paper-12(Disciplinary Major) | 4 |
| | MJ-602T | Major Paper-13(Disciplinary Major) | 4 |
| | MJ-603T | Major Paper-14(Disciplinary Major) | 4 |
| | MJ-604T | Major Paper-15(Disciplinary Major) | 4 |
| VII | MN-701T | Minor From Discipline-1 | 4 |
| | MJ-701T | Major Paper-16(Disciplinary Major) | 4 |
| | MJ-702T | Major Paper-17(Disciplinary Major) | 4 |
| | MJ-703T | Major Paper-18(Disciplinary Major) | 4 |
| | MJ-704T | Major Paper-19(Disciplinary Major) | 4 |
| VIII | MVC-801T | Minor From Discipline-2 (Vocational Studies) | 3 |
| | MVC-801T | Minor From Discipline-2 (Vocational Studies) Practical | 1 |
| | MJ-801T | Major Paper-20(Disciplinary Major) | 4 |
| | RC/ | Research Internship/ Field Work/ Dissertation  OR | 12/ |
| | AMJ-802T | Advanced Major Paper-1(Disciplinary Major) | 4 |
| | AMJ-803T | Advanced Major Paper-2(Disciplinary Major) | 4 |
| | AMJ-804T | Advanced Major Paper-3(Disciplinary Major) | 4 |
| | | **Total Credit** | **160** |

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**Semester Wise Examination Structure in Discipline Courses:**

| Semester | Major, Skill Enhancement Internship, Introductory and Research Courses | | Examination Structure | | | | Award |
|---|---|---|---|---|---|---|---|
| | Code | Papers | Credits | Mid Semester Theory (F.M.) | End Semester Theory (F.M.) | End Semester Practical (F.M.) | |
| I | MJ-101T | Differential and Integral Calculus | 4 | 25 | 75 | --- | Certificate |
| | SEC-101 | Elementary Computer Application Software | 2+1 | --- | 50 | 25 | |
| II | MJ-201T | Matrices and Analytical Geometry | 4 | 25 | 75 | --- | |
| | MJ-202T | Vector Calculus & Trigonometry | 4 | 25 | 75 | --- | |
| | SEC-2 | C++ Programming for Mathematics | 2+1 | --- | 50 | 25 | |
| III | MJ-301T | Analysis-1 | 4 | 25 | 75 | --- | Diploma |
| | MJ-302T | Group Theory and Set Theory | 4 | 25 | 75 | --- | |
| | SEC-3 | LaTeX and HTML | 2+1 | --- | 50 | 25 | |
| IV | MJ-401T | Ordinary Differential Equation | 4 | 25 | 75 | --- | |
| | MJ-402T | Theory of Real Functions | 4 | 25 | 75 | --- | |
| | MJ-403T | Mechanics | 4 | 25 | 75 | --- | |
| V | MJ-501T | Linear Algebra | 4 | 25 | 75 | --- | Degree |
| | MJ-502T | Linear Programming | 4 | 25 | 75 | --- | |
| | MJ-503T | Ring Theory | 4 | 25 | 75 | --- | |
| VI | MJ-601T | Advanced Mechanics | 4 | 25 | 75 | --- | |
| | MJ-602T | Number Theory and Laplace Transform | 4 | 25 | 75 | --- | |
| | MJ-603T | Complex Analysis | 4 | 25 | 75 | --- | |
| | MJ-604T | Numerical Analysis | 4 | 25 | 75 | --- | |
| VII | MJ-701T | P. D. E. and Calculus of Variation | 4 | 25 | 75 | --- | B.Sc. Research |
| | MJ-702T | Metric Space | 4 | 25 | 75 | --- | |
| | MJ-703T | Advance Integral and Special Function | 4 | 25 | 75 | --- | |
| | MJ-704T | Discrete Mathematics and Logic Gates Function | 4 | 25 | 75 | --- | |
| VIII | MJ-801T | Integral Equations | 4 | 25 | 75 | --- | |
| | RC-801T | Research Methodology | 4 | 25 | 75 | --- | |
| | RC-802T | Research Proposal, Internship and Field Work | 4 | --- | --- | 100 | |
| | RC-803T | Research Report | 4 | --- | --- | 100 | |
| | **OR** | | | | | | |
| | AMJ-802T | Topology | 4 | 25 | 75 | --- | |
| | AMJ-803T | Tensor & Differential Geometry | 4 | 25 | 75 | --- | |
| | AMJ-804T | Functional Analysis | 4 | 25 | 75 | --- | |

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# AIMS OF BACHELOR'S DEGREE PROGRAMME IN MATHEMATICS

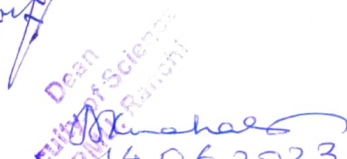**The broad aims of the NEP 2020 programme for Mathematics are to:**

- Create deep interest in learning mathematics.
- Develop broad and balanced knowledge and understanding of definitions, concepts, principles and theorems.
- Familiarize the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.
- Enhance the ability of learners to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics.
- Provide students/learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.
- Encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

# PROGRAM LEARNING OUTCOMES

**The broad programme learning outcomes in Mathematics are:**

1) Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of mathematics. This also leads to study of related areas like computer science and statistics. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics.

2) The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilized in modelling and solving real life problems.

3) Students undergoing this programme learn to logically question assertions, to recognize patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn behave responsibly in a rapidly changing interdependent society.

4) Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.

5) Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools.

6) This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.

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## SEMESTER-I

1. **MAJOR COURSES – MJ 101T**
   **DIFFERENTIAL AND INTEGRAL CALCULUS - 4 CREDITS**
   60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. Assimilate the notions of limit of a sequence and convergence of a series of real numbers.
2. Calculate the limit and examine the continuity of a function at a point.
3. Understand the consequences of various mean value theorems for differentiable functions.
4. Sketch curves in Cartesian and polar coordinate systems.
5. Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

### GROUP -A
### DIFFERENTIAL CALCULUS

Successive differentiation, Leibnitz's theorem. Maclaurin's and Taylor series expansion.

**1 Question**

Partial differentiation, Euler's theorem for functions of two variables, Total differential, Jacobian

**2 Questions**

Tangent and normal, curvature. Asymptotes, Maxima and Minima of functions of two variables, Lagrange's multipliers.

**2 Questions**

### GROUP – B
### INTEGRAL CALCULUS

Integration of rational and irrational functions. Evaluation of definite integrals, differentiations and integration under the sign of integration (Beta and Gamma function are excluded), Reduction formula. Point of inflexion, double point, curve tracing. Length of plane curve and area bounded by plane curves. Volume and surface area of solid of revolution.

**5 Questions**

### Books Recommended:

1. Differential Calculus  :   Das & Mukherjee.
2. Differential Calculus  :   M. L. Khanna.
3. Integral Calculus       :   Das & Mukherjee.
4. Integral Calculus       :   Lalji Prasad.
5. Integral Calculus       :   J. N. Sharma.

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## SEMESTER-II

1. **MAJOR COURSES – MJ 201T**
**DIFFERENTIAL AND INTEGRAL CALCULUS - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:
This course will enable the students to:
1. Understand operations and types of Matrices.
2. Calculate solution of linear equations using matrix method.
3. Reduce the general equation of second degree to the standard forms.
4. Know the polar equation of the conic.
5. Know the properties of three dimensional shapes.

### GROUP – A
### MATRICES

Different types of Matrices, Algebra of Matrices, Adjoint and inverse of a Matrix, different ways of finding inverses.

Elementary row and column operations. Elementary matrices, equivalent matrices, Rank of a matrix, Invariance of rank through elementary row/column operations, rank of sum and product of matrices and related theorems.

Solution of a system of linear equations via matrix methods, Consistency, Inconsistency.

**3 Questions**

### GROUP - B
### ANALYTICAL GEOMETRY OF TWO& THRE DIMENSIONS

Change of rectangular axes. Condition for the general equation of second degree to represent parabola, ellipse, hyperbola and reduction into standard forms. Equations of tangent and normal (Using Calculus). Chord of contact, Pole and Polar. Pair of tangents in reference to general equation of conic. Axes, centre, director circle in reference to general equation of conic. Polar equation of conic.

**4 Questions**

3D – Rectangular, spherical-polar and cylindrical co-ordinates, Direction cosines. Angle between straight lines equation of planes and straight lines, shortest distance between the lines. Sphere.

**3 Questions**

### Books Recommended:
1. Matrices : A. R. Vashishta.
2. Matrices : Shanti Narayan.
3. Analytical Geometry & Vector Analysis : B. K. Kar.
4. Co-Ordinate Geometry : Lalji Prasad.
5. Coordinate Geometry of 3D : J. T. Bell.

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2. **MAJOR COURSES – MJ 202T**
**VECTOR CALCULUS & TRIGONOMETRY - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:
This course will enable the students to:
1. Understand Vector Multiplication, differentiation.
2. Evaluate Gradient, Divergence & Curl.
3. Understand Vector Integration and evaluate surface and volume integrals.
4. Evaluate trigonometric and exponential functions and Gregory series.

### GROUP - A
### VECTOR CALCULUS

Product of three and four vectors, work done, moment of a vector about a point and a line. Scalar and vector point functions, differentiation of a vector function of scalar variables. Gradient, Divergence and Curl, second order operators in Cartesian coordinate system.

**4 Questions**

Vector integration: Line integral, surface integral, volume integral, Green's theorem in $R^2$. Stoke's theorem, Gauss Divergence theorem.

**3 Questions**

### GROUP - B
### TRIGONOMETRY

De Moivre's theorem and its applications. Trigonometric and Exponential functions of complex argument and hyperbolic functions. Gregory- Series Summation of Trigonometrical series. Factorization of $\sin\theta$ & $\cos\theta$.

**3 Questions**

### Books Recommended:
1. Trigonometry     :     Das & Mukherjee.
2. Trigonometry     :     Lalji Prasad.
3. Vector Calculus  :     Lalji Prasad.
4. Vector Calculus  :     Shanti Narayan.

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## SEMESTER-III

1. **MAJOR COURSES – MJ 301T**
   **REAL ANALYSIS - 4 CREDITS**
   60Lectures

   | Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
   | --- | --- |

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
2. Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
3. Apply the ratio, root, and alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

### GROUP - A

The axiom of least upper bound and greatest lower bound in R. The completeness property of R, Archimedean property, denseness of rational and irrational numbers in R. Neighbourhoods and limit point of a set, open and closed sets, isolated points, Bolzano — Weierstrass theorem for sets. Sequences, bounded sequence, convergent sequence, theorems on convergent sequence, subsequence, Cauchy sequence and Cauchy's general principle of convergence.

**5 Questions**

### GROUP - B

Infinite series, Convergence and divergence of infinite series of real numbers, Cauchy's general principle of convergence for real numbers, Pringsheim's theorem, Comparison test, Cauchy's root test, D'Alembert's ratio test, Raabe's test, De-Morgan's and Bertrand's test, Gauss's ratio test, Cauchy's condensation test, Integral test, Alternating Series, Leibnitz test, Absolute and conditional convergence.

**5 Questions**

### Books Recommended:

1. Elements of Real Analysis     Shanti Narayan & M. D.Raisinghania.
2. Higher Algebra     S. Bernard & J. M. Child

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2. **MAJOR COURSES – MJ 302T**

**GROUP THEORY AND SET THEORY - 4 CREDITS**

60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

**Course Objective and Learning Outcomes:**

This course will enable the students to:

1. Recognize the mathematical objects called groups.
2. Link the fundamental concepts of groups and symmetries of geometrical objects.
3. Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4. Analyze consequences of Lagrange's theorem.
5. Learn about structure preserving maps between groups and their consequences.
6. Learn about Countable, Uncountable & Cardinality of sets.

## GROUP - A
### GROUP THEORY

Definition and examples of groups including dihedral, Symmetries of a square, permutation and quaternion groups, Elementary properties of groups. Subgroups and examples of subgroups, cyclic groups, Properties of cyclic groups. Cosets of a Group Properties of cosets, Lagrange's theorem. Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups. Centralizer, Normalizer, Center of a group, Product of two subgroups.

**3 Questions**

Classification of subgroups of a cyclic groups. Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications. Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms. First, second and third isomorphism theorems for groups. Definitions and elementary properties of rings and fields.

**4 Questions**

## GROUP - B
### SET THEORY

Indexed family of sets, Generalised set of operations & DeMorgan's laws, Set mapping. Equivalence relation and related fundamental theorem of partition. Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, Partial order relation and relate concepts of u.b., l.b., inf., sup, maximal element, minimal element and lattice (definition and examples only), statement of Zorn's lemma.

**3 Questions**

**Books Recommended:**

1. Modern Algebra : A. R.Vashishtha& A. K. Vashishtha.
2. Modern Algebra : Quazi Zameeruddin
3. Contemporary Abstract Algebra : Joseph A. Gallian.
4. Set Theory : K. K. Jha
5. Set Theory : Thomas Jech

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## SEMESTER-IV

1. **MAJOR COURSES – MJ-401T**
**ORDINARY DIFFERENTIAL EQUATION - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:
This course will enable the students to:
1. Understand the genesis of ordinary as well as partial differential equations.
2. Learn various techniques of getting exact solutions of certain solvable first order differential equations and linear differential equations of second order.
3. Know Picard's method of obtaining successive approximations of solutions of first order ordinary differential equations, passing through a given point in the plane.
4. Learn about solution of first order linear partial differential equations using Lagrange's method.
5. Know how to solve second order linear partial differential equations with constant coefficients.
6. Formulate mathematical models in the form of ordinary and partial differential equations to problems arising in physical, chemical and biological disciplines.

### Unit-I: First Order Differential Equations
Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for $x$, $y$ and $p$. Clairaut's form and singular solutions. Orthogonal trajectories. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

**3 Questions**

### Second Order Linear Differential Equations
Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Simultaneous linear differential equations with constant coefficients.

**3 Questions**

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## Higher Order Linear Differential Equations

Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

**4 Questions**

### Books Recommended:

1. Differential Equations : M. D. Raisinghania.
2. Advanced Engineering Mathematics : Erwin Kreyszig.
3. A Course in Ordinary Differential Equations : B. Rai, D. P. Choudhury & H. I. Freedman.
4. Differential Equations : Shepley L. Ross.
5. Differential Equations : H. T. H. Piaggio

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2. **MAJOR COURSES – MJ 402T**
**THEORY OF REAL FUNCTIONS - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

**Course Objective and Learning Outcomes:**
This course will enable the students to:

1. Realize importance of bounded, convergent, Cauchy and monotonic sequences of real numbers, find their limit superior and limit inferior.
2. Apply various tests to determine convergence and absolute convergence of a series of real numbers.
3. Learn about Riemann integrability of bounded functions and algebra of R-integrable functions.
4. Determine various applications of the fundamental theorem of integral calculus.

### GROUP – A

Limit of function: Limit, algebra of limit of functions, Continuity and discontinuities, algebra of continuous functions. Intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, functions of bounded variations.

**3 Questions**

### GROUP – B

Derivability: Derivability, relationship with continuity, Rolle's theorem, Lagrange's and Cauchy Mean value theorem, Taylor's Theorem, Maclaurin's theorem, remainder after n terms, power series expansion of $(1 + x)^n$, $sinx$, $cos\ x$, $e^x$, $log\ x$ using suitable remainder after n terms.

**4 Questions**

### GROUP- C

Riemann Integration: Definition, Darboux theorem $I$ and $II$, Integrability conditions. Particular classes of bounded integrable functions. Primitive, Fundamental theorem, First and Second Mean Value theorem.

**3 Questions**

**Books Recommended:**
1. Introduction to Real Analysis  :  R. Bartle & D. R.Sherbert
2. Elements of Real Analysis  :  Shanti Narayan & M. D.Raisinghania.
3. Real Analysis  :  Lalji Prasad

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3. **MAJOR COURSES – MJ-403T**
**MECHANICS - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
| --- | --- |

**Course Objective and Learning Outcomes:**

This course will enable the students to:

1. Familiarize with concepts of Linear and Coplanar forces acting on a particle/ system of particles.
2. Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a particle.
3. Determine the centre of gravity of materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.
4. Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
5. Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

## GROUP – A

### STATICS

Coplanar forces acting on a system of particles, Equilibrium of a particle, Equilibrium of a system of particles, Necessary conditions of equilibrium, Moment of a force about a point, Moment of a force about a line, Couples, Moment of a couple, Equipollent system of forces, Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omitted in forming the equations of virtual work.

**2 Questions**

Centres of gravity of plane area including a uniform thin straight rod, triangle, circular arc, semicircular area and quadrant of a circle, Centre of gravity of a plane area bounded by a curve, Centre of gravity of a volume of revolution. Flexible strings, Common catenary, Intrinsic and Cartesian equations of the common catenary, Approximations of the catenary.

**2 Questions**

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## GROUP – B

### DYNAMICS

Motion of a Particle in a straight line under central forces. Simple harmonic motion (SHM) and its geometrical representation, SHM under elastic forces, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varying mass.

**2 Questions**

Kinematics and kinetics of the motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates. Motion in a vertical circle, projectiles in a vertical plane and cycloidal motion.

**2 Questions**

Equation of motion in a plane under a central force, Central orbit, Differential equation of the orbit, (p, r) equation of the orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion.

**2 Questions**

**Books Recommended:**
1. Degree level Mechanics : Singh and Sen.
2. Principle of Mechanics : J. L. Synge & B. A. Griffith
3. Statics : A. S. Ramsey.
4. Statics : S. L. Loney
5. Dynamics : R. K. Gupta and D. C. Agarwal.
6. Dynamics : A. S. Ramsey.
7. Elementary Dynamics : P. L. Srivastava.
8. Dynamics : S. L. Loney

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## SEMESTER-V

1. **MAJOR COURSES – MJ 501T**
**LINEAR ALGEBRA - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:
This course will enable the students to:
1. Learn about properties of linear transformation and isomorphism theorems.
2. Understand the concept of polynomials and their prime factorization.
3. Find canonical form of linear transformations.
4. Obtain various variants of diagonalisation of linear transformations.
5. Apply Cauchy-Schwarz inequality for deriving metric on inner product spaces and obtain orthonormal basis using Gram-Schmidt orthogonalisation.

### GROUP -A
Vector spaces, subspaces, algebra of subspaces, linear combination of vectors, linear span, linear dependence and linear independence, basis and dimension, coordinate vector of a vector relative to a basis and related theorems. Complement of a subspace, direct sum and quotient space.

**4 Questions**

### GROUP - B
Linear transformations, null space, range, rank and nullity of a linear transformation, Sylvester's law of nullity. Matrix representation of a linear transformation, algebra of linear transformations. Isomorphism, isomorphism theorems, invertibility and isomorphism, change of coordinate matrix.

**3 Questions**

### GROUP -C
Linear functional, dual spaces, dual basis, double dual transpose of a linear transformation and its matrix in the dual basis. Characteristic polynomial and characteristic values of a linear operator, diagonalizability, Cayley-Hamilton theorem and its applications.

**3 Questions**

### Books Recommended:
1. Linear Algebra                                         :    K. Hoffman & R.Kunze.
2. Introduction to Linear Algebra              :    Gilbert Strang.
3. Linear Algebra                                         :    A. R.Vashishtha.
4. Video Lectures of Linear Algebra          :    Robert Gardner

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2. **MAJOR COURSES – MJ-502T**
**LINEAR PROGRAMMING - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. Analyze and solve linear programming models of real life situations.
2. Provide graphical solution of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
3. Solve linear programming problems using simplex method.
4. Learn techniques to solve transportation and assignment problems.
5. Solve two-person zero sum game problems.

### GROUP -A

Convex sets and their properties, Introduction to linear programming problem, solution by graphical method, simplex method, optimality and unboundedness, artificial variables, two-phase method, Big-M method.

**4 Questions**

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

**2 Question**

### GROUP - B

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem

**2 Questions**

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

**2 Questions**

### Books Recommended:

1. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.

2. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
3. Operations Research —S. D. Sharma.
4. Linear Programming Problems — R. K. Gupta.

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3. **MAJOR COURSES – MJ503T**
**RING THEORY - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

## Course Objective and Learning Outcomes:

This course will enable the students to:

1. Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
2. Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

Ring: Definition and examples, commutative ring, ring with unity, unit in a ring, Matrix ring, Boolean ring, Ring of continuous functions. Direct product of rings, Properties of rings, subrings.

**2 Questions**

Nilpotent element, idempotent element, zero divisors, integral domain, division ring and field. Characteristic of a ring.

**2 Questions**

Ideal, ideal generated by a subset of a ring, simple ring, factor rings, operations on ideals, prime and maximal ideals.

**2 Questions**

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems 1, II and III, field of quotients.

**2 Questions**

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, and Eisenstein's criterion.

**2 Questions**

## Books Recommended:

1. John B. Fraleigh, A First Course in Abstract Algebra, $7^{th}$ Ed., Pearson, 2002.
2. Joseph A. Gallian, Contemporary Abstract Algebra, $4^{th}$ Ed., Narosa Publishing House, New Delhi, 1999.
3. C Musili, Introduction to Rings and Modules, $2^{nd}$ edition, Narosa Publishing House.
4. Modern Algebra — Surjeet Singh and Qazi Zameeruddin
5. Topics in Algebra – I. N. Herstein

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## SEMESTER-VI

1. ### MAJOR COURSES – MJ-601T
   ### ADVANCED MECHANICS - 4 CREDITS
   60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:

This . course will enable the students to:

1. Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.
2. Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.
3. Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed.
4. Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.
5. Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of source.

### GROUP – A

### Statics

Three dimensional forces acting in a rigid body, Condition of equilibrium of forces in three dimension.

**1 Question**

Central axis, Wrench, Pitch, Null lines.

**2 Question**

Principle of virtual work and its application in two dimensional cases.

**1 Question**

Common Catenary. Stable equilibrium, energy test of stability (problems involving one variable only).

**1Question**

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## GROUP- B

### Dynamics

Motion of a particle under a central force, differential equations of central orbit in both polar and pedal co-ordinates.

**1 Question**

Newton's law of gravitation, planetary orbits, Keplar's laws of motion.

**1 Question**

Motion of a projectile under gravity in a non-resisting medium

**1 Question**

Motion of mass center and motion relative to mass center, D' Alembert's principle.

**1 Question**

Two dimensional motion of a rigid body, compound pendulum

**1 Question**

### Books Recommended:

1. Statics     :     S. L. Loney.
2. Statics     :     A. S. Ramsey.
3. Statics     :     Goyal & Gupta.
4. Dynamics     :     S. L.Loney.
5. Dynamics     :     R. K. Gupta & D. C. Agarwal.
6. Dynamics     :     A. S. Ramsey.

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2. **MAJOR COURSES – MJ-602T**
**NUMBER THEORY AND LAPLACE TRANSFORM - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
| --- | --- |

### Course Objective and Learning Outcomes:
This course will enable the students to:

1. Some of the open problems related to prime numbers, viz., Goldbach conjecture etc.
2. About number theoretic functions and modular arithmetic.
3. Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.
4. Solve ordinary differential equations using Laplace transforms.
5. Familiarise with Fourier transforms of functions belonging to $L^1(\mathbb{R})$ class, relation between Laplace and Fourier transforms.
6. Learn Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier series.
7. Apply the concepts of the course in real life problems.

### GROUP – A
### NUMBER THEORY

Divisibility and primes, H.C.F., Euclid's Algorithm, unique factorization, perfect numbers. Goldbach conjecture equation.

**2 Questions**

Residue class, complete and reduced residue system, congruences and their properties, Fermat's theorem, Wilson's theorem. Number theoretic functions, Euler's and Mobius function, Mobius inversion formula.

**2 Questions**

The Linear Diophantine equations: $ax + by = c$ . Algebraic Congruence, solution by inspection, Solution of $ax \equiv b(mod\ c)$ system of linear congruence, Chinese remainder theorem.

**1 Question**

### GROUP – B
### LAPLACE TRANSFORM

Laplace Transform: Definition, Laplace Transform of elementary functions, properties, uniqueness and inverse Laplace Transform, Dirac delta function, Laplace Transform of derivatives and integrals, Multiplication by $t^n$, division by $t$. Convolution theorem, Application of Laplace transform to differential equations.

**5 Questions**

### Books Recommended:
1. Number Theory : G. H. Hardy & E. M. Wright.
2. Number Theory : S. G. Telang.
3. Number Theory : Harikisan.
4. Number Theory : S. B. Malik.
5. Laplace Transform : David V. Widder.
6. Advance Differential equations : M. D.Raisinghania.

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3. **MAJOR COURSES – MJ-603T**
**COMPLEX ANALYSIS - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

## Course Objective and Learning Outcomes:

This course will enable the students to:

1. Visualize complex numbers as points of $\mathbb{R}$ and stereographic projection of complex plane on the Riemann sphere.
2. Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy–Riemann equations.
3. Learn the role of Cauchy–Goursat theorem and Cauchy integral formula in evaluation of contour integrals.
4. Apply Liouville's theorem in fundamental theorem of algebra.
5. Understand the convergence, term by term integration and differentiation of a power series.
6. Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

### Complex Plane and functions.

Complex numbers and their representation, algebra of complex numbers. Complex plane, Open set, Domain and region in complex plane. Stereographic projection and Riemann sphere. Complex functions and their limits including limit at infinity. Continuity, Linear fractional transformations and their geometrical properties.

**2 Questions**

### Analytic Functions and Cauchy-Riemann Equations

Differentiability of a complex valued function, Cauchy-Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability, Analytic functions. Analyticity and zeros of exponential, trigonometric and logarithmic functions. Branch cut and branch of multi-valued functions.

**2 Questions**

### Cauchy's Theorems and Fundamental Theorem of Algebra

Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

**2 Questions**

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**Power Series**

Sequences, series and their convergence, Taylor series and Laurent series of analytic functions, Power series, Radius of convergence, Integration and differentiation of power series, Absolute and uniform convergence of power series.

**2 Questions**

**Singularities and Contour Integration**

Meromorphic functions, Zeros and poles of meromorphic functions, Nature of singularities, Picard's theorem, Residues, Cauchy's residue theorem, Argument principle, Rouche's theorem, Jordan's lemma, Evaluation of proper and improper integrals.

**2 Questions**

**Books Recommended:**

1. Complex variable                :     J. N. Sharma.
2. Complex variable                :     B. S. Tyagi.
3. Complex variable                :     M. L. Khanna.
4. Complex variable and Applications  :     Churchill and Brown.

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4. **MAJOR COURSES – MJ-604T**
   **NUMERICAL ANALYSIS - 4 CREDITS**
   60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
| --- | --- |

## Course Objective and Learning Outcomes:

This course will enable the students to:

1. Obtain numerical solutions of algebraic and transcendental equations.
2. Find numerical solutions of system of linear equations and check the accuracy of the solutions.
3. Learn about various interpolating and extrapolating methods.
4. Solve initial and boundary value problems in differential equations using numerical methods.
5. Apply various numerical methods in real life problems.

### GROUP -A

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

**1 Question** –

Solution of simultaneous equations: Gauss's elimination method, Matrix inversion by triangularization method.

**1 Question**

Calculus of finite difference: The operators $\Delta, \nabla$, E, factorial notation, their properties and inter-relation between them, Fundamental theorem of difference calculus, divided differences.

**2 Questions**

### GROUP - B

Interpolation: Newton's forward and backward difference interpolation formula, Lagrange's interpolation formula, central difference interpolation, Gauss's forward, backward and central difference interpolation formula.

**2 Questions**

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

**1 Question**

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

**1 Question**

Solution of ordinary differential equations: Picard's method of successive approximations, Euler's Method, Modified Euler's Method.

**1 Question**

NB : USE OF SCIENTIFIC CALCULATOR ALLOWED.

## Books Recommended:

1. Numerical Analysis    :    G. S. Mallik.
2. Numerical Analysis    :    G. Shankar Rao.
3. Numerical Methods    :    B. S. Grewal.

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# SEMESTER-VII

## 1. MAJOR COURSES – MJ-701T
### P. D. E. AND CALCULUS OF VARIATION - 4 CREDITS

60Lectures

Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100

Pass Marks: Th(SIE+ESE)=40

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. Understand the genesis of ordinary as well as partial differential equations.
2. Learn about solution of first order linear partial differential equations using Lagrange's method.
3. Apply a range of techniques to solve first & second order partial differential equations.
4. Model physical phenomena using partial differential equations such as the heat and wave equations.
5. Understand problems, methods and techniques of calculus of variations.

## GROUP –A

### PARTIAL DIFFERENTIAL EQUATION

**First Order Partial Differential Equations**

Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

**2 Questions**

**Second Order Partial Differential Equations with Constant Coefficients**

Classification of linear partial differential equations of second order, Homogeneous and non-homogeneous equations with constant coefficients.

**2 Questions**

**Second Order Partial Differential Equations with Variable Coefficients**

Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

**2 Questions**

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## GROUP –B

### CALCULUS OF VARIATIONS

**Variational Problems with Fixed Boundaries**
Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

**2 Questions**

**Calculus of Variations-Variational Problems with Moving Boundaries**
Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation.

**2 Questions**

**Books Recommended:**
1. Ordinary and Partial Differential Equations     :     M. D. Raisinghania.
2. Differential Equations with Applications     :     S. B. Rao & H. R. Anuradha.
3. Calculus of Variations with Applications     :     A. S. Gupta.
4. Calculus of Variations     :     R. K. Sharma.

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2. ## MAJOR COURSES – MJ-702T
## METRIC SPACE - 4 CREDITS
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

## Course Objective and Learning Outcomes:

This course will enable the students to:

1. Understand several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano–Weierstrass property, compactness, and connectedness.
2. Identify the continuity of a function defined on metric spaces and homeomorphisms.

### Concepts in Metric Spaces

Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space.

**3 Questions**

### Complete Metric Spaces and Continuous Functions

Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

**3 Questions**

### Compactness

Compact spaces, Sequential compactness, Bolzano-Weierstrass property, Compactness and finite intersection property, Heine-Borel theorem, totally bounded sets, Equivalence of compactness and sequential compactness, Continuous functions on compact spaces.

**2 Questions**

### Connectedness

Separated sets, Disconnected and connected sets, Components, Connected subsets of $\mathbb{R}$, Continuous functions on connected sets.

**2 Questions**

### Books Recommended:

1. Introduction to Topology : G. F. Simmons.
2. Metric Spaces : P. K. Jain & Khalil Ahmad.

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3. **MAJOR COURSES – MJ-703T**
**ADVANCE INTEGRAL AND SPECIAL FUNCTION - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

**Course Objective and Learning Outcomes:**

This course will enable the students to:

1. Learn about Improper integrals & their convergence condition.
2. Know about series solution of Ordinary Differential Equation.
3. Learn about Some special functions such as Legendre's and Bessel's equations etc. and their orthogonality properties.

## GROUP - A

Convergence of improper integrals, comparison tests, absolute convergence, Abel's and Dirichlet's tests, Frullani's Integrals. Definition & convergence of Beta & Gamma functions and their properties, duplication formula, inter-relation.

**3 Questions**

## GROUP – B

Evaluation of double and triple integrals. Multiple Integrals of Dirichlet's form, Liouville's extension, change of order of integration and change of variables.

**3 Questions**

## GROUP - C

Series Solution: Ordinary point, singular point (regular), general methods and forms of series solution (Indicial equation —Frobenius method) [ N.B.: Results of analysis regarding validity of series solution are taken to be granted].

**2 Questions**

Legendre's equation: Solution, Rodrigue's formula, Legendre's polynomials, generating function for $P_n(x)$, orthogonality of Legendre's polynomials.

**1 Question**

Bessel's equation: Solution, recurrence formula for $J_n(x)$ , Generating function for $J_n(x)$, equations reducible to Bessel's equation, Orthogonality of Bessel's function.

**1 Question**

### Books Recommended:

| 1. | Advanced Integral Calculus | : | D. C. Agarwal/ J. N. Sharma. |
| 2. | Integral Calculus | : | Shanti Narayan & P. K. Mittal. |
| 3. | Differential Equations | : | J. N. Sharma. |
| 4. | Advance differential equations | : | Goyal & Gupta. |
| 5. | Advance differential equations | : | M. D. Raisinghania. |

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4. **MAJOR COURSES – MJ-704T**
**DISCRETE MATHEMATICS AND LOGIC GATES FUNCTION - 4 CREDITS**          60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

**Course Objective and Learning Outcomes:**

This course will enable the students to:

1.  Learn about partially ordered sets, lattices and their types.
2.  Understand Boolean algebra and Boolean functions, logic gates, switching circuits and their applications.
3.  Solve real-life problems using finite-state and Turing machines.
4.  Assimilate various graph theoretic concepts and familiarize with their applications.

**Partially Ordered Sets**

Definitions, examples and basic properties of partially ordered sets (poset), Order isomorphism, Hasse diagrams, Dual of a poset, Duality principle, Maximal and minimalelements, least upper bound and greatest upper bound, Building new poset, Maps between posets.

**2 Questions**

**Lattices**

Lattices as posets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, examples and properties of modular and distributive lattices; Complemented, relatively complemented and sectionally complemented lattices.

**2 Questions**

**Boolean Algebras and Switching Circuits**

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

**2 Questions**

**Finite-State and Turing Machines**

Finite-state machines with outputs, and with no output; Deterministic and non-deterministic finite-state automaton; Turing machines: Definition, examples, and computations.

**2 Questions**

**Graphs**

Definition, examples and basic properties of graphs, Königsberg bridge problem; Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, Shortest path and Dijkstra's algorithm.

**2 Questions**

**Books Recommended:**

1.  Discrete mathematics                              :          M. K. Gupta.
2.  Discrete Mathematics with Graph Theory  :          Goodaire & Parmenter.
3.  A Textbook of Discrete Mathematics        :          Swapan Kumar Sarkar.
4.  Discrete mathematics and its Applications  :          Kamala Krithivasan.
5.  Discrete Mathematics                              :          Kolman, Busby & Ross

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## SEMESTER-VIII

1. **MAJOR COURSES – MJ-801T**
   **INTEGRAL EQUATIONS - 4 CREDITS**
   60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. Introduction to Integral Equations.
2. Solution of Integral equations: Volterra & Fredholm equations.
3. Application of Integral transform in the solution of integral equation.

### Classification of Linear Integral Equations

Fredholm, Volterra, Integro-Differential Equations, Singular Integral Equations, Converting Volterra Equation to ODE, Conversion of IVP to Volterra equation, Conversion of BVP to Fredholm equation.

**2 Questions**

### Fredholm Integral Equations

Decomposition method, Direct Computation method, successive approximation method, method of successive substitutions, Homogeneous Fredholm Equations, Comparison between alternative methods.

**3 Questions**

### Volterra Integral Equation

Adomian Decomposition method, Series solution method, Successive Approximation method, Successive substitution method, comparison between alternative methods.

**3 Questions**

### Singular Integral Equations

Abel problem, Generalized Abel Integral Equation, Existence and uniqueness of solutions using fixed – point theorems in case of Linear and nonlinear Volterra and Fredholm Integral equations. Solution of Integral equations by Laplace, Fourier transforms methods.

**2 Questions**

### Books Recommended:

1. Murry R. Spiegal, Laplace Transform (SCHAUM Outline Series), McGraw-Hill.
2. Abdul J.jerry, Introduction to integral equations with applications, Marcel Dekkar Inc. NY.
3. R. P. Kanwal, Linear Integral equations, equations, Springer Sc., 1997.
4. Harry Hochsdedt, Integral Equations, John Wiley & Sons.

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**DEPARTMENT OF MATHEMATICS**
**DR. SHYAMA PRASAD MUKHERJEE UNIVERSITY**

## RESEARCH COURSE – RC-801T
### Research Methodology - 4 CREDITS
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. Identify and discuss the role and importance of research.
2. Identify and discuss the issues and concepts salient to the research process.
3. Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting
   5. Read, comprehend and explain research article and writing a research article.

### UNIT I

Research Formulation and Design Motivation and objectives – Research methods vs. Methodology. Steps of research, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web.

**3 Questions**

### UNIT II

Data measurement and Data Analysis Measurement: Concept of measurement, Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis, hypothesis testing.

**3 Questions**

### UNIT III (MATLAB)

Soft Computing Computer and its role in research, some mathematical software like MATLAB, R etc. and their application in research. Software for paper formatting like LaTeX/MS Office.

**2 Questions**

### UNIT IV

Research Ethics and Report Writing Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to publishing, Plagiarism, Software for detection of Plagiarism, publishing a research article.

**2 Questions**

### Books Recommended::

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
3. R. Balaji: Basics of MATLAB Programming.
4. Rudra Pratap: Getting started with MATLAB.
5. S.N. Alam, S. S. Alam : Understanding MATLAB.

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**RESEARCH COURSE – RC-802T**

**RESEARCH PROPOSAL, INTERNSHIP AND FIELD WORK - 4 CREDITS**

| Marks: 100 (Project: 75 + VIVA: 25) = 100 | Pass Marks: Pr(ESP) = 40 |
| --- | --- |

## RESEARCH PROJECT

A project may be undertaken in the form of a case study or otherwise and data be collected, if required, as the case may be. The topic of the project be chosen in consultation with the assigned supervisor and the candidate should prepare a summary/synopsis of the proposed project related to some topic in Mathematics. The candidate needs to collect data/related literature on any particular aspect of the identified topic and shall prepare the report of the project from historical point of view, or as a survey or unification of different aspects.

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**RESEARCH COURSE – RC-803T**

**RESEARCH REPORT- 4 CREDITS**

| Marks: 100 (ESP: 3Hrs.) = 100 | Pass Marks: Pr(ESP) = 40 |
|---|---|

## DISSERTATION (RESEARCH REPORT)

Any topic in mathematics may be picked up by a candidate in consultation with the assigned supervisor. An in-depth study of the topic in a specific direction be made leading to the identification of a problem. The derivation of full/partial answer to the problem be written in the form of a thesis. The investigation be made either to give birth to another proof of an existing result or a new technique be proposed in lieu of an existing technique or a novel finding.

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2. **ADVANCE MAJOR COURSES – AMJ-802T**
**TOPOLOGY - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

### Course Objective and Learning Outcomes:

This course will enable the students to:

1. The knowledge gained in this subject will make students able to generalize and extend concepts of real/complex analysis to more abstract spaces.
2. This course will enable the students to understand the importance and properties of abstract analysis.

## FUNDAMENTALS OF A TOPOLOGICAL SPACE

Definition and example of topological spaces. Closed sets, Closure. Dense Subsets. Neighbourhoods, Interior, exterior and boundary. Accumulation points and derived sets. Bases. Sub-bases and relative topologies. Quotient topology.

**3 Questions**

## CONTINUITY AND CONNECTEDNESS

Continuity and homeomorphism, Product of topological spaces, connected space and its properties.

**2 Questions**

## COUNTABILITY AND SEPARATION AXIOMS

First and Second countable spaces. Lindelof's theorem, separable spaces, second countability and Separability. Separation axioms $T_0, T_1, T_2, T_3, T_4$ : their Characterizations and basic properties. Urysohn's Lemma. Tietze extension theorem.

**3 Questions**

## COMPACTNESS

Compactness. Continuous image of compact sets. Basic property of compactness. Compactness and finite intersection property Tychonoff's Theorem, One point compactification of a topological space.

**2 Questions**

### Text/ Reference Book:

1. K.D. Joshi. Introduction to General Topology, Wiley Eastern Ltd. 1983.
2. G.F. Simmons, Introduction to topology and modern Analysis, McGraw Hill Int. Book Company.
3. J.R. Munkres, Topology A first course, Prentice hall India Pvt. Ltd.
4. S. Lipschutz, General Topology, Schaum's outline series.

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3. ## ADVANCE MAJOR COURSES – AMJ-803T
## TENSOR & DIFFERENTIAL GEOMETRY - 4 CREDITS

60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |

## Course Objective and Learning Outcomes:

This course will enable the students to:

1. Explain the basic concepts of tensors.
2. Understand role of tensors in differential geometry.
3. Learn various properties of curves including Frenet–Serret formulae and their applications.
4. Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae.
5. Understand the role of Gauss's Theorema Egregium and its consequences.
6. Apply problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

## Tensors

Contravariant and covariant vectors, Transformation formulae, Tensor product of two vector spaces, Tensor of type $(r, s)$, Symmetric and skew-symmetric properties, Contraction of tensors, Quotient law, Inner product of vectors.

**3 Questions**

## Further Properties of Tensors

Fundamental tensors, Associated covariant and contravariant vectors, Inclination of twovectors and orthogonal vectors, Christoffel symbols, Law of transformation of Christoffel symbols, Covariant derivatives of covariant and contravariant vectors, Covariant differentiation of tensors, Curvature tensor, Ricci tensor, Curvature tensor identities.

**3 Questions**

## Curves in $\mathbb{R}2$and $\mathbb{R}3$

Basic definitions and examples, Arc length, Curvature and the Frenet-Serret formulae, Fundamental existence and uniqueness theorem for curves, Non-unit speed curves.

**3 Questions**

## Surfaces in $\mathbb{R}3$

Basic definitions and examples, The first fundamental form, Arc length of curves on surfaces, Normal curvature, Geodesic curvature, Gauss and Weingarten formulae, Geodesics, Parallel vector fields along a curve and parallelism.

**3 Questions**

## Geometry of Surfaces

The second fundamental form and the Weingarten map; Principal, Gauss and mean curvatures; Isometries of surfaces, Gauss's Theorema Egregium, The fundamental theorem of surfaces, Surfaces of constant Gauss curvature, Exponential map, Gauss lemma, Geodesic coordinates, The Gauss-Bonnet formula and theorem.

**3 Questions**

Books Recommended:-

1. Differential Geometry of Three Dimension : C. E. Weatherburn.
2. Tensor Calculus : C. E. Weatherburn.
3. Differential Geometry : Mittal & Agarwal.
4. Tensor Calculus and Riemanian Geometry : R. S. Mishra.
5. Tensor and Differential Geometry : Gupta-Malik-Pundir

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4. **ADVANCE MAJOR COURSES – AMJ-804T**
**MATHEMATICAL MODELLING - 4 CREDITS**
60Lectures

| Marks: 25(5 Attd. + 20 SIE: 1Hr) +75 (ESE: 3Hrs.)=100 | Pass Marks: Th(SIE+ESE)=40 |
|---|---|

## Course Objective and Learning Outcomes:

This course will enable the students to:

1. Know the concept of how to develop mathematical models using experimental data and observation data (Discrete and continuous) in the form of difference and differential equations and basic methods to solve them.
2. To develop Models of growth and decay (for problems of aging), Prey Predator (problems of ecology and environment), drugs delivery problem (Medical problems), motion of planets and satellites (Space problems), population dynamics (genetics and microbiology), etc

### Introduction to mathematical modeling

Simple Situations requiring mathematical modeling, techniques of mathematical modeling, classifications, characteristics and limitations of mathematical models, some simple illustrations.

**2 Questions**

### Mathematical modeling through differential equations

Linear growth and decay models, non-linear growth and decay models, Compartment models, Mathematical modeling in dynamics through ordinary differential equations of first order.

**3 Questions**

### Mathematical models through difference equations

Some simple mathematical models, basic theory of linear difference equations with constant coefficients.

**2 Questions**

### Application of mathematical modeling in economics, finance & genetics

Mathematical modeling through difference equations in economics and finance, mathematical modeling through difference equations in population dynamics and genetics.

**3 Questions**

### Text/Reference Books:

1. J. N. Kapur, Mathematical Modeling, Wiley Eastern.
2. D. N. Burghes, Mathematical Modeling in social Management and life science, Ellie Herwood and John Wiley.
3. F. Charlton, Ordinary Differential and Difference Equations, Van Nostrand.

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COURSES OF STUDY FOR MINOR ELECTIVE (TRADITIONAL & VOCATIONAL) IN
"MATHEMATICS"

## SEMESTER-I

1. **MINOR COURSES – MN-101T**
**MATHEMATICS - I (4 CREDITS)**

60Lectures

Pass Marks: Th(ESE)=40

Marks: (ESE: 3Hrs.)=100

### DIFFERENTIAL CALCULUS -I

Successive differentiation, $n^{th}$ order derivative of some standard Functions. Leibnitz's theorem. $n^{th}$ derivative of rational functions. Taylor's and Maclaurin's series expansions of functions. Applications of Taylor's and Maclaurin's series. Tangent and Normal, their equations in the Cartesian form, parametric form, Tangents at the origin.

**2 QUESTIONS**

### DIFFERENTIAL CALCULUS -II

Angle between two curves. Length of tangent, normal, sub tangent, subnormal in Cartesian forms. Partial Differentiation, Curvature, Asymptotes, Maxima and Minima of functions of two variables.

**2 QUESTIONS**

### INTEGRAL CALCULUS-I

Integration of rational and irrational functions. Integration by partial fractions, Integration by transformations, Integration by substitution, Integration by parts.

**2 QUESTIONS**

### INTEGRALS CALCULUS-II

Evaluation of definite integrals, reduction formulae, curve tracing, length and area, Surface area and volume of solids of revolution.

**2 QUESTIONS**

### DIFFERENTIAL EQUATIONS-I

Differential equations of first order and higher degree, Clairaut's form, singular solution, orthogonal trajectories.

**2 QUESTIONS**

### BOOKS RECOMMENDED

1. Differential Calculus : A. Das Gupta & S. B. Prasad
2. Integral Calculus : A. Das Gupta
3. Differential Equations : .Lalji Prasad/ M. D. Raisinghania

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# SEMESTER-II

2. **MINOR COURSES – MVC-201T**
**PRELIMINARY DESCRIPTIVE STATISTICS (3 CREDITS)**

45Lectures

Pass Marks: Th(ESE)=30

Marks: (ESE: 3Hrs.)=75

### Unit-1

Introduction to Statistics, Meaning of Statistics as a Science, Importance of Statistics. Scopeof Statistics in Industry, Biological sciences, Medical sciences, Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology .Population and Sample. Variables: Interval scale, ratio scale, discrete and continuous variables, difference between linear scale and circular scale.Primary and secondary data, Cross-sectional data, time series data, directional data. Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample. Presentation of Data. Classification: Raw data and its classification, ungrouped frequency distribution, Sturge'srule, grouped frequency distribution, cumulative frequency distribution, inclusive and exclusive methods of classification, Open end classes, and relative frequency distribution.

### Unit-2

Measures of Central Tendency. Partition Values: Quartiles, Deciles and Percentiles (from grouped and grouped data), Box Plot. Measures of Dispersion, Moments, Skewness and Kurtosis. Bivariate Data: Definition, Scatter Diagram, Simple, Partial and Multiple Correlation upto 3 variables, Rank correlation. Simple Linear Regression, Equation of Lines of regression, Regression coefficients. Principle of Least Squares and Fitting of Curves.

### Unit-3

Theory of Attributes: Nominal scale, ordinal scale, classification, notion of manifold classification, dichotomy, class-frequency, order of class, positive class-frequency, negative class frequency, quanta class frequencies, ultimate class frequency, relationship among different class frequencies (up to three attributes), dot operator to find the relation between frequencies, fundamental set of class frequencies. Consistency of data up to 2 attributes. Concepts of independence and association of two attributes. Yule's coefficient of association (Q), $-1 \leq Q \leq 1$, interpretation. Examples and Problems.

### References:

1) Gun, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.
2) Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statisticswith Applications, (7th Edn.), Pearson Education, Asia.
3) Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, (3rd Edn.), Tata McGraw-Hill Pub. Co. Ltd.
4) J. N. Kapur, H. C. Saxena, (1997). Mathematical Statistics (18th Edition), S. Chand. New Delhi
5) S. P. Gupta, M. P. Gupta. Buisness Statistics (18th Edition), Sultan Chand & Sons, New Delhi.

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**Preliminary Descriptive Statistics Practical  MVC-201P -1 Credits**          15 Lectures

**Marks: (ESP: 1Hrs.)=25**                                     **Pass Marks: Pr(ESP)=10**

1) Graphical Representation of Data in Microsoft Excel.
2) Problems and their solution with graphical representation based on Arithmetic mean in Microsoft Excel.
3) Problems and their solution with graphical representation based on Median and Mode in Microsoft Excel.
4) Problems and their solution with graphical representation based on Mean Deviation in Microsoft Excel.
5) Problems and their solution with graphical representation based on Standard Deviation in Microsoft Excel.
6) Problems and their solution with graphical representation based on Variance in Microsoft Excel.
7) Problems and their solution with graphical representation based on Coefficient of Variation in Microsoft Excel.
8) Problems and their solution with graphical representation based on Quartiles in Microsoft Excel.
9) Problems and their solution with graphical representation based on Moments, Skewness and Kurtosis in Microsoft Excel.
10) Problems and their solution with graphical representation (Scatter Diagram) based on Karl-Pearson Correlation Coefficient in Microsoft Excel.
11) Problems and their solution with graphical representation (Scatter Diagram) based on Partial and Multiple Correlation in Microsoft Excel.
12) Problems and their solution with graphical representation (Scatter Diagram) based on Spearman Rank Correlation with and without ties in Microsoft Excel.
13) Problems and their solution with graphical representation (Scatter Diagram) based on bivariate frequency distribution in Microsoft Excel.
14) Problems and their solution with graphical representation based on Lines of Regression, angles between lines and estimated values of variables in Microsoft Excel.
15) Checking consistency of data and finding association among attributes in Microsoft Excel.

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## SEMESTER-III

3. **MINOR COURSES – MN-301T**
**MATHEMATICS - II (4 CREDITS)**

| | |
|---|---|
| 60Lectures | Pass Marks: Th(ESE)=40 |
| Marks: (ESE: 3Hrs.)=100 | |

### VECTOR CALCULUS–I

Scalar and Vector point functions, vector function of a scalar variables, Continuity of a vector function. Differentiation of a vector with respect to the scalar variable "$t$". Differentiation of a vector function. Derivatives of a sum of vectors, derivatives of a product of vectors (both scalar and vector products.)

**2 QUESTIONS**

### VECTOR CALCULUS-II

Gradient, Divergence and curl and second order vector differential operators in Cartesian coordinates systems.

**2 QUESTIONS**

### COORDINATE GEOMETRY OF TWO DIMENSION-I

Change of rectangular axes, Rotation and Shifting of origin. Transformation of the general equation of the second degree. Conditions for the general equation of second degree to represent a parabola, ellipse and hyperbola. Equations of the tangent and normal to a given curve using calculus.

**2 QUESTIONS**

### CO- ORDINATE GEOMETRY OF TWO DIMENSIONS II

Reduction of the general equation of second degree to the standard forms, Chord of Contact, Polar of pair of tangents in reference to general equation of conic, Polar equation.

**2 QUESTIONS**

### DIFFERENTIAL EQUATIONS II

Linear Equation with constant co-efficients, Homogenous linear equations with variable coefficients. Simultaneous equation s $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ and total differential equation $Pdx + Qdy + Rdz = 0$ together with their geometric significance.

**3 QUESTIONS**

### BOOKS RECOMMENDED

1. Vector Analysis : .Lalji Prasad/ A Das Gupta & S B Prasad
2. Coordinate Geometry : A Das Gupta
3. Differential Equations : .Lalji Prasad/ M. D. Raisinghania

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## SEMESTER-IV

4. **MINOR COURSES – MVC-401T**
**Statistical Methods (3 CREDITS)**
45 Lectures

| Marks: (ESE: 3Hrs.)=75 | Pass Marks: Th(ESE)=30 |
|---|---|

### Unit-1

Index numbers: Classification, Weighted and unweighted index numbers, Tests of perfection, Chain Index numbers, Base shifting, CPI, WPI, Limitations. Business Forecasting, Time series analysis: Trends and Variations, Methods of measurement, Straight line and non-linear trend, Measuring trends and Variations.

### Unit-2

Sampling distributions: Random and Non-random sampling methods. Population distribution, Relationships, Difference of two means, Estimation of Population Mean, Confidence Intervals (limits) for parameters of normal distribution (one sample and two samples). Tests of hypothesis (null and alternate), Type I and Type II errors, Basic Idea of Significance tests, Type of hypothesis for parameters of normal distribution (one sample and two samples).

### Unit-3

Central and non-central Chi-square, t and F distributions. Testing of equality of two means and two variances of two normal distributions, testing for the significance of sample correlation coefficient. Use of central limit theorem for testing a single mean, single proportion, equality of two means and two proportions, Fisher's Z transformation and its uses, Pearson's chi-square test for goodness of fit, test of independence of two attributes. Analysis of Variance: One way classification, Two way classification.

### References:

1) Gun, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.
2) Gun, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.
3) Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.
4) Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
5) Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, (3rd Edn.), Tata McGraw-Hill Pub. Co. Ltd.
6) J. N. Kapur, H. C. Saxena, (1997). Mathematical Statistics (18th Edition), S. Chand. New Delhi.
7) S. P. Gupta, M. P. Gupta. Business Statistics (18th Edition), Sultan Chand & Sons, New Delhi.

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15 Lectures

Statistical Methods Practical -1 MVC-401P Credits

Marks: (ESP: 1Hrs.)=25

Pass Marks: Pr(ESP)=10

1) Estimators of population mean in Microsoft Excel.
2) Confidence Intervals (limits) for parameters of normal distribution (one sample and two samples)in Microsoft Excel.
3) Type of hypothesis for parameters of normal distribution (one sample and two samples)in Microsoft Excel.
4) Chi Square test of proportions in Microsoft Excel.
5) Chi-Square tests of goodness of fit in Microsoft Excel.
6) T-test, F-test and Z-test in Microsoft Excel.

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## SEMESTER-V

**5.** **MINOR COURSES – MN-501T**
**MATHEMATICS - III (4 CREDITS)**

60Lectures

Marks: (ESE: 3Hrs.)=100

Pass Marks: Th(ESE)=40

### REAL ANALYSIS-I

Sequence: Definition, Bounds, Limit of a sequence, Monotonic Sequences and their Convergence, Algebraic operations and limits, Cauchy Sequence, General principle of convergence of a sequence.

**2 QUESTIONS**

### REAL ANALYSIS-II

Series: Definition, Convergent Series, Divergent Series, Pringsheim's theorem, Comparison tests, Cauchy's root test, D'Alembert's ratio test, Alternation Series and Leibnitz test, absolutely convergent series.

**2 QUESTIONS**

### REAL ANALYSIS-III

Continuity & Derivability of function of one variable, relationship with continuity, Rolle's theorem, Lagrange's Mean Value theorem, Taylor's and Maclaurin's theorem with $R_n$.

**2 QUESTIONS**

### REAL ANALYSIS-IV

Riemann Integration, definition, Oscillatory sum and integrability condition. Integrability of monotonic and continuous functions. Fundamental theorem of integral calculus.

**2 QUESTIONS**

### SET THEORY-I

Indexed family of sets, Generalised set of operations &DeMorgan's laws, Set mapping.Equivalence relation and related fundamental theorem of partition.

**2 QUESTIONS**

### BOOKS RECOMMENDED

1. Real Analysis      :      Lalji Prasad
2. Set Theory        :      Lalji Prasad/ Dr. K. K. Jha

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## SEMESTER-VI

6. **MINOR COURSES – MVC-601T**
**PROBABILITY THEORY AND DISTRIBUTIONS (4 CREDITS)**
60Lectures

| Marks: (ESE: 3Hrs.)=100 | Pass Marks: Th(ESE)=40 |
| --- | --- |

**Unit-1**

Review of probability, conditional probability, independence. Experiments/Models, Ideas of deterministic and non-deterministic models. Random Experiment, concept of statistical regularity. Definitions of - (i) Sample space, (ii) Discrete sample space: finite and countably infinite,(iii) Event, (iv) Elementary event, (v) Complement of an event. (vi) Certain event (vii) Impossible event.

**Unit-2**

Concept of occurrence of an event. Algebra of events and its representation in set theory notation. Occurrence of following events. (i) at least one of the given events, (ii) none of the given events, (iii) all of the given events, (iv) mutually exclusive events, (v) mutually exhaustive events, (vi) exactly one event out of the given events. Classical definition of probability and its limitations. Probability model, probability of an event, equiprobable and non-equiprobable sample space, Axiomatic definition of probability. Definition of conditional probability of an event. Definition of independence of two events. Pairwise independence and mutual independence for three events. Multiplication theorem and its generalization.

**Unit-3**

Baye'sTheorem: Partition of the sample space, Proof of Baye's theorem. Applications of Baye's theorem in real life. Concept and definition of a discrete random variable. Probability mass function (p.m.f.) and cumulative distribution function (c.d.f.) $F(\cdot)$ of discrete random variable, properties of c.d.f. Mode and median of a univariate discrete probability distribution. Mathematical Expectation (Univariate Random Variable), expectation of a function of a random variable, moment generating function (m.g.f.) and cummulant generating function(c.g.f.), Properties of m.g.f. and c.g.f.

**Unit-4**

Some Standard Discrete Probability Distributions. Degenerate distribution (one-point distribution), mean and variance. Evaluation of p.m.f., c.d.f., mean, variance, m.g.f. and c.g.f. of the following distributions: Uniform discrete distribution, Bernoulli distribution, Binomial distribution, Poisson distribution, Geometric distribution, Negative binomial distribution, Hypergeometric distribution. Approximation of binomial to Poisson.

**References:**
1) Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.
2) Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-CalculusBased Approach. Narosa Publishing Comp. New Delhi.
3) Rao, C.R. (2009). Linear Statistical Inference and its Applications, 2nd Edition,Wiley Eastern.
4) Rohatgi, V.K. and Saleh, A.E. (2008). An introduction to Probability Theoryand Mathematical Statistics, Wiley Eastern.
5) J. N. Kapur, H. C. Saxena, (1997). Mathematical Statistics (18th Edition), S. Chand. New Delhi.
6) S. P. Gupta, M. P. Gupta. Business Statistics (18th Edition), Sultan Chand & Sons, New Delhi.

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## SEMESTER-VII

7. **MINOR COURSES – MN-701T**
**MATHEMATICS –IV (4 CREDITS)**

60Lectures

Marks: (ESE: 3Hrs.)=100

Pass Marks: Th(ESE)=40

### COMPLEX VARIABLE-I
Real functions of two variables: Simultaneous and iterated limits: Continuity, partial derivatives, Differentiability and related necessary and sufficient conditions.

**2 QUESTIONS**

### COMPLEX VARIABLE-II
Functions of complex variables limit, Continuity, derivative, Cauchy-Riemann Equations, Analytic function, Harmonic function.

Import of some standard transformations e.g., $w = z + c$, $w = cz$, $w = 1/z$, $w = (az + b)/(cz + d)$ (bilinear). Conformal transformation as transformation effected by analytic function. Special conformal transformation $w = z^2$, $w = e^z$, $w = \sin z$.

**2 QUESTIONS**

### ABSTRACT ALGEBRA-I
Binary operations, Notion of group, Abelian group and non-Abelian group with examples. Uniqueness of identity element and inverse elements in a group, different ways of defining a group, concept of Subgroup and cyclic group, Cosets, Lagrange's theorem.

**2 QUESTIONS**

### ABSTRACT ALGEBRA-II
Matrices, operations on matrices, matrix algebra, kinds of matrices, Transpose, adjoint and inverse of a matrix, solution of system of linear equations.

**2 QUESTIONS**

### SET THEORY-II
Partial order relation and relate concepts of u.b., l.b., inf., sup, maximal element, minimal element and lattice (definition and examples only), statement of Zorn's lemma.

**1 QUESTION**

### BOOKS RECOMMENDED:
1. Complex variable     :     J N Sharma.
2. Set Theory     :     Lalji Prasad/ Dr. K. K. Jha

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## SEMESTER-VIII

8. **MINOR COURSES – MVC-801T**
**OPTIMIZATION TECHNIQUES (4 CREDITS)**                    60Lectures

| Marks: (ESE: 3Hrs.)=100 | Pass Marks: Th(ESE)=40 |
|---|---|

### Unit-1

Definitions and scope of operations research, different types of models in operations research: their construction and general method of solution. Elements of linear programming problem (LPP): Canonical and standard forms, formulation of LPP, graphical method to solve two variable LPP, solution of LPP using simplex

procedure, use of artificial variables in LPP, generation of extreme point solutions, principle of duality in LPP, statement and proof of duality theorem, simple problems based on duality theorem.

### Unit-2

Allocation Models: Transportation problem (T.P.), different methods of finding initial feasible solution of a T.P., UV method of finding optimal solution of a T.P., solution of assignment problem using Hungarian method.

### Unit-3

Inventory Control: Definitions of various costs involved in inventory control. ABC inventory system, characteristics of inventory system. Deterministic Economic Lot Sizeproblems, EOQ model and its variations (with and without shortages). Quantity discount model with price breaks.

### Unit-4

Theory of games: Two person zero-sum games, pure and mixed strategies, saddle point, minimax-maximin principle of rectangular games, games without saddle point, dominance and modified dominance principles, graphical solution of $2 \times N$ and $M \times 2$games, reduction of game problems to a Linear programming problem. Networking: Shortest route and minimal spanning tree problem.

### References:
1) Gass, S. I. (2010). Linear Programming, Methods and Applications, 5th Ed., Dover Books.
2) Hadley, G. (2002). Linear programming. Narosa.
3) Hiller, F.S. and Liebermann, G.J. (2009). Introduction to Operations Research, McGraw Hill.
4) McKinsey, J.C.C. (2003). Introduction to the Theory and Games. Dover Books.
5) Swaroop, K., Gupta, P.K. and Singh, M.M. (2005). Operations Research. Sultan Chand and Sons.
6) Taha, H.A. (2014). Operations Research, Ninth Edition, Pearson Education India.

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## SEMESTER-I/II/III

**MULTI DISCIPLINARY COURSE – MDC I/II/III**
**INTRODUCTORY MATHEMATICS (3 CREDITS)**

45Lectures

Marks: (ESE: 3Hrs.)=75

Pass Marks: Th(ESE)=30

### SETS
Sets and their representations, Empty set, Finite and Infinite sets, Equal sets, Subsets, Subsets of a set of real numbers especially intervals (with notations). Universal set. Venn diagrams. Union and Intersection of sets. Difference of sets. Complement of a set. Properties of Complement. De-Morgan's Law.

### RELATION AND FUNCTIONS
Ordered pairs. Cartesian product of sets. Number of elements in the Cartesian product of two finite sets. Cartesian product of the set of reals with itself (upto R x R x R).Definition of relation, pictorial diagrams, domain, co-domain and range of a relation. Function as a special type of relation. Pictorial representation of a function, domain, co-domain and range of a function. Real valued functions, domain and range of these functions, constant, identity, polynomial, rational, modulus, signum, exponential, logarithmic and greatest integer functions, with their graphs. Sum, difference, product and quotients of functions.

### MATRICES
Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operation on matrices: Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication. On-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Invertible matrices and proof of the uniqueness of inverse, if it exists; (Here all matrices will have real entries).

### DETERMINANTS
Determinant of a square matrix (up to 3 x 3 matrices), minors, co-factors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

### CONTINUITY AND DIFFERENTIABILITY
Continuity and differentiability, chain rule, derivative of inverse trigonometric functions, like $sin^{-1} x$ , $cos^{-1} x$ and $tan^{-1} x$, derivative of implicit functions. Concept of exponential and logarithmic functions. Derivatives of logarithmic and exponential functions. Logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives.

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## INTEGRAL CALCULUS

Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts, Evaluation of simple integrals of the following types and problems based on them.

$$\int \frac{dx}{x^2 \pm a^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2 + bx + c}, \int \frac{dx}{\sqrt{ax^2 + bx + c}} \int \frac{px + q}{ax^2 + bx + c} dx,$$

$$\int \frac{px + q}{\sqrt{ax^2 + bx + c}} dx, \int \sqrt{a^2 \pm x^2}\, dx, \int \sqrt{x^2 - a^2}\, dx$$

$$\int \sqrt{ax^2 + bx + c}\, dx$$

## VECTORS

Vectors and scalars, magnitude and direction of a vector. Direction cosines and direction ratios of a vector. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Definition, Geometrical Interpretation, properties and application of scalar (dot) product of vectors, vector (cross) product of vectors.

## STRAIGHT LINES

General Equation of a line, Slope of a line and angle between two lines. Various forms of equations of a line: parallel to axis, point -slope form, slope-intercept form, two-point form, intercept form, Distance of a point from a line.

## CONIC SECTIONS

Sections of a cone: circles, ellipse, parabola, hyperbola, a point, a straight line and a pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse and hyperbola. Standard equation of a circle.

## THREE - DIMENSIONAL GEOMETRY

Direction cosines and direction ratios of a line joining two points. Cartesian equation and vector equation of a line, skew lines, shortest distance between two lines. Angle between two lines.

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# SEMESTER-I

**SKILL ENHANCEMENT COURSES – SEC 101T**
**ELEMENTARY COMPUTER APPLICATION SOFTWARE (3 CREDITS)**  45Lectures

| Marks: (ESE: 3Hrs.)=75 | Pass Marks: Th(ESE)=30 |
|---|---|

**Objective of the Course**

The objective of the course is to generate qualified manpower in the area of Computer Application/Information Technology and Graphic designing which will enable such person to work seamlessly at any Offices, whether Govt. or Private or for future entrepreneurs in the field of Computer Science/IT.

**Basic Computer Concept:** Characteristics of Computers, Communication between Various Units of a Computer System, CPU. Input Devices: Keyboard, Mouse, joystick, Scanner, webcam. Output Devices: Softcopy devices, monitors , projectors, speakers, Hardcopy devices, Printers: Dotmatrix, inkjet, laser, Plotters.

**[6Lectures]**

**Computer Memory and Processors:** Memory hierarchy, Processor registers, Cache memory, Primary memory- RAM, ROM, Secondary Memory and devices.
Number System: Numbers System, Decimal number system, Binary number system, Octal number system, Hexadecimal number system, Conversion between the number systems. Basic Logic gates-AND, OR, NOT, Universal logic gates- NAND, NOR.

**[6Lectures]**

**Word Processing Concepts**: saving, closing, Opening an existing document, Selecting and Editing text, Finding and replacing text, Creating and Printing documents, Character and Paragraph Formatting, Mathematical Typing, Page Design and Layout. Editing and Spelling Checking, using thesaurus, Handling Graphics, Creating Tables, Document Templates, Mail merge and Macros.

**[6Lectures]**

**Microsoft Excel (Spreadsheet) Spreadsheet Concepts:** Creating, Saving and Editing a Workbook, Inserting, Entering data in a cell / formula Copying and Moving from selected cells, handling operators in Formulae, Functions: Mathematical, Logical, statistical, text, financial, Date and Time functions, Using Function Wizard. Formatting a Worksheet: Formatting Cells changing data alignment, changing date, number, character or currency format, changing font, adding borders and colors, Printing worksheets, Charts and Graphs – Creating, Previewing, Modifying Charts.

**[7Lectures]**

**Microsoft Power Point**: Creating, Opening and Saving Presentations, Creating the Look of Your Presentation, Working in Different Views, Working with Slides, Adding and Formatting Text, Formatting Paragraphs, Drawing and Working with Objects, Adding Clip Art and other pictures, Designing Slide Shows, Running and Controlling a Slide Show, Printing Presentations. Creating photo album, Rehearse timing and record narration. Master slides.

**[5 Lectures]**

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**Text Book:**

- Computer Fundamental MS Office: Including Internet & Web Technology by Anupama Jain (Author), Avneet Mehra (Author), Publisher: Vitasta Publishing Pvt.Ltd (2 August 2010)
- Fundamentals of Computers and MS-Office, by Harish Gujjar (Author, Contributor), Publisher :.S Bhavikatti Prakashana (1 January 2015)
- Computer Fundamental MS Office: Including Internet & Web Technology by Anupama Jain, Avneet Mehra: Published August 2nd 2010 by Vitasta Publishing Pvt.Ltd

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SEC-101P
## ELEMENTARY COMPUTER APPLICATION SOFTWARE - LAB

[Practical: 15 Lectures]

### A. MS-WORD LAB ASSIGNMENT

1. Write down the following Paragraph OR anyone provided by your teacher;

   Without a doubt, the Internet is one of the most important inventions of modern times. The Internet is a global interconnected computer networks which allow each connected computer to share and exchange information with each other. The origins of the Internet can be traced to the creation of Advanced Research Projects Agency Network (ARPANET) as a network of computers under the auspices of the U.S.Department of Defense in 1969.

   Apply following effects on the paragraph:
   i. Paragraph **font-size** and **font-type** must be 12 Verdana.
   ii. Paragraph **alignment** must be justified and double line spacing.
   iii. **Highlight** the "(ARPANET)" with green color.
   iv. Make the "Internet" keywords **Bold and Italic**.
   v. Insert any "**WordArt**" and a **symbol** to your document.
   vi. Insert a **clipart** to your document.
   vii. Add following lines to your document:
        Internet, Intranet, Extranet, URL, WWW, Networking, Protocols, HTTP, TCP/IP

2. Create a Table of following fields:
   Name, Surname, Age, Gender, Job and apply the following effects
   i. Insert 10 records
   ii. Font size should be 12
   iii. Title size should be 14
   iv. Font type should be Times new Roman
   v. Title color should be blue
   vi. Text color should be black
   vii. Table border should be 2

3. Write a letter on 'Road Safety' and send to 'Multiple Recipients' using mail merge.

### B. MICROSOFT EXCEL LAB ASSIGNMENT

**Basic Formatting and Spreadsheet Manipulation**
1. Add rows and columns to an existing spreadsheet
2. Reformat data(center, command currency styles, bold, text color)
3. Work with a simple formula (product)and function (sum)

**Assignment**
1. Create a workbook as shown below.
2. To enter new rows or columns, simply click on the row or column header to select the whole row or column. Then right click with the mouse and choose insert.
3. Add the new row for S Spade with the data that's shown below (between the original rows 7 and8).
4. Add a column for gender and the data as shown below (between the original columns A and B).Enter the appropriate gender for yourself in the last row.

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| A | B | C | D |
|---|---|---|---|
| Name | Male/Female | Genre | NumberofSongs |
| J Smith | F | Blues | 50 |
| B Doe | M | Country | 110 |
| S Spade | F | Country | 200 |
| F Zappa | M | Blues | 1400 |
| F Zappa | M | Alternative | 2300 |
| J Smith | F | Alternative | 150 |
| S Spade | F | Blues | 1000 |
| B Doe | M | Blues | 75 |
| Your name | M | Blues | 800 |

5. Center the data in columns B and C. Do this by selecting the whole column and click the center icon on the ribbon.

6. Bold the data in row 1, the column headings (ensure that the data all remains visible within the column boundaries).

7. Change the font color for row 1toBlue.

8. Change the format of the data in column D to comma style (no decimal places showing).There is an icon on the home tab that sets it to comma style easily.

9. Add two new column labels to the right of the current columns; **Unit Price** and **Total Cost**. (They will be in columns E and F.) These two columns of data should be currency type so that the dollar sign is shown. There is an icon to quickly format the selected column as currency type.

10. All tunes are$.99, so enter that value for all rows in Column E. You can copy quickly by using the **AutoFill** handle and drag that amount down. When you over your mouse over the tiny square in the bottom right hand corner of the active cell, your mouse shape will become a skinny plus sign, and
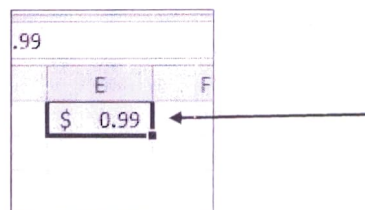


you can click and drag that cell to make a copy.

11. Calculate Total Cost (column F) as *column D times Column E*. You will type in a formula like this into cell F2: **=D2*E2**(Be sure to begin the formula with an equal sign)

12. Use the AutoFill (skinny plus sign) again to copy the formula down column F; down to F10.Doublecheck the picture below to make sure yours has the correct values

13. Add a border to all of the cells (A1-f10) using the Borders tool in the Fonts group on the Home Tab.

14. Change the page layout to landscape. Do this by clicking the Page Layout tab on the ribbon and then to Orientation to Landscape.

15. Save the file.

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16. Click in cell F11 and Use the sum function or the shortcut icon that looks like **Σ** to get the total of the Total Cost column.

17. Ensure that the data is all visible within the column boundaries. Make the columns wider if needed.

18. Save the workbook. Your final spreadsheet should look like the following when printed.

| Name | Male/Female | Genre | Number of Songs | Unit Price | Total Cost |
|---|---|---|---|---|---|
| J Smith | F | Blues | 50 | $0.99 | $ 49.50 |
| B Doe | M | Country | 110 | $ 0.99 | $ 108.90 |
| S Spade | F | Country | 200 | $ 0.99 | $ 198.00 |
| F Zappa | M | Blues | 1,400 | $ 0.99 | $ 1,386.00 |
| F Zappa | M | Alternative | 2,300 | $ 0.99 | $ 2,277.00 |
| S Spade | F | Blues | 1,000 | $ 0.99 | $ 990.00 |
| J Smith | F | Alternative | 150 | $ 0.99 | $ 148.50 |
| B Doe | M | Blues | 75 | $ 0.99 | $ 74.25 |
| Your name | M | Blues | 800 | $ 0.99 | $ 792.00 |
| | | | | | $ 6,024.15 |

### Create a sample table given below in Excel

➢ Using formula find Total
➢ Find the maximum value using MAX function from the **Units** column
➢ Find minimum value from **Total** column

| Order Date | Region | Rep | Item | Units | UnitCost | Total |
|---|---|---|---|---|---|---|
| 1/6/2016 | East | Jones | Pencil | 95 | 1.99 | 189.05 |
| 1/23/2016 | Central | Kivell | Binder | 50 | 19.99 | 999.50 |
| 2/9/2016 | Central | Jardine | Pencil | 36 | 4.99 | 179.64 |
| 2/26/2016 | Central | Gill | Pen | 27 | 19.99 | 539.73 |
| 3/15/2016 | West | Sorvino | Pencil | 56 | 2.99 | 167.44 |
| 4/1/2016 | East | Jones | Binder | 60 | 4.99 | 299.40 |
| 4/18/2016 | Central | Andrews | Pencil | 75 | 1.99 | 149.25 |
| 5/5/2016 | Central | Jardine | Pencil | 90 | 4.99 | 449.10 |
| 5/22/2016 | West | Thompson | Pencil | 32 | 1.99 | 63.68 |
| 6/8/2016 | East | Jones | Binder | 60 | 8.99 | 539.40 |
| 6/25/2016 | Central | Morgan | Pencil | 90 | 4.99 | 449.10 |
| 7/12/2016 | East | Howard | Binder | 29 | 1.99 | 57.71 |
| 7/29/2016 | East | Parent | Binder | 81 | 19.99 | 1,619.19 |
| 8/15/2016 | East | Jones | Pencil | 35 | 4.99 | 174.65 |
| 9/1/2016 | Central | Smith | Desk | 2 | 125.00 | 250.00 |
| 9/18/2016 | East | Jones | PenSet | 16 | 15.99 | 255.84 |
| 10/5/2016 | Central | Morgan | Binder | 28 | 8.99 | 251.72 |

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| 10/22/2016 | East | Jones | Pen | 64 | 8.99 | 575.36 |
| 11/8/2016 | East | Parent | Pen | 15 | 19.99 | 299.85 |
| 11/25/2016 | Central | Kivell | PenSet | 96 | 4.99 | 479.04 |
| 12/12/2016 | Central | Smith | Pencil | 67 | 1.29 | 86.43 |
| 12/29/2016 | East | Parent | PenSet | 74 | 15.99 | 1,183.26 |

## C. MS-POWERPOINT LABASSIGNMENT

*Activity 1: Using Text & Background/Themes*
    i.    Create one new slide and insert any text.
    ii.    To make your slide more attractive, use the themes or background.
    iii.    Make sure it apply for every slide not only one slide.

*Activity 2: Apply Custom Animation On Text*
    i.    Use the custom animation to add effects on your text. Set the text move after you click the mouse.
    ii.    If you have more than one text, add effects for each of text.

*Activity 3: Insert Image& WordArt*
    i.    Insert one new blank slide.
    ii.    Choose one pictures or clip art from any source and insert in your new slide.
    iii.    Using the WordArt, make a note or title on your picture.
    iv.    Use the custom animation again to add effects on your picture and WordArt.

*Activity 4: Insert Text Box*
    i.    Insert one new blank slide.
    ii.    Use the text box to insert one paragraph of text and adjust your text.

*Activity 5: Insert Smart Art*
    i.    Insert one new blank slide.
    ii.    Insert the SmartArt and put your text on the SmartArt.

*Activity 6: Insert Audio*
    i.    Back to your first slide and insert one audio on that slide. The audio must play automatically when you show your slide.
    ii.    Make sure the speaker also not appear when you show your slide.(the icon).
    iii.    The audio must play when you show alls your slide, not only one slide.

*Activity 7: inserting Video*
i.    Insert one new slide and insert one short video

*Activity8: SaveFile*
i.    Save your file

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*Activity9: Create Photo Album& Hyperlink*
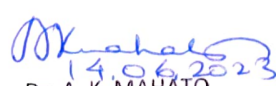
    i.    Insert one new slide and put a text ex: "My Photo Album"

    ii.   Create one photo album and adjust your text and your photos

    iii.  Save your photo album with a new file

    iv.  Make a hyperlink to your photo using the text "My Photo Album"

**Reference Books:**

☐  Faithewempen, word2016indepth1$^{st}$edition, que publishing(2015)

☐  stevenwelkler,Office2016forbignners,CreateSpaceIndependentpublishingplateform(2016)

☐  Elaine Marmel, office 2016simplified,1$^{st}$Edition,John wileyandsons Inc(2016)

☐  Patrice-Anne Rutledge,Easyoffice2016 1stedition,Que publishing(2016)

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## SEMESTER-II

### SKILL ENHANCEMENT COURSES – SEC-201T
### C++ PROGRAMMING FOR MATHEMATICS (3 CREDITS)

| | |
|---|---|
| 45Lectures | Pass Marks: Th(ESE)=30 |
| Marks: (ESE: 3Hrs.)=75 | |

**Course Learning Outcomes:** This course will enable the students to:
1) Understand and apply the programming concepts of C++ for solving mathematical problems.
2) Apply to find greatest common divisors, generate random numbers, and understand Cartesian geometry and algebraic concepts through programming.
3) Represent the outputs of programs visually in terms of well formatted text and plots.

### Unit 1: Essentials of C++
### (6Lectures)
Basics of programming, concept of OOPs, Structure of C++ program, A simple C++ program, Compiling and Executing simple C++ program. Declaring, Defining and Initializing Variables, Scope of Variables, Constants, Keywords, Data Types, Casting of Data Types, Operators, Simple Expressions in C++ (including Unary Operator Expressions, Binary Operator Expressions),Understanding Operators Precedence in Expressions.

### Unit 2: Control Statements of C++
### (6Lectures)
Conditional Statements: (if, if else, nested if, if else if ladder, switch case) Iterative/Looping Statements: (while, do-while, and for loops), Use of break and continue in Loops, Using Nested iterative/looping statements.

### Unit 3: Functions and Arrays in C++
### (8Lectures)
Functions, function prototyping, Call by Value, Call by Reference, Functions returning value, Void functions, Functions parameters, function overloading, Inline Functions, Functions with default arguments, Recursion function, Math library functions.

Array, Creating and Using One Dimensional Arrays, Accessing individual elements in an Array, Manipulating array elements using loops, Two-dimensional Arrays(Declaring, Defining and Initializing Two Dimensional Array, Working with Rows and Columns),Introduction to Multi-dimensional arrays.

### Unit 4: Classes in C++
### (7Lectures)
Defining Classes, declaring data member, member function, Access Modifiers, Simple program using class and object, Passing values as parameter function, Objects as parameters, Constructors, Parameterized Constructor, Constructor Overloading, Copy Constructor, Function overloading in classes, Operator overloading (including assignment operators, unary operators)

### Unit 5: Inheritance, Polymorphism and Exception Handling
### (8Lectures)
Introduction to Inheritance (Single Inheritance, Multi-Level Inheritance, Multiple Inheritance, Hybrid Inheritance, Hierarchical Inheritance), Polymorphism (Virtual Functions, Pure Virtual Functions), Basics Exceptional Handling (using catch and throw, multiple catch statements), Catching all exceptions.

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REFERENCE BOOKS:

□ C++ The complete Reference, Scheldt, 5th Ed, TMH.
□ Herbtz Schildt, "C++:The Complete Reference", FourthEdition,McGrawHill.2003
□ Bjarne Stroustrup,"The C++ProgrammingLanguage",4thEdition, Addison-Wesley,2013.
□ Bjarne Stroustroup, "Programming -- Principles and Practice using C++", 2nd Edition, Addison-Wesley2014.
□ E Balaguruswamy,"Object Oriented Programming with C++"Tata McGraw-Hill Education, 2008.

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# SEC-201P
# C++ Programming for Mathematics - LAB

[Practical: 15 Lectures]

## Operators:

1. Write a program in C++ input N numbers to calculate sum and average of the numbers.
2. Write a program in C++ input a three digits number to find out reverse and sum.
3. Write a program in C++ input three numbers to find out greatest and smallest using conditional operator.
4. Write a program in C++ input a number to check the number is even or not using conditional operator.
5. Write a program in C++ input a four digits numbers to check the 1st and last digit are equal or not.
6. Write a program in C++ input two numbers to swap the numbers by using 3rd variables.
7. Write a program in C++ input two numbers to swap the numbers without using 3rd variables.
8. Write a program in C++ input value of side of a square and display the Area & Perimeter of the Square.
9. Write a program in C++ input the radius of a Circle and calculate the Area and Circumference.
10. Write a program in C++ input the length and breadth of a Rectangle calculate and print the area and Perimeter of Rectangle.
11. Write a program in C++ to input the marks obtained by a student in English, Maths, Science, Computers and calculate the Total and Percentage by a student in the 4 subjects.
12. Write a program in C++ to input the time in seconds and split it into hours, minutes, and seconds.
13. Write a program in C++ to the convert the amount entered by the user in denominations of Rs. 1000, Rs. 500, Rs. 100, Rs. 50, Rs. 20, Rs. 10, Rs. 5, Rs. 2 and Re.1 notes
14. Write a program in C++ to input the Basic Salary of an employee and Calculate his Gross and Net Salary based on the information given below:
    D.A. (Dearness Allowance) = 75% of Basic Salary
    H.R.A. (House Rent Allowance) = 25% of Basic Salary
    P.F. (Provident Fund) = 12% of (Basic + D.A.)
    Gross Salary = Basic + D.A + H.R.A
    Net Salary = Gross Salary – P.F.

## SELECTION or CONDITIONAL statements

15. Write a program in C++ to input two numbers to find out greatest and smallest using simple if.
16. Write a program in C++ find out the greatest of 3 numbers using nested if statement.
17. Write a program in C++ input the age of a person and check if he is a Senior Citizen or not.
18. Write a program in C++ input any year and check if it a leap year or not.
19. Write a program in C++ input number from 1 to 7 and display the corresponding day of the week using switch...case.
20. Write a program in C++ a menu driven program to input/assign/store 2 numbers and perform the following mathematical operations on the two variables as given below in the menu... 1. Addition (+) 2. Subtraction (-) 3. Multiplication (x) 4. Division (/)
21. Write a program in C++ a menu driven program to calculate the area of
    a. Circle (П.r2)
    b. Square (side * side)
    c. Rectangle (l * b)

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22. Write a program in C++ to enter a three digits number to check the number is Armstrong or not.

23. Write a program in C++ to enter a three digits number to check the number is Palindrome or not.

## ITERATION or LOOPING statements

24. Write a program in C++ to Display the first ten Even numbers in reverse order.

25. Write a program in C++ Generate the table of any integer number. Follow the below example:

26. 8 x 1 = 8

27. 8 x 2 = 16

28. 8 x 3 = 24 till 10...

29. Write a program in C++ input any number and print its Factorial (Hint: 5! = 5 x 4 x 3 x 2 x 1)

30. Write a program in C++ input a number and count the number of digits.

31. Write a program in C++ to input any digit's number to calculate sum and reverse them.

32. Write a program in C++ input ten numbers and count the number of positive nos., negative nos., even positive nos., even negative nos., odd positive nos., odd negative and zeros.

33. Write a program in C++ to input a number and print the sum of all the digits that are even. E.g., 456, output is 10.

34. Write a program in C++ generate Fibonacci Series up to N

35. Write a program in C++ to check whether the given no is prime or not.

36. Write a program in C++ print all the Series of Prime numbers between x and y limits.

37. Write a program in C++ to calculate sum of series: S=1 + 1/2 + 1/3 + 1/4 + ... till 10 terms.

38. Write a program in C++ to calculate sum of series: S = 1 + 1/4 + 1/9 + ... till 10 terms

39. Write a program in C++ to calculate sum of series: S = 1 + 1/3 + 1/5 + ... till 10 terms

40. Write a program in C++ that checks whether the given string is palindrome or not.

41. Write a program in C++ input any number and check if it is an Armstrong number or not.

42. Print the following pattern/series:

| a) | b) | c) | d) |
|---|---|---|---|
| * | 1 | A | 3 2 1 |
| * * | 1 2 | A B | 2 1 |
| * * * | 1 2 3 | A B C | 1 |

## ARRAY/MATRIX

43. Write a program in C++ to store 10 numbers in an array and print the sum of all the ten nos.

44. Write a program in C++ to input 10 numbers in an array and search a given number from within that array and print all its positions of occurrence using Linear Search Technique. If not found display proper message.

45. Write a program in C++ to accept 10 integer type numbers in an array and sort the array in ascending order using Bubble Sort Technique. Display the elements of the array before and after sorting.

46. Write a program in C++ to accept 10 integer type numbers in an array and to find out maximum and minimum number in the array and display them.

47. Write a program in C++ display transpose of a 3x3 matrix, values input by the user and print them.

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48. Write a program in C++ to calculate summation of left diagonal and right diagonal of a 3x3 matrix values and display them.
49. Write a program in C++ to calculate summation of two matrixes (3x3).
50. Write a program in C++ to calculate multiplications of two matrixes (3x3)

## RECURSION

51. Write a program in C++ finding factorial of a number in Java using recursion
52. Write a program in C++ generate the Fibonacci series using recursion

## CLASSES & OBJECTS

53. Write a program in C++ input two values through INPUT method to calculate sum and display using display method.
54. Write a program in C++ calculate sum of two numbers using passing by value method and display them.
55. Write a program in C++ find out greatest of numbers using nesting of methods.
56. Write a program in C++ input two numbers to swapping the numbers by using pass by value method.
57. Write a program in C++ input two numbers to swapping the numbers by using pass by reference method.
58. Write a program in C++ to calculate addition of two Distances (Feet and Inches) and display them. (Ex. Distance3=Distance1+Distance2)
59. Write a program in C++ to calculate addition of Two Times (Hour, Minute and Seconds) and display them. (Ex. Time=Time1+Time2)
60. Write a program in C++ to calculate addition of Two Complex numbers (Real and Imaginary) and display them. (Ex. Comp=Comp1+Comp2).
61. Write a program in C++ based on method overloading to calculate (Area of Circle, Area of Triangle, Area of Rectangle) and display the result separately.
62. Write a program in C++ based on method overloading to find out max of two, three and four numbers.

## CONSTRUCTOR

63. Write a program in C++ to calculate sum of two numbers using default constructor method and display them.
64. Write a program in C++ passing two values (feet and inches) to the parameterized constructor method through an object and display them.
65. Write a program in C++ passing two values (feet and inches) by two different objects and calculate sum of two objects and display them.
66. Write a program in C++ based on constructor overloading to find out max of two, three and four numbers and display the output separately.
67. Write a program in C++ based on copy constructor give a suitable example.
68. Write a program in C++ based on default argument function give a suitable example.

## INHERITANCE

69. Write a program in C++ to illustrate the use of single inheritance input name and roll in classA: input 3 subject marks in class B and display them.
70. Write a program in C++ to illustrate the use of multilevel inheritance input name and roll in class A: input 3 subject marks in class B: calculate total, percentage and division in class C: (if per>=70 div="Distinction", per>=60 and per<80 div="First", per>=50 and per<60 div="Second", per>=40and per<50 div="Third" other below 40 div="Fail") display them.

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71. Write a program in C++ to illustrate the use of multiple inheritance input name and roll in class A: input course and sem in class B: input 3 subject marks in class c: to calculate total, percentage and division in class C.

72. Write a program in C++ using the concept of hierarchical Inheritance give a suitable example.

73. Write a program in C++ using the concept of hybrid Inheritance give a suitable example.

## POLYMORPHISM

74. Write a program to create Compute class which contains two methods with the same name but with different signatures.

75. Write a program in C++ where calculate () method of super class is overridden by the calculate () method of sub class. The behavior of the calculate () method is dynamically decided.

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## SEMESTER-III

SKILL ENHANCEMENT COURSES – SEC-301T
LaTeX and HTML (3 CREDITS)
45Lectures

| Marks: (ESE: 3Hrs.)=75 | Pass Marks: Th(ESE)=30 |
|---|---|

### Unit 1: Getting Started with LaTeX

Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic Information to a document, Environments, Footnotes, Sectioning and displayed material.

[5Lectures]

### Unit 2: Mathematical Typesetting with LaTex:

Accents and symbols, Mathematical Typesetting (Elementary and Advanced): Subscript Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

[5Lectures]

### Unit 3: Graphics and Beamer Presentation in LaTex:

Graphics in LaTex, Simple pictures using PS Tricks, Plotting of functions, Beamer presentations.

[3Lectures]

### Unit 4: HTML Tags:

Concept of Tag, types of HTML tags, structure of HTML program. Text formatting through HTML: Paragraph breaks, line breaks, background and BG color attributes. Text styles and other text effects: centering, spacing, controlling font size & color. Lists: Using unordered, ordered, definition lists. Adding Graphics to HTML Documents: Using Image tag, attributes of Image tag, changing width & height of image.

[7Lectures]

### Unit 5: TABLES, FRAMES AND LINKING DOCUMENTS Handling Tables:

To define header rows & data rows, use of table tag and its attributes. Use of caption tag. Linking Documents: Concept of hyperlink, types of hyperlinks, linking to the beginning of document, linking to a particular location in a document, Images as hyperlinks. Frames: Introduction To frames, using frames & frameset tags, named frames how to fix the size of a frame, targeting named frames. Design of web pages.

[7Lectures]

### Text Book:

- LATEX -A BEGINNER GUIDE TO PROFESSIONAL DOCUMENTATION,Author: Dr. S. SWAPNA KUMAR, Edition: First, 2019
- LATEX Kitchen, Author: Suman Bandyopadhyaya , Publisher : Techno World (29 July 2021)
- Web Design With HTML & CSS: HTML & CSS Complete Beginner's Guide by Prem Kumar | 31 October 2021
- Mastering HTML, CSS & Javascript Web Publishing, Author: Laura Lemay, Rafe Colburn.

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**SEC-301P**
**LaTeX and HTML - LAB**

1. Create an html page with Heading6 separate lines in different colors. State color of each line in its text.
2. Create an html page containing the polynomial expression as follows: $a_0 + a_1x + a_2x^2 + a_3x_3$
3. Create an html page with following specifications
a. Title should be about my college
b. Put the image in the background
c. Place your College name at the top of the page in large text followed by address in smaller size
d. Add names of courses offered each in a different color, style and typeface
e. Add scrolling text with a message of your choice

4. Create the following output in HTML

| Country | Population (In Crores) | |
|---|---|---|
| | 1998 | 85 |
| INDIA | 1999 | 90 |
| | 2000 | 100 |
| | 1998 | 30 |
| USA | 1999 | 35 |
| | 2000 | 40 |
| | 1998 | 25 |
| UK | 1999 | 30 |
| | 2000 | 35 |

5. Create following output.
   - Milk
      - A. Paneer
      - B. Ghee
      - C. IceCream
   - Coffee
      - a. HotCoffee
      - b. Cold

6. Write html code to generate following output.
   - Punjab
   - Maharashtra
      - o Pune
      - o Mumbai
   - Gujrat

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## DEPARTMENT OF MATHEMATICS
## DR. SHYAMA PRASAD MUKHERJEE UNIVERSITY

### FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATION

Question format for **10 Marks:**

| | Subject/Code | |
|---|---|---|
| F.M. =10 | Time=1Hr | Exam |
| Year | | |

**General Instructions:**
- I.   **Group A** carries very short answer type compulsory questions.
- II.  **Answer 1 out of 2** subjective/descriptive questions given in **Group B.**
- III. Answer in your words as far as practicable.
- IV.  Answer all sub parts of a question at one place.
- V.   Numbers in right indicate full marks of the question.

#### Group A

1.

   [5x1=5]
   i) ...............
   ii) ...............
   iii) ...............
   iv) ...............
   v) ...............

#### Group B

2. ...............
   [5]
3. ...............
   [5]

**Note:** There may be subdivisions in each question asked in Theory Examination.

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Question format for **20 Marks:**

| | Subject/Code | |
|---|---|---|
| F.M. =20 | Time=1Hr | Exam |
| Year | | |

**General Instructions:**
- I.   **Group A** carries very short answer type compulsory questions.
- II.  **Answer 1 out of 2** subjective/descriptive questions given in **Group B.**
- III. Answer in your words as far as practicable.
- IV.  Answer all sub parts of a question at one place.
- V.   Numbers in right indicate full marks of the question.

#### Group A

1.

   [5x1=5]
   i) ...............
   ii) ...............
   iii) ...............
   iv) ...............
   v) ...............
2. ...............
   [5]

#### Group B

3. ...............
   [10]
4. ...............
   [10]

**Note:** There may be subdivisions in each question asked in Theory Examination

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## DEPARTMENT OF MATHEMATICS
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### FORMAT OF QUESTION PAPER FOR END SEMESTER EXAMINATION

Question format for **75 Marks:**

| | Subject/Code | |
|---|---|---|
| F.M. =75 | Time=3Hr | Exam Year |

**General Instructions:**

I. **Group A** carries very short answer type compulsory questions.
II. **Answer 4 out of 6** subjective/descriptive questions given in **Group B.**
III. Answer in your words as far as practicable.
IV. Answer all sub parts of a question at one place.
V. Numbers in right indicate full marks of the question.

### Group A

1.
    i) ..............
    ii) ..............
    iii) ..............
    iv) ..............
    v) ..............
                                                 [5x1=5]

2. .............. [5]
3. .............. [5]

### Group B

4. .............. [15]
5. .............. [15]
6. .............. [15]
7. .............. [15]
8. .............. [15]
9. .............. [15]

**Note:** There may be subdivisions in each question asked in Theory Examination

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Question format for **75 Marks:**

| | Subject/Code | |
|---|---|---|
| F.M. =75 | Time=3Hr | Exam Year |

**General Instructions:**

I. **Group A** carries very short answer type compulsory questions.
II. **Answer 4 out of 6** subjective/descriptive questions given in **Group B.**
III. Answer in your words as far as practicable.
IV. Answer all sub parts of a question at one place.
V. Numbers in right indicate full marks of the question.

### Group A

1.
    i) ..............       vi) ..............
    ii) ..............      vii) ..............
    iii) ..............     vii) ..............
    iv) ..............     ix) ..............
    v) ..............       x) ..............
                                       [10x1=10]

2. ..............
3. .............. [5]
                       [5]

### Group B

4. ..............
5. .............. [20]
6. .............. [20]
7. .............. [20]
8. .............. [20]
9. .............. [20]
                       [20]

**Note:** There may be subdivisions in each question asked in Theory Examination

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