

**SCHEME**  
**&**  
**SYLLABUS**  
**FOR**  
**M.Sc. (Mathematics)**  
**(Regular)**  
**(Semester I-IV)**  
**w.e.f. Session: 2022– 2023**



**BADDI UNIVERSITY OF EMERGING  
SCIENCES & TECHNOLOGY**



**SEMESTER - FIRST**

**Total Credits- 20**

**Total Marks - 500**

Course Code	Course Name	L	T	P	Credits
PMA-101	Real Analysis- I	4	0	0	4
PMA-102	Complex Analysis – I	4	0	0	4
PMA-103	Ordinary Differential Equations	4	0	0	4
PMA-104	Advance Algebra – I	4	0	0	4
PMA-105	Analytical Mechanics	4	0	0	4
	Total	20	0	0	
	<b>Total Contact Hours:</b>	<b>20</b>			

**SEMESTER - SECOND**

**Total Credits – 20.5**

**Total Marks - 530**

Course Code	Course Name	L	T	P	Credits
PMA-151	Real Analysis- II	4	0	0	4
PMA-152	Complex Analysis- II	4	0	0	4
PMA-153	Operation Research – I	4	0	1	4.5
PMA-154	Advanced Algebra – II	4	0	0	4
PMA-155	Solid Mechanics	4	0	0	4
	Total	20	0	0	
	<b>Total Contact Hours:</b>	<b>20</b>			

**SEMESTER - THIRD****Total Credits – 20****Total Marks - 500**

Course Code	Course Name	L	T	P	Credits
PMA-201	Topology	4	0	0	4
PMA-202	Partial Differential Equations	4	0	0	4
PMA-203	Functional Analysis	4	0	0	4
<b>Student has to opt other two subjects out of PMA-204 to PMA-209</b>					
XXX	Option 1	4	0	0	4
XXX	Option 2	4	0	0	4
	Total	20	0	0	
	<b>Total Contact Hours:</b>	<b>20</b>			

**SEMESTER – FOURTH****Total Credits – 21****Total marks - 560**

Course Code	Course Name	L	T	P	Credits
PMA-251	Probability and Statistics	4	0	0	4
PMA-252	Operation Research – II	4	0	1	4.5
PMA-253	Numerical methods	4	0	1	4.5
<b>Student has to opt other two subjects out of PMA-254 to PMA-259</b>					
XXX	Option 1	4	0	0	4
XXX	Option 2	4	0	0	4
	Total	20	0	0	
	<b>Total Contact Hours:</b>	<b>20</b>			

## List of Optional Subjects

<b>Student has to opt other two subjects out of PMA-204 to PMA-209 for Semester Third</b>					
PMA-204 (opt. (i))	Differential Geometry & Riemann Geometry	4	0	0	4
PMA-205 (opt. (ii))	Integral Equations	4	0	0	4
PMA-206 (opt. (iii))	Fluid Mechanics	4	0	0	4
PMA-207 (opt. (iv))	Commutative Algebra	4	0	0	4
PMA-208 (opt. (v))	Number Theory	4	0	0	4
PMA-209 (opt. (vi))	Discrete Mathematics	4	0	0	4

<b>Student has to opt other two subjects out of PMA-254 to PMA-259 for Semester Fourth</b>					
PMA-254 (opt. (i))	Integral Transforms	4	0	0	4
PMA-255(opt. (ii))	Fluid Dynamics	4	0	0	4
PMA-256(opt. (iii))	Applied Algebra	4	0	0	4
PMA-257 (opt. (iv))	Algebraic Number Theory	4	0	0	4
PMA-258 (opt. (v))	Non Commutative Rings	4	0	0	4
PMA-259 (opt. (vi))	Mathematical Modeling	4	0	0	4

# ***1<sup>st</sup> Semester***

Course Code	Course Title	L	T	P	Credit
PMA-101	REAL ANALYSIS-I	4	0	0	4

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Objective:**

1. The objective of this subject is to be able to write rigorous mathematical proofs for basic theorems in multi-variable calculus involving the fundamental tools such as continuity and differentiability.

**UNIT-I (2 Questions)**

The Riemann-Stieltjes Integral Definition and existence of Riemann-Stieltjes integral, Properties of the Integral, Integration and differentiation, The Fundamental theorem of calculus, Integration of vector – valued functions, Rectifiable curves

**UNIT-II (3 Questions)**

Sequences and Series of Functions Pointwise and uniform convergence, Cauchy Criterion for uniform convergence, Weierstrass M-Test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and Riemann – Stieltjes integration, Uniform convergence and differentiation, Weierstrass approximation Theorem. Power series, Uniqueness theorem for power series, Abel's and Taylor's Theorem.

**UNIT-III (3 Questions)**

Functions of Several Variables Linear Transformations, Differentiation, Partial derivatives, Continuity of partial derivatives, The contraction Principle, The Inverse Function Theorem, The Implicit Function Theorem, Derivatives in an open subset of  $\mathbb{R}^n$ , Chain rule, Derivatives of higher orders, The Rank Theorem. Determinants, Jacobians

**Course Outcome:**

After successful completion of this course the student will be able to:

1. Learn about the basic principles of multi-variable calculus with proofs.
2. Get the bridge between freshman calculus and more advanced real analysis.
3. Categorize and clarify open and closed sets, boundary points, convergent and Cauchy sets, convergent sets, complete spaces, compactness and uniform continuity etc. in a metric space.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks) –25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- Attendance –5 Marks
- End-Term (100 Marks) – 50 marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. Walter Rudin, Principles of Mathematical Analysis (3rd Edition), McGrawHill, Kogakusha, 1976, International Student Edition, (Chapter 6: §§ 6.1 to 6.27, Chapter 7: §§ 7.1 to 7.18, 7.26 – 7.32, Chapter 8: §§ 8.1 to 8.5, Chapter 9: §§ 9.1 to 9.41).
2. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975. A.J. White, Real Analysis; an introduction. Addison-Wesley Publishing Co., Inc., 1968.
3. E. Hewitt and K. Stromberg. Real and Abstract Analysis. Bedin, Springer, 1969.
4. Malik, S. C. and Arora S., Mathematical Analysis, Wiley Eastern (1992).
5. Copson, E.T., Metric Spaces, Cambridge University Press (1988).

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-102	COMPLEX ANALYSIS-I	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. The Objective of this course is to introduce students to the algebra and geometry of complex numbers and to the calculus of functions of a complex variable.</li> <li>2. The aim is to give emphasis on gaining a geometric understanding of complex analytic functions as well as developing computational skills.</li> <li>3. To make student able to employ the powerful tools of complex analysis for solving theoretical and applied problems.</li> </ol>					
<b>Unit I (3 Questions)</b>					
<p>The algebra and the geometric representation of complex numbers, Limits and continuity, Analytic functions, Polynomials and rational functions, Exponential and the trigonometric functions, periodicity, logarithm, Arcs and closed curves, Analytic functions in region Conformal mapping and bilinear transformations, linear group, the cross ratio, symmetry, oriented circles, family of circles, Stereographic Projection - Riemann surfaces</p>					
<b>Unit- II (3 Questions)</b>					
<p>Sequences, Series, Uniform convergence, Power series and Abel's limit theorem. Line integrals, rectifiable arcs, line integral as function of arcs, Cauchy's theorem for a rectangle, Cauchy's theorem in a disk, The index of a point with respect to a closed curve, The Cauchy integral formula, Higher derivatives Weierstrass's theorem, the Taylor's and the Laurent's Theorem, maximum modulus principle, Schwarz's Lemma</p>					
<b>Unit- III(2 Questions)</b>					
<p>Chains and cycles, simple connectivity, Homology, the general form of Cauchy's theorem, Zeros and Singularities, Rouche's Theorem, Fundamental Theorem of Algebra, The residue theorem, the argument principle and evaluation of definite integrals (contour integration)</p>					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. Perform basic mathematical operations (arithmetic's, powers, roots) with complex numbers in Cartesian and polar forms;</li> <li>2. Determine continuity/differentiability/analyticity of a function and find the derivative of a function;</li> <li>3. Work with functions (polynomials, reciprocals, exponential, trigonometric, hyperbolic, etc) of single complex variable and describe mappings in the complex plane;</li> <li>4. Work with multi-valued functions (logarithmic, complex power) and determine branches of these functions;</li> <li>5. Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula;</li> <li>6. Find the Taylor series of a function and determine its circle or annulus of convergence;</li> <li>7. Compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line.</li> </ol>					

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks) –25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- Attendance –5 Marks
- End-Term (100 Marks) – 50 marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. Shanti Narayan, *Theory of Functions of a Complex Variable*, S. Chand and Co. (Seventh Edition, 1986).
2. Ahlfors, D.V., *Complex Analysis*, Third Edition (International student edition) McGraw-Hill International Book Company.
3. Conway, J.B., *Function of One Complex Variable*, Second Edition, 1978, Corr 4th Print 1986, Graduate Texts, Springer-Verlag, Indian Edition by Narosa Publishing House, New Delhi.
4. Copson, E. T., *An Introduction to the Theory of Functions of a Complex Variable*, The English Language Book Society and Oxford University Press, 1985.
5. Knopp, K., *Theory of Functions* (translated by F. Bagemite) in Two Volumes, Dover Publications, Inc. New York 1945, 1947.
6. Pati, T., *Functions of a Complex Variable*, Allahabad Pothishala, 1971.
7. S. Ponnusamy, *Foundations of Complex Analysis*, Narosa Publishing House, New Delhi.

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-103	ORDINARY DIFFERENTIAL EQUATIONS	4	0	0	4
<p><b>Prerequisites:</b> Students are required to have a reasonable mastery of multivariable calculus and differential equations.</p>					
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. The general purpose of this course is to provide an understanding of differential equations, and to give methods for solving them.</li> <li>2. To make student able to express relationship between changing quantities.</li> </ol>					
<p><b>Unit I (3 Questions)</b></p>					
<p><b>Existence and Uniqueness Theory</b> Some Concepts from Real Function Theory, The Fundamental Existence and Uniqueness Theorem, Dependence of Solutions on Initial Conditions and on the Function <math>f</math>, Existence and Uniqueness Theorems for Systems and Higher-Order equations</p> <p><b>The Theory of Linear Differential Equations</b> Introduction, Basic Theory of the Homogeneous Linear System, Further Theory of the Homogeneous Linear System, The Non-homogeneous Linear System, Basic Theory of the <math>n</math>th-Order Homogeneous Linear Differential Equation, The <math>n</math>th-Order Non-homogeneous Linear equation</p>					
<p><b>Unit II (3 Questions)</b></p>					
<p><b>Sturm-Liouville Boundary-Value Problems</b> Sturm-Liouville Problems, Orthogonality of Characteristic Functions, The Expansion of a Function in a Series of Orthonormal Functions</p> <p><b>Strumian Theory</b> The separation theorem, Sturm's fundamental theorem, Modification due to Picone, Conditions for Oscillatory or non-oscillatory solution, First and Second comparison theorems, Sturm's Oscillation theorems, Application to Sturm Liouville System</p>					
<p><b>Unit III (2 Questions)</b></p>					
<p><b>Nonlinear Differential Equations</b> Phase Plane, Paths, and Critical Points, Critical Points and paths of Linear Systems, Critical Points and Paths of Nonlinear Systems, Limit Cycles and Periodic Solutions, The Method of Kryloff and Bogoliuboff.</p>					
<p><b>Course Outcomes:</b> After successful completion of this course the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Use analytic techniques to compute solutions to various differential equations.</li> <li>2. Use analytic and qualitative techniques to understand the behaviour of solutions to various differential equations.</li> <li>3. Understand the mathematical foundations of the techniques we study and why they are valid.</li> </ol>					
<p><b>Assessment Model:</b></p> <ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks) –25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• Attendance –5 Marks</li> </ul>					

- End-Term (100 Marks) – 50 marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. L. Ross, Differential Equations, Third Edition, John Wiley & Sons, Inc., Chapter 10: §§ 10.1 to 10.4; Chapter 11: §§ 11.1 to 11.8; Chapter 12: §§ 12.1 to 12.3; Chapter 13: §§ 13.1 to 13.5).
2. E.L. Ince, Ordinary Differential Equations,, Dover Publication Inc. 1956 (Chapter X: §§ 10.1 to 10.6.1)
3. W. Boyce and R. Diprima, Elementry Differential Equations and Boundary value Problems, 3rd Ed. New York, (1977).
4. E.A. Coddington, An Introduction to Ordinary Differential Equations, 2nd Ed. Prentice Hall of India Pvt. Ltd., Delhi, (1974).

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-104	ADVANCED ALGEBRA-I	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. The purpose of this course is to understand several important concepts in abstract algebra, including group, ring, field, vector space, homomorphism, isomorphism, substructure, and quotient structure.</li> <li>2. To apply these concepts to such real world problems as describing molecular symmetry and detecting and correcting errors in coded information.</li> </ol>					
<b>Unit I (3 Questions)</b>					
Conjugacy and G-Sets, Normal Series, Solvable Groups, Nilpotent Groups, Direct Products, Finitely Generated Abelian Groups, Invariants of a Finite abelian Groups, Sylow Theorems, Groups of Orders $p^2$ , $pq$ .					
<b>Unit II (3 Questions)</b>					
Definition and Examples of Rings, Some Special Classes of Rings, Homomorphisms, Ideals and Quotient Rings, More Ideals and Quotient Rings and The Field of Quotients of an Integral Domain Euclidean Rings, a Particular Euclidean Ring, Polynomial Rings, Polynomials over the Rational Field, Polynomial Rings over Commutative Rings					
<b>Unit III (2 Questions)</b>					
Unitary Operators, Normal Operators, Forms on Inner Product Spaces, Positive Forms, More on Forms, Spectral Theory.					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. Explore groups, subgroups, including symmetric groups.</li> <li>2. To differentiate among the properties of permutation groups, cyclic groups, regular subgroups, and quotient groups.</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks) –25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• Attendance –5 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>					
<b>Preferred Reading:</b>					
<ol style="list-style-type: none"> <li>1. P.B. Bhattacharya, S.K. Jain &amp; S.R. Nagpal, Basic Abstract Algebra, 2nd Edition, Cambridge University Press (§§ 5.4-8.5).</li> <li>2. I.N. Herstein, 'Topics in Algebra', Second Edition), John Wiley &amp; Sons, New York (§§ 3.1 to 3.11).</li> <li>3. Kenneth Hoffman &amp; Ray Kunze, 'Linear Algebra', Second Edition, Prentice-Hall of India Private Limited, New Delhi (§§ 8.4, 8.5, 9.1 to 9.5).</li> </ol>					
<b>Web Resources:</b>					
Course Code	Course Title	L	T	P	Credit

<b>PMA-105</b>	<b>ANALYTICAL MECHANICS</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. The major objectives of this course are for students to learn the fundamental principles of Analytical Mechanics.</li> <li>2. To develop solid and systematic problem solving skill.</li> <li>3. To lay the foundations for further studies in physics, physical sciences, and engineering.</li> </ol>					
<b>Unit-I (3 Questions)</b>					
Generalized Coordinates, Constraints, Work and potential energy, Generalized forces, The Principle of virtual work, Introduction to Lagrange's equations, Lagrange's Equations for a particle in a plane, The Classification of Dynamical Systems, Lagrange's equations for any simple Dynamical system, Lagrange's equations for Non-holonomic systems with moving constraints, Lagrange's equations for impulsive motion					
<b>Unit-II (2 Questions)</b>					
Hamilton's Principle, Stationary Values of a function, Constrained stationary values, Stationary Value of a definite integral, The Brachistochrone problem, Hamilton's equations, Derivation of Hamilton's equations, Ignorable coordinates, The Routhian function					
<b>Unit-III (3 Questions)</b>					
The form of Hamiltonian function, Modified Hamilton's principle, Principle of least action, The Hamilton-Jacobi equation, Lagrange and Poisson Brackets Calculus of Variation –variation of a functional, Euler-Lagrange equation, Invariance of Lagrange and Poisson Brackets under canonical transformation					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. Use How to use Newton's laws of motion to solve advanced problems involving the dynamic motion of classical mechanical systems.</li> <li>2. How to use differential equations and other advanced mathematics in the solution of the problems considered in item 1.</li> <li>3. How to use conservation of energy and linear and angular momentum to solve dynamics problems.</li> <li>4. How to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Attendance –5 Marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>					
<b>Preferred Reading:</b>					
<ol style="list-style-type: none"> <li>1. Principle of Mechanics, John L. Synge and Byron A. Griffith, McGraw Hill, International Edition (§§ 10.6, 10.7, 15.1 &amp; 15.2), Third Edition.</li> </ol>					

2. Classical Dynamics, Donald. T. Green Wood, Prentice Hall of India, 1979, (§§ 4.2, 4.3, 5.2 & 6.3).
3. Classical Mechanics, K. Sankara Rao, Prentice-Hall of India, 2005 (§§ 6.7, 6.8, 7.5 & 7.6).

**Web Resources:**

# ***2<sup>nd</sup> Semester***

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>PMA-151</b>	<b>REAL ANALYSIS-II</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. To provide a solid foundation in the Lebesgue integration theory and basic techniques in analysis.
2. Students taking this course are expected to have knowledge in advanced calculus and objectives of this course are for students to learn the fundamental principles of Analytical Mechanics.

**UNIT-I (3 Questions)**

Lebesgue outer measure, elementary properties of outer measure, Measurable sets and their properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets and their measurability, characterization of measurable sets in terms of open, closed, F and G sets, existence of a non-measurable set

Lebesgue measurable functions and their properties, characteristic functions, simple functions, approximation of measurable functions by sequences of simple functions, measurable functions as nearly continuous functions, Borel measurability of a function, almost uniform convergence, Egoroff's theorem, Lusin's theorem, convergence in measure, F. Riesz theorem that every sequence which is convergent in measure has an almost everywhere convergent subsequence

**UNIT-II (3 Questions)**

**The Lebesgue Integral:** Shortcomings of Riemann integral, Lebesgue integral of a bounded function over a set of finite measure and its properties, Lebesgue integral as a generalization of the Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions, integral of a non negative function, Fatou's lemma, Monotone convergence theorem, integration of series, the general Lebesgue integral, Lebesgue convergence theorem

**UNIT-III (2 Questions)**

**Differentiation and Integration:** Differentiation of monotone functions, Vitali's covering lemma, the four Dini derivatives, Lebesgue differentiation theorem, functions of bounded variation and their representation as difference of monotone functions, Differentiation of an integral, absolutely continuous functions, convex functions, Jensen's inequality

**LP spaces:** The LP spaces, Minkowski and Holder inequalities, completeness of LP spaces, Bounded linear functionals on the LP spaces, Riesz representation theorem.

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Differentiate between Lebesgue and Riemann Integrals.
2. Understand the basic properties of  $\mathbb{R}$ , such as its complete and ordered field characterization, the Archimedean property, the  $\mathbb{Q}$  and  $\mathbb{R} \setminus \mathbb{Q}$  density, and the uncountability of each interval.
3. Realize how, from the real line to metric spaces, completeness, continuity and other notions are generalized.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks) – 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- End-Term (100 Marks) – 50 marks

- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. H.L. Royden, Real analysis (3<sup>rd</sup> Edition) Prentice Hall of India
2. G.de Barra, Measure theory and integration, Willey Eastern Ltd., 1981.
3. P.R.Halmos, Measure Theory, Van Nostrans, Princeton, 1950
4. I.P.Natanson, Theory of functions of a real variable Vol.1, Frederick Ungar Publishing Co., 1961
5. R.G.Bartle, The elements of integration, John Wiley & Sons, Inc. New York, 1966
6. K.R.Parthsarthy, Introduction to Probability and measure, Macmillan Company of India Ltd., Delhi, 1977.
7. P.K.Jain and V.P.Gupta, Lebesgue measure and integration, New age International (P) Ltd., Publishers, New Delhi, 1986., Jain P.K. and Gupta V.P., Lebesgue Measure and Integration, New Age International Ltd (2000).

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-152	COMPLEX ANALYSIS-II	4	0	0	4

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. The major objectives of this course are to make students aware about different types of functions.
2. To apply different theorem on mathematical problems.

**UNIT-I (2 Questions)**

Infinite products, Canonical products, Weierstrass factorization theorem, Factorization of sine function, Gamma function and its properties, functional equation for gamma function, Integral version of gamma function, Riemann-zeta function, Riemann's functional equation, Mittag-Leffler's theorem

**UNIT-II (3 Questions)**

Analytic continuation, uniqueness of direct analytic continuation, uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Schwarz's reflection principle, natural boundary, Monodromy theorem and its consequences, Harmonic function as a disk, Poisson's Kernel, Dirichlet problem for a unit disk

**UNIT-III (3 Questions)**

Harnack's inequality, Harnack's theorem, Dirichlet problem for a region, Green's function, Canonical product, Jensen's formula, Poisson-Jensen formula, Hadamard's three circle theorem, order of an entire function, Exponent of convergence, Borel theorem, Hadamard's factorization theorem, range of an analytic function, Bloch's theorem, Little-Picard theorem, Schottky's theorem {Montel-Carathéodory theorem, Great Picard theorem, Univalent functions, Bieberbach's conjecture (Statement only) and  $1/4$  theorem

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Understand the algebraically and geometrically symbolic form of complex numbers.
2. Describes and analyzes limits and continuity for complex vector functions.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. Ahlfors, L.V., Complex Analysis. McGraw-Hill Book Company, 1979.
2. Churchill, R.V. and Brown, J.W., Complex Variables and Applications McGraw Hill Publishing Company, 1990.
3. Conway, I.B., Functions of One complex variables Narosa Publishing, 2000.
4. Priestly, H.A., Introduction to Complex Analysis, Claredon Press, Orford, 1990.
5. Liang-shin Hann & Bernard Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
6. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.

7. Mark J., Ablewitz and A. S. Fokas, Complex Variables: Introduction & Applications, Cambridge University Press, South Asian Edition, 1998.
8. E. C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
9. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-153	OPERATION RESEARCH-I	4	0	0	4

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. To prepare students to solve daily life problems using different formulae of operation research
2. To solve transportation problems by reducing cost.

**UNIT-I (2 Questions)**

**Linear Programming:** Formulation of linear programming problem (LPP) -graphical method, Simplex method, Theory of simplex method, Revised simplex method, Big M Method, Two phase Method, Degeneracy, Unrestricted variables, unbounded solutions, Duality theory, Dual LPP, fundamental properties of Dual problems, Complementary slackness, Dual simplex algorithm, Sensitivity analysis.

**UNIT-II (3 Questions)**

**Integer programming:** Gomory's Method, Branch and Bound Method

**Transportation Problem (TP):** Mathematical formulation, Basic feasible solutions of T.Ps by North – West corner method, Least cost-Method, Vogel's approximation method. Unbalanced TP, optimality test of Basic Feasible Solution (BFS) by U-V method, Stepping Stone method, degeneracy in TP

**Assignment Problem (AP):** Mathematical formulation, assignment methods, Hungarian method, Unbalanced AP

**UNIT-III (3 Questions)**

**Goal programming Problem (GPP):** formulation of G.P., Graphical Goal attainment method, simplex method for GPP

**Game theory:** Two-person, zero-sum games, The maximin – minimax principle, pure strategies, mixed strategies, Graphical solution of  $2 \times n$  and  $m \times 2$  games, Dominance property, General solution of  $m \times n$  rectangular games, Linear programming problem of GP

**Network Techniques**

Shortest path model, Dijkstra algorithm, Floyd's algorithm, Minimal Spanning tree, Maximal flow problem

**Laboratory Work:** Laboratory experiments will be set in consonance with the topics covered in theory and solve through TORA.

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Formulate some real life concerns into the problem of linear programming.
2. To find an optimum vector for the regular linear programming problem and the corresponding dual problem, use the simplex method.
3. Determine which of the techniques are most appropriate given the nature of the system, the goals for improvement, and constraints on time and computing power.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks

- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. S. D. Sharma, Operations Research, Kedar Nath Ram Nath & Co. 14th Edition 2004 (Scope as in relevant sections of Chapters 3 to 13 and 19).
2. Kanti Swarup, P. K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons 12th Edition, 2004 (Scope as in relevant sections of Chapters 0, 02 to 08 & 10, 11 & 17).
3. R. Panneerselvam, Operations Research, Prentice Hall of India Pvt. Ltd., 2004 (Chapters 5: §§ 5.1 to 5.4).
4. G. Hadley, Linear Programming, Narosa Publishing House (2002).
5. H.A. Taha, Operations Research: An Introduction, Prentice Hall of India Pvt. Ltd., 7th Edition, 2004.
6. J.K. Sharma, Operations Research, Macmillan India Pvt. Ltd. 2003.

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-154	ADVANCED ALGEBRA-II	4	0	0	4

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. The main objective of this course is to extend the student's knowledge of both group and ring theory to intermediate or pre-doctoral levels.

**UNIT- I (3 Questions)**

**Normal Series:** Normal Series, Composition series, Jordan-Holder theorem, Solvable groups, Nilpotent groups

**Structure Theory of Groups:** Direct products, Finitely generated abelian groups, Fundamental theorem of finitely generated abelian groups, Invariants of a finite abelian group

**UNIT II (3 Questions)**

**Rings:** Rings, subrings, Ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain, Polynomial Rings and irreducible criteria Noetherian and Artinian modules and rings, Hilbert basis theorem. Wedderburn-Artin theorem, Uniform modules, primary modules, and Noether-Lasker theorem, Smith normal form over a principal ideal domain and rank, Fundamental structure theorem for finitely generated modules over a Principal ideal domain and its application to finitely generated Abelian groups

**UNIT –III (2 Questions)**

**Field theory:** Algebraic and transcendental extensions, Separable and inseparable extensions, Normal extensions, Perfect fields, Finite fields, Primitive elements, Algebraically closed fields, Automorphism of extensions, Galois extensions, Fundamental theorem of Galois Theory

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Go deeper into the abstract concepts of Groups, Rings, and Fields
2. Gain an appreciation for the power of abstract mathematics, and
3. Build upon his logic, proof writing, and presentation skills
4. Explore the properties of rings, sub-rings, ideals such as integral domain, ideal domain theory, Euclidean ring and Euclidean domain, and consider the definitions between rings of homomorphism and isomorphism.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. Singh Surjit, and Zameeruddin Q., Modern Algebra, Vikas Publication House (2006).

2. Herstein I. N., Topics in Algebra, Wiley Eastern Ltd (2005).
3. Bhattacharya P.B., Jain S.K. and Nagpaul S.R., Basic Abstract Algebra, Cambridge University Press, (1997).
4. Musli C., Introduction to Rings and Modules, Narosa Publishing House (2009).

**Web Resources:**

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
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PMA-155	SOLID MECHANICS	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. The course objective is to develop skills in approaching new structures, identifying critical knowns and unknowns.</li> <li>2. Students will learn to derive and use an impressive list of stress analysis formulas, to clearly document solution procedures and assess the reasonableness of their answers.</li> <li>3. The major objectives of this course are for students to learn the fundamental principles of Solid Mechanics.</li> </ol>					
<b>UNIT-I (2 Questions)</b>					
<p><b>Tensor Algebra:</b> Coordinate-transformation, Cartesian Tensor of Different order, Properties of tensors, Isotropic tensors of different orders and relation between them, Symmetric and skew symmetric tensors, Tensor invariants, Eigen-values and eigen-vectors of tensor</p> <p><b>Tensor Analysis:</b> Scalar, vector, tensor functions, comma notation, Gradient, divergence and curl of a vector/tensor field. (Relevant portions of Chapters 2 and 3 of book by D.S. Chandrasekharaiah and Debnath)</p>					
<b>UNIT-II (3 Questions)</b>					
<p><b>Analysis of Strain:</b> Affine transformation, Infinitesimal affine deformation, Geometrical interpretation of the components of strain, Strain quadric of Cauchy, Principal strains and invariance, General infinitesimal deformation, Saint-Venant's equations of compatibility, Finite deformations</p> <p><b>Analysis of Stress:</b> Stress tensor, Equations of equilibrium, Transformation of coordinates, Stress quadric of Cauchy, Principal stress and invariants, Maximum normal and shear stresses, (Relevant portion of Chapter I &amp; II of book by I.S. Sokolnikoff)</p>					
<b>UNIT-III (3 Questions)</b>					
<p><b>Equations of Elasticity:</b> Generalised Hooks Law, Anisotropic medium, Homogeneous isotropic media, Elasticity moduli for Isotropic media Equilibrium and dynamic equations for an isotropic elastic solid, Strain energy function and its connection with Hooke's Law, Uniqueness of solution. Beltrami-Michell compatibility equations, Saint- Venant's Principle (Relevant portion of Chapter III of book by I.S. Sokoinikoff)</p>					
<p><b>Course Outcomes:</b> After successful completion of this course the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand advanced stress/strain correlations</li> <li>2. Demonstrate advanced understanding of the finite element method</li> <li>3. Model an engineering structure without detailed instruction</li> <li>4. Validate results obtained using the finite element method</li> <li>5. Establish links between theoretical and practical applications; identify problems and formulate solution strategies</li> </ol>					

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. I.S. Sokolnikoff, *Mathematical Theory of Elasticity*, Tata McGraw Hill Publishing Company Ltd. New Delhi 1977.
2. D.S. Chandrasekharaiah and L. Debnath *Continuum Mechanics*, Academic Press 1994
3. A.E.H. Love *A Treatise on the Mathematical Theory of Elasticity* Dover Publications New York
4. Y.C. Fung *Foundations of Solid Mechanics*, Prentice Hall , New Delhi 1965
5. Shanti Naryan, *Text Book of Cartesian Tensor*, S. Chand & Co. 1950
6. S. Timoshenko and N. Goodier *Theory of Elasticity* McGraw Hill New York, 1970
7. I.H. Shames *Introduction to Solid Mechanics* Prentice Hall , New Delhi 1975

**Web Resources:**

# ***3<sup>rd</sup> Semester***

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>PMA-201</b>	<b>TOPOLOGY</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. To study the spaces of functions and the formulation of properties of transformations of functions such as the Fourier transform as transformations defining continuous, unitary etc.
2. To use the concept of subject for the study of differential and integral equation.

**UNIT-I (3 Questions)**

**Elementary Set Theory**

Partial ordered sets and lattices

**Metric Spaces**

Open sets, closed sets, convergence, completeness, Baire's category theorem, continuity

**Topological Spaces**

The definition and some examples, elementary concepts, Open bases and open subbases, weak topologies, the function algebras  $C(X, \mathbb{R})$  and  $C(X, \mathbb{C})$

**UNIT-II (3 Questions)**

**Compactness**

Compact spaces, products of spaces, Tychonoff's theorem and locally compact spaces, compactness for metric spaces, Ascoli's theorem

**Separation**

T1-spaces and Hausdorff spaces, completely regular spaces and normal spaces, Urysohn's lemma and Tietze's extension theorem, the Urysohn imbedding theorem, the Stone-Cech compactification

**UNIT-III (2 Questions)**

**Connectedness**

Connected spaces, the components of a space, totally disconnected spaces, locally connected spaces.

**Approximation**

The Weierstrass approximation theorem

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Learn to establish mapping between different spaces.
2. Understand the construction of topological spaces from metric spaces and the use of general neighborhood properties, open sets, close sets, foundations and sub-bases.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. G.F. Simmons, Introduction to Topology and Modern Analysis, International Student Edition, McGraw Hill Book Company, Inc. 1963, Chapter1: §§ 8; Chapter 2: §§ 9-15; Chapter3: §§ 16-20; Chapter 4: §§ 21-25; Chapter 5: §§ 26-30); Chapter 6: §§ 31-34 and Chapter 7: 35.

2. Munkres James R., Topology: a first course, PHI (2007).
3. Joshi K. D., Introduction to general Topology, Willey (1983).
4. Hu Sze-Tsen, Elements of General Topology, Holden-Day Inc (1965).
5. Kelley, R.L.: General Topology.

**Web Resources:**

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>PMA-202</b>	<b>PARTIAL DIFFERENTIAL EQUATIONS</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. To make students able to solve classical problems of mathematical physics with their standard methods of solution.
2. To provide the students opportunity to explore the standard methods of solution from a broader class of problems selected from astronomy, atmospheric science, biology, chemistry, physical oceanography, and physics.

**UNIT I (2 Questions)**

Partial differential equations (PDE) of first order, origin of first order partial differential equations and their classification, classification of Integrals, The Cauchy problem integral surfaces passing through given curve, Compatible system, Charpit's method, Jacobi's method, quasi linear equations, Langrage Method

**UNIT II (3 Questions)**

PDE of kth order; Definition, example and classifications transport equations Initial value problem, Non-homogeneous equation, Laplace's equation, Fundamental solutions, Mean value Formulas, Properties of Harmonic functions, Green's functions, Energy method, Heat equations – fundamental solution. Mean value formulas, Properties of solutions, Energy methods

**UNIT III (3 Questions)**

Wave equation – solution by spherical means, Non homogenous equations, Energy method, Non-Linear first order PDE complete integrals, envelopes characteristics Hamilton Jacobi equations (Calculus of variations Hamilton's ODE, Legendre Transform, Hopf-Lax formula, weak solution, Uniqueness) Servation Laws (shocks, entropy condition, Lax-Olcinik formula, weak solution uniqueness, Riemann's problem, long time behavior

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Derive the heat and wave equations with various boundary conditions;
2. Classify Partial Differential equations given in any of the standard coordinate systems;
3. Determine the existence of a solution and if an analytic solution can be obtained, select the appropriate technique for constructing the solution;
4. Utilize technology tools to find geometric, graphical and (optionally) numeric techniques for the analysis of solutions;
5. Use the method of separation of variables; Use transform methods; Construct a Green's function;

6. Understanding analogies in physics and engineering between mathematical representations of various phenomena.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. L.C. Evans: Partial differential equations, Graduate studies in Mathematics, Volume 19, AMS, 1998.
2. I. N.: Sneddon: Partial differential equations.
3. K. Sankara Rao, Introduction to Partial Differential Equations, Prentice Hall of India Private Limited, New Delhi, 1997 (Scope as in relevant sections of Chapters 1 to 4)

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-203	FUNCTIONAL ANALYSIS	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>The course objective is to develop skills of differentiating between Banach, Hilbert, and Normal Spaces.</li> </ol>					
<b>UNIT-I (3 Questions)</b>					
<b>Banach Spaces</b>					
The definition and some examples, continuous linear transformations, The Hahn-Banach Theorem, the Open Mapping Theorem, the Closed Graph Theorem, the Uniform Boundedness Theorem, the natural embedding of $N$ in $N^{**}$ , reflexivity					
<b>UNIT-II (2 Questions)</b>					
<b>Hilbert Spaces</b>					
The definition and some simple properties, orthogonal complements, orthonormal sets, the conjugate space $H^*$ , the adjoint of an operator, self-adjoint normal and unitary operators, projections					
<b>UNIT-III (3 Questions)</b>					
<b>Spectral Theory of Linear Operators in Normed Spaces</b>					
Spectral Theory in Finite Dimensional Normed Spaces, Basic Concepts, Spectral Properties of Bounded Linear Operators, Further Properties of Resolvent and Spectrum, Use of Complex Analysis in Spectral Theory, Banach Algebras, Further Properties of Banach Algebras					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>Understand the regular linear spaces, the space of Banach and the dual spaces.</li> <li>Know the spaces of the internal product, orthogonality and Hilbert spaces.</li> <li>Determine differentiate between dimensional spaces that are finite and infinite.</li> <li>In the formulation of differential and integral equations, apply linear operators.</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>End-Term (100 Marks) – 50 marks</li> <li>Attendance –5 Marks</li> <li>Total Assessment (Out of 100 Marks)</li> </ul>					
<b>Preferred Reading:</b>					
<ol style="list-style-type: none"> <li>G.F. Simmons, Introduction to Topology and Modern Analysis, International Student Edition, McGraw Hill Book Company, Inc. 1963, (Chapter 9: §§ 46-51 and Chapter10: §§ 52-59).</li> <li>E. Kreyszig, Introductory Functional Analysis with Applications, John, Wiley and Sons, Wiley Classics Library Edition Published, 1989 (Chapter 7).</li> </ol>					
<b>Web Resources:</b>					

Course Code	Course Title	L	T	P	Credit
PMA-204	<b>DIFFERENTIAL GEOMETRY &amp; RIEMANN GEOMETRY</b>	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. Differential and Riemannian Geometry provide an important tool in modern mathematics, impacting on diverse areas from the pure to the applied. The first aim of this course is to give a thorough introduction to the theory of abstract manifolds, which are the fundamental objects in Differential Geometry.</li> <li>2. The second aim is to describe the basics of Riemannian Geometry, in particular the notion of geodesics and curvature. The course objective is to develop skills in approaching new structures, identifying critical knowns and unknowns.</li> </ol>					
<b>UNIT-1 (3Questions)</b>					
<b>Theory of Space Curves :</b> Tangent, principal normal, bi-normal, curvature and torsion.					
Serret - Frenet Formulae. Contact between curves and surfaces, Locus of centre of curvature, spherical curvature, Helices, Spherical indicatrix, Involute, Evolute Bertrand curves, surfaces, envelopes, edge of regression, developable surfaces, Two Fundamental forms					
<b>UNIT-II (3 Questions)</b>					
Curves on a surface, Conjugate direction, Principle directions, Lines of Curvature, Principal Curvatures, Asymptotic Lines, Theorem of Beltrami and Enneper, Mainardi – Codazzi equations, Geodesics, Differential equation of Geodesic, torsion of Geodesic, Geodesic Curvature, Clairaut's theorem, Gauss- Bonnet theorem, Joachimsthal's theorem, Geodesic Mapping, Tissot's theorem					
<b>UNIT-III (2 Questions)</b>					
Riemannian space, Fundamental tensors, length of curve, magnitude of vector, associated covariant and contravariant vectors, inclination of two vectors, orthogonal vectors, coordinate hyper surfaces, coordinate curves, field of normal to a hyper surface, principal direction for symmetric covariant tensor of the second order, Euclidean space of n dimensions					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. analyse manifolds with constant curvature, with a focus on the sphere and hyperbolic space</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Attendance –5 Marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>					
<b>Preferred Reading:</b>					

1. A. W. Joshi: Matrices and Tensors in Physics, Wiley and sons, Australia
2. Shanti Narayan: Tensor Analysis, S. Chand
3. Mathematical Physics: B.S. Rajput, Pragati Prakashan
4. C. E. Weather Burn: Differential Geometry
5. T. J. Willmore: Introduction to Differential Geometry, dover Publications.
6. Bansi Lal, Differential Geometry, Atma Ram & son's.

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-205	INTEGRAL EQUATIONS	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. To provide students a classic approach to the study of existence and uniqueness questions.</li> <li>2. The method provides an alternative formulation which can be efficiently discredited.</li> </ol>					
<b>UNIT- I (3 Questions)</b>					
<p>Definition of integral Equations and their classifications, Eigen values and Eigen functions, Special Kinds of Kernel Convolution Integral, The inner or scalar product of two functions, Reduction to a system of algebraic equations, Fredholm's alternative, Fredholm theorem, Fredholm alternative theorem, An approximate method, Method of successive approximations, alternative scheme for Fredholm and Volterra Integral equations of the second kind, Conditions of uniform convergence and uniqueness of series solution, Some results about the resolvent Kernel. Application of iterative scheme to Volterra integral equations of the second kind (Relevant portions from the Chapters 1 to 3 of the book "Linear Integral Equations, Theory &amp; Techniques by R. P. Kanwal")</p>					
<b>UNIT –II (3 Questions)</b>					
<p>Classical Fredholm's theory, the method of solution of Fredholm equation, Fredholm's First theorem, Fredholm's second theorem's third theorem Symmetric Kernels, Introduction, Complex Hilbert space, An orthonormal system of functions, Riesz-Fisher theorem, A complete two – Dimensional orthonormal set over the rectangle, Fundamental properties of Eigen values and Eigen function for symmetric Kernels, Expansion in eigen functions and Bilinear form, Hilbert-Schmidt theorem and some immediate consequences Definite kernels and Mercer's theorem, Solution of a symmetric Integral Equation, Approximation of general kernel (Not necessarily symmetric) by a separable Kernel, The operator method in the theory of integral equations, Rayleigh-Ritz method for finding the first eigen value (Relevant portions from the Chapters 4 and 7 of the book "linear Integral Equation, Theory and Techniques by R.P Kanwal)</p>					
<b>UNIT –III (2 Questions)</b>					
<p>The Abel Integral equation, Inversion formula for singular integral equation with Kernel of the type <math>b(h(s)-h(t)), 0 &lt; t &lt; I</math>, Cauchy's principle value for integrals solution of the Cauchy-type singular integral equation, closed contour, unclosed contours and the Riemann-Hilbert problem, The Hilbert-Kernel, solution of the Hilbert-Type singular Integral equation (Relevant portions from the Chapter 8 of the book "Linear Integral Equation, Theory and Techniques by R.P. Kanwal")</p>					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					

1. Solve core problems arising in electromagnetics, acoustics, solid and fluid mechanics, molecular dynamics, quantum physics and chemistry, and astrophysics.
2. To develop and implement highly effective and robust methods for solving linear boundary value problems associated with the Laplace and Helmholtz equations, the equations of elasticity, the time-harmonic Maxwell equations, the Stokes equation, and many more.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. R.P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York.
2. S.G. Mikhlin, Linear Integral Equations(translated from Russian) Hindustan Book, Agency, 1960.
3. I.N. Sheddon, Mixed Boundary Value in potential theory, North Holland, 1966.
4. I. Stakgold, Boundary Value Problems of Mathematical Physics Vol, II Mac.Millan, 1969

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
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<b>PMA-206</b>	<b>FLUID MECHANICS</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. The course objective is to provide students with the fundamental physical and analytical principles of fluid mechanics through the understanding of the: conservation of mass, conservation of energy, and the conservation of momentum equations.</li> <li>2. The student will demonstrate the understanding of these fundamentals by solving problems dealing with: fluid properties, fluid statics, pressure on plane and curved surfaces, buoyancy and floatation, kinematics, systems, control volumes, conservation principles, ideal incompressible flow, impulse-momentum, and flow of a real fluid.</li> </ol>					
<b>UNIT-I (2 Questions)</b>					
Kinematics: Lagrangian and Eulerian methods. Acceleration and Material derivative Equation of continuity, General analysis of fluid motion, Boundary Surfaces, Stream lines, path lines and streak lines, vorticity and circulation, Vortex lines, Irrotational and rotational motions, Velocity potential					
<b>UNIT-II (3 Questions)</b>					
Equation of Motion: Lagrange's and Euler's equations of Motion, Bernoulli's theorem, Equation of motion by flux method, Kelvin's circulation theorem, vorticity equation, Energy equation for incompressible flow, Kinetic energy of irrotational flow, Kelvin's minimum energy theorem, mean potential over a spherical surface, Kinetic energy of infinite liquid, Uniqueness theorem					
<b>UNIT-III (3 Questions)</b>					
Stream function: Irrotational motion in two dimensions, Complex velocity potential, Sources, sinks, doublets and their images, Conformal mapping Milne- Thomson circle theorem, Two dimensional irrotational motion produced by motion of circular, and elliptic cylinders in an infinite mass of liquid, Kinetic energy of liquid, Theorem of Blasius, Kutta–Joukowski theorem					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. Define the following terms in relation to fluid mechanics: viscosity, density, specific gravity, and surface tension.</li> <li>2. Measure the properties listed above for any given fluid, Calculate hydrostatic pressure at any depth in a fluid or fluid combination.</li> <li>3. Apply the principles of manometer to calculate pressure.</li> <li>4. Determine the magnitude, direction and location of the resultant hydrostatic force acting on any submerged surface.</li> <li>5. Apply the principles of hydrostatics to derive an expression for buoyancy.</li> <li>6. Use the Bernoulli Equation to calculate pressure head, velocity head, or elevation head given two of the three.</li> </ol>					
<b>Assessment Model:</b>					

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. F. Chorlton, Textbook of Fluid Dynamics, C. B. S. Publishers, Delhi, 1985.
2. S. W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Ltd; New Delhi.
3. W. H. Besant and A. S. Ramsey, A Treatise on Hydromechanics, Part-II, CBS Publishers, Delhi, 1988.
4. Michael E. O. Neill and F. Chortlon, Ideal and incompressible Fluid Dynamics, John Wiley & Sons, 1986.
5. G. K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.
6. A. J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics Verlag, New York, 1993.
7. L. D. Landau and E. M. Lipschitz, Fluid Machanics Pergamon Press, London 1985.
8. R.K. Rathy. An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi. 1976.

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-207	COMMUTATIVE ALGEBRA	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					

**Course Objectives:**

1. To make students knowledgeable about commutative rings, their Sections and ideals. It is a tool in the study of two enormously important branches of mathematics: algebraic geometry and algebraic number theory.

**UNIT-I (3 Questions)**

Definition & examples of rings, sub rings, ideals & quotient rings, Ring homomorphism, Zero divisors, units & nilpotent elements, examples of units & nilpotent elements & their properties, sums and products of such elements, Prime ideals, maximal ideals, Prime radical and Jacobson radical, Operations on ideals, extension and contraction of ideals in homomorphism

**UNIT-II (2 Questions)**

Modules, sub modules, quotient modules, module homomorphism, Operations on submodules, direct sum and direct product of modules, Finitely generated modules, exact sequences, Tensor product of modules, Exactness properties of tensor products

**UNIT-III (3 Questions)**

Rings of fractions & modules of fractions, Extended & contracted ideals in rings of fractions, Primary ideals, uniqueness theorems on irredundant primary decomposition, Discrete valuation rings, Dedekind domains, fractional ideals, Graded rings & modules

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Use good knowledge of factorization theory in commutative rings.
2. Understand the basic theory of Sections and its application to different mathematical situations.
3. Gain greater understanding of abstract pure mathematics and its application to solving concrete mathematical problems.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. M. F. Atiyah & I. G. Macdonald : Introduction to Commutative Algebra, West view press, 1994 (Chapters 1, 2, 3, 4, 9)
2. Bourbaki: Commutative Algebra, Herman 1972.
3. D. G. Northcott: Ideal Theory, Cambridge University Press.
4. O. Zariski & P. Samue: Commutative Algebra (vol. I), Springer.

<b>Web Resources:</b>
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<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>PMA-208</b>	<b>NUMBER THEORY</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					

**Course Objectives:**

1. Number theory is the study of the integers which includes such things as cryptology, divisibility rules, finding massive primes. Students will learn some of the history of the theory of numbers
2. Will draw the importance and uncertainty of conjectures, learn methods of computation in number theory and investigate conjectures, follow deductive proofs of many of the theorems in the subject, and develop and write up some of their own proofs.

**UNIT – I (3 Questions)**

**Divisibility Theory in the Integers** The Division Algorithm, The Greatest Common Divisor, The Euclidean Algorithm, and The Diophantine Equation  $ax + by = c$

**Primes and their Distribution**

The Fundamental Theorem of Arithmetic The Sieve of Eratosthenes and The Goldbach Conjecture.

**The Theory of Congruence**

Basic Properties of Congruence, Special Divisibility Tests and Linear Congruence

**Fermat s Theorem**

Fermat s Factorization Method, The Little Theorem and Wilson s Theorem

**UNIT-II (2 Questions)****Number Theoretic Functions**

The Functions and The Mobius Inversion Formula, The Greatest Integer Function and an Application to the Calendar

**Euler’s Generalization of Fermat’s Theorem**

Euler’s Phi-Function, Euler’s Theorem and Some properties of the Phi-Function, An Application to Cryptography

**UNIT – III (3 Questions)****Primitive Roots and Indices**

The Order of an Integer Modulo  $n$ , Primitive Roots for Primes, Composite Numbers Having Primitive Roots and The Theory of Indices.

**The Quadratic Reciprocity Law**

Euler s Criterion, The Legendre Symbol and Its Properties, Quadratic Reciprocity and Quadratic Congruences with Composite Moduli.

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Find the greatest common divisor and least common multiple of a pair of natural numbers, and finding the linear form of the greatest common divisor.
2. Find Prime factorization;Solve linear congruences and systems of simultaneous linear congruences.
3. Apply the theorems of Fermat, Wilson, and Euler;
4. Find Primitive roots modulo primes and prime powers;
5. Determine whether a quadratic congruence has solutions, and if so, find them

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks

- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. David M. Burton, Elementary Number Theory, (Fifth Edition) International Edition, McGraw Hill, (Chapter 2nd to 9th)

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-209	DISCRETE MATHEMATICS	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					

1. One objective is to introduce you to a variety of topics in discrete mathematics and their applications to computer science.
2. The second is to develop your ability understand mathematical reasoning and to prove material on your own. The third, and a very important objective, is to develop your ability to communicate mathematics correctly and effectively.
3. We continue your education in understanding mathematical reasoning and communication through the study of relations, graphs, and Boolean algebra.

### UNIT- I (3 Questions)

#### Boolean Algebras

Logic, Propositional Equivalences, Predicates and Quantifiers, Partial Ordered Sets, Lattices and Algebraic Systems, Principle of Duality, Basic Properties of Algebraic Systems defined by Lattices, Distributive and Complemented Lattices, Boolean Lattices and Boolean Algebras, Uniqueness of Finite Boolean Algebras, Boolean Functions and Boolean Expressions, Propositional Calculus, Switching Circuits

#### The Pigeonhole Principle

Pigeonhole principle: Simple form, Pigeonhole principle: Strong form, A theorem of Ramsey

#### Permutations and Combinations

Two basic counting principles, Permutations of sets, Combinations of Sets, Permutations of multi-sets, Combinations of multi-sets

#### Generating Permutations and Combinations

Generating permutations, Inversions in permutations, Generating combinations, Partial orders and equivalence relations

### UNIT-II (3 Questions)

The Inclusion-Exclusion Principle and Applications

The inclusion-exclusion principle, Combinations with repetition, Derangements, Permutations with forbidden positions

#### Recurrence Relations and Generating Functions

Some number sequences, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Generating functions, Recurrences and generating functions, Exponential generating functions.

### UNIT-III (2 Questions)

#### Introduction to Graph Theory

Basic properties, Eulerian trails, Hamilton chains and cycles, Bipartite multi-graphs, Trees, The Shannon switching game.

#### Digraphs and Networks

Digraphs and Networks

#### More on Graph Theory

Chromatic number, Plane and planar graphs, A 5-color theorem, Independence number and clique number, Connectivity

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Develop knowledge and skills in fundamental mathematical topics that are relevant to computing.
2. Master of the concepts injective, surjective and bijective functions
3. Master of equivalence relations and equivalence classes

#### Assessment Model:

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. C.L. Liu, Elements of Discrete Mathematics , Tata McGraw-Hill, Second Edition, (§§ 12.1 to 12.8 & 12.10)
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications , Tata McGraw-Hill, Fourth Edition.
3. Richard A. Brualdi, Introductory Combinatorics, third Edition, (Chapter 2 to 7 and Chapter 11 to 13).

**Web Resources:**

# ***4<sup>th</sup> Semester***

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>PMA-251</b>	<b>PROBABILITY AND STATISTICS</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					

1. It is an introductory course on the concepts and methods of statistics, covering topics such as variability, data analysis, probability, estimation and hypothesis testing.

### UNIT-I (2 Questions)

**Introduction:** Review of axiomatic approach to probability

**Random variables:** probability distribution of a random variable, Distribution function, Discrete and continuous random variables, Functions of a random variable

**Mathematical Expectation:** moments, moment generating functions, Characteristic function

### UNIT-II (3 Questions)

**Study of special distributions:** binomial, Poisson, negative binomial, geometric distribution, exponential, normal, gamma

**Bi-variate probability distribution:** Marginal and conditional distributions, Bi-variate normal distribution

**Limit theorems:** Modes of convergence and their interrelationships; law of large numbers, central limit theorem,

**Correlation and Regression:** Regression between two variables, Karl-Pearson correlation coefficient and Rank Correlation, Multiple regressions, partial and multiple correlation (three variables case only)

### UNIT –III (3 Questions)

**Random Sampling:** Sampling distributions of chi-square, t and F distribution of mean and variation in sampling from a normal population

**Testing of Hypothesis:** Fundamental notions, Neyman-Pearson lemma (without proof), Important tests based on normal, chi-square, t and F distributions

**Interval Estimation:** Confidence interval for mean and variance

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Understand and discuss some of the issues and problems associated with collecting and interpreting data from surveys, polls, and other statistical studies.
2. Select and produce appropriate tabular and graphical formats for displaying univariate data sets and know how to summarize information about the centre and spread of a univariate data set.
3. Understand the concepts of probability, random variables and their distributions, in particular the binomial distribution and normal distributions.
4. Understand the concepts of estimation (confidence intervals) and hypothesis testing for population averages and percentages.
5. Select and produce the appropriate tabular and graphical formats for displaying bivariate data sets and carry out correlation, regression and chi-square analyses.

### Assessment Model:

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks

- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics, Forth Edition, Macmillan Publishing Co., Inc., New York, 1989, (Chapter 1 to 5).
2. Feller, W.: Introduction to Probability and its Applications, Wiley Eastern Pvt. Ltd. Vol. 1, (1972).
3. Rohatgi, V.K, Introduction to Probability Theory and Mathematical Statistics. Wiley Eastern (1985).
4. Goon, A.M., Gupta, M.K. and Dasgupta, B, An Outline of statistical theory, Vol. I The world press Pvt. Ltd (1998).
5. Meyer P. L., Introduction to Probability and Statistical Applications, Oxford and IBH (2007).

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-252	OPERATION RESEARCH-II	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					

1. To make students able to use wide range of problem-solving techniques and methods applied in the pursuit of improved decision-making and efficiency such as simulation, mathematical optimization, queuing theory and other stochastic-process models.
2. To make students able to use methods of OR range from the qualitative to the quantitative, and the study designs from the non-experimental to the true experimental.

### Unit – I (3 Questions)

**Queuing Theory** Queuing systems, Queuing problem, Transient and steady states, Probability Distributions in Queuing systems. Poisson process (pure birth process), Properties of poisson arrivals, Exponential process, Markovian property, Pure death process, Service time distribution, Erlang service time distribution, Solution of Queuing Models

**Dynamic Programming** Decision Tree and Bellman s principle of optimality, Concept of dynamic programming, minimum path problem, Mathematical formulation of Multistage Model, Backward & Forward Recursive approach, Application in linear programming

### Unit – II(2 Questions)

**Non-Linear Programming Problems (NLPP):** Formulation of a NLPP, General non-linear NLPP, Constrained optimization with equality constraint, Necessary and sufficient condition for a general NLPP (with one constraint), with  $m (< n)$  constraints, constrained optimization with inequality constraints (Kuhn Tucker conditions), Saddle point problem, saddle point and NLPP, Graphical solution of NLPP, Verification of Kuhn Tucker conditions, Kuhn Tucker conditions with Non-negative constraints

### Unit – III(3 Questions)

**Quadratic programming:** Quadratic programming; Wolfe s Modified Simplex method, Beale s Method

**Separable Programming:** Separable Programming, Piecewise linear approximation, Separable programming algorithm

**Simulation:** Definition, Types of simulation, Event type simulation, Generation of random numbers, Monte Carlo Simulation

**Laboratory Work:** Laboratory experiments will be set in consonance with the topics covered in theory and solve through MAPPLE.

**Course Outcomes:** After successful completion of this course the student will be able to:

1. Determine which of the techniques are most appropriate given the nature of the system, the goals for improvement, and constraints on time and computing power.

### Assessment Model:

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

### Preferred Reading:

1. S. D. Sharma, Operations Research, Kedar Nath Ram Nath & Co. 14<sup>th</sup> Edition 2004 (Scope as in relevant sections of Chapters 17, 23, 27 to 30 and 33).

2. Kanti Swarup, P. K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons n 12 Edition, 2004 (Scope as in relevant sections of Chapters 13,20,23,24 and 25).
3. J. K. Sharma, Operations Research, Macmillan India Pvt. Ltd. 2003.
4. M. S. Bazara, D. Sherali and C.M. Shetty, Non-Linear Programming, Theory and Algorithms, 2 Ed., John Wiley & Sons, Inc

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-253	NUMERICAL METHODS	4	0	0	4

**Prerequisites:** Mathematics should be one of the subjects at Undergraduate level.

**Course Objectives:**

1. To make students able to utilize computers to solve Engineering Problems that is not easily solved or even impossible to solve by analytical means. Usually involve large numbers of tedious Arithmetic operations.

**Unit – I (2 Questions)**

**Error Analysis:** Definition and sources of errors, Propagation of errors, Backward error analysis, Sensitivity and conditioning, Stability and accuracy, Floating-point arithmetic and rounding errors.

**Nonlinear equations:** Bisection method, Newton's method and its variants, Fixed point iterations, Convergence analysis. Newton's method for non-linear systems, Polynomial equations

**Unit- II (3 Questions)**

**Linear Systems and Eigen-Values:** Gauss-elimination method (using Pivoting strategies), triangularisation method and Jacobi's and Gauss-Seidel Iterative methods, Rayleigh's power and Jacobi's method for eigen-values and eigen-vectors

**Interpolation and Approximation:** Finite differences, Polynomial interpolation, Hermite interpolation, Spline interpolation, B-splines, Bivariate interpolation, Least square polynomial approximation, Polynomial approximation using orthogonal polynomial, Rational functions

**Unit – III (3 Questions)**

**Numerical Integration:** Trapezoidal and Simpson's rules, Newton-Cotes formula, Gaussian quadrature with error analysis.

**Numerical Solution of Differential Equations:** Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Multistep methods, Adams-Bashforth, Adams-Moulton and milne's methods Predictor-Corrector method, Convergence and stability, Solution for stiff equations, BVP: Finite difference method

**Laboratory Work:** Laboratory experiments will be set in consonance with the topics covered in theory.

**Computer programs based on following Numerical Methods:**

1. Solutions of simultaneous linear equations.
2. Solution of algebraic / transcendental equations.
3. Inversion of matrices
4. Numerical differentiation and integration

**Course Outcomes:** After successful completion of this course the student will be able to:

1. State the definition of the order of an interpolation, differentiation, or integration method. Describe the relationships between the order of a given method and error estimation. Use the knowledge of the order of given methods to estimate error by either extrapolation or the "next term" paradigm.
2. Describe what the terms convergence, stability and consistency mean in the context of numerical solution ordinary differential equations. Explain the possible instability of multistep methods.

<ol style="list-style-type: none"> <li>3. State the definition of the order of convergence of an iterative method, and describe how the order of a method relates to both the convergence and error behavior for that method. Describe the order of convergence of standard iterative methods.</li> <li>4. Describe difficulties that can arise because computers usually use finite precision, often non-decimal arithmetic.</li> </ol>
<p><b>Assessment Model:</b></p> <ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Attendance –5 Marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>
<p><b>Preferred Reading:</b></p> <ol style="list-style-type: none"> <li>1. Conte S. D. and Boor Carl de, Elementary Numerical Analysis- An Algorithmic Approach, Tata McGraw Hill (1980).</li> <li>2. Atkinson K. E., Introduction to Numerical Analysis, John Wiley (1989).</li> <li>3. Gerald C. F. and Wheatley P. O., Applied Numerical Analysis, Addison Wesley (1994).</li> <li>4. Jain M. K., Iyengar S.R.K. and Jain R. K., Numerical Methods for Scientific and Engineering Computation, New Age International Publisher (2004).</li> <li>5. Gupta R.S., Elements of Numerical Analysis, Macmillan India Ltd (2008).</li> </ol>
<p><b>Web Resources:</b></p>

Course Code	Course Title	L	T	P	Credit
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<b>PMA-254</b>	<b>INTEGRAL TRANSFORMS</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. To make students able to apply course content on widely used in various branches of engineering problems.</li> <li>2. To make students able to apply Fourier Transforms, Laplace Transforms, Hankel Transforms and Z Transforms.</li> </ol>					
<b>UNIT-I (3 Questions)</b>					
<p><b>Fourier Transforms:</b> Fourier transform, Fourier integral formula, complex Fourier transform, Fourier sine, cosine transforms, modulation theorem, convolution theorem, relation between Fourier &amp; Laplace transforms</p> <p><b>Finite Fourier Transforms:</b> Finite Fourier sine, cosine transforms, inversion formula for sine &amp; cosine transforms, multiple finite Fourier transforms, problems related to finite Fourier transforms, Applications of Fourier transforms in initial &amp; boundary value problems</p>					
<b>UNIT-II (2 Questions)</b>					
Application of Laplace and Fourier Transforms in Ordinary differential equations and Partial differential equations: Heat conduction equation, wave equation, Laplace equation & problems based on above equations					
<b>UNIT-III (3 Questions)</b>					
<p><b>Hankel Transforms:</b> Hankel transforms, inversion formula for the Hankel transform, infinite Hankel transform, Hankel transform of the derivative of a function, Parseval's theorem. The finite Hankel transforms, Applications of Hankel transform in boundary value problems, Z transforms and its applications</p>					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. Find Solution of signal problems</li> <li>2. Solve IVP and BVP</li> <li>3. Solve Heat and Wave equations</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Attendance –5 Marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>					

**Preferred Reading:**

1. Gupta, Deepak & Saroa, M.S., Engineering Mathematics Vol-III Ajay Publications.
2. Sheddon I.N. : The Uses of Integral Transforms, McGraw Hill 1972
3. Churchill, R.V. : Operational Mathematics, McGraw Hill 1971

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
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PMA-255	FLUID DYNAMICS	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. The course objective is to provide students with the fundamental physical and analytical principles of fluid mechanics through the understanding of the: conservation of mass, conservation of energy, and the conservation of momentum equations.</li> <li>2. The student will demonstrate the understanding of these fundamentals by solving problems dealing with: fluid properties, fluid statics, pressure on plane and curved surfaces, buoyancy and floatation, kinematics, systems, control volumes, conservation principles, ideal incompressible flow, impulse-momentum, and flow of a real fluid.</li> </ol>					
<p><b>Unit – I (3 Questions)</b></p> <p>Continuum hypothesis, Newton’s Law of Viscosity, Some Cartesian Tensor Notations, General Analysis of Fluid Motion, Thermal Conductivity, Generalised Heat conduction, Fundamental Equations of Motion of Viscous Fluid</p> <p>Equation of State, Equation of Continuity, Navier – Stokes (NS), Equations (equation of Motion, Equation of Energy, Streamlines &amp; Pathlines, Vorticity and Circulation (Kelvin’s Circulation Theorem)</p> <p><b>Unit – II (3 Questions)</b></p> <p>Dynamical Similarity (Reynold’s Law), Inspection Analysis- Dimensional Analysis, Buckingham – <math>\pi</math> - Theorem, and its Applications <math>\pi</math> –products and coefficients, Non-dimensional parameters and their physical importance, Exact Solutions of the N S Equations, Steady Motion between parallel plates (a) Velocity distribution, (b) Temperature Distribution, Plane Couette flow, plane Poiseuille flow, generalized plane Couette flow, Flow in a circular pipe (Hagen-Poiseuille flow (a) velocity distribution (b) Temperature distribution</p> <p><b>Unit – III (2 Questions)</b></p> <p>Flow between two concentric Rotating Cylinders (Couette flow): (a) Velocity distribution (b) Temperature distribution, Flow due to a plane wall suddenly set in motion, flow due to an oscillating plane wall, Plane Couette flow with transpiration cooling, Steady Flow past a fixed sphere: Stokes equation and Oseen’s equation of flow, Theory of Lubrication, Prandtl’s boundary layer equations, the boundary layer on a flat plate (Blassius equation), Characteristic boundary layer parameters</p>					
<p><b>Course Outcomes:</b> After successful completion of this course the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Define the following terms in relation to fluid mechanics: viscosity, density, specific gravity, and surface tension.</li> <li>2. Measure the properties listed above for any given fluid.</li> <li>3. Calculate hydrostatic pressure at any depth in a fluid or fluid combination.</li> <li>4. Apply the principles of manometry to calculate pressure.</li> </ol>					

5. Determine the magnitude, direction and location of the resultant hydrostatic force acting on any submerged surface.

**Assessment Model:**

- Average of best four out of six Quizzes (25 Marks)-25 Marks
- Average of TWO Mid-Terms (50 Marks) –20 Marks
- End-Term (100 Marks) – 50 marks
- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. J.L. Bansal, Viscous Fluid Dynamics, Oxford and IBH Publishing Co. Pvt. Ltd., (1977), (Scope as in relevant sections of Chapters 1 to 6).
2. F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors (2000) (Scope as in relevant sections of Chapters 1, 2, 3, 6 & 8).
3. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press (1970).
4. C.S. Yih, Fluid Mechanics, McGraw-Hill Book, Company.

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
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<b>PMA-256</b>	<b>APPLIED ALGEBRA</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>1. To make students aware of different types of coding techniques.</li> </ol>					
<b>UNIT-I (2 Questions)</b>					
Linear Codes Description of Linear codes by matrices, code Costel decomposition of linear, codes, Polynomial codes, error detecting and error correcting, Equivalence, Dual codes, weight distributions, and McWilliams, Hamming codes.					
<b>UNIT-II (3 Questions)</b>					
Existence and construction of finite fields, Minimal Polynomials, Cyclic codes, Factors of X-I, B.C.H. Codes, Maximum distance separable (MDS) Codes, Generator and Parity Check matrices of MDS Codes, The weight distribution of MDS Codes, Bounds of Minimum distance for linear, codes, Hadamard matrices Hadamard codes					
<b>UNIT-III (3 Questions)</b>					
Partially ordered sets, Lattices, Complete lattices, Modular lattices, Distributive lattices Scheior theorem. The chain conditions, Independence, Complemented lattices, Boolean Algebras, (Scope of the course is as given in chapter VII of the book given at Sr. No 9), Boolean Expressions, Applications Hamiltonian paths, Subgraphs and spannings					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>1. Understand the concept of coding.</li> <li>2. To apply the coding methods oon mathematical problems.</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Attendance –5 Marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>					
<b>Preferred Reading:</b>					
<ol style="list-style-type: none"> <li>1. G. Birkhoff &amp; T.C. Bartee, Modern Applied Algebra, McGraw Hill, Inc, 1970.</li> <li>2. L.L.Domhoff &amp; F.E. Hohn , Applied Modern Algebra, Macmillan Co.,Inc., 1978.</li> <li>3. R.J.McEIlce, The Theory of Information &amp; Coding, Addison ,Wesley Pb.Co., 1977.</li> <li>4. F.J. Mac Williams &amp; M.J.A. Sloane, The Theory Error-correcting Codes.</li> <li>5. N.J.A. Sloane , A short course on Error correcting codes, Springer</li> <li>6. 6. J.H. Vanlint , Coding Theory, Springer Veriag lectures, Notes in Math , No 201,1971.</li> <li>7. Raymond Hill, A First Course in Coding Theory, Clarendon Press, Oxford, 1968.</li> <li>8. I.I. Fisher, Application Oriented Algebra.</li> <li>9. N. Jacobson, Lect. In Ab. Algebra Vol.I</li> <li>10. M. Hall, Combinatorial Theory.</li> </ol>					
Allan Daur, Applied Discrete Structure for Computer Sc., Kenneth Levasur					

<b>Web Resources:</b>

Course Code	Course Title	L	T	P	Credit
PMA-257	ALGEBRAIC NUMBER THEORY	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b> <ol style="list-style-type: none"> <li>1. This course give the basic tools of number theory as applicable to the investigation of congruences, arithmetic functions, Diophantine equations and beyond.</li> <li>2. To make students familiar with the underlying themes and current state of knowledge of several branches of Number Theory and its interaction with partner disciplines.</li> <li>3. The focus of this course is on the use of algebra as a tool for obtaining information about integers and rational numbers</li> </ol>					
<b>UNIT-I (3 Questions)</b>					
Algebraic numbers, algebraic integers, Transcendental Numbers, Liouville's Theorem for real Algebraic numbers, Thue Theorem and Roth's theorem (statement only) Algebraic number field K. Theorem of Primitive elements, Liouville's Theorem for complex algebraic numbers. Minimal polynomial of an algebraic integer, Primitive m-th roots of unity. Cyclotomic Polynomials, Norm and trace of algebraic numbers and algebraic integers, Bilinear form an algebraic number field, Index of an element of K, Ring A of algebraic discriminant of an algebraic number field K. Ideals in the ring of algebraic number field K					
<b>UNIT-II (2 Questions)</b>					
Integral closed domains, Dedekind domains. Fractional ideals of K. Factorization of ideal as a product of prime ideals in the ring of algebraic integers of an algebraic numbers field K.G.C.D. and L.C.M. of ideals, A Chinese remainder theorem, Different of an algebraic number field Dedekind's theorem					
<b>UNIT-III (3 Questions)</b>					
Euclidean rings, Hurwitz Lemma and Hurwitz constant, Equivalent fractional ideals, Ideal class group, Finiteness of the ideal class group, Class number of the algebraic number field K, Diophantine equations Minkowski's bound, Quadratic reciprocity Legendre Symbol, Gauss sums, Law of quadratic reciprocity, Quadratic fields, Prime in special progression					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to: <ol style="list-style-type: none"> <li>1. Understand and apply the basic properties of modular arithmetic so as to analyse the solubility of polynomial congruences and equations.</li> <li>2. Estimate average and maximal values of basic arithmetic functions.</li> <li>3. Exhibit some familiarity with the underlying themes and current state of knowledge of several branches of Number Theory and its interaction with partner disciplines.</li> </ol>					
<b>Assessment Model:</b> <ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> <li>• Attendance –5 Marks</li> <li>• Total Assessment (Out of 100 Marks)</li> </ul>					

**Preferred Reading:**

1. Jody. Esmondde and Murty, Problems in algebraic Number theory ,
2. Paulo Ribenbiom Algebraic numbers
3. R. Narashimhan and S. Raghavan, Algebraic Number theory, Mathematics Pamphlets-4, Tata Institute of Fundamental Research (1996)

**Web Resources:**

Course Code	Course Title	L	T	P	Credit
PMA-258	NON- COMMUTATIVE RINGS	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b>					
<ol style="list-style-type: none"> <li>To make student able to use and different theorems.</li> <li>To make student able to understand the concept of rings.</li> </ol>					
<b>UNIT-I (2 Questions)</b>					
Rings with chain conditions and Hilbert basis theorem, Matrix rings and their ideals, Zorn's lemma, subdirect sum of rings and sub directly irreducible rings					
<b>UNIT-II (3 Questions)</b>					
Boolean rings, prime ideals, m-systems, semi prime ideals and prime radical, Rings of endomorphism, irreducible rings of endomorphism and primitive rings					
<b>UNIT-III (3 Questions)</b>					
Rings with descending chain conditions, Wedderburn Artin theorem, Quasi-regular elements and the Jacobson radical					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to:					
<ol style="list-style-type: none"> <li>obtain information about the structure of a ring by making use of its Sections as Section theory has various applications in no commutative ring theory.</li> <li>Find the intersection of all right/left annihilators of simple right/left Sections over a ring</li> </ol>					
<b>Assessment Model:</b>					
<ul style="list-style-type: none"> <li>Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>End-Term (100 Marks) – 50 marks</li> <li>Attendance –5 Marks</li> <li>Total Assessment (Out of 100 Marks)</li> </ul>					
<b>Preferred Reading:</b>					
<ol style="list-style-type: none"> <li>N.H.McCoy : The theory of rings, Chelsea Pub. Co. ,New York, 1973.</li> <li>J.Lambek : Lectures on rings and modules, Blaisdell Pub. Co., Massachusetters,1966.</li> </ol>					
<b>Web Resources:</b>					

Course Code	Course Title	L	T	P	Credit
PMA-259	MATHEMATICAL MODELING	4	0	0	4
<b>Prerequisites:</b> Mathematics should be one of the subjects at Undergraduate level.					
<b>Course Objectives:</b> <ol style="list-style-type: none"> <li>1. This course deals with the process of representing real world problems in mathematical terms in an attempt to find solutions to the problems.</li> <li>2. A mathematical model can be considered as a simplification or abstraction of a (complex) real world problem or situation into a mathematical form, thereby converting the real world problem into a mathematical problem.</li> </ol>					
<b>UNIT-I (3 Questions)</b>					
The process of Applied Mathematics; mathematical modeling: need, techniques, classification and illustrative; mathematical modeling through ordinary differential equation of first order; qualitative solutions through sketching, Mathematical modeling in population dynamics, epidemic spreading and compartment models, mathematical modeling through systems of ordinary differential equations; mathematical modeling in economics, medicine, arm-race, battle.					
<b>UNIT – II (3 Questions)</b>					
Mathematical modeling through ordinary differential equations of second order, Higher order (linear) models. Mathematical modeling through difference equations: Need, basic theory; mathematical modeling in probability theory, economics, finance, population dynamics and genetics.					
<b>UNIT - III (2 Questions)</b>					
Mathematical modeling through partial differential equations: simple models, mass-balance equations, variational principles, probability generating function, traffic flow problems, initial & boundary conditions.					
<b>Course Outcomes:</b> After successful completion of this course the student will be able to: <ol style="list-style-type: none"> <li>1. understand and explore the meaning of equations or functional relationships.</li> <li>2. develop a mathematical model that will allow one to estimate the quantitative behavior of the conceptual model of a physical system</li> <li>3. Compare Quantitative results from mathematical models with observational data to identify a model's strengths and weaknesses.</li> </ol>					
<b>Assessment Model:</b> <ul style="list-style-type: none"> <li>• Average of best four out of six Quizzes (25 Marks)-25 Marks</li> <li>• Average of TWO Mid-Terms (50 Marks) –20 Marks</li> <li>• End-Term (100 Marks) – 50 marks</li> </ul>					

- Attendance –5 Marks
- Total Assessment (Out of 100 Marks)

**Preferred Reading:**

1. J.N. Kapur: Mathematical Modeling, Wiley Eastern Limited, 1990 (Relevant portions, mainly from Chapters 1 to 6)

**Web :**