# NATIONAL EDUCATION POLICY-2020

# Syllabus of

## BACHELOR'S DEGREE

## and

## BACHELOR'S DEGREE WITH HONOURS

## in

## MATHEMATICS

**Sridev Suman Uttarakhand University**
**Badshahi Thaul (Tehri Garhwal) Uttarakhand -249199**
**(State University of Uttarakhand)**

**2023**

# Syllabus of

# BACHELOR'S DEGREE

(First Three Years of Higher Education)

**and**

# BACHELOR'S DEGREE WITH HONOURS

(First Four Years of Higher Education)

# in

# MATHEMATICS

**(Revised in Board of Studies on July 11, 2023)**

# Curriculum Design Committee, Uttarakhand

| S. No. | Name & Designation | |
|---|---|---|
| **1.** | Prof. N.K. Joshi<br>Vice-Chancellor, Sridev Suman Uttarakhand University,<br>Badshahi Thaul, Tehri Garhwal, Uttarakhand | **Chairman** |
| **2.** | Prof. Manmohan Singh Chauhan<br>Vice-Chancellor, Kumaon University, Nainital,Uttarakhand | **Member** |
| **3.** | Prof. O.P.S. Negi<br>Vice-Chancellor, Uttarakhand Open University | **Member** |
| **4.** | Prof. Jagat Singh Bisht,<br>Vice-Chancellor, Soban Singh Jeena University, Almora | **Member** |
| **5.** | Prof. Surekha Dangwal<br>Vice-Chancellor, Doon University, Dehradun | **Member** |
| **6.** | Prof. M.S.M. Rawat<br>Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand | **Member** |
| **7.** | Prof. K.D. Purohit Advisor<br>Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand | **Member** |

# Sridev Suman Uttarakhand University
# Badshahi Thaul, Tehri Garhwal (Uttarakhand)

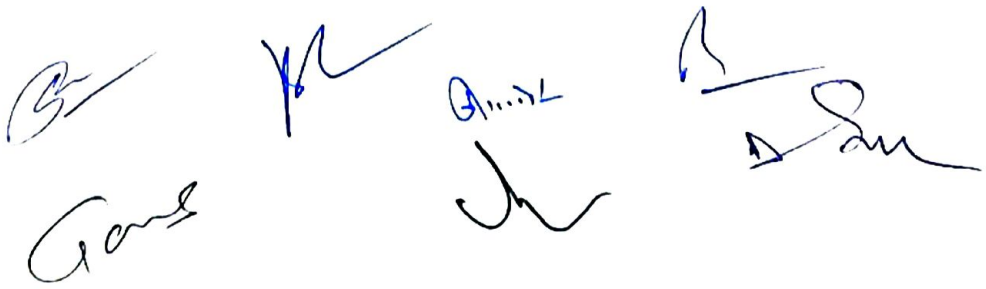
## Department of Mathematics

## Members of Board of Studies

| S.N. | Name | Designation | Department | Board of Studies | Signature |
|---|---|---|---|---|---|
| 1. | Prof. G. K. Dhingra | Dean<br>Faculty of Science<br>Pt. L.M.S. Campus<br>Sridev Suman Uttarakhand University Rishikesh | Faculty of Science | Chairman | |
| 2. | Director | Uttarakhand Science Education and Research Council | USERC | Member | |
| 3. | Prof. K.S. Rawat | Professor and Head<br>Department of Mathematics<br>H.N.B. Garhwal Central University<br>S.R.T. Campus, Tehri Garhwal, Uttarakhand | Mathematics | Member (External Expert) | 11.07.23 |
| 4. | Prof. Pushpa Negi | Principal<br>Govt. P.G.College New Tehri | Higher Education | Member | |
| 5. | Prof. Pankaj Pant | Principal, Govt. P.G.College Nagnath Pokhari | Higher Education | Member | 11.7.2023 |
| 4. | Prof. Kuldeep Singh Negi | Principal, Govt. P.G. College, Khanpur(Haridwar) | Higher Education | Member | 11.7.2023 |
| 5. | Prof. Anita Tomar | Professor & Head,<br>Department of Mathematics<br>Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh | Mathematics | Member | |
| 6. | Prof. Dipa Sharma | Professor<br>Department of Mathematics<br>Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh | Mathematics | Member | |
| 7. | Dr. Gaurav Varshney | Associate Professor,<br>Department of Mathematics<br>Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh | Mathematics | Member | |
| 8 | Dr. Dhirendra Singh | Assistant Professor,<br>Department of Mathematics<br>Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh | Mathematics | Member | |

# Syllabus Preparation Committee

| S. No. | Name | Designation | Department | Affiliation |
|---|---|---|---|---|
| **1.** | Prof. Anita Tomar | Professor & Head | Mathematics | Pt. L.M.S. Campus, Sridev Suman Uttarakhand University, Rishikesh |
| **2.** | Prof. Dipa Sharma | Professor | Mathematics | Pt. L.M.S. Campus, Sridev Suman Uttarakhand University, Rishikesh |
| **3.** | Dr. Gaurav Varshney | Associate Professor | Mathematics | Pt. L.M.S. Campus, Sridev Suman Uttarakhand University, Rishikesh |
| **4.** | Dr. Dhirendra Singh | Assistant Professor | Mathematics | Pt. L.M.S. Campus, Sridev Suman Uttarakhand University, Rishikesh |
| **5.** | Dr. Sudhir Petwal | Assistant Professor | Mathematics | A.P.B Govt. (P.G.) College Agastyamuni |
| **6.** | Dr. Deepak Singh | Assistant Professor | Mathematics | B.L.J. Govt. (P.G.) College Purola, Uttarkashi |



| SEMESTER WISE COURSES IN UG MATHEMATICS PROGRAMS | | | | | |
|---|---|---|---|---|---|
| **YEAR** | **SEMESTER** | **COURSE CODE** | **PAPER TITLE** | **THEORY/ PRACTICAL** | **CREDIT** |
| **CERTIFICATE COURSE IN MATHEMATICS** | | | | | |
| **FIRST YEAR** | **I** | **UGMAT101T** | **Matrices, Trigonometry and Differential Calculus** | THEORY | **4** |
| | | **UGMAT102P** | **Practical** | **PRACTICAL** | **2** |
| | **II** | **UGMAT201T** | **Integral Calculus and VectorAnalysis** | THEORY | **6** |
| **DIPLOMA IN MATHEMATICS** | | | | | |
| **SECOND YEAR** | **III** | **UGMAT301T** | **Abstract Algebra:**<br>**Part A** - Group Theory<br>**Part B** - Ring Theory | THEORY | **6** |
| | **IV** | **UGMAT401T** | **Differential Equations:**<br>**Part A** - Ordinary Differential Equations<br>**Part B** - Partial Differential Equations | THEORY | **6** |
| **DEGREE IN MATHEMATICS** | | | | | |
| **THIRD YEAR** | **V** | **UGMAT501T** | **Analysis:**<br>**Part A** - Real Analysis<br>**Part B** - Complex Analysis | THEORY | **5** |
| | | **UGMAT502T**<br>**UGMAT503T**<br>**UGMAT504T**<br>**UGMAT505T**<br>**UGMAT506T**<br>**UGMAT507T** | **Any one of the following-**<br>**(i) Mathematical Methods**<br>**(ii) Number Theory and Relativity**<br>**(iii) Analytical Geometry**<br>**(iv) Numerical Analysis**<br>**(v) Graph Theory**<br>(vi) **Mechanics** | THEORY | **5** |
| | | **UGMAT-PR** | **Project Work**: Industrial Training/Research Project/ Vocational Course/ Entrepreneurship Skills in Mathematics | **PROJECT** | **4** |
| | **VI** | **UGMAT601T** | **Linear Programming Problem** | THEORY | **5** |
| | | **UGMAT602T** | **Linear Algebra** | THEORY | **5** |
| | | **UGMAT-PR** | **Project Work:** Industrial Training/Research Project/ Vocational Course/ Entrepreneurship Skills in Mathematics | **PROJECT** | **4** |
| **HONOURS DEGREE IN MATHEMATICS** | | | | | |
| **FOURTH YEAR** | **VII** | **MTH101** | **Discrete Mathematics** | THEORY | **5** |
| | | **MTH102** | **Abstract Algebra** | THEORY | **5** |
| | | **MTH103** | **Real Analysis** | THEORY | **5** |
| | | **MTH104** | **Differential Geometry and Tensor Calculus** | THEORY | **5** |
| | | **MTH105** | **Project Work**: Industrial Training/Research Project/ Vocational Course/ Entrepreneurship Skills in Mathematics | **PROJECT** | **4** |
| | **VIII** | **MTH201** | **Linear Algebra** | THEORY | **5** |
| | | **MTH202** | **Complex Analysis** | THEORY | **5** |
| | | **MTH203** | **Differential Equations** | THEORY | **5** |
| | | **MTH204** | **Operations Research I** | THEORY | **5** |
| | | **MTH205** | **Project Work**: Industrial Training/Research Project/ Vocational Course/ Entrepreneurship Skills in Mathematics | **PROJECT** | **4** |
| **MINOR/ADDITIONAL/INTERDISCIPLINARY / MULTIDISCIPLINARY COURSE IN MATHEMATICS** | | | | | |
| **FIRST YEAR** | **I/II** | **MEC01** | **Probability** | THEORY | **4** |
| **SECOND YEAR** | **III/IV** | **MEC02** | **Financial Mathematics** | THEORY | **4** |
| **FOURTH YEAR** | **VII/ VIII** | **MEC03** | **Research Methodology** | THEORY | **4** |

## PROPOSED STRUCTURE OF UNDERGRADUATE MATHEMATICS SYLLABUS

## AS PER NEP 2020 GUIDELINES GENERAL OVERVIEW

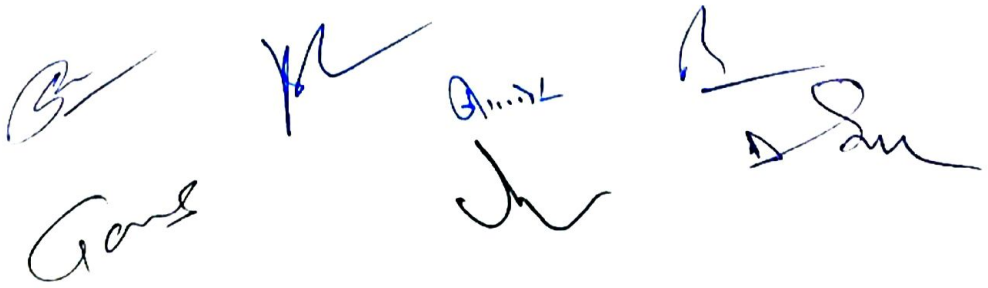
| Graduation – 1st Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **PROGRAMME** | **YEAR** | **SEMESTER (15Weeks)** | **PAPER** | **CREDIT** | **PERIODS Per Week** | **PERIODS (HOURS) Per Semester** | **PAPER TITLE** | **UNIT (Periods Per Semester)** | **PREREQUISITE** | **ELECTIVE (For students of other subject groups who have studied Mathematics in 12th Standard)** |
| **CERTIFICATE COURSE IN MATHEMATICS** | **FIRST YEAR** | **SEMESTER – I** | **Paper-1** | **4** | **4** | 4x15=60 | **Matrices, Trigonometry and Differential Calculus**<br>**Part A:** Matrices<br>**Part B:** Trigonometry<br>**Part C:** Differential Calculus | **Part A**<br>Unit I (8)<br>Unit II (7)<br>Unit III (5)<br>**Part B**<br>Unit IV (6)<br>Unit V (6)<br>**Part C**<br>Unit VI (7)<br>Unit VII (6)<br>Unit VIII (8)<br>Unit IX (7) | Mathematics in12th | Engineering and Technology (UG), Biochemistry Chemistry/ Sciences (UG), Economics (UG/PG), Commerce(UG), BBA/ BCA, B.Sc. (C.S.) |
| | | | **Paper-2 Practical** | **2** | **2 Lab Periods** (2 Hours Each) | 2x2x15=60 | **Practical** (Practical to be done using Mathematica/ MATLA B / Maple/ Scilab /Maxima etc.) | | Mathematics in 12th | Engineering and Technology (UG), B.Sc. (C.S.) |
| | | **SEMESTER – II** | **Paper-1** | **6** | **6** | 15x6=90 | **Integral Calculus and Vector Analysis**<br>**Part A:** Integral Calculus<br>**Part B:** Vector Analysis | **Part A**<br>Unit I (12)<br>Unit II (11)<br>Unit III (12)<br>Unit IV (11)<br>**Part B**<br>Unit V (11)<br>Unit VI (12)<br>Unit VII (11)<br>Unit VIII (10) | Mathematics in 12th | Engineering and Technology (UG), B.Sc. (C.S.) |

## Graduation- 2nd Year

| PROGRAMME | YEAR | SEMESTER (15Weeks) | PAPER | CREDIT | PERIODS Per Week | PERIODS (HOURS) Per Semester | PAPER TITLE | UNIT (Periods Per Semester) | PREREQUISITE | ELECTIVE (For students of other subject groups who have studied Mathematics in 12th Standard) |
|---|---|---|---|---|---|---|---|---|---|---|
| DIPLOMA IN MATHEMATICS | SECOND YEAR | SEMESTER – III | Paper-1 | 6 | 6 | 6x15=90 | **Abstract Algebra**<br>**Part A:** Group Theory<br>**Part B:** Ring Theory | **Part A**<br>Unit I (12)<br>Unit II (20)<br>Unit III (13)<br>**Part B**<br>Unit IV (11)<br>Unit V (12)<br>Unit VI (12)<br>Unit VII (10) | Certificate Course in Mathematics | Engineering and Technology (UG), B.Sc. (C.S.) |
| | | SEMESTER – IV | Paper-1 | 6 | 6 | 6x15=90 | **Differential Equations**<br>**Part A:** ODE<br>**Part B:** PDE | **Part A**<br>Unit I (12)<br>Unit II (11)<br>Unit III (11)<br>Unit IV (11)<br>**Part B**<br>Unit V (11)<br>Unit VI (10)<br>Unit VII (12)<br>Unit VIII (12) | Certificate Course in Mathematics | Economics (UG/PG), B.Sc. (C.S.)<br>Engineering and Technology (UG), Science (Physics-UG) |

## Graduation- 3rd Year

| PROGRAMME | YEAR | SEMESTER (15Weeks) | PAPER | CREDIT | PERIODS (Per Week) | PERIODS (HOURS) Per Semester | PAPER TITLE | UNIT (Periods Per Semester) | PREREQUISITE | ELECTIVE (For students of other subject groups who have studied Mathematics in 12th Standard) |
|---|---|---|---|---|---|---|---|---|---|---|
| DEGREE IN MATHEMATICS | THIRD YEAR | SEMESTER–V | Paper-1 | 5 | 5 | 5x15=75 | **Analysis**<br>**Part A:** Real Analysis<br>**Part B:** Complex Analysis | **Part A**<br>Unit I (12)<br>Unit II (11)<br>Unit III (11)<br>Unit IV (11)<br>**Part B**<br>Unit V (11)<br>Unit VI (10)<br>Unit VII (12)<br>Unit VII (12) | Diploma in Mathematics | Engineering and Technology(UG), Economics(UG/PG), B.Sc.(C.S.) |
| | | | Paper-2 | 5 | 5 | 5x15= 75 | **Any one of the following-**<br>• Mathematical Methods<br>• Number Theory and Relativity<br>• Analytical Geometry<br>• Numerical Analysis<br>• Graph Theory<br>• Mechanics | Unit I (15)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (20) | Diploma in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-3 | 4 | 4 | 4x15= 60 | Project Work | Industrial Training/Survey/ Research Project/ Vocational course/ Entrepreneurship skills | Diploma in Mathematics | Engineering and Technology (UG), BCA, B.Sc. (C.S.) |
| | | SEMESTER–VI | Paper-1 | 5 | 5 | 5x15= 75 | Linear Programming Problems | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | Diploma in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-2 | 5 | 5 | 5x15= 75 | Linear Algebra | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | Diploma in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-3 | 4 | 4 | 4x15= 60 | Project Work | Industrial Training/ Research Project/Vocational course/ Entrepreneurship skills | Diploma in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |



## Graduation- 4th Year

| PROGRAMME | YEAR | SEMESTER (15Weeks) | PAPER | CREDIT | PERIODS (Per Week) | PERIODS (HOURS) Per Semester | PAPER TITLE | UNIT (Periods Per Semester) | PREREQUISITE | ELECTIVE (For students of other subject groups who have studied Mathematics in Degree/Graduation) |
|---|---|---|---|---|---|---|---|---|---|---|
| HONOURS DEGREE IN MATHEMATICS | FOURTH YEAR | SEMESTER–VII | Paper-1 | 5 | 5 | 5x15= 75 | **Discrete Mathematics** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-II | 5 | 5 | 5x15= 75 | **Abstract Algebra** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-III | 5 | 5 | 5x15= 75 | **Real analysis** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-IV | 5 | 5 | 5x15= 75 | **Differential Geometry & Tensor Calculus** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-V | 4 | 4 | --- | **Research Project** | --- | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | SEMESTER–VIII | Paper-1 | 5 | 5 | 5x15= 75 | **Linear Algebra** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-II | 5 | 5 | 5x15= 75 | **Complex Analysis** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-III | 5 | 5 | 5x15= 75 | **Differential Equations** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-IV | 5 | 5 | 5x15= 75 | **Operations Research I** | Unit I (20)<br>Unit II (20)<br>Unit III (20)<br>Unit IV (15) | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |
| | | | Paper-V | 4 | 4 | --- | **Research Project** | --- | DEGREE in Mathematics | Engineering and Technology (UG), BCA, B.Sc.(C.S.) |

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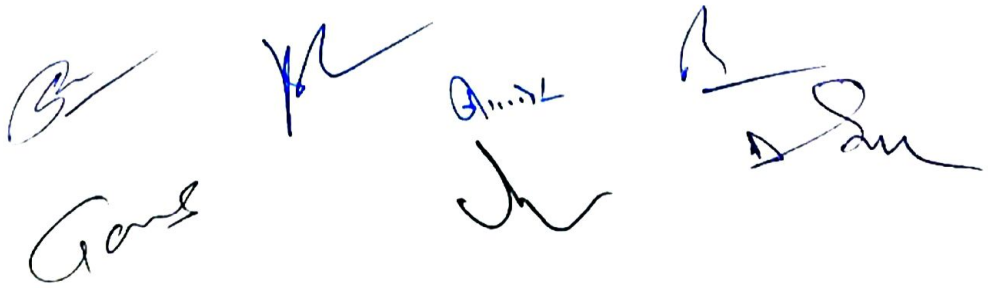
## Programme Outcome/Programme Specific Outcome

### Programme Outcome:

- **PO1:** It is to give in-depth knowledge of geometry, algebra, calculus, differential equations, and several other branches of pure and applied mathematics. This also leads to study the related areas such as computer science and other allied subjects.
- **PO2:** The skills and knowledge gained in this program will be helpful for modeling and solving real life problems.
- **PO3:** Students will become employable in various government and private sectors.
- **PO4:** The completing this programme develop enhanced quantitative skills and pursuing higher mathematics and research as well.
- **PO5:** The completion of this programme will enable the learner to use appropriate digital programmes and software to solve various mathematical problems.

### Programme Specific Outcome:

- **PSO1:** Student will be able to think in a critical manner and develop problem solving skills.
- **PSO2:** Students will be able to recall basic facts about mathematics and display knowledge of conventions such as notations, terminology etc.
- **PSO3:** Students will be able to formulate and develop mathematical arguments in a logical manner.
- **PSO4:** Students will be motivated and prepare for research studies in mathematics and related fields.
- **PSO5:** Student will be able to apply their skills and knowledge in various fields of studies including science, engineering, commerce, and management etc.



Detailed Syllabus

For

# CERTIFICATE

# COURSE IN

# MATHEMATICS

## GRADUATION-1st Year
## (Semester-I & II)

# GRADUATION-1st Year (SEMESTER-I)

## PAPER-I: Matrices, Trigonometry and Differential Calculus

| Programme: CERTIFICATE COURSE IN MATHEMATICS | Year: First | Semester: First |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT101T | Course Title: Matrices, Trigonometry and Differential Calculus | |

**Course outcomes:**

**CO1:** The programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developingenhanced quantitative skills and pursuing higher mathematics and research as well.

**CO2:** By the time students complete the course they will have wide ranging application of the subject and have the knowledge of matrices and basics of differentiation.

**CO3:** The student will be able to sum the trigonometric series of real and complex numbers and separate the trigonometric function in form of A+iB.

**CO4:** The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.

**CO5:** The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.

| Credits: 4 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25 + 75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures-Tutorials – Practical (in hours per week): L-T-P: (4-0-0)**

### Part-A: Matrices

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Matrix introduction, matrix operations with their properties, symmetric, skew-symmetric, Hermitian, and skew-Hermitian matrices, idempotent, nilpotent, involuntary, orthogonal, and unitary matrices, singular and non-singular matrices, elementary operations on matrices, adjoint and inverse of a matrix, singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix. | 8 |
| II | Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of amatrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices. | 7 |
| III | Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations. | 5 |

### Part-B: Trigonometry

| Unit | Topics | No. of Lectures |
|---|---|---|
| IV | Trigonometric or circular and hyperbolic function of complex variable together with their inverses, De Moivre's Theorem and its applications, Euler's theorem, relation between trigonometric and hyperbolic function, Exponential function of a complex variable,Logarithms of complex variable, Properties of logarithmic function, Separation into real and imaginary parts | 6 |
| V | Gregory's series, Value of $\pi$ by different series, Summation of Trigonometric series by C+iS method based on Arithmetic Progression, Geometric Progression, Logarithms and Binomial expansions, Summation of Trigonometric series by difference method. | 6 |

### Part-C: Differential Calculus

| Unit | Topics | No. of Lectures |
|---|---|---|
| VI | Functions of one variable, Limit of a function (ε-δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of single variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. | 7 |
| VII | Successive Differentiation, $n^{th}$ Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem,Taylor's, and Maclaurin's series expansions. | 6 |
| VIII | Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normal of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula). | 8 |
| IX | Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection. | 7 |

**Suggested Readings (PART-A Matrices):**

1. Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008
2. Fuzhen Zhang, Matrix Theory- Basic Results and Techniques, Springer, 1999
3. Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (PART-B Trigonometry):**

1. Margaret L. Lial, John Hornsby, David I. Schneider, Trigonometry, Addison-Wesley, 2001
2. Robert Moyer, Frank Aryes, Schaum's Outline of trigonometry, 2012
3. I. M. Gelfand, Mark Saul, Trigonometry, Birkhäuser; 2001st edition (June 8, 2001)
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part- C Differential Calculus):**

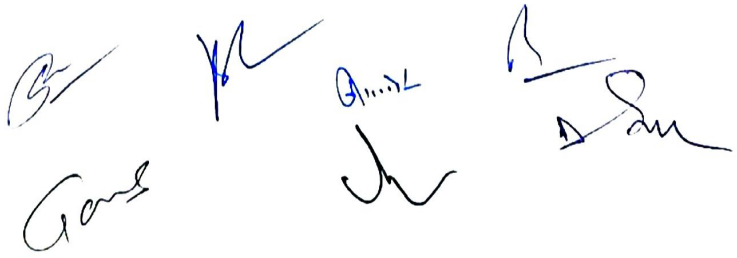
1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1999
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc., 1974
3. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2019
4. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication. 1992
5. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007
6. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**This course can be opted as an elective by the students of following subjects:** Engineering and Technology(UG), Chemistry/ Biochemistry/ Life Sciences (UG), Economics (UG/PG), Commerce (UG), BBA/ BCA, B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods:** Max. Marks: **25**

| S.N. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | **10** |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | **5** |
| 3 | **Attendance** | **5** |
| 4 | **Assignment** | **5** |

**Course perquisites:** To study this course a student must have studied Mathematics in class 12th.



# GRADUATION – 1st Year (SEMESTER-I)
## Paper-II - Practical

| | | |
|---|---|---|
| **Programme:** CERTIFICATE COURSE IN MATHEMATICS | **Year:** First | **Semester:** First |
| **Subject:** Mathematics | | |
| **Course Code:** UGMAT102P | **Course Title:** Practical | |

**Course outcomes:**

**CO1:** The main objective of the course is to make familiar the student with different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc.

**CO2.** The students will be able to compute various operations on matrices by using different computer software such as Mathematica /MATLAB /Maple/Scilab/Maxima etc.

**CO2.** The students will also be able to compute $n^{th}$ derivative of various functions by using different computer software.

| | |
|---|---|
| **Credits: 2** | **Core Compulsory/Elective** |
| **Max. Marks: 25+75** | **Min. Passing Marks:** As per University norms |

**Total No. of Lectures – Tutorials – Practical (in hours per week): L-T-P: (0-0-4)**

**Course Title: Practical**

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **Practical / Lab work to be performed in Computer Lab.**<br>List of the practical to be done using R/Python/Mathematica/MATLAB/Maple/Scilab/Maxima etc.<br>1. Introduction to the software and commands related to the topic.<br>2. Computation of addition and subtraction of matrices,<br>3. Computation of multiplication of matrices.<br>4. Computation of Trace and Transpose of Matrix.<br>5. Computation of Rank of matrix.<br>6. Computation of Inverse of a Matrix.<br>7. Solving the system of homogeneous and non-homogeneous linear algebraic equations.<br>8. Finding the $n^{th}$ Derivative of $e^{ax}$, trigonometric and hyperbolic functions.<br>9. Finding the $n^{th}$ Derivative of algebraic and logarithmic functions.<br>10. Finding the $n^{th}$ Derivative of $e^{ax}\sin(bx+c)$ , $e^{ax}\cos(bx+c)$.<br>11. Finding the Taylor's and Maclaurin's expansions of the given functions. | **60** |

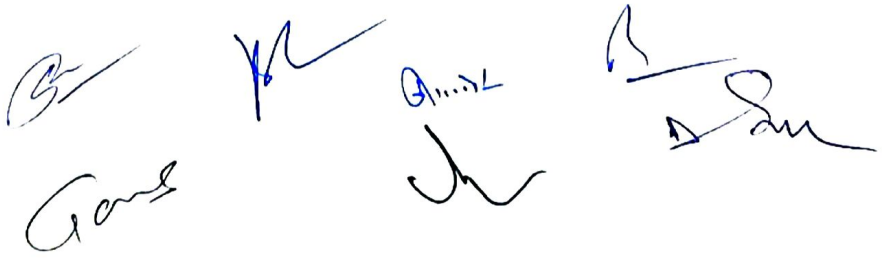
**Suggested Readings:**

**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods:** Max. Marks: 25

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course a student must have subject Mathematics in class $12^{th}$.



# GRADUATION-1st Year (SEMESTER-II)

## PAPER–I: Integral calculus and Vector Analysis

| Programme: CERTIFICATE COURSE IN MATHEMATICS | Year: First | Semester: Second |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT201T | Course Title: Integral calculus and Vector Analysis | |

**Course outcomes:**

**CO1:** The Programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.

**CO2:** By the time students complete the course they will have wide ranging application of the subject and have the knowledge of surface area and volume of shapes.

**CO3:** The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he learns to solve a variety of practical problems in science and engineering.

**CO4:** The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.

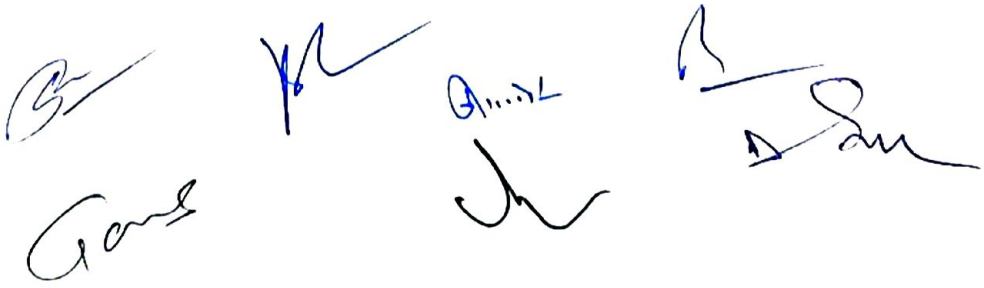
| Credits: 6 | Core Compulsory/Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |
| Total No. of Lectures – Tutorials – Practical (in hours per week): L-T-P: (6-0-0) | |

**PART-A: Integral Calculus**

| Unit | Topics | No of Lectures |
|---|---|---|
| I | Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation, and integration under the integral sign. | 12 |
| II | Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions. | 11 |
| III | Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Dirichlet's theorem and its Liouville's extension. | 12 |
| IV | Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution. | 11 |

**PART- B: Vector Analysis**

| Unit | Topics | No. of Lectures |
|---|---|---|
| V | Triple product, Reciprocal vectors, Product of four vectors, General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes. | 11 |
| VI | Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line, Intersection of three planes, Transformation of coordinates. | 12 |
| VII | Ordinary differentiation of vectors, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl. | 11 |
| VIII | Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem (without proof). | 10 |



**Suggested Readings (Part- A Integral Calculus):**

1. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc., 1974
2. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2010
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**Suggested Readings (Part- B Vector Analysis):**

1. Murray R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill.
2. N. Saran and S. N. Nigam: Introduction to Vector Analysis, Pothishala Pvt. Ltd. Allahabad.
3. Suggested digital platform: NPTEL/SWAYAM/MOOCs

**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | **10** |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | **5** |
| 3 | **Attendance** | **5** |
| 4 | **Assignment** | **5** |

**Course prerequisites:** To study this course a student must have studied Mathematics in class $12^{th}$.

Detailed Syllabus

For

# DIPLOMA
# IN
# MATHEMATICS

## GRADUATION- 2nd Year

## (Semester: III and IV)

# GRADUATION-2nd Year (SEMESTER-III)
# PAPER-I: Abstract Algebra

| Programme: DIPLOMA IN MATHEMATICS | Year: Second | Semester: Third |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT301T | Course Title: Abstract Algebra | |

**Course outcomes:**

**CO1: Understanding of abstract algebraic structures:** Students will gain a strong understanding of groups, rings, and fields, including their definitions, properties, and examples.

**CO2: Proficiency in proof techniques:** Students will develop the ability to construct rigorous proofs using various techniques specific to abstract algebra.

**CO3: Application of abstract algebra in problem-solving:** Students will apply abstract algebraic concepts to solve problems in different mathematical contexts, such as symmetry, isomorphism, factorization, and polynomial rings.

| Credits: 6 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures - Tutorials-Practical (in hours per week): L-T-P: (6-0-0)**

## Part A: Group Theory

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence Modulo n, Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups | 12 |
| II | An Alternative set of postulates of groups, Subgroups, Permutations, Cyclic Permutations, Even and odd permutations, group of Permutations alternating group, Integral power of an element of a group, Order of an element of a group, Group homomorphism, Isomorphism on groups, the relation of isomorphism in the set of all groups Complexes and subgroup of a group, theorems on subgroups, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem, Cyclic group, generating system of group. | 20 |
| III | Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant subgroups, Quotient group, Homomorphism, Kernel of a Homomorphism and related theorems and Isomorphism on groups. | 13 |

## Part-B: Ring Theory

| Unit | Topics | No. of Lectures |
|---|---|---|
| IV | Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings, Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring. | 20 |
| V | Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorization Domain, Euclidean rings. | 12 |
| VI | Polynomials over a ring, Degree of a polynomial, Zero, Constant and monic polynomials, Equality of polynomials, Addition and multiplication of polynomials, Polynomial rings, Embedding of a ring R into R[x], Division algorithm, Euclidean algorithm, Units and associates in polynomials, Irreducible polynomials. | 13 |

**Suggested Readings:**


1. Dummit and Foote, Abstract Algebra, 3rd Edition, 2003.
2. J. B. Fraleigh, A first course in Abstract Algebra, Addison-Wiley, 2003
3. I. N. Herstein, Topics in Algebra, John Wiley & Sons, 2006
4. Thomas W Hungerford, Abstract Algebra–An Introduction, Sauders College Publishing, 1990
5. Joseph A Gallian, Contemporary Abstract Algebra, Brooks/Cole Cengage Learning, 2016
6. V. K. Khanna and S. K. Bhambri, A course in Abstract Algebra, Vikas Publishing House Pvt (Ltd), 2014.
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs.


**Suggested Continuous Evaluation Methods: Max. Marks:25**

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Certificate Course in Mathematics.

# GRADUATION-2nd Year (SEMESTER-IV)
# PAPER-I: Differential Equations

| Programme: DIPLOMA IN MATHEMATICS | Year: Second | Semester: Fourth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT401T | Course Title: Differential Equations | |

**Course outcomes:**

**CO1:** The objective of this course is to familiarize the students with various methods of solving differential equations of first and second order and to have qualitative applications.

**CO2:** A student doing this course can solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, nonlinear evolution equation etc.

| Credits: 6 | Core Compulsory/Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures - Tutorials-Practical (in hours per week): L-T-P: (6-0-0)**

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **Part A: Ordinary Differential Equations** | |
| I | Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution, and singular solutions), Existence and uniqueness of the solution dy/dx= f(x,y). Differential equations of first order and first degree, Separation of variables, Homogeneous linear Equations, Exact Equations, Integrating Factor, Equation of First order but not of first degree, Various methods of solution, Clairaut's form, Singular solutions, Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves. | 30 |
| II | Linear differential equations with constant coefficients, Complementary function, Particular integral, Working rule for finding solution of linear differential equations with constant coefficients, Homogeneous linear equations or Cauchy-Euler equations, Differential equations of the form dx/P= dy/Q= dz/R where P, Q, R are functions of x, y, z. Exact differential equations, Total differential equations, Series solutions of differential equations, Linear differential equations of second order with variable coefficients, Initial and boundary value problems. | 30 |
| | **Part A: Partial Differential Equations** | |
| III | Partial differential equations of first order, Charpit's method, Linear partial differential equations with constant coefficients. First-order linear, quasi-linear and non-linear PDE's using the method of characteristics: explicit solutions. | 15 |
| IV | Partial differential equations of 2nd-order: Classification of 2nd-order linear equations in two independent variables: hyperbolic, parabolic and elliptic types (with examples). | 15 |

**Suggested Readings (Part-A Differential Equations):**

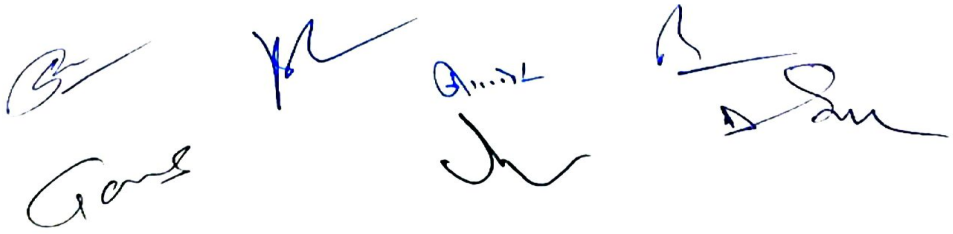

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGraw Hill, 2002
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa, 2002
3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication, 2013
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific. 1970
5. M. D. Raisinghania, Ordinary and Partial Differential Equations, S Chand, 2018.
6. K Sankar Rao: Partial Differential Equations, PHI
7. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Economics (UG/PG), B.Sc. (C.S.) Engineering and Technology (UG), Science (Physics-UG)

**Suggested Continuous Evaluation Methods: Max. Marks:25**

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Certificate Course in Mathematics.



Detailed Syllabus

For

# DEGREE

# IN

# MATHEMATICS

## GRADUATION-3rd Year

## (Semester- V and VI )

# GRADUATION- 3rd Year (SEMESTER-V)

## PAPER-I: Analysis

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT501T | Course Title: Analysis | |

**Course outcomes:**

**CO1:** Students will be able to know the basic concepts and developments of real analysis which will prepare the students to take up further applications in therelevant fields.

**CO2:** On successful completion of the course students should have knowledge about real analysis and that will help them in going for higher studies and research.

**CO3:** The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives thestudent the foundation in mathematics.

**CO4:** Upon successful completion, students will be able to understand the complex variables, analytic functions, complex integration, and residues.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)**

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **Part A: Real Analysis** | |
| I | Continuity and Differentiability of functions: Continuity of functions, Uniform continuity, Differentiability, Taylor's theoremwith various forms of remainders, Riemann integral-definition and properties, integrability of continuous and monotonic functions, Fundamentaltheorem of integral calculus, Mean value theorems of integral calculus. | 15 |
| II | Sequence and Series**:** Sequences, theorems on limit of sequences, Cauchy's convergence criterion, infinite series, series of non- negative terms, Absolute convergence, tests for convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's, Logarithmic test, De Morgan's Test, Alternating series, Leibnitz's theorem, Improper Integrals**:** Improper integrals and their convergence, Comparison test, Dirichlet's test, Absolute and uniform convergence, Weierstrass M-Test, Infinite integral depending on a parameter. Uniform Convergence**:** Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Dirichlet's test, Convergence and uniform convergence of sequences and series of functions. | 30 |
| | **Part A: Complex Analysis** | |
| III | Complex Variables: Functions of a complex variable, Limit, continuity and differentiability, Analytic functions, Cauchy and Riemann equations, Harmonic functions. | 15 |
| IV | Complex Integration**:** Complex integrals, Cauchy's theorem, Cauchy's integral formula, Morera's Theorem, Liouville's Theorem,Taylor's series, Laurent's series, Poles and singularities, Residues, the Residue theorem, the principal part of a function, Evaluation of Improper real integrals. | 15 |

**Suggested Readings (Part-A Real Analysis and Complex Analysis):**

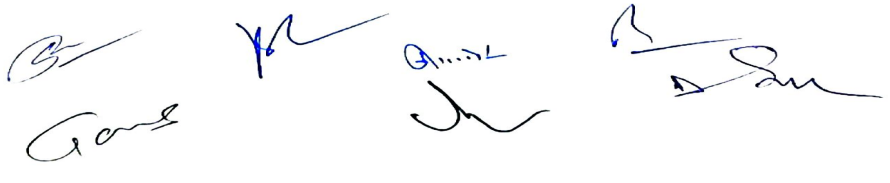

1. Walter Rudin: Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, 1976, International Student Edition.
2. K. Knopp: Theory and Application of Infinite Series.
3. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
4. S. C. Malik and Savita Arora, Mathematical Analysis , New Age International Pvt. (Ltd), 2012.
5. J. B. Conway: Functions of One Complex Variable, Narosa Publishing House, 1980.
6. E. T. Copson: Complex Variables, Oxford University Press.
7. L. V. Ahlfors: Complex Analysis, McGraw-Hill, 1977.
8. D. Sarason: Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
9. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engg. And Tech.(UG), Economics (UG/PG), B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.



# GRADUATION-3rd Year (SEMESTER-V)
## PAPER-II: Mathematical Methods

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT502T | Course Title: Mathematical Methods | |

**Course outcomes:**

**CO1:** The student will be able to find the integral transform, Laplace transform, inverse Laplace transform and Fourier transform. The course in mathematical methods basically develops a problem-solving skill in the students.

**CO2:** Upon successful completion, students will have the knowledge of various types of graphs, their terminology, and applications.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)**

**Course Title: Mathematical Methods**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Laplace Transforms: Definition, Kernel, Definition, Existence theorem, Linearity property, Laplace transforms of elementary functions, Heaviside Step and Dirac Delta Functions, First Shifting Theorem, Second Shifting Theorem, Initial-Value Theorem, Final-Value Theorem, The Laplace Transform of derivatives, integrals, and Periodic functions. | 25 |
| II | Inverse Laplace transforms**:** Inverse Laplace transforms of simple functions, Inverse Laplace transforms using partial fractions, Convolution, Solutions of differential and integro-differential equations using Laplace transforms. Dirichlet'scondition, | 25 |
| III | Fourier Transforms: Fourier Complex Transforms, Fourier sine and cosine transforms, Properties of Fourier Transforms,Inverse Fourier transforms. | 10 |
| IV | Applications of Fourier transform to simple one-dimensional heat transfer equations, wave equations and Laplace equations, Z Transform, and its application to solve difference equations. | 15 |

**Suggested Readings (Part-A Mathematical Methods):**

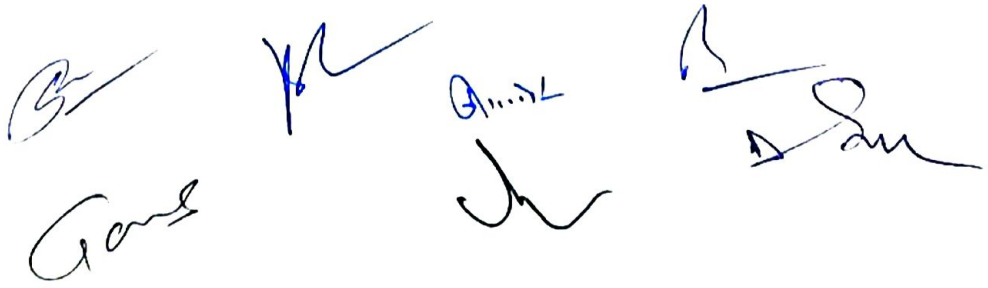

1. Murry R. Spiegal: Laplace Transform (SCHAUM Outline Series), McGraw-Hill.
2. J. F. James: A student's guide to Fourier transforms, Cambridge University Press.
3. Ronald N. Bracewell: The Fourier transforms and its applications, Mcgraw Hill.
4. J. H. Davis: Methods of Applied Mathematics with a MATLAB Overview, Birkhäuser, Inc.,Boston, MA, 2004.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech.(UG), BCA, B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | 10 |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | 5 |
| 3 | **Attendance** | 5 |
| 4 | **Assignment** | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.



# GRADUATION-3rd Year (SEMESTER-V)
## PAPER-II: Number Theory & Relativity

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT503T | Course Title: Number Theory & Relativity | |

**Course outcomes:**
**CO1:** The student will be able to solve problems in elementary number theory and apply elementary number theory to cryptography.
**CO2:** Upon successful completion, students will be able to describe the basic concepts of the theory of relativity.
**CO3:** After Successful completion of this course students will be able to discuss postulates of the special theory of relativity and their consequences.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)**

### PART-A: Number Theory

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Prime Numbers, Unique Factorization theorem, Farey series, Irrational numbers, Congruences, Residues, Quadratic Reciprocity Law, Primitive roots. | 16 |
| II | Fermat's theorem, Wilson's theorem, Continued fractions, Approximation of irrational numbers by rational numbers, Hurwitz theorem. | 11 |
| III | The fundamental theorem of arithmetic in K(1), K($i$), K($\rho$), Diophantine equation $X^2 + Y^2 = Z^2$, $X^4 + Y^4 = Z^4$, $ax^2 + by^2 + cz^2 = 0$,Quadratic fields, the arithmetic functions: d(n), σ(n), μ(n) and $\varphi(n)$ including elementary result on their order and average order. | 18 |

### PART-B: Relativity

| Unit | Topics | No. of Lectures |
|---|---|---|
| IV | Special Relativity: Inertial Frames of reference, Michelson-Morley experiment, Doppler effect, Stellar aberration, Simultaneity,Postulates of special relativity, Lorentz transformation, Length contraction, Time dilation, Clock paradox, Addition of velocities and accelerations, Four- dimensional space time, Light cone, Mass variation, Velocity four vector, Momentum and force, Mass- Energy relationship. | 18 |
| V | General Relativity: Geodesics, Geodesic coordinates, Curvature tensor and its algebraic properties, Bianchi's identities, Contracted curvature tensor, Conditions for a flat space time, Displacement of space –time, Killing equations, Groups of motion,Space–time of constant curvature. | 11 |
| VI | Principal of covariance, non-inertial frames of reference, Principal of equivalence, Weak field approximation of geodesic equations, Law of gravitation in empty space-time, Canonical coordinates, Schwarzschild solutions. | 16 |

**Suggested Readings (Part-A Number Theory):**


1. G. H. Hardy and E. M. Wright: Introduction to the theory of numbers, Oxford University Press, 4th Edition.
2. D. M. Burton: Elementary Number Theory, 6th Edition, Tata McGraw Hill.
3. Thomas Koshy: Elementary Number Theory with Applications, Academic Press, 2nd Edition.
4. Kenneth H. Rosen: Elementary Number Theory and its Applications, Addison-Wesley Publishing Company, 1986.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**Suggested Readings (Part-B Relativity):**


1. D. F. Lawden: An Introduction to tensor calculus and relativity.
2. J. V. Narlikar: General relativity and cosmology.
3. R. H. Good: Basic concept of relativity, 1978.
4. A. S. Eddington: Mathematical theory of relativity, 1981.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engineering and Technology (UG), BCA, B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks:** 25

| S. No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.

## GRADUATION – 3rd Year (SEMESTER-V)

## PAPER-II: Analytical Geometry

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth |
|---|---|---|
| **Subject: Mathematics** | | |
| **Credits: 5** | **Core Compulsory / Elective** | |
| **Max. Marks: 25+75** | **Min. Passing Marks:** As per University norms | |
| **Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)** | | |

**Course Code: UGMAT504T** **Course Title: Analytical Geometry**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Polar Equation of conics, Polar coordinate system, Distance between two points, Polar equation of a Straight line, Polar equation of acircle, Polar equation of a conic, Chords, Tangent and Normal to a conic. | 15 |
| II | Curvilinear coordinates, Spherical and Cylindrical coordinates, Definition and equation of a sphere, Plane section of a sphere, Intersection of two spheres, Intersection of a sphere and a line, Power of a point, tangent plane, Plane of contact, Polar plane, Pole, Angle of Intersection of two spheres, Radical plane, Co-axial system of spheres. | 25 |
| III | Definition and equation of a cone, Vertex, Guiding curve, Generators, Three mutually perpendicular generators, Intersection of a line with a cone, Tangent line and tangent plane, Reciprocal cone, right circular cone, Definition and equation of a cylinder, right circular cylinder, Enveloping cylinder. | 20 |
| IV | General equation of second degree, Tangent plane, Director sphere, Normal, Plane of contact, Polar plane, Conjugate plane, and conjugate points. | 15 |

**Suggested Readings Analytical Geometry):**

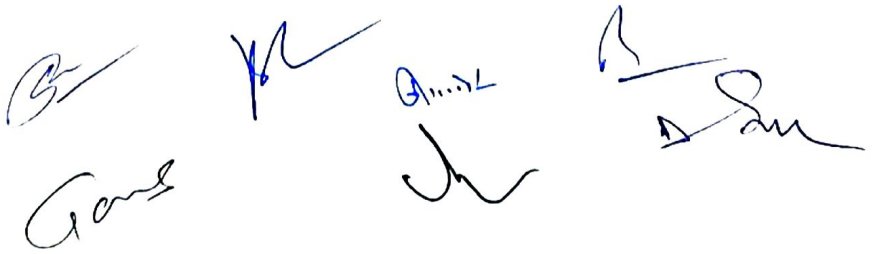

1. Robert J.T Bell, An Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd., 1923
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson, 2013
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London. 2018
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc. (C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | 10 |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | 5 |
| 3 | **Attendance** | 5 |
| 4 | **Assignment** | 5 |

**Course prerequisites:** To study this course, a student must have Certificate Course in Basic Mathematics.



# GRADUATION- 3rd Year (SEMESTER-V)
## PAPER-II: Numerical Analysis

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth |
|---|---|---|
| **Subject: Mathematics** | | |
| **Course Code: UGMAT505T** | **Course Title: Numerical Analysis** | |

**Course outcomes:**

**CO1:** After Successful completion of this course the student will be able to perform error analysis for arithmetic operations.
**CO2:** Upon successful completion, students will be able to understand the use of interpolation and curve fitting and finite differences.
**CO3:** After Successful completion of this course students will be able to use some solution methods for solving the linear programming problems.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| **Max. Marks: 25+75** | **Min. Passing Marks:** As per University norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)**

**Course Title: Numerical Analysis**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Errors in numerical Calculations: Absolute, Relative and Percentage errors, General Error, Error in series approximation. | 10 |
| II | Solutions of Algebraic and Transcendental Equations: Bisection method, False position method, Newton-Raphson Method, Picard'siteration method. | 10 |
| III | Linear systems of equations: Consistency of Linear System of equations, Solutions of Linear Systems by direct method: Gaussian elimination and computation of inverse of a matrix, Method of Factorization, Solutions of linear systems by iterative methods: Jacobimethod, Gauss-Seidel method. | 25 |
| IV | Interpolation and curve fitting: Errors in Polynomial interpolation, Finite differences, Differences of a polynomial, Newton's forwardand backward interpolation, Central differences, Gauss, Stirling, Bessel's and Everett's Formulae, Lagrange's Interpolation formula. | 20 |
| V | Numerical differentiation and integration: Numerical differentiation, Newton-Cotes Integration formula, Numerical integration by Trapezoidal rule, Simpson'1/3, Simpson's 3/8, and Romberg Integration. | 10 |

**Suggested Readings (Part-A Numerical Analysis):**

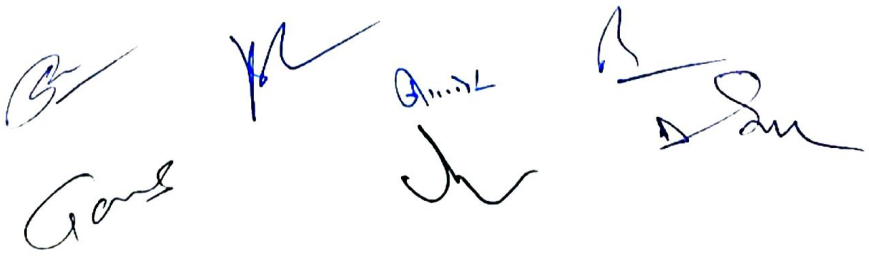

1. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India.
2. C.F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison- Wesley, 1998.
3. Konte and Debour: Numerical Analysis.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), Economics(UG/PG), BBA/BCA, B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | 10 |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | 5 |
| 3 | **Attendance** | 5 |
| 4 | **Assignment** | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.



# GRADUATION- 3rd Year (SEMESTER-V)
## PAPER-II: Graph Theory

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT506T | Course Title: Graph Theory | |

**Course outcomes:**

**CO1:** Upon successful completion, students will have the knowledge of various types of graphs, their terminology, and applications.

**CO2:** After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topics include path, circuits, adjacency matrix, tree, coloring. After successful completion ofthis course the student will have the knowledge graph coloring, color problem, vertex coloring.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)**

**Course Title: Graph Theory**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph. | 20 |
| II | Walk and unilateral components, unicursal graph, Hamiltonian path and circuits, Graph coloring, chromatics number,isomorphism and homomorphism of graphs, Incidence relation and degree of the graph. | 20 |
| III | Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix, Weighted graph,Travelling salesman problem, shortest path, Dijkstra's algorithm. | 20 |
| IV | Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties. | 15 |

**Suggested Readings (Part-B Graph Theory):**

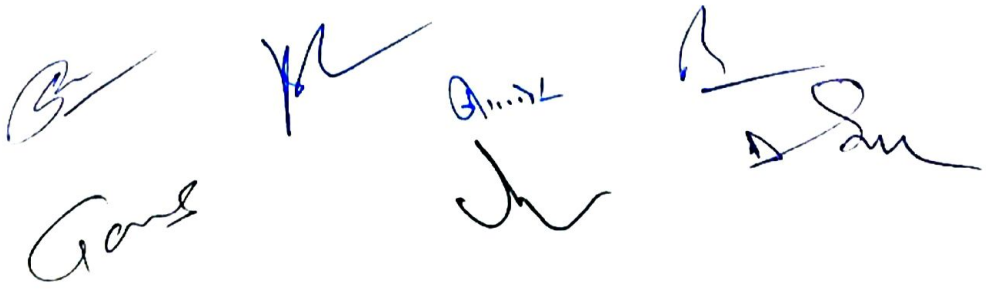

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications, 2017.
2. Douglas B West, Introduction to Graph Theory, Pearson, 2018.
3. Santanu Saha Ray, Graph Theory with Algorithms and Its Applications: In Applied Science and Technology, Springer India, 2012.
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech.(UG), BCA, B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.



# GRADUATION- 3rd Year (SEMESTER-V)
## PAPER-II: Mechanics

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Sixth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT507T | Course Title: Mechanics | |

**Course outcomes:**

**CO1:** The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces.

**CO2:** The student, after completing the course can go for higher problems in mechanic such as hydrodynamics, this will be helpful in getting employment inindustry.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0) | |

**Course Title: Mechanics**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Rectilinear motion: Newton's Laws of Motion, velocity and acceleration, motion under constant acceleration, motion under inversesquare law, rectilinear motion with variable acceleration, Simple Harmonic Motion. | 15 |
| II | Kinematics in two dimensions: Angular velocity and angular acceleration, Components of velocity and acceleration along coordinateaxes, Radial and transverse components of velocity and acceleration, tangential and normal components of velocity and acceleration. | 25 |
| III | Motion in resisting medium, constrained motion and Central orbits: Terminal Velocity, Motion in resisting medium in a straightline, Motion on vertical circle, Cycloidal motion, Central Force, Central orbit, intrinsic equation, Pedal form, apse and apsidal distance. | 25 |
| IV | Statics: Coplanar Forces, Equilibrium of forces in three dimensions, Common catenary, Catenary of uniform strength, Virtual work. | 10 |

**Suggested Readings (Mechanics) :**

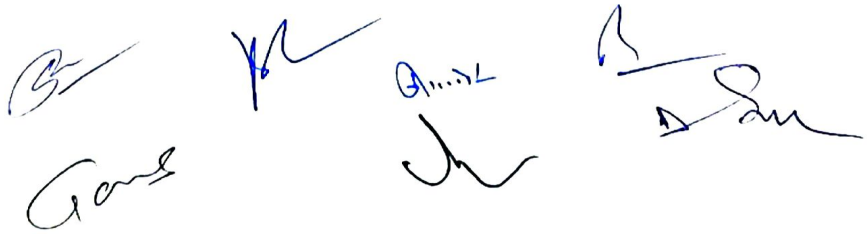

1. M. Ray: A Textbook on Dynamics, S. Chand.
2. M. Ray: A Textbook on Statics, S. Chand.
3. A. S. Ramsay: Dynamics, Cambridge University Press.
4. S. L. Loney: Dynamics of a particle and of rigid bodies, Cambridge University Press.
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.



# GRADUATION- 3rd Year (SEMESTER-VI)

## PAPER-I: Linear Programming Problem

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Sixth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT601T | Course Title: Linear Programming Problem | |

**Course outcomes:**

**CO1:** The object of the paper is to give students knowledge of basic I. Linear programming problems, Graphical approach, simplex method, Optimality and unboundedness, Two-phase method, Big-M method and their comparison, Duality for solving some LPP.

**CO2:** The student, after completing the course can go for higher problems in Linear as well as nonlinear Programing and operations research, this will be helpful in getting employment inindustry.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0) | |

**Course Title: Linear Programming Problem**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Linear programming problems, Graphical approach for solving some LPP, Convex sets, Supporting and separating hyper planes. | 15 |
| II | Theory of simplex method, Optimality and unboundedness, The simplex algorithm, Simplex method in tableau format, Introduction to artificial variables. | 25 |
| III | Two-phase method, Big-M method, and their comparison. | 15 |
| IV | Duality, formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual. | 20 |

**Suggested Readings :**

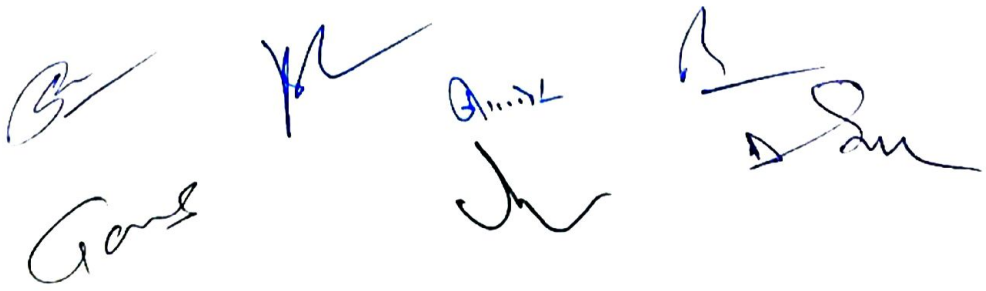

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India,2004.
2. F.S.Hillierand, G.J.Lieberman, ,Introduction to Operations Research,8thEd.,TataMcGrawHill, Singapore, 2004.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India,2006.


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.



# GRADUATION- 3rd Year (SEMESTER-VI)

## PAPER-II: Linear Algebra

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Sixth |
|---|---|---|
| Subject: Mathematics | | |
| Course Code: UGMAT602T | Course Title: Linear Algebra | |

**Course outcomes:**

**CO1:** Fundamental understanding of key concepts in linear algebra.

**CO2:** Proficiency in matrix operations and solving systems of linear equations.

**CO3:** Application of linear algebra in mathematics and other fields.

**CO4:** Development of critical thinking and problem-solving skills.

| Credits: 5 | Core Compulsory / Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per University norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (5-0-0)**

**Course Title: Linear Algebra**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | **Vector space:** Introduction, subspaces, Linear combinations, linear spans, Sums and direct sums, Linear dependence and independence, Bases and dimensions, Dimensions and subspaces, Coordinates and change of bases. | 15 |
| II | **Linear transformations:** Linear transformations, rank and nullity, Linear operators, Algebra of linear transformations, Invertible lineartransformations, isomorphism. | 15 |
| III | **Matrix and linear transformation:** Matrix of a linear transformation, Matrix of the sum and product of linear transformations, Changeof basis, similarity of matrices. | 15 |
| IV | **Linear functional:** Linear functional, Dual space and dual basis, Double dual space, Annihilators, Hyperspace, Transpose of a linear transformation. | 10 |
| V | **Eigen values and Eigen vectors:** Eigen vectors and Eigen values of a matrix, product of characteristic roots of a matrix and basic results on characteristic roots, nature of the characteristic roots of Hermitian, skew-Hermitian, unitary, and orthogonal matrices, characteristic equation of a matrix, Cayley-Hamilton theorem, and its use in finding inverse of a matrix. | 20 |

**Suggested Readings (Part-A Linear Algebra):**


1. Hadley: Linear Algebra.
2. Hoffman and Kunze: Linear Algebra, Prentice Hall of India, New Delhi, 1972.
3. H. Helson: Linear Algebra, Hindustan Book Agency, New Delhi, 1994.
4. K. B. Dutta: Matrix and Linear Algebra, Prentice Hall of India.
5. S. Lang: Linear Algebra, Springer.
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs.


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc.(C.S.)

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | Class Tests | 10 |
| 2 | Online Quizzes/Objective Tests/ Presentation | 5 |
| 3 | Attendance | 5 |
| 4 | Assignment | 5 |

**Course prerequisites:** To study this course, a student must have Diploma in Mathematics.

# GRADUATION- 3rd Year (SEMESTER-V & VI)

## PAPER-III: Project Work

| Programme: DEGREE IN MATHEMATICS | Year: Third | Semester: Fifth & Sixth |
|---|---|---|
| Course Code: UGMAT-PW | Course Title: Project Work | Credits: 4 in each semester |

**Course Outcomes:**

**CO1:** Develop practical problem-solving skills by applying mathematical concepts to real-world challenges.

**CO2:** Acquire research and project management skills, from planning to execution and reporting.

**CO3:** Strengthen written and oral communication through structured reports and presentations.

**CO4:** Gain exposure to industrial, vocational, or entrepreneurial environments, preparing for professional careers.

| Max. Marks: | Qualified/non-qualified in 5th semester<br>100 marks in 6th semester | **Min. Passing Marks:** As per University norms |
|---|---|---|

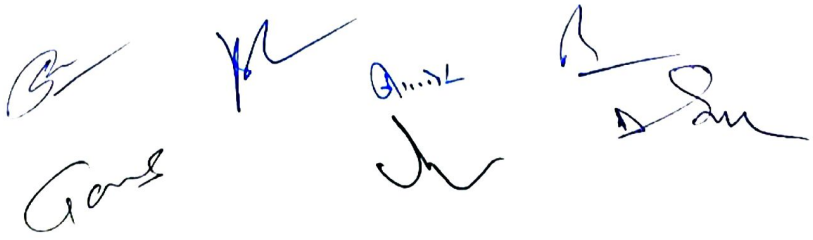
**Course Title:** Project Work on Industrial Training/Research Project/ Vocational Course/ Entrepreneurship Skills in Mathematics

| Semester | Topics |
|---|---|
| V | **Project Orientation and Topic Finalization (5th Semester):**<br>1. **Introduction to Project Work:** Overview of Industrial Training/Survey/Research Project/Vocational Course/ Entrepreneurship Skills in Mathematics.<br>2. **Selection of Project Area:** Guidelines on selecting a suitable project topic from any of the fields.<br>3. **Proposal Writing:** Developing a project proposal outlining objectives, methodologies, and expected outcomes.<br>4. **Internal Evaluation:** Proposal submission and presentation for internal feedback. |
| | **Literature Review and Data Collection Strategy (5th Semester):**<br>1. **Conducting a Literature Review:** Search for relevant research papers, books, and case studies.<br>2. **Preliminary Data Collection:** Developing a data collection strategy suitable for the project.<br>3. **Report on Literature Review:** Submission of a literature review report summarizing key findings and gaps.<br>4. **Internal Review:** Presentation of literature review and data collection strategy for internal evaluation and feedback. |
| VI | **Execution of Project Work and Data Analysis (6th Semester):**<br>1. **Project Execution:** Hands-on work/analysis of the work in the chosen area.<br>2. **Data Collection and Management:** Collecting necessary data from surveys/experiments/practical industrial work etc.<br>3. **Solution Methodology /Data Analysis:** Utilizing appropriate tools and techniques (statistical/Analytical/Numerical, mathematical modeling, etc.) to analyze the collected data.<br>4. **Progress Review:** Submission of a mid-semester progress report on project execution and initial findings. |
| | **Report Writing, Presentation, and Final Submission (6th Semester):**<br>1. **Report Writing:** Introduction, Literature Review, Methodology, Data Analysis, Conclusion, and References.<br>2. **Final Presentation:** Oral presentation of the project work, highlighting the process, findings, and recommendations.<br>3. **Viva-Voce:** Evaluation based on the project report, presentation, and ability to answer questions related to the project.<br>4. **Final Report Submission:** Submission of the completed report by the end of the 6th semester. |

**Suggested Evaluation Methods**

| Fifth Semester (Internal Evaluation) | | Sixth Semester (Final Evaluation) | |
|---|---|---|---|
| • Proposal and Topic Selection | 20% | • Execution of Project Work | 30% |
| • Literature Review | 20% | • Data Analysis and Findings | 20% |
| • Data Collection Strategy | 20% | • Final Report: | 20% |
| • Interim Report and Presentation | 40% | • Presentation and Viva-Voce: | 30% |

**Note: The project work may be carried out in any field of Mathematics, based on the areas of expertise/specialization of faculty members at the respective University/College/Institute.**



Detailed Syllabus

For

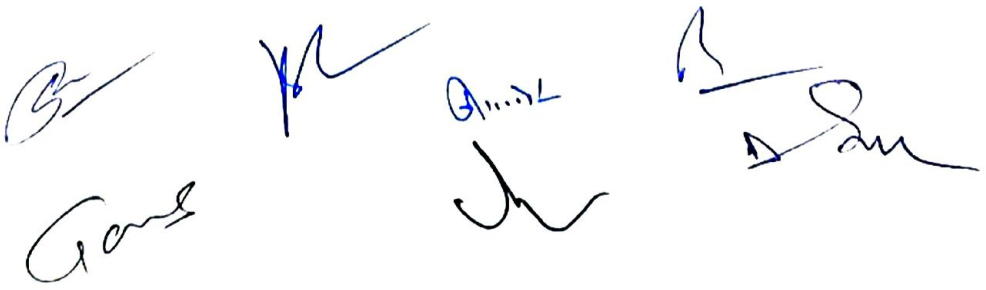
**HONOURS DEGREE**
**IN**
**MATHEMATICS**

# GRADUATION-4th Year
# (Semester -VII & VIII)

# VII Semester

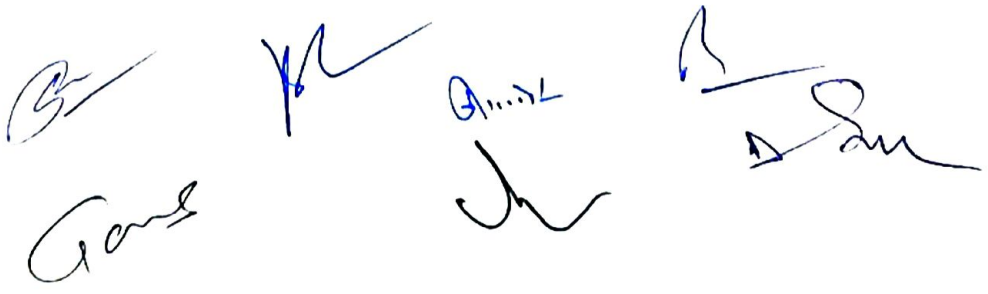
| MTH101 - Discrete Mathematics |
|---|
| **Unit 1.** Principle of mathematical induction partially ordered sets, Lattices: Lattices as partially ordered sets, Their Properties, Lattices, and algebraic systems, Principle of duality, Sub lattices, Complete, Complemented and Distributive lattices. |
| **Unit 2.** Boolean algebra, Boolean functions, Boolean expressions, Applications to switching circuits. |
| **Unit 3.** Elements of graph theory: Basic terminology, Paths and circuits, Eulerian and Hamiltonian graphs, planar graphs, Directed graphs. |
| **Unit 4.** Trees: Rooted trees, Path lengths, spanning trees, minimum spanning trees. |
| |
| **Books Recommended:**<br>C. L. Liu: "Elements of Discrete Mathematics", Tata McGraw Hill Education,2008.<br>Ram Babu: "Discrete Mathematics", Pearson Edition India, 2011.<br>Lipschutz: "Discrete Mathematics", Tata McGraw Hill, 2011. |

| MTH102 - Abstract Algebra |
|---|
| **Unit 1.** Introductions of group, Relation of conjugacy, Conjugate class of a group, Class equation, Lagrange's theorem, Cayley's theorem, Sylow's theorem and its applications. |
| **Unit 2.** Normal and subnormal series, Composition series, Jordan Holder theorem, Chain conditions, Commutators. Solvable groups, solvability of subgroups and factor groups, Nilpotent groups, and their equivalent characterizations. |
| **Unit 3.** Rings, ideals, prime and maximal ideals, quotient rings. Factorization theory in commutative domains, Prime and irreducible elements, Euclidean Domains, Principal Ideal Domain, Divisor chain condition, Unique Factorization Domains, examples, and counter examples, Polynomial rings over domains, Eisenstein's irreducibility criterion, Unique factorization in polynomial rings over U.F.D.s. |
| **Unit 4.** Fields, Finite fields, Field extensions, Galois group. |
| |
| **Books Recommended:**<br>1. J.A. Gallian - "Contemporary Abstract Algebra", Narosa Publication.<br>2. N. Jacobson - "Basic Algebra", Vol.1, Hindustan Publishing Co., New Delhi.<br>3. Ramji Lal - "Fundamentals in Abstract Algebra", Chakra Prakashan, Allahabad, 1985.<br>4. I.N. Herstein - "Topics in Algebra", Wiley Eastern Ltd., N.D., 1975.<br>5. D.S. Dummit and R.M. Foote - "Abstract Algebra", John Wiley, N.Y.<br>**6.** J.B. Fraleigh - "Abstract Algebra", Narosa Publication. |



| MTH103 - Real Analysis |
|---|
| **Unit 1.** Functions of several variables: Concept of functions of two variables, Simultaneous and iterated limits in functions of two variables, Partial derivatives: Definition and examples, Existence and continuity, Interchange of order of differentiation, Directional derivatives. |
| **Unit 2.** Composite functions, Continuity of function of two variables, Differentiability of functions of two variables, Taylor's Theorem. |
| **Unit 3.** Definition and examples of metric space, pseudo metric, discrete and usual metric space, diameter of a set. Open and closed sets in a metric space, Interior point, Limit point, Adherent point, Closed set, Neighbourhood, Closure of a set, Interior of a set, Bolzano-Weirstrass theorem, Complete metric space, Cauchy sequence, Convergent sequence, Bounded Sequence. |
| **Unit 4.** Separated sets, Connected and disconnected sets, Continuity and connectedness, Compactness, Compactness and uniform continuity, Continuity and Uniform continuity in a metric space. |
| |
| **Books Recommended:**<br>1. S.C. Malik and Savita Arora: "Mathematical Analysis".<br>2. W. Rudin: "Principles of Mathematical Analysis".<br>3. T.M. Apostol: "Mathematical Analysis".<br>4. S.K. Mapa: "Introduction to Real Analysis"<br>5. Terence Tao: "Real Analysis"<br>6. J. R. Munkres: "Analysis on Manifolds".<br>7. E.T.Copson, "Metric Space" |

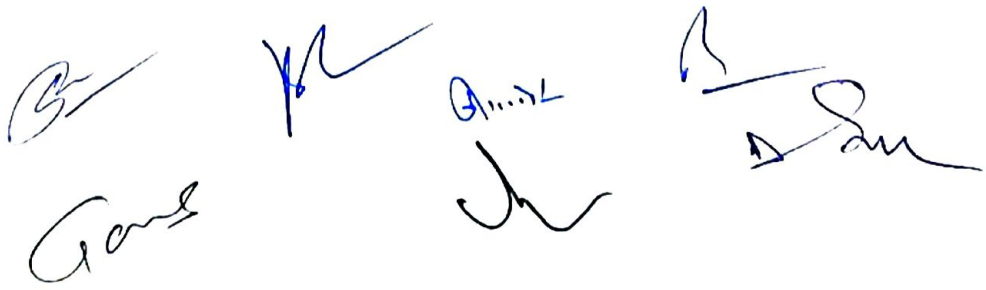
| MTH104 - Differential Geometry and Tensor Calculus |
|---|
| **Unit 1.** Curve in space, parameterized curves, Regular curves, Helices, Arc length, Re-parameterization (by arc length), Tangent, Principal normal, Binormal, Osculating plane, Normal plane, Rectifying plane, Curvature torsion of smooth curves, Serret-Frenet formulae, Frenet approximation of space curve. |
| **Unit 2.** Order of contact, Osculating circle, Osculating sphere, Spherical indicatrices, Involutes and Evolutes, Bertrand Curves, Intrinsic equations of space curves, Isometries of $R^3$, Fundamental theorem of space curves, Surfaces in $R^3$. |
| **Unit 3.** Curvature of curves on surfaces, Normal curvature, Principal curvatures, Geometric interpretation of principal curvatures, Euler theorem, Mean curvature, Lines of curvature, Rodrigue's formula, Umbilical points, Minimal surfaces, Definition and examples, Gaussian curvature, Intrinsic formulae for the Gaussian curvature, Isometries of surfaces. |
| **Unit 4.** n-dimensional real vector space, Covariant vectors, Contravariant vectors, Kronecker delta, Fundamental algebraic operations: Addition, Multiplication, Tensor product, Dual vector space, Second order tensors, Tensors of type (r, s), Symmetry and Skew symmetry of tensors, Contraction, and Inner product, Quotient law of tensors, Christoffel symbol. |
| |
| **Books Recommended**:<br>1. C.E. Weatherburn: "Riemannian Geometry and Tensor Calculus".<br>2. Andrew Pressley: "Elementary Differential Geometry".<br>3. J.A. Thorpe: "Elementary Topics in Differential Geometry".<br>4. D. Somasundaram: "Differential Geometry, A First Course".<br>5. T.J. Willmore: "An Introduction to Differential Geometry".<br>6. N. J. Hicks, Notes on Differential Geometry, Van Nostrand. |



# VIII Semester

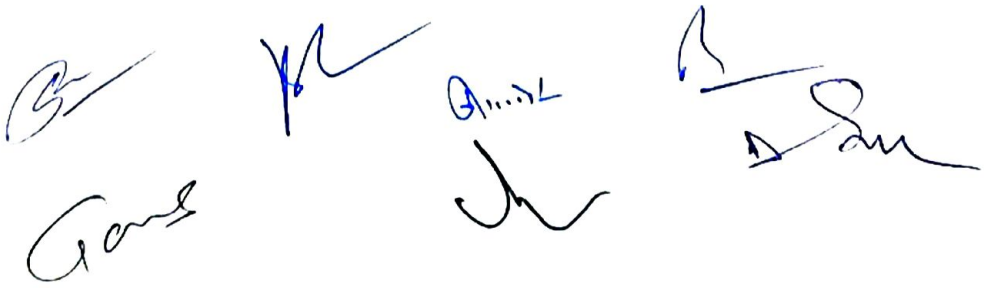
| MTH201 – Linear Algebra |
|---|
| **Unit 1.** A brief review of vector space, Inner products, Orthogonality, Best approximations, Projections, Cauchy-Schwartz inequality. |
| **Unit 2.** Adjoint of a linear transformation, Self-adjoint transformations, Unitary operators. Normal operators: Definition and properties and Spectral theorem. |
| **Unit 3.** Eigen vectors and eigen values of a linear operator, Minimal polynomial of a linear operator and its relations to characteristic polynomial, Cayley-Hamilton theorem. |
| **Unit 4.** Bilinear forms, Symmetric and skew-symmetric bilinear forms, Groups preserving bilinear forms. |
| |
| **Books Recommended:**<br>1. Sheldon Axler - "Linear Algebra Done Right".<br>2. Kenneth Hoffman and Ray Kunze - "Linear Algebra".<br>3. Serge Lang - "Linear Algebra".<br>4. Gilbert Strang - "Linear Algebra and its Applications".<br>5. Hadley - "Linear Algebra".<br>**6.** H. Helson - "Linear Algebra", Hindustan Book Agency, New Delhi, 1994. |

| MTH202 - Complex Analysis |
|---|
| **Unit 1.** Conformal mappings, Power series representation of analytic functions, Analytic functions as mappings, Riemann sphere, Linear transformations, Mobius transformation, Cross ratios, Mobius transformation on circles. |
| **Unit 2.** Analytic Continuation: Direct Analytic Continuation, Monodromy theorem, Poisson Integral Formula, Analytical Formula, Analytical Continuation via Reflection. |
| **Unit 3.** Entire functions, Hadmard's three circle theorem, Meromorphic functions, The argument principle, Rouche's theorem**,** Schwarz lemma, The open mapping theorem. |
| **Unit 4.** Linen of half planes in complex plane, Extended complex plane, Stereographic projection.<br>Maximum modulus principle, Little Picard Theorem, Great Picard Theorem. |
| |
| **Books Recommended:**<br>1. Lars V. Ahlfors - "Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable", McGraw-Hill Education.<br>2. John B. Conway - "Functions of One Complex Variable I".<br>3. Walter Rudin - "Real and Complex Analysis".<br>4. S. S. Ponnusamy and Silverman J. - "Complex Variables with Applications".<br>5. Denish G. Zill and Patrick D. Shanahan - "Complex Analysis", Jones & Bartlett Learning.<br>6. D. Sarason - "Complex Function Theory", Hindustan Book Agency, Delhi, 1994. |



| MTH203- Differential Equations |
|---|
| **Unit 1.** Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, Singular solutions of first order ODEs, System of first order ODEs., General theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function, Wronskians. |
| **Unit 2.** Formation of P.D.Es. First order P.D. Es, Classification of first order, P.D.Es, Complete, general, and singular integrals, Lagrange's or quasi-linear equations, Integral surfaces through a given curve. Orthogonal surfaces to a given system of surfaces, Characteristic curves. |
| **Unit 3.** Pfaffian differential equations, Compatible systems, Charpit's method, Jacobi's Method. Cauchy problem for first order PDEs. |
| **Unit 4.** Classification of second order P.D.Es, Linear PDEs equations with constant coefficients, General solution of higher order PDEs with constant coefficients, Reduction to canonical forms. |
| |
| **Books Recommended:**<br>1. M.D. Raisinghania - "Advanced Differential Equations".<br>2. D.P. Choudhary and H.I. Freedman - "A Course in Ordinary Differential Equations".<br>3. T. Amaranath - "An Elementary Course in Partial Differential Equations".<br>4. Erwin Kreyszig - "Advanced Engineering Mathematics".<br>5. S. L. Ross - "Differential Equations", Wiley Publications.<br>6. G. F. Simmons - "Differential Equations with applications and historical notes", CRC Press. |

| MTH204- Operations Research-I |
|---|
| **Unit 1.** Introduction to Operations research, methodology of Operations research, Features of Operations research problems, Different models in Operations research, Opportunity, and shortcomings of Operations research's approach. |
| **Unit 2.** Game theory: two persons zero sum game, game with saddle points, rule of dominance; algebraic, graphical, and linear programming, concept of mixed strategy. Sequencing problems: processing of n jobs through 2 machines, n jobs through 3 machines, 2-jobs through m machines, n jobs through m machines. |
| **Unit 3.** Revised simplex method and bounded variable problems. Pure and Mixed Integer Programming, Gomory's cutting plane method for Integer Programming, Fractional Cut Method, Sensitivity analysis. |
| **Unit 4.** Dynamic Programming under certainty, Nonlinear Programming Method, Quadratic Programming, Kuhn-Tucker conditions. |
| |
| **Books Recommended**:<br>1. Hamdy A. Taha: "Operations Research: An Introduction".<br>2. Wayne L. Winston: "Operations Research: Applications and Algorithms".<br>3. Richard Bronson: "Operations Research: A Practical Introduction".<br>4. Kanti Swarup, P.K. Gupta, Man Mohan: "Operations Research: Theory and Applications".<br>5. S. Kalavathy: "Operations Research".<br>6. S. S. Rao: "Optimization Theory and Applications" , Wiley Eastern. |



# Minor/Additional/ Interdisciplinary/ Multidisciplinary Course

# GRADUATION-1st Year (SEMESTER-I/II)

## Minor Elective: Probability

| Programme: Minor/Additional/ Interdisciplinary/ Multidisciplinary Course | Year: First | Semester: First/Second |
|---|---|---|
| **Subject: Mathematics** | | |
| **Course Code: MEC01** | **Course Title: Probability** | |

**Course outcomes:**
**CO1:** Learn about probability density and moment generating functions.
**CO2:** Know about various univariate distributions such as Bernoulli, Binomial, Poisson, Gamma and exponential distributions.
**CO3:** Learn about distributions to study the joint behavior of two random variables.

| Credits: 4 | Minor Elective |
|---|---|
| Max. Marks: 25+75 | Min. Passing Marks: As per university norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (4-0-0)**

**Course Title: Probability**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function. | 15 |
| II | Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution. | 15 |
| III | Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions. | 15 |
| IV | Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations. | 15 |

**Suggested Readings (Part-A Linear Algebra):**

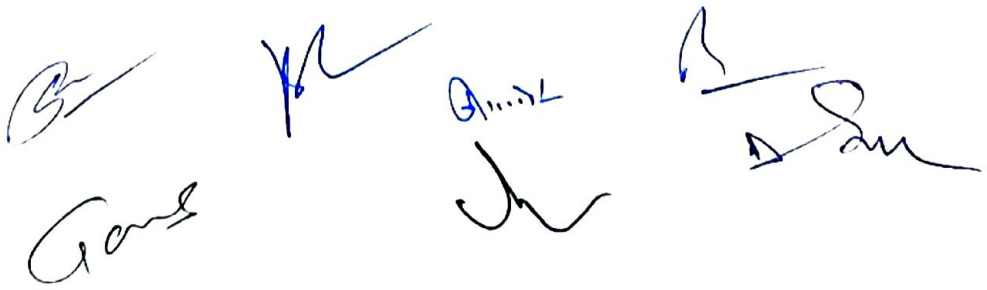

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). *Introduction to Mathematical Statistics* (7th ed.). Pearson Education, Inc.
2. Miller, Irwin & Miller, Marylees. (2014). John E. Freund's *Mathematical Statistics with Applications* (8th ed.). Pearson. Dorling Kindersley (India).
3. Ross, Sheldon M. (2014). *Introduction to Probability Models* (11th ed.). Elsevier Inc.


**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc.(C.S.) and other subject's students.

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S. No | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | **10** |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | **5** |
| 3 | **Attendance** | **5** |
| 4 | **Assignment** | **5** |

**Course perquisites:** To study this course a student must have studied Mathematics in class 12th.



# GRADUATION-2nd Year (SEMESTER- III/IV)

## Minor Elective: Financial Mathematics

| **Programme: Minor/Additional/ Interdisciplinary / Multidisciplinary Course** | **Year: Second** | **Semester: Third/Fourth** |
|---|---|---|
| **Subject: Mathematics** | | |
| **Course Code: MEC02** | **Course Title: Financial Mathematics** | |

**Course outcomes:** On completion of this course, the student will be able to:

**CO1:** Know the basics of financial markets and derivatives including options and futures.

**CO2:** Learn about pricing and hedging of options, as well as interest rate swaps.

**CO3:** Learn about the no-arbitrage pricing concept and types of options.

| **Credits: 4** | **Minor Elective** |
|---|---|
| **Max. Marks: 25+75** | **Min. Passing Marks:** As per university norms |

**Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (4-0-0)**

**Course Title: Financial Mathematics**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Interest rates, Types of rates, Measuring interest rates, Zero rates, Bond pricing, Forward rate, Duration, Convexity, Exchange traded markets and OTC markets, Derivatives--forward contracts, Futures contract, Options, Types of traders, Hedging, Speculation, Arbitrage. | 20 |
| II | No Arbitrage principle, short selling, Forward price for an investment asset, Types of options, Option positions, Underlying assets, Factors affecting option prices. | 15 |
| III | Bounds on option prices, Put-call parity, Early exercise, Effect of dividends. Binomial option pricing model. | 10 |
| IV | Risk neutral valuation (for European and American options on assets following binomial tree model), Lognormal property of stock prices, Distribution of rate of return, expected return. | 15 |

**Suggested Readings (Part-A Linear Algebra):**

**1.** Hull, J. C., & Basu, S. (2010). *Options, Futures and Other Derivatives* (7th ed.). Pearson Education. New Delhi.

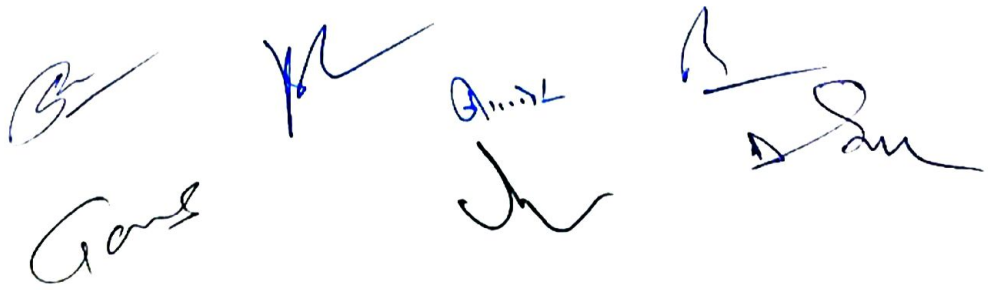
**2.** David G. (1998). *Investment Science*, Oxford University Press. Delhi.

**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc.(C.S.) and other subject's students.

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | 10 |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | 5 |
| 3 | **Attendance** | 5 |
| 4 | **Assignment** | 5 |

**Course perquisites:** To study this course a student must have studied Mathematics in class 12th.



## GRADUATION-4th Year (SEMESTER- VII/VIII)

### Degree with Honours /Research

### Minor Elective: Research Methodology

| **Programme: Minor/Additional/ Interdisciplinary / Multidisciplinary Course** | **Year: Fourth** | **Semester: Seventh/ Eighth** |
|---|---|---|
| **Subject: Mathematics** | | |
| **Course Code: MEC03** | **Course Title:** Research Methodology | |
| **Course outcomes:** On completion of this course, the student will be able to understand the basics of research and some methodology. | | |
| **Credits: 4** | **Minor Elective** | |
| **Max. Marks: 25+75** | **Min. Passing Marks:** As per university norms | |
| **Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (4-0-0)** | | |

**Course Title: Research Methodology**

| Unit | Topics | No. of Lectures |
|---|---|---|
| I | Perception of Research, Meaning of Research, Empirical and theoretical research, Inductive and Deductive logics. | 15 |
| II | Research hypothesis, Scientific Methods, Research Design, Type of Data and Collection. Use of computers in obtaining results, valid & invalid generalization. | 15 |
| III | Sampling, Sampling Distribution, Testing of Hypothesis. | 15 |
| IV | Correlation and Regression, Time Series Analysis. | 15 |

**Suggested Readings:**

1. Ethics in Research and Publication Ethics: Philosophy and ethics, Scientific conduct, Publication ethics.
2. Write Mathematics Right by L. Radhakrishna, Narosa Publishing House, 2003.

**This course can be opted as an elective by the students of following subjects:** Engg. and Tech. (UG), B.Sc. (C.S.) and other subject's students.

**Suggested Continuous Evaluation Methods: Max. Marks: 25**

| S.No. | Assessment Type | Max. Marks |
|---|---|---|
| 1 | **Class Tests** | 10 |
| 2 | **Online Quizzes/Objective Tests/ Presentation** | 5 |
| 3 | **Attendance** | 5 |
| 4 | **Assignment** | 5 |

**Course perquisites:** To study this course a student must have studied Mathematics.