SYLLABUS

POST GRADUATE PROGRAMME
IN
MATHEMATICS

(Approved in the meeting of Board of Studies in Mathematics held on 13th June, 2025)

DHAKUAKHANA COLLEGE (AUTONOMOUS)

DHAKUAKHANA

Structure of Post Graduate Programme in **Mathematics**

Semester	Nature of Course		Course Code	Course Title	Credit
I	Core		PMTHC101	Abstract Algebra	4
			PMTHC102	Differential Equations	4
			PMTHC103	Real Analysis	4
	Elective	DSE (Any one)	PMTHD104	Fuzzy Set Theory	4
			PMTHD105	Probability Theory and Statistics	4
	AEC		PMTHA101	Scientific Writing with Latex	2
	Total Credit				**18**
II	Core		PMTHC201	Complex Analysis	4
			PMTHC202	Linear Algebra	4
			PMTHC203	Numerical Analysis	4
	Elective	DSE (Any one)	PMTHD204	Fluid Dynamics	4
			PMTHD205	Operations Research	4
			PMTHD206	Topology	4
		GEC	PMTHG201	Fundamentals of Mathematics	4
	Total Credit				**20**
III	Core		PMTHC301	Functional Analysis	4
			PMTHC302	Graph Theory	4
			PMTHC303	Numerical Partial Differential Equation	4
	Elective	DSE (Any one)	PMTHD204	Advanced Algebra	4
			PMTHD205	Magnetohydrodynamics	4
		GEC	PMTHG301	Mathematical Modelling	4
	AEC		PMTHA301	Thesis preparation with Latex	2
	Total Credit				**22**
IV	Core		PMTHC401	Mathematical Methods	4
			PMTHC402	Mathematical Modelling	4
			PMTHC403	Measure Theory	4
			PMTHC404	Mathematics Teaching OR Dissertation (4 Credit)	4
	Elective	DSE (Any one)	PMTHD405	Algebraic Graph Theory	4
			PMTHD406	Computational Fluid Dynamics	4
			PMTHD407	Game Theory	4
	Total Credit				**20**

Two Year Post Graduate Programme in MATHEMATICS

First Semester

Title of the Course	**:**	**Abstract Algebra**
Course Code	**:**	**PMTHC101**
Category	**:**	**CORE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives : The students are expected to develop a strong foundation in Algebra with special emphasis on finite groups.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (10 Marks)	A review of groups and properties, examples of groups, subgroups, symmetric, alternating and dihedral groups. Isomorphism theorems. Normal subgroups, Factor groups.	06	04	10
II (15 Marks)	Group action, The class equation of finite groups, Syllow theorems, Direct products of groups.	11	04	15
III (15 Marks)	A review of Rings, properties and examples of rings. Ideals, Homomorphism and Quotient Rings, Field of quotients of an Integral Domain, Unique factorization domain, Principal Ideal Domain, Euclidean Domain.	12	03	15
IV (20 Marks)	Extension fields; The fundamental theorem of Field Theory, Splitting Fields, Zeros of an irreducible Polynomial. Classification of Finite Field, Structure of Finite Fields, Subfields of a Finite Field.	16	04	20
Total		45	15	60

- **L** indicates **Lectures,** **T** indicates **Tutorial Classes,** **P** indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes: After going through this course, the students will be able to

(i) Describe the Group theoretic notions of class equation and the related results.

(ii) Discuss three important classes of Ring structures, viz., the Principal ideal Domain, Euclidean domain and the unique factorization domain.
(iii) Understand field structures such as algebraically closed fields, splitting fields and field extensions and to use the fundamental results in algebra, find out the number of subgroups, normal subgroups of a finite group and solve problems using above mentioned powerful concepts.

Suggested Readings:

Text Books:

1. Gallian, J. A. (2013), Contemporary Abstract Algebra, New Age International.
2. Herstein, I. N. (1975), Topics in Algebra, Wiley Eastern Limited.
3. Dummit, D. S., Foote, R.M. (2004), Abstract Algebra, Hoboken: Wiley.+

Reference Books:

1. Khanna, V.K., Bhambri, S. K., A course in Abstract Algebra.
2. Hungerford, T. W. (1974), Algebra, Springer-Verlag. New York.
3. Bhattacharya, P.B., Jain, S.K., Nagpaul, S.R. (1994), Basic Abstract Algebra, Cambridge University Press.

Two Year Post Graduate Programme in MATHEMATICS

First Semester

Title of the Course : Differential Equations
Course Code : PMTHC102
Category : CORE
Total Credits : 04 (L = 3, T = 1, P = 0)
Distribution of Marks : 60 (End Semester) + 40 (In-Semester)

Course Objectives : The students will learn the governing mathematical formulations and their solutions of various physical problems.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (15 Marks)	**Ordinary Differential Equations:** Series solutions of second order linear differential equations, Legendre equation and Legendre polynomials, Bessel equation and Bessel functions, Systems of first-order linear differential equations.	10	3	13
II (15 Marks)	**Partial Differential Equations of Second Order:** Linear partial differential equations of second order with constant co-efficients, Characteristic curves of second order equations, Classification of second order partial differential equations with two independent variables into elliptic, parabolic and hyperbolic forms and reduction of linear second order PDEs into Canonical forms, Separation of variables, Solution of nonlinear equations of second order by Monge's method	12	4	16
III (15 Marks)	**Laplace's Equation, Wave Equation, Diffusion Equation:** Elementary solutions of Laplace equation, boundary value problems, solution of Laplace's equation by separation of variables, application of Laplace's equation in real life problem. Elementary solutions of the one-dimensional Wave equation, solution of the Wave equation by separation of variables, application of the Wave equation in real life problem. Elementary solutions of the Diffusion equation, Solution of the Diffusion equation by separation of variables, application of the Diffusion equation in real life problem.	12	4	16

IV (15 Marks)	**Methods of Green's Function:** Green's Function, Green's Function for the Laplace's equation, Green's function for the Wave equation, Green's function for the Diffusion equation.	11	4	15
Total		45	15	60

- **L** indicates **Lectures,** **T** indicates **Tutorial Classes,** **P** indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes: After going through this course the students will be able to

(i) Formulate the governing Mathematical equations of Physical Problems.

(ii) Solve Differential Equations using various Mathematical tools.

Suggested Readings:

Text Books:

(i) Ross, S.L. (1984), Differential Equations, Wiley India.

(ii) Coddington, E.A. (2001), An Introduction to Ordinary Differential Equations, PHI.

(iii) Sneddon, I.N. (2006), Elements of Partial Differential Equations, Dover Publications, Inc.

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Reference Books:

(i) Boyce, W. E., DiPrima, R. C. (2009), Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India

(ii) Raisinghania, M.D., Advanced Differential Equations, S. Chand Company.

(iii) Piaggio, E.T.H. (1985), Differential Equations, CBS Publishers and Distributors

(iv) Bhamra, K.S. (2010), Partial Differential Equations, PHI Learning Pvt. Ltd.

(v) Ayres, F(Jr.). (1972), Theory and Problems of Differential Equations, SI(Metric) Edition

(vi) Rao, K.S.(2010), Introduction to Partial Differential Equations, PHI Learning Pvt. Ltd

Two Year Post Graduate Programme in MATHEMATICS

First Semester

Title of the Course : Real Analysis
Course Code : PMTHC103
Category : CORE
Total Credits : 04 (L = 3, T = 1, P = 0)
Distribution of Marks : 60 (End Semester) + 40 (In-Semester)

Course Objectives: To build up a strong analytical foundation of basic Real Analysis.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (10 Marks)	**Introduction:** A review of Countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, convergence of sequence in R, Bolzano-Weierstrass theorem	5	2	7
II (10 Marks)	**Metric Space:** Metric spaces, compactness, completeness, Bolzano-Weierstrass theorem, Heine-Borel theorem; connectedness and continuity.	6	2	8
III (10 Marks)	**Sequences and Series of Functions:** Pointwise and uniform convergence, consequence of uniform convergence. Series of Functions, Power series, Taylor series, Binomial Series, Weierstrass Approximation Theorem.	11	4	15
IV (15 Marks)	**Functions of Several Variables:** Directional derivatives, Continuity, total derivatives, Jacobian matrix, the chain rule and its matrix form, the mean value theorem for differentiable functions, sufficient condition for differentiability.	12	3	15
V (15 Marks)	**Riemann-Stieltjes Integral:** Riemann-Stieltjes integrals, The R-S integral as a limit of sum, Classes of R-S integrable functions, Algebra of R-S integrable functions, Relation between Riemann and Riemann-Stieltjes integral.	11	4	15
Total		45	15	60

- **L** indicates **Lectures,** **T** indicates **Tutorial Classes,** **P** indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 40 Marks

- ❖ Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- ❖ Seminar Presentation / Group Discussion : 10 Marks
- ❖ Home Assignment : 05 Marks
- ❖ Attendance : 05 Marks

Learning Outcomes: After going through this course the students will be able to

1) Describe the properties of the Real numbers.
2) Analyze the properties of advanced differentiation and Integration of real valued functions in one or multiple variables.
3) Describe R as a metric space and identify its special metric properties.

Suggested Readings:

Text Books:

(i) Bartle, R. G., Sherbert, D. R. (2011), Introduction to real analysis, Hoboken, NJ: Wiley. (Unit I and II)

(ii) Kumar A., Kumaresan, S., A Basic Course in Real Analysis, CRC Press, New York. (Unit III)

(iii) Apostol, T.M. (2008), Mathematical Analysis. Narosa Publishing House. (Unit IV and V).

(iv) Fitzpatrick, P.M., (2010), Advanced Calculus, Orient Black Swan.

Reference Books:

(i) Rudin, W. (1964), Principles of Mathematical Analysis, New York, McGraw-Hill.

(ii) Simmons, G.F. (1963), Introduction to Topology and Modern Analysis, McGraw Hill.

(iii) Kaczor, W.J., Nowak, M.T., Nowak, N.T. (2000), Problems in Mathematical Analysis: Integration, American Mathematical Soc.

(iv) Carothers, N.L. (2009), Real Analysis, S Chand Company.

Two Year Post Graduate Programme in MATHEMATICS

First Semester

Title of the Course	**:**	**Fuzzy Set Theory**
Course Code	**:**	**PMTHD104**
Category	**:**	**DSE**
Total Credits	**:**	**04 (L = 3, T = 1, P= 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: The objective of the course is to introduce classifications and modeling of Uncertainty

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (12 Marks)	**Basic of Fuzzy Sets:** Uncertainty, Taxonomy of Uncertainty, Motivation, Concepts of crispness and fuzziness, Fuzzy set and its re presentation, cut, convex fuzzy set, basic operations on fuzzy sets, types of fuzzy sets, extension principle, t-norm, t-conorms and their properties.	9	3	12
II (12 Marks)	**Fuzzy Arithmetic and Method of Construction of Membership Function:** Fuzzy Numbers, Types of Fuzzy numbers, Interval Arithmetic, Arithmetic operations on fuzzy numbers, membership function formulation.	9	3	12
III (12 Marks)	**Fuzzy Relations:** Fuzzy relation, binary fuzzy relations, union and intersection of fuzzy relations, projection and cylindrical extensions, fuzzy equivalence relation, Fuzzy compatibility relations, Fuzzy ordering relations, compositions of fuzzy relations and their properties.	9	3	12
IV (12 Marks)	**Fuzzy logic and Fuzzy System:** Defuzzification, classic and fuzzylogic, approximate reasoning, linguistic hedges, fuzzy inference, fuzzy rule based system.	9	3	12

V (12 Marks)	**Uncertainty measure and Applications of Fuzzy sets:** Uncertainty based in formation, non-specificity of fuzzy set, fuzziness of fuzzy sets, Applications of fuzzy sets in decision making and other real world problems.	9	3	12
Total		45	15	60

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(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes :

After going through this course the students will be able to

(i) Explain uncertainty using fuzzy set theory
(ii) Gauge Uncertainty of fuzzy set
(iii) Apply fuzzy set theory in different types of real world problems under uncertainty

Suggested Readings:

Text Books:

(i) Klir, G. J., Yuan, B. (1995), Fuzzy sets and Fuzzy logic: theory and applications, New Jersey, Prentice Hall PTR.
(ii) Zimmermann, H.J. (2011), Fuzzy set theory and its applications, Springer Science & Business Media.

Reference Books:

(i) Ross, T.J.(2005), Fuzzy logic with engineering applications, John Wiley & Sons.
(ii) Pedrycz, W., Gomide, F.(1998), An introduction to fuzzy sets, analysis and design, MIT.

Two Year Post Graduate Programme in MATHEMATICS

First Semester

Title of the Course	**:**	**Probability Theory and Statistics**
Course Code	**:**	**PMTHD105**
Category	**:**	**DSE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: This course will introduce the theory of enumeration and probability.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (20 Marks)	**Combinatorics:** Counting principles, multinomial theorem, set partitions and Stirling numbers of the second kind, permutations and Stirling numbers of the first kind, infinite matrices, inversion of sequences, probability generating functions, generating functions, evaluating sums, the exponential formula	14	4	18
II (15 Marks)	**Probability:** Axiomatic definition of probability, probability spaces, probability measures on countable and uncountable spaces, conditional probability, independence; Random variables, distribution functions, probability mass and density functions, functions of random variables, standard univariate discrete and continuous distributions and their properties	11	4	15
III (10 Marks)	**Moments and Joint Distribution:** Mathematical expectations, moments, moment generating functions, characteristic functions, inequalities; Random vectors, joint, marginal and conditional distributions, conditional expectations, independence, covariance, correlation, standard multivariate distributions	9	3	12
IV (15 Marks)	**Correlation analysis:** Relationship of variables, methods of studying correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation and properties, Calculation of Correlation from a 2-way table, Interpretation of Correlation Coefficient, Rank Correlation.	11	4	15

	Regression analysis: Linear regression, Regression Equation, Identifying the Regression Lines properties of regression coefficients, numerical problems.			
Total		45	15	60

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(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes :

After going through this course the students will be able to

(i) Use techniques of enumeration in real life problems

(ii) Model the real life situations using probability theory.

Suggested Readings:

Text Books:

(i) Stanley, R.P. (2011), Enumerative Combinatorics, Cambridge Univ Press.

(ii) Ross, S.M. (2002), A first course in probability, Pearson Education India.

(iii) Rohatgi, V. K., Saleh, A. K. Md. E. (2001), An Introduction to Probability and Statistics. Wiley.

Reference Books:

(i) Berge, C. (1971), Principles of Combinatorics, New York, 176.

(ii) Aigner, M. (2007), A course in Enumeration, Springer Science & Business Media.

(iii) Ross, S.M. (2007), Introduction to Probability Models. Elsevier.

Two Year Post Graduate Programme in MATHEMATICS

First Semester

Title of the Course	**:**	**Scientific Writing with Latex**
Course Code	**:**	**PMTHA106**
Category	**:**	**AEC**
Total Credits	**:**	**02 (L = 0, P = 2)**
Distribution of Marks	**:**	**30 (End Semester) + 20 (In-Semester)**

Course Objectives: To introduce scientific writing through Latex.

(A) Modes of End-Semester Assessment (Practical) : 30 Marks

Units	Contents	L	T	P	Total Hours
I (30 Marks)	**Introduction to LaTeX:** Introduction to LaTeX and its advantages, Basic LaTeX commands, Document structure and formatting **Tables, Figures and Equations:** Creating tables using LaTeX, Inserting figures in LaTeX, Creating equations and formulas with LaTeX, Mathematical typesetting in LaTeX **Bibliography Management:** Creating bibliographies and references using LaTeX, Managing citations using BibTeX, Formatting bibliographies and references	0	0	60	60
Total		0	0	60	60

- L indicates **Lectures,** T indicates **Tutorial Classes,** P indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 20 Marks

- Two Internal Examinations (Sessional Exams) : 10 Marks (= 05 + 05)
- Seminar Presentation / Group Discussion : 05 Marks
- Home Assignment : 03 Marks
- Attendance : 02 Marks

Learning Outcomes :

After going through this course, learners will be able to

(i) Write scientific expression using Latex.

(ii) Write scientific literature

Suggested Readings:

Text Books:

(i) Kumar, S. Swapna (2019), LATEX - A Beginner Guide to Professional Documentation, Laxmi Publications Pvt. Ltd.

(ii) Lamport, Leslie (1994), "LaTeX: A Document Preparation System", 2nd Edition, Addison-Wesley.

(iii) Kopka, Helmut, Daly, Patrick W, Guide to LaTeX (Tools and Techniques for Computer Typesetting), Addison-Wesley Professional

Reference Books:

(i) Wilkins, David R. (1995), Getting Started with LATEX

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course	**:**	**Complex Analysis**
Course Code	**:**	**PMTHC201**
Category	**:**	**CORE**
Total Credits	**:**	**04 (L = 3, T = 1, P= 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: It is expected that the students will be exposed to an advanced course in Complex Analysis.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (20 Marks)	**Functions of Complex variable:** Functions of Complex variables, derivatives, differentiation formulae, analytic functions, Cauchy-Riemann equations, necessary and sufficient conditions for differentiability, Harmonic functions and harmonic conjugate, Exponential functions, logarithmic functions and trigonometric functions. **Complex line integrals:** Basic properties of Complex Integration, Cauchy's Theorem, Morera's Theorem, Cauchy Integral formula, Cauchy's inequality, Liouville's theorem and applications, Gauss Mean value theorem, Maximum modulus theorem, Minimum modulus principle and applications, Schwarz lemma.	15	5	20
II (10 Marks)	**Series of Complex variables:** Power series, Absolute convergence, Uniform convergence of power series, Weierstrass M-test, radius and domain of convergence, Taylor and Laurent's expansion theore. Zeros of analytic functions, singularities, poles, types and properties of singularities, singularities at infinity. rational and meromorphic functions, Argument theorem and principle, Rouche's theorem.	7	3	10
III (15 Marks)	**Calculus of Residues:** Residues and their calculus, Cauchy's residue theorem,	12	3	15

	evaluation of definite integrals, special lemmas and theorems used in evaluating integrals.			
IV (15 Marks)	**Conformal Mapping:** Elementary Transformation: rotation, translation, stretching, inversion, Jacobian of a transformation, conformal and isogonal transformations, bilinear transformation, cross-ratio, fixed points and normal form of bilinear transformation, inverse points and critical points. Some special bilinear transformations: real axis onto itself, half plane onto unit circular disc, circular disc onto circular disc. Transformation of harmonic functions and applications.	11	4	15
Total		45	15	60

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(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes:

After going through this course, the students will be able to

(i) Define various functions of Complex variables.
(ii) Discuss the principles involved with Complex Integration.
(iii) Obtain the conformal mappings of standard complex valued functions.

Suggested Readings:

Text Books:

(i) Brown, J. W., Churchill, R. V. (2009), Complex variables and applications, Boston: McGraw- Hill Higher Education.
(ii) Ponnusamy, S. (2002), Foundations of functional analysis, CRC Press.
(iii) Apostol, T.M. (2008), Mathematical Analysis, Narosa Publishing House.

Reference Books:

(i) Karunakaran, V. (2005), Complex analysis. Alpha Science Int'l Ltd.
(ii) Rudin, W. (2006), Real and complex analysis, Tata McGraw-Hill Education.
(iii) Hahn, L.S., Epstein, B. (1996), Classical complex analysis, Royal Society of Chemistry

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course	**:**	**Linear Algebra**
Course Code	**:**	**PMTHC202**
Category	**:**	**CORE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: To build up a foundation of Linear algebra**.**

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (15 Marks)	**Linear Maps:** Linear transformation and operators, matrix representation of linear transformations, Annihilating polynomial of a linear transformation; Elementary Canonical forms: diagonalization and triangulation of linear operators. Gerschgorin's disk theorem.	12	3	15
II (15 Marks)	**Eigenvalues and Eigenvectors:** Eigenvalues and Eigenvectors, Characteristic polynomial, minimal polynomial and Cayley-Hamilton theorem, Invarient Subspaces, Polynomials applied to operators, Upper triangular, Diagonal matrices.	12	3	15
III (10 Marks)	Primary Decomposition theorem; rational and Jordan forms.	6	4	10
IV (20 Marks)	**Inner product Space**: Inner Product, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization process, linear functional and adjoints, Self adjoint and normal operators, spectral theorem, Normal operators on Real Inner product spaces, Positive operators.	15	5	20
Total		45	15	60

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(B) Modes of In-Semester Assessment : 40 Marks

- ❖ Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- ❖ Seminar Presentation / Group Discussion : 10 Marks
- ❖ Home Assignment : 05 Marks
- ❖ Attendance : 05 Marks

Learning Outcomes: After going through this course, student will able to

(i) Give the theoretical treatment to solve system of linear equations.

(ii) Discuss basic properties of inner products spaces and operators.

Suggested Readings:

Text Books:

(i) Dummit, D.S., Foote, R. M.(2004), Abstract algebra. Hoboken: Wiley. Hoffmn, K. Kunze, R. Pearson

(ii) Saikia, P.K. (2014), Linear Algebra, Pearson Education India.

(iii) Axler. S. (1997), Linear Algebra Done Right, Springer.

Reference Books:

(i) Artin, M. (2015), Algebra, Pearson Ed. India.

(ii) Strang,G. (2005), Linear Algebra and its Applications, Cengage Learning.

(iii) Bhattacharya, P. B., Jain, S. K., Nagpaul, S. R. (1994), Basic abstract algebra. Cambridge University Press.

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course	**:**	**Numerical Analysis**
Course Code	**:**	**PMTHC203**
Category	**:**	**CORE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: To give a theoretical treatment to the numerical methods used to solve various problems of science and engineering

(A) Modes of End-Semester Assessment (written examination): 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (5 Marks)	**Floating point representation and Errors:** Review of Taylor series, floating point representation, loss of significance	4	1	5
II (15 Marks)	**Solution of system of equations:** Doolittle and C rout's Decomposition. Successive approximation by Gauss Jacobi, Gauss Seidal's Method. Picard's Method, Convergence of successive approximations.	11	4	15
III (15 Marks)	**Numerical Integration:** General Newton's quadrature formula, Weddle's rule, Newton-Cotes formula, Gaussian Quadrature.	11	4	15
IV (15 Marks)	**Solution of Ordinary Differential Equations:** Stability and Convergence of numerical methods, Runge-Kutta method of second, third and fourth order, General explicit method, Adam-Bashforth, General implicit method, Adam-Moultan, Milne-Simpson method.	11	4	15
V (10 Marks)	**Curve Fitting:** General Least Square Method, Normal equations, Fitting of a polynomial (second and third degree), Fitting of exponential curves, Chebyshev polynomials.	8	2	10
Total		45	15	60

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(B) Modes of In-Semester Assessment: 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes: After completing this course learners will be able to

(i) Use and analyze various numerical methods in solving scientific problem

(ii) Discuss various issues in a numerical technique such as convergence and stability Fit polynomial and exponential function to a given set of data

Suggested Readings:

Text Books:

(i) Kincaid, D., Cheney, W. (2002), Numerical Analysis: Mathematics of Scientific Computing. AMS.

(ii) Atkinson, K., Han, W. (2003), Elementary Numerical Analysis, John Wiley & Sons.

(iii) Madhumangal, P. (2009), Numerical Analysis for Scientist and Engineers, Narosa Pub. House.

Reference Books:

(i) Hilderbrand, F.B. (1987), Elementary Numerical Analysis, Dover publications.

(ii) Conte, S.D. (1980), Elementary Numerical Analysis: Algorithmic approach, Tata McGraw Hills

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course	**:**	**Fluid Dynamics**
Course Code	**:**	**PMTHD204**
Category	**:**	**DSE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: The objective of this course is to introduce
(i) Fundamental aspects of fluid flow behaviours.
(ii) Dynamics of viscous fluid flows and governing equations of motion.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (20 Marks)	**Kinematics of Fluids in motion & Stress and Strain Analysis:** Methods of describing fluid motion, material, local and convective derivatives, path lines, stream lines, vortex lines, strain and its types, small deformation theory, stress vector and stress tensor, various stresses, constitutive equations, Reynolds transport formula, conservation laws and mathematical forms in various fluid motions (steady and unsteady flows, compressible and incompressible fluids, rational and irrational flows etc.), Bernouli's equation.	15	5	20
II (14 Marks)	**Two and Three Dimensional Inviscid Fluid Flows**: Complex potential, Sources, sinks, doublets, images with respect to plane and circle, Milne-Thomson circle theorem, Blasius theorem, motion past a circular cylinder, axi-symmetric flows, stocks stream function, motion past a sphere. D- Alembert's paradox.	10	3	13
III (14 Marks)	**Navier-Stokes Equations:** Navier-Stokes equations, rate of change of circulation, diffusion of vorticity, vorticity equation and energy dissipation due to viscosity, exact solutions of Navier-Stokes equations: Couette flow, Poiseuille flow, Hagen-Poiesuille flow through a pipe, flow through annular region, Stokes first problem.	10	3	13

IV (12 Marks)	**Boundary Layer Theory:** Laminar boundary layer, two-dimensional boundary layer equations, Blasius equation, Boundary layer parameters, separation of boundary layer, momentum and energy equation.	10	4	14
Total		45	15	60

- L indicates **Lectures,** T indicates **Tutorial Classes,** P indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes :

After going through this course, learners will be able to

(i) Describe stress- strain relationship of Newtonian fluids.

(ii) Derive some exact solutions of Navier-Stokes equations under different geometries.

Suggested Readings:

Text Books:

(i) Chatterjee, R. (2015), Mathematical Theory of Continuum Mechanics, Narosa Publishing House.

(ii) Schlichting, H., Gersten, K. (2016), Boundary-layer theory, Springer.

(iii) Chorlton,F. (2004), Text book of fluid dynamics, CBS Publisher. Thomson,

Reference Books:

(i) Spencer, A.J.M.(2004), Continuum Mechanics, Dover Publications.

(ii) Raisinghania, M.D. (2003), Fluid Dynamics, S. Chand Publications.

(iii) Lamb, S.R. (1945), Hydrodynamics, Dover Publications.

(iv) Ramsay, A.S. (1913), Hydrodynamics (A Treatise on Hydromechanics, G. Belland Sons, ltd.

(v) Kundu, P.K., Cohen, I.M., Dowling, D.R. (2011), Fluid Mechanics, Academic Press.

(vi) Thomson, L.M.M. (2011), Theoretical Hydrodynamics. Dover Publications

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course	**:**	**Operations Research**
Course Code	**:**	**PMTHD205**
Category	**:**	**DSE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: The objective of this course is to build up a strong analytical foundation of the Operations Research methods and Theory

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (20 Marks)	**Operations Research Fundamentals:** Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions, sensitivity analysis-graphical approach.	18	6	24
II (20 Marks)	**Non-linear Programming:** Non-linear Programming: single variable optimization, sequential search techniques, Fibonacci search, convex functions, multi-variable optimizations without constraints: the method of steepest ascent, Newton-Raphson method, multi-variable optimizations with constraints: Lagrange multipliers, Newton-Raphson Method, Penalty Functions, Kuhn-Tucker condition.	14	4	18
III (20 Marks)	**Network Analysis:** Networks, Minimum-span problems, Shortest route problems, Maximal flow problems, PERT/CPM. Critical path computations for PERT, Construction of Time schedules. LPP formulations for PERT.	13	5	18
Total		45	15	60

- L indicates **Lectures,** T indicates **Tutorial Classes,** P indicates **Practical Classes**

(B) Modes of In-Semester Assessment: 40 Marks

- ❖ Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- ❖ Seminar Presentation / Group Discussion : 10 Marks
- ❖ Home Assignment : 05 Marks
- ❖ Attendance : 05 Marks

Learning Outcomes :

After going through this course, learners will be able to

(i) Model and solve non-linear programming problems.
(ii) Solve the minimum and maximum tree problems.
(iii) Apply the OR tools in real time Industry oriented problems.

Suggested Readings:

Text Books:

(i) Taha, H.A. (2007), Operations Research: An introduction, Pearson Education, 2007.
(ii) Bronson,R., Naadimuthu, G. (1997), Operations Research, Sharma, S. Chand & Sons.

Reference Books:

(i) Sharma, J.K.(2007), Operations Research Theory & Applications .Macmillan India Ltd.
(ii) Raju, N.V.S. (2002), Operations Research, HI-TECH.
(iii) Swarup, K., Gupta, P.K., Mohan, M. (2014), Operation Research. Sharma, S. Chand & Sons.

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course	**:**	**Topology**
Course Code	**:**	**PMTHD206**
Category	**:**	**DSE**
Total Credits	**:**	**04 (L = 3, T = 1, P = 0)**
Distribution of Marks	**:**	**60 (End Semester) + 40 (In-Semester)**

Course Objectives: To introduce the most general mathematical structure for discussing notions of analysis like convergence, continuity, compactness and connectedness. Notions like separation axioms, nets and filters will be introduced to emphasize that topological structures are more general than metric structures.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (15 Marks)	**Basics Topology:** Open Sets, Closed Sets, Neighbourhood, Limit Point, Interior, Closure, Basis, Sub-basis, finer and coarser topology, Subspace. Continuous Functions, Open Functions, Closed Functions, Homoemorphism, Composition of Continuous Functions, Pasting Lemma, Product Topology, Quotient Topology.	9	3	12
II (15 Marks)	**Compactness:** Compact Space, Countable Compact Spaces, Linderloff Space, Local Compactness, Idea of Comapactification, One point compactification, Stone Cech compactification	12	4	16
III (15 Marks)	**Connectedness:** Connectedness, totally disconnected, locally connected components, locally and path connectedness.	12	4	16
III (15 Marks)	**Countability, Separation Axioms, Metrisation:** The countability axioms, the separation axioms, T_0, T_1-space, Hausdroff space, Regular space, Normal spaces, Completely regular space, The Urysohn Lemma, Tietze Extension theorem, Metrisation, Urysohn's Metrization's Theorem	12	4	16
Total		45	15	60

- L indicates **Lectures,** T indicates **Tutorial Classes,** P indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 40 Marks

- ❖ Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- ❖ Seminar Presentation / Group Discussion : 10 Marks
- ❖ Home Assignment : 05 Marks
- ❖ Attendance : 05 Marks

Learning Outcomes :

After going through this course, learners will be able to

(i) Prove results of classical analysis in a more general setting

(ii) Obtain relationship of continuity with connectedness, compactness and separation axioms

Suggested Readings:

Text Books:

(i) Munkres, J. (2015), Topology, Pearson.

(ii) Joshi, K.D. (1983), Introduction to general topology, New Age International.

(iii) Simmons, G. F., Hammitt, J. K. (2017), Introduction to topology and modern analysis, New York, McGraw-Hill.

(iv) Murdeshwar, M.G. (1990), General topology, New Age.

Reference Book:

(i) Lipschutz S., Schaum's Outlines, New York, McGraw-Hill.

(ii) Kelley, J.L. (1975), General Topology, Springer.

Two Year Post Graduate Programme in MATHEMATICS

Second Semester

Title of the Course : Fundamentals of Mathematics
Course Code : PMTHG201
Category : GE
Total Credits : 04 (L = 3, T = 1, P = 0)
Distribution of Marks : 60 (End Semester) + 40 (In-Semester)

Course Objectives: To build up a strong foundation of the basic Mathematical tools.

(A) Modes of End-Semester Assessment (written examination) : 60 Marks

Units	Contents	L (Hrs)	T (Hrs)	Total Hours
I (15 Marks)	**Sets and Logic:** Statements, Statements with quantifiers, compound statements, implications; Sets, Power sets, Cartesian product, countability of sets, functions and relations, graphs of functions	10	4	14
II (15 Marks)	**Counting Principles:** Sum and Product rule of counting, permutation and combination, multinomial theorem, Pigeon hole principle, inclusion-exclusion principle, set partitions, Catalan numbers.	11	3	14
III (15Marks)	**Linear Algebra:** Systems of Linear equations, Vector space, Linear Transformations, matrix and determinants	12	4	16
IV (15 Marks)	**Finite Differences and Interpolation:** Introduction, Forward difference operators, Operators E and D, Backward differences, forward and backward interpolation formula, Lagrang's interpolation formula	12	4	16
Total		45	15	60

- L indicates **Lectures,** T indicates **Tutorial Classes,** P indicates **Practical Classes**

(B) Modes of In-Semester Assessment : 40 Marks

- Two Internal Examinations (Sessional Exams) : 20 Marks (= 10 + 10)
- Seminar Presentation / Group Discussion : 10 Marks
- Home Assignment : 05 Marks
- Attendance : 05 Marks

Learning Outcomes :

After going through this course the students will be able to

(i) Identify the Mathematical objects to describe social and physical systems.
(ii) Use the Mathematical tools to address context based problems

Suggested Readings:

Text Books:

(i) Kumar, A., Kumaresan, S., Sarma, B.K. (2018), A Foundation Course in Mathematics, Narosa.(Unit I)
(ii) Berge, C. (1971), Principles of combinatorics, New York. (Unit II)
(iii) Kumaresan, S. (2006), Linear Algebra- A Geometric Approach, Prentice Hall of India. (Unit III)
(iv) Rao, G. S. (2003), Numerical Analysis. New Age International Publishers. (Unit IV)

Reference Book:

(i) Stewart, I., Tall, D. (2015), The Foundations of Mathematics, Oxford University Press.
(ii) Shastry, S. S. (2012), Introductory Methods of Numerical Analysis, Prentice Hall India Learning Private Limited.