

GAUHATI UNIVERSITY

FOUR YEAR UNDER GRADUATE PROGRAMME (FYUMP)(Minor)

SUBJECT: MATHEMATICS

Syllabus: Version-I

Programme Code: MAT027

Programme name	Eligibility Criteria of the programme, if any	Semester	Course name	Course code	credits	Credit distribution of the course			Pre-requisite of the course (if any)	Internal marks	External Marks
						Lecture	Tutorial	Practical			
FYUGP in Mathematics	Nil	1	Classical Algebra	MAT0100104	4	4	0	0	Mathematics in 10+2 or equivalent standard	40	60
		2	Calculus	MAT0200104	4	4	0	0	Do	40	60
		3	Ordinary Differential Equations	MAT0300104	4	4	0	0	MAT0200104	40	60
			Abstract Algebra	MAT0300204	4	4	0	0	Do	40	60
		4	Analytical Geometry	MAT0400104	4	4	0	0	Do	40	60
			Number Theory-I	MAT0400204	4	4	0	0	Do	40	60

		5	Multivariate Calculus	MAT0500104	4	4	0	0	MAT0200104	40	60
			Numerical Analysis-I (with practical)	MAT0500204	4	3	0	1	Mathematics in 10+2 or equivalent standard	Practical 25+Internal 30	45
		6	Linear Algebra	MAT0600104	4	4	0	0	MAT0300204	40	60
			Partial Differential Equations (with practical)	MAT0600204	4	3	0	1	MAT0300104	Practical 25+Internal 30	45
			Mechanics	MAT0600304	4	4	0	0	Mathematics in 10+2 or equivalent standard	40	60

Programme Specific Outcomes:

PSO1: Demonstrate mathematical ability effectively by oral, written, computational and graphical means.

PSO2: Measure the hypothesis, theories, techniques and proofs provisionally through analytic ability.

PSO3: Utilize mathematics to solve theoretical and applied/ real world problems by critical understanding, analysis and synthesis.

PSO4: Develop a spirit of lifelong learning through continued education and research.

SEMESTER-I**MAT0100104: Classical Algebra**

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: Mathematics in 10+2 or equivalent standard

Course Outcomes:

The students who take this course will be able to:

CO1 Identify symmetric functions of the roots for cubic and biquadratic equations, solve cubic and biquadratic equations.

CO2 Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix and calculate the inverse and rank of a matrix.

CO3 Classify and compute the nature of the roots of a given polynomial equation by Descartes' rule

CO4 Express the basic concepts of exponential, logarithmic and hyperbolic functions of complex numbers.

CO5 Apply De Moivre's theorem in a number of applications to solve numerical problems.

UNIT 1: Polar representation of complex number, De Moivre's theorem (both integral and rational index), Roots of complex numbers, n^{th} roots of unity, Application of De Moivre's Theorem, Exponential and logarithmic functions of complex numbers, Hyperbolic functions.

[1] Chapter 2 (Sections 2.7-2.13, 2.16)

(No. of classes: 20, Marks: 20)

UNIT 2: Algebraic equations: Deduction from Fundamental Theorem of Classical Algebra, Descartes' rule of signs, relation between roots and coefficients of a polynomial equation of degree n , symmetric functions of roots, Transformation of equations, Cardon's method of solution of a cubic equation, Euler's method of solution of a biquadratic equation.

[1] Chapter 5; Theorem 5.1.1, Theorem 5.2.1, Section 5.3 - 5.6, 5.11, 5.12.

(No. of classes: 20, Marks: 20)

UNIT 3: Matrix Algebra, Addition, Transposition, Symmetry, Multiplication of matrices and their properties, Matrix inversion and properties, Row Echelon form and Rank of a matrix, Reduced row Echelon form, Consistency of linear systems, Solutions of system of homogeneous linear equations with number of equations and unknowns up to four.

[2] Chapter 3 (Sections 3.2, 3.5, and 3.7) Chapter 2 (Sections 2.1 to 2.4)

(No. of classes: 20, Marks: 20)

Text Books:

1. Mappa, S.K., Higher Algebra (Classical), Revised 8th Edition, 2011, Levant Books.
2. Meyer, Carl D. (2000). Matrix Analysis and Applied Linear Algebra. Society for Industrial and Applied Mathematics (Siam).

Reference Books:

1. Dickson, Leonard Eugene (2009). First Course in The Theory of Equations. The Project Gutenberg eBook (<http://www.gutenberg.org/ebooks/29785>)
2. Gilbert, William J., & Vanstone, Scott A. (1993). Classical Algebra (3rd ed.). Waterloo Mathematics Foundation, Canada.
3. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.

SEMESTER-II

MAT0200104: Calculus

Total Marks: 100 (External: 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: Mathematics in 10+2 or equivalent standard

Course Outcomes: The students who take this course will be able to:

- CO1 Describe asymptotic behavior in terms of limits involving infinity.
- CO2 Recognize function of two variables and operate the partial derivatives.
- CO3 Express continuity and differentiability in terms of limits.
- CO4 Calculate integrations which can be solved by reduction formula
- CO5 Use the mean value theorems.

UNIT 1: Limits and continuity of a function including different approaches, Properties of continuous functions including Intermediate value theorem.

[1] Chapter 1

(No. of classes: 15, Marks: 15)

UNIT 2: (a) Differentiability, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivatives.

(b) Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x \, dx$, $\int \cos^n x \, dx$, $\int \tan^n x \, dx$, $\int \sec^n x \, dx$, $\int (\log x)^n \, dx$, $\int \sin^n x \cos^m x \, dx$.

[2] Chapter 5(for part (a))

[3] Chapter 4 (4.1-4.6) (only for part (b))

(No. of classes: 15, Marks: 15)

UNIT 3: Rolle's theorem, Lagrange's mean value theorem with geometrical interpretations and simple applications, Maclaurin and Taylor polynomials and their sigma notations. Taylor's formula with remainder, Introduction to Maclaurin and Taylor series.

[1] Chapter 9 (Sections 9.8 and 9.9 (without 'convergence' part))

[2] Chapter 6

(No. of classes: 15, Marks: 15)

UNIT 4: Functions of two or more variables, Partial differentiation up to second order, Euler's theorem on homogeneous functions

[1] Chapter 13 (Sections 13.1 and 13.3)

[2] Chapter 10(10.81)

(No. of classes: 15, Marks: 15)

Text books:

[1] Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi

[2] Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand, 2005

[3] Shanti Narayan and P.K. Mittal, Integral Calculus, S. Chand, 2007.

Reference book:

[1] Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13th ed). Pearson Education, Delhi. Indian Reprint 2017.

SEMESTER-III

MAT0300104: Ordinary Differential Equations

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: MAT0200104

Course Outcomes:

- CO1 Identify 1st order ordinary differential equations like exact first order differential equations, Bernoulli equations and rules of finding integrating factors of exact equations.
- CO2 Recognize the second order differential equations like homogenous equations with constant coefficients equations, non-homogenous equations and Cauchy-Euler equations
- CO3 Solve first order and second order differential equations
- CO4 Calculate Wronskian and show its properties.
- CO5 Use the method of undetermined coefficients, variation of parameters.

UNIT 1: First Order Ordinary Differential Equations

Classification of differential equations; their origin and application. Solutions. First order exact differential equation. Integrating factors, Rules to find an integrating factor.

[1] Chapter 1 (Sections 1.1 and 1.2) Chapter 2 (Sections 2.1, 2.2 and 2.4)

Linear equations and Bernoulli equations. Basic theory of higher order linear differential equations. Solving differential equation by reducing its order. Wronskian and its properties.

[1] Chapter 2 (Section 2.3), Chapter 4 (Sections 4.1 and 4.6)

(No. of classes: 30, Marks: 30)

UNIT 2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients. Linear non- homogenous equations; the method of undetermined coefficients, the method of Variation of Parameters. The Cauchy-Euler equations.

[1] Chapter 4 (Sections 4.2, 4.3, 4.4 and 4.5)

(No. of classes: 30, Marks: 30)

Text Book:

[1] Ross, Shepley L. (1984). Differential Equations (3rd Ed.), John Wiley & Sons, Inc.

Reference Book:

1. Kreyszig, Erwin (2011). Advanced Engineering Mathematics (10th ed.). John Wiley & Sons, Inc. Wiley India Edition 2015.

MAT0300204: Abstract Algebra

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: Mathematics in 10+2 or equivalent standard

Course Outcomes:

- CO1 Recognize the mathematical objects called group, ring and fields.
- CO2 Associate the fundamental concepts of groups and symmetries of geometrical objects.
- CO3 Explain the significance of the notion of Permutation groups, cosets, cyclic groups, normal subgroups, factor groups.
- CO4 Analyse consequences of Lagrange's theorem and Fermat's Little theorem.
- CO5 Describe structure preserving mappings between groups and their consequences.
- CO6 Describe the fundamental concepts in ring theory such as of the subrings, integral domains, ideals, factor rings and fields.

Unit 1: Definition and examples of groups, Elementary properties of groups, Symmetries of a square, Dihedral groups, order of a group, Order of an element in a group, Subgroups, Subgroup Tests, Subgroup generated by an element of a group, Centre of a group, Centralizer of an element in a group, Cyclic groups, Properties of cyclic groups, Fundamental theorem of cyclic groups.

[1] Chapter 1 to Chapter 4.

(No. of classes: 25, Marks: 25)

Unit 2: Permutations, Permutation group, Properties of permutations, Even and odd permutations, Alternating groups, Cosets, Properties of cosets, Lagrange's Theorem, Fermat's Little Theorem, Normal subgroups, Factor groups.

[1] Chapter 5 (up to theorem 5.7), Chapter 7 (up to theorem 7.2), Chapter 9 (up to theorem 9.2)

(No. of classes: 25, Marks: 25)

Unit 3: Rings, Examples of rings.

[1] Chapter 12 to Chapter 14.

(No. of classes: 10, Marks: 10)

Text Books:

1. Gallian Joseph A., *Contemporary Abstract Algebra* (8th Edition) , Cengage Learning India Private limited, Delhi, Fourth impression, 2015.

Online link: <https://ict.iitk.ac.in/wp-content/uploads/CS203-Mathematics-for-Computer-Science-III-Gallian.pdf>

Reference Books:

1. David S. Dummit and Richard M. Foote, *Abstract Algebra* (2nd Edition) , John Wiley and Sons (Asia) Pvt. Ltd. , Singapore, 2003.

2. John B. Fraleigh, *A First course in Abstract Algebra*, 7th Edition, Pearson, 2002.

3. G. Santhanam. *Algebra*, Narosa Publishing House, 2017.

SEMESTER-IV

MAT0400104: Analytical Geometry

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: Mathematics in 10+2 or equivalent standard

Course Outcomes:

- CO1 Define Vector Algebra and represent the use of geometric view of vectors in Coordinate Geometry.
- CO2 Recognize three dimensional surfaces represented by equations of the second degree
- CO3 Change the coordinate systems
- CO4 Explain pair of straight lines, conic sections and related properties
- CO5 Express systems of coordinates which are very useful to define the position of a point in space

UNIT 1: Transformation of coordinates, invariants under orthogonal transformations, pair of straight lines.

[1] Chapter 1 (Section 1.3), Chapter 2, Chapter 3

(No. of classes: 15, Marks: 15)

UNIT 2: Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, General conics: tangent, condition of tangency, pole and polar, centre of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes, polar equation of a conic, tangent and normal, and properties.

[1] Chapters 4, 5, 6, 7, 9 (upto Section 9.43)

(No. of classes: 15, Marks: 15)

UNIT 3: Quadric surfaces: Sphere, Cylinder and Cone. Cylindrical and spherical polar coordinates.

[1] Chapter 6 (Section 6.1 – 6.3), Chapter 12

(No. of classes: 15, Marks: 15)

UNIT 4: Rectangular coordinates in 3-space, Vector viewed geometrically, Vectors in coordinates system, Vectors determined by length and angle, Dot product, Cross product and their geometrical properties, Triple product, Parametric equations of lines in 2-space and 3-space.

[2] Chapter 11 (Section 11.1 - 11.5)

(No. of classes: 15, Marks: 15)

Text Books:

1. R.M. Khan, Analytical Geometry of two and three dimensions and Vector Analysis. New Central Book Agency, 2012.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013), Calculus (10th ed.). John Wiley & Sons, Singapore Reprint (2016) by Wiley India Pvt. Ltd., Delhi.

Reference Book:

1. R.J.T. Bell, Coordinate Solid Geometry, Macmillan, 1983.
2. E.H. Askwith, The Analytical Geometry of the Conic Sections, Nabu Press (27 February 2012)
3. B. Das, Analytical Geometry and Vector Analysis, Orient Book Company, Kolkata -700007

SEMESTER-IV

MAT0400204: Number Theory-I

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of

Non-Contact classes: 0

Prerequisites: Mathematics in 10+2 or equivalent standard

Course Outcomes:

- CO1 State Fermat's theorem and Wilson's theorem and use them to solve problems
- CO2 Explain division algorithm, Euclid's algorithms, greatest common divisor, the concepts of congruences, linear congruences
- CO3 Explore the Chinese Remainder theorem to solve simultaneous linear congruences.
- CO4 Apply mathematical ideas and concepts within the context of number theory.
- CO5 Summarize number theoretic techniques to a mathematical audience.

UNIT 1: Well-Ordering Principle of integers, Archimedian property, First principle of finite induction, Second principle of finite induction, The division algorithm of integers, The greatest common divisor, The Euclidean algorithm, The Diophantine equation $ax + by = c$, Fundamental Theorem of Arithmetic, The sieve of Eratosthenes, The Goldbach Conjecture.

[1] Chapter 1 (Sections 1.1), Chapter2 (sections 2.2 -- 2.5), Chapter3.

(No of classes:20, Marks:20)

UNIT 2: Congruence modulo of a fixed positive integer, Basic properties of congruences, Binary and decimal representation of integers, Linear congruences, Chinese Remainder Theorem, Fermat's Little Theorem, pseudoprimes, Wilson's Theorem.

[1] Chapter 4 (Sections 4.2-4.4) Chapter5 (Sections: 5.2, 5.3).

(No of classes: 20, Marks: 20)

UNIT 3: Number Theoretic Functions: The sum and number of divisors of a positive integer, Multiplicative functions, Mobius function, The Mobius inversion Formula, The greatest integer function, Euler's Phi-Function, Euler's Theorem, Properties of Euler's Phi function.

[1] Chapter 6 (Sections 6.1-6.3), Chapter 7 (Sections 7.2 to 7.4) .

(No of classes:20, Marks: 20)

Text Books:

1. David M. Burton, *Elementary Number Theory*, 7th Edition, McGraw Hill Education (India) private limited. 2012.

Reference Books:

1. G.A. Jones and J. Mary Jones, *Elementary Number Theory*. Undergraduate Mathematics Series (SUMS) , 2005.
2. Neville Robinns, *Beginning Number Theory*. 2nd Ed., Narosa Publishing House Pvt. Ltd. Delhi-2007
3. K.C. Chowdhury, *A First Course in Number Theory*, Asian Books Publications- 2012.

SEMESTER-V

MAT0500104: Multivariate Calculus

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

(Use of Scientific calculator is allowed)

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: MAT0200104: Calculus and Knowledge on the Vector valued functions, dot and cross product of vectors.

Course Outcomes:

CO1 Identify the conceptual variations when advancing in calculus from one variable to multivariable discussion.

CO2 Describe the maximization and minimization of multivariable functions subject to the given constraints on variables.

CO3 Explain about the inter-relationship amongst the line integral, double and triple integral formulations.

CO4 Assess Green's, Stokes' and Gauss divergence theorems

UNIT1: Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Chain rule, Directional derivatives, The gradient, Maximal property of the gradient.

[1] Chapter 11 [(Sections 11.1, 11.2, 11.3, 11.5, Section 11.6 (upto page 592)]

(No. of classes: 30, Marks: 30)

UNIT 2: Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems; Definition of vector field, Divergence and curl.

[1] Chapter 11 [Section 11.7 (upto page 605), Section 11.8 (pages 610-614)], Chapter 13 (Section 13.1)

(No. of classes: 30, Marks:- 30)

Textbook:

[1] Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rded.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011

Reference Books:

1. Marsden, J.E., Tromba, A., & Weinstein, A. (2004). *Basic Multivariable Calculus*. Springer (SIE). First Indian Reprint.
2. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
3. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks / Cole, Thomson Learning, USA, 2001.

SEMESTER-V**MAT0500204: Numerical Analysis (with practical)****Total Marks: 100**

(External 45, Practical 25, Internal Assessment: 30)

No. of Credits: 4 (Theory 3, Practical 1)

(Use of Scientific calculator is allowed)

No. of Contact classes: 75 (45+30×1)**No. of Non-Contact classes: 0****Prerequisites:** Mathematics in 10+2 or equivalent standard, Knowledge on computer software and programming**Course Outcomes:**

- CO1 Apply numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, upto a certain given level of precision.
- CO2 Compute the values for a tabulated function at points not in the table using interpolation techniques.
- CO3 Measure a definite integral that cannot be done analytically
- CO4 Estimate numerical differentiation of functional values

CO5 Solve differential equations that cannot be solved by analytical methods

UNIT1: Gaussian elimination method (with row pivoting), Gauss-Jordan method; Iterative methods: Jacobi method, Gauss-Seidel method; Interpolation: Lagrange form, Newton form, Finite difference operators, Gregory-Newton forward and backward difference interpolations, Piecewise polynomial interpolation (Linear and Quadratic).

[1] Chapter 3 (Sections 3.1, and 3.2), Chapter 6 (Sections 6.1 and 6.2) Chapter 8 (Section 8.1, Section 8.3 (8.3.1, and 8.3.2))

[2] Chapter 3 (Sections 3.2, and 3.4) Chapter 4 (Section 4.2) Chapter 4 (Sections 4.3, and 4.4) [1] Chapter 18 (Sections 18.1 to 18.3)

[3] **(No. of classes: 20, Marks: 25)**

UNIT 2: Numerical differentiation: First and second order derivatives; Numerical integration: Trapezoid rule, Simpson's rule; Extrapolation methods: Richardson extrapolation, Romberg integration; Ordinary differential equation: Euler's method, Modified Euler's methods (Heun and Mid-point).

[2] Chapter 11 [Sections 11.1 (11.1.1, 11.1.2, 11.1.4), and 11.2 (11.2.1, 11.2.2, 11.2.4)]

[1] Chapter 22 (Sections 22.1, and 22.2, 22.3)

(No. of classes: 25, Marks: 20)

Practical /Lab work to be performed on a computer:

Use of computer aided software (CAS), for example *Matlab/Mathematica/Maple* etc., for developing the following numerical programs:

- (i) Lagrange's interpolation method
- (ii) Newton's interpolation method
- (iii) To calculate forward and backward differences
- (iv) Trapezoidal rule
- (v) Simpson's rule

Note: For any of the CAS *Matlab/Mathematica/Maple* etc., Data types-simple data types, floating data

types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, arrays should be introduced to the students.

(No. of practical classes: 30, Marks: 25)

Text Books:

[1] Chapra, Steven C.(2018).*Applied Numerical Methods with MATLAB for Engineers and Scientists*(4th ed.) Mc Graw-Hill Education.

[2] Fausett ,LaureneV. (2009). *Applied Numerical Analysis Using MATLAB*.Pearson.India

[3] Jain,M.K.,Iyengar,S.R.K.,&JainR.K.(2012). *NumericalMethods for Scientific and Engineering Computation*(6th ed.).New Age International Publishers.
Delhi.

SEMESTER-VI

MAT0600104: Linear Algebra

Total Marks: 100 (External 60, Internal Assessment 40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: MAT0300204: Abstract Algebra

Course Outcomes:

- CO1 Define linear spaces and discuss their general properties, linear dependence and linear independence of vectors, bases and dimensions of vector spaces
- CO2 Explain the basic concepts of linear transformations, dimension theorem, matrix representations of linear transformations, and the change of coordinate matrix.
- CO3 Compute the characteristic polynomial, eigenvalues, eigenvectors and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.
- CO4 Determine inner products and orthogonality on vector spaces.
- CO5 Use Gram-Schmidt orthogonalization to obtain orthonormal basis.

UNIT 1: Definition and examples of vector spaces, general properties of vector spaces, Definition and examples of subspaces, subspace criteria and algebra of subspaces, null space and column space of a matrix, Linear transformations, Kernel and range of a linear transformation.

[1]: Chapter 4 (Sections 4.1-4.2), [2] : Chapter 4

(No. of classes: 15, Marks: 15)

UNIT 2: Linear combinations of vectors, linearly dependent and independent sets, bases of vector spaces, coordinate systems, dimension of a vector space, ranks, change of basis.

[1]: Chapter 4 (Sections 4.3-4.7), [2] : Chapter 5

(No. of classes: 15, Marks: 15)

UNIT 3: Eigenvectors and eigenvalues of a matrix, The Characteristic equation, Diagonalization, eigenvector of a linear transformation, Complex eigenvalues. Invariant subspaces and Cayley- Hamilton Theorem.

[1]: Chapter 5 (Sections 5.1-5.5), [2]: Chapter 9, [3]: Chapter 5 (Sections 5.4)

(No. of classes: 15, Marks: 15)

UNIT 4: Inner products, Length and orthogonality, orthogonal sets, orthogonal projections, The Gram-Schmidt process, Inner product spaces.

[1]: Chapter 6 (Sections 6.1-6.4, 6.7), [2]: Chapter 12

(No. of classes: 15, Marks: 15)

Text Books:

1. David C. Lay, *Linear Algebra and its Applications*, 3rd Edition, Pearson Education, Asia, Indian Reprint, 2007
2. Seymour Lipschutz, *Theory and Problems of Linear Algebra*, Schaum's Outline Series, McGraw-Hill Book Company, Singapore
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

Reference Books:

1. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 2017
2. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007
3. G. Schay, *Introduction to Linear Algebra*, Narosa, 1997

SEMESTER-VI

MAT0600204: Partial Differential Equations (with practical)

Total Marks: 100

(External:45, Practical 25, Internal Assessment: 30)

No. of Credits: 4 (Theory 3, Practical 1)

No. of Contact classes: 75 (15×3+30×1)

No. of Non-Contact classes: 0

Prerequisites: MAT0300104: Ordinary Differential Equations and Knowledge on computer software

Course Outcomes:

- CO1 Formulate, classify and transform first order PDEs into canonical form.
- CO2 Explain method of characteristics, separation of variables and solve first order PDE's.
- CO3 Classify and solve second order linear PDEs.
- CO4 Discuss Cauchy problem for second order PDE and homogeneous and non-homogeneous wave equations.
- CO5 Apply the method of separation of variables for solving many well-known second-order PDEs.

UNIT 1: Introduction, Classification, Construction of first order partial differential equations (PDE). Cauchy's problem for first order equations, linear equations of the first order, Integral surfaces passing through a given curve, Nonlinear partial differential equations of the first order, Cauchy's method of characteristics, Charpit's method. Solutions satisfying given conditions, Jacobi's method.

[1] Chapter 2 (Sections 2.1 to 2.3), [2] Chapter 2 (Section 3, 4,5, 7,8,10,12, 13)

(No. of classes: 15, Marks: 15)

UNIT 2: Canonical form of first order PDE, Method of separation of variables for first order PDE.

[1] Chapter 2 (Sections 2.6 and 2.7)

(No. of classes: 15, Marks: 15)

UNIT 3: Reduction to canonical forms, Equations with constant coefficients, General solution.

[1] Chapter 4 (Sections 4.1 to 4.5), [2] Chapter 3 (Sections 4, 5)

(No. of classes: 15, Marks: 15)

Practical /Lab work to be performed in a Computer Lab:

Modelling of the following similar problems using Mathematica /MATLAB/ Maple/ Maxima/Scilab etc.

1. Solution of Cauchy problem for first order PDE.
2. Plotting the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ for any two of the following associated conditions:
 - (a) $u(x,0) = \phi(x); u_t(x,0) = \psi(x), x \in R; t > 0$
 - (b) $u(x,0) = \phi(x); u_t(x,0) = \psi(x); u(0,t) = 0, x > 0; t > 0$
 - (c) $u(x,0) = \phi(x); u_t(x,0) = \psi(x); u_x(0,t) = 0, x > 0; t > 0$
 - (d) $u(x,0) = \phi(x); u_t(x,0) = \psi(x); u(0,t) = 0, u(l,t) = 0, x > 0; t > 0$
5. Solving systems of ordinary differential equations.
6. Solution of one-Dimensional heat equation $u_t = k u_{xx}$, for a homogeneous rod of length l .

That is - solve the IBVP:

$$\begin{aligned}u_t &= k u_{xx}, & 0 < x < l, & \quad t > 0 \\u(0,t) &= 0, & u(l,t) &= 0, & \quad t \geq 0 \\u(0,t) &= f(x), & 0 \leq x \leq l\end{aligned}$$

(No. of practical classes: 30, Marks: 25)

Text Book:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equation for Scientists and Engineers*, Springer, Indian reprint, 2006.
2. Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, Dover Publications. Indian Reprint.

Reference Book:

1. Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). *Partial Differential Equations: An Introduction with Mathematica and MAPLE* (2nd ed.). World Scientific.
2. M. D. Raisinghania, *Advanced Differenti al Equations*, S. Chand & Company LTD.

SEMESTER-VI

MAT0600304: Mechanics

Total Marks: 100 (External 60, Internal Assessment:40)

No. of Credits: 4

No. of Contact classes: 60

No. of Non-Contact classes: 0

Prerequisites: Mathematics in 10+2 or equivalent standard

Course Outcomes:

- CO1 Define the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.
- CO2 Explain the theory behind friction and center of gravity.
- CO3 Formulate conservation of mechanical energy and work-energy equations.
- CO4 Illustrate translational and rotational motion of rigid bodies.

UNIT1: Composition and resolution of forces, Parallelogram of forces, Triangle of forces, Converse of triangle of forces, Lami's Theorem, Parallel forces, Moment of a force about a point and an axis. Couple, Resultant of a system of forces. Equilibrium of coplanar forces. Friction, C.G of an arc, plane area, surface of revolution, solid of revolution.

[3] Chapter I-X

(No. of classes: 30, Marks: 30)

UNIT 2: Velocities and acceleration along radial and transverse directions and along tangential and normal directions, motion in a straight line under variable acceleration, simple harmonic motion and elastic string. Newton's law of motion. Work, Energy and momentum, Conservative forces-Potential energy, Impulsive forces, Motion in resisting medium.

[1] Chapter I Sections 1.1, 1.2,1.3, Chapter –2 Sections 2.1,2.2, Chapter 3 Sections 3.1.3.2, Chapter 4 Sections 4.1, Chapter 5 Sections 5.1,5.3,Chapter 6 Sections 6.1,6.3.

[2] Chapter 3(Sections:3.1,3.2,3.3,3.4).

(No. of classes: 30, Marks: 30)

Text Books:

1. S.L. Loney, An elementary treatise on the dynamics of a particle and of rigid bodies, Surjeet publications
2. F.Chorlton,TextbookofDynamics,CBS,Publications2ndEdition,1985
3. B.C. Das & B. N. Mukherjee, Statics, U. N. Dhur & Sons Pvt. Ltd.

Reference books:

1. M.R.Spiegel, Theoretical Mechanics, Schaum Series 2010.