DAV UNIVERSITY, JALANDHAR

Course Scheme & Syllabus

For

B.Sc. (Hons.) Mathematics
(Program ID-29)

(As per Choice Based Credit System)

1st to 6th SEMESTER

Examinations 2019–2020 Session Onwards

Syllabi Applicable For Admissions in 2019

Mission of the Programme

The mission of the B.Sc. (Hons.) Mathematics Programme is to:

- Provide a broad and comprehensive knowledge of core areas of pure and applied mathematics in a supportive teaching environment.
- To stimulate an interest among students in all aspects of modern mathematics.
- To foster skills including problem solving, communication, team work and the ability to work individually on complex problems.

Programme Learning Outcomes

Upon completion of the B.Sc. (Hons.) Mathematics programme, students will be able to:

- Apply the underlying unifying structures of mathematics (i.e. sets, relations and functions, logical structure) and the relationships among them.
- Demonstrate proficiency in writing proofs.
- Communicate mathematical ideas both orally and in writing.
- Function on multidisciplinary teams by working cooperatively, creatively and responsibly as a member of a team.
- Provide a systematic understanding of the concepts and theories of mathematics and their application in the real world – to an advanced level, and enhance career prospects in a huge array of fields.
- Recognize the need to engage in lifelong learning through continuing education and research.

Scheme of B.Sc. (Hons.)

B.Sc. (Hons.) Mathematics
Semester 1

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr.
1	MTH 121A	Calculus	Core	4	0	0	4
2	MTH 122	Calculus Lab	Core	0	0	4	2
3	MTH 123A	Algebra	Core	5	1	0	6
4	ENG 151B	Basic Communication Skills	AECC	3	0	0	3
5	ENG152A	Basic Communication Skills Lab		0	0	2	1
6	CSA171	Computer Fundamentals and Programming Using C	AECC	4	0	0	4
7	CSA172	Computer Fundamentals and Programming Using C Lab	AECC	0	0	4	2
8	Generic Elective-I		GE				6
	Total						28

GE (Generic Elective-I) (Choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	PHY 153A	Optics and Lasers	4	0	0	4
	PHY 154	Optics and Lasers Lab	0	0	4	2
2	CHE153A	Organic Chemistry	4	0	0	4
	CHE154	Organic Chemistry Lab	0	0	3	2
3	MTH 140	Finite Element Methods	5	1	0	6
4	ECO 214A	Econometrics	5	1	0	6

Semester 2

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr.
1	MTH 127	Theory of Equations	Core	5	1	0	6
2	MTH 128	Differential Equations	Core	4	0	0	4
3	MTH 129	Differential Equations Lab	Core	0	0	4	2
4	EVS 100	Environmental Studies	AECC	4	0	0	4
5	ENG 352	Technical Communication	AECC	3	0	0	3
6	SGS 107	Human value and General Studies	AECC	4	0	0	4
7	Generic Elective-II		GE				6
	Total						29

GE (Generic Electives)-II) (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	PHY 155A	Modern Physics	4	0	0	4
	PHY 156	Modern Physics Lab	0	0	4	2
2	CHE155A	Spectroscopy	4	0	0	4
	CHE156	Chemistry Lab	0	0	3	2
3	MTH 141	Mathematical Finance	5	1	0	6

Semester 3

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr.
1	MTH 222	Group Theory I	Core	5	1	0	6
2	MTH 229	Real Analysis	Core	5	1	0	6
3	MTH 231	Partial Differential Equations	Core	4	0	0	4
4	MTH 232	Partial Differential Equations Lab	Core	0	0	4	2
5	Skill Enhancement Course-I		SEC	2	0	0	2
6	Generic Elective-III		GE				6
	Total						26

SEC (Skill Enhancement Course)-I (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	MTH 142	Logic and Sets	2	0	0	2
2	CSA 260	Operating systems	2	0	0	2
3	MTH 146	Vedic Mathematics	2	0	0	2

GE (Generic Electives-III) (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	PHY253A	Electricity and Magnetism and Electronics	4	0	0	4
	PHY254	EM and Electronics Lab	0	0	4	2
2	CHE253A	Inorganic Chemistry	4	0	0	4
	CHE254	Inorganic Chemistry Lab	0	0	3	2
3	MTH 143	Applications of Algebra	5	1	0	6

Semester 4

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr.
1	MTH 221	Theory of Real Functions	Core	5	1	0	6
2	MTH 225A	Numerical Methods	Core	4	0	0	4
3	MTH 226	Numerical Methods Lab	Core	0	0	4	2
4	MTH 234	Analytical Geometry	Core	5	1	0	6
5	Skill Enhancement Course-II		SEC	2	0	0	2
6	Generic Elective-IV		GE				6
	Total						26

SEC (Skill Enhancement Course)-II (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	MTH 144	Latex and HTML	0	0	4	2
2	CSA 261	Data Base Management Systems	2	0	0	2
3	Swachh Bharat Summer Internships		0	0	4	2

GE (Generic Electives)-IV (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	PHY 353A	Mechanics and Waves	4	0	0	4
	PHY 354	Mechanics and Waves Lab	0	0	4	2
2	CHE353A	Physical chemistry	4	0	0	4
	CHE354	Physical chemistry Lab	0	0	3	2
3	CSA 210	Programming in C+ +	4	0	0	4
	CSA 216	Programming in C+ + Laboratory	0	0	4	2
4	MTH 145	Combinatorial Mathematics	5	1	0	6

Semester 5

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr.
1	MTH 341	Mechanics I	Core	5	1	0	6
2	MTH 345	Riemann Integration and Series of Functions	Core	5	1	0	6
3	Discipline Specific Elective-I		DSE	5	1	0	6
4	Discipline Specific Elective-II		DSE	5	1	0	6
	Total						24

DSE (Discipline Specific Electives)-I (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	MTH 324	Number Theory	5	1	0	6
2	MTH 327	Discrete Mathematics	5	1	0	6
3	MTH 340	Project				6

DSE (Discipline Specific Electives)-II (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	MTH 326	Industrial Mathematics	5	1	0	6
2	MTH 322	Group Theory II	5	1	0	6
3	MTH 328	Probability and Statistics	5	1	0	6

Semester 6

S. No.	Course Code	Course Title	Course Type	L	T	P	Cr.
1	MTH 321	Multivariate Calculus	Core	5	1	0	6
2	MTH 344	Mechanics II	Core	5	1	0	6
3	Discipline Specific Elective-III		DSE	5	1	0	6
4	Discipline Specific Elective-IV		DSE	5	1	0	6
	Total						24

DSE (Discipline Specific Electives)-III (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	MTH 343	Metric Spaces and Complex Analysis	5	1	0	6
2	MTH 332	Bio-Mathematics	5	1	0	6
3	MTH 333	Linear Programming	5	1	0	6

DSE (Discipline Specific Electives)-IV (choose one)

S. No.	Course Code	Course Title	L	T	P	Cr.
1	MTH 334	Mathematical Modeling	5	1	0	6
2	MTH 347	Ring Theory and Linear Algebra I	5	1	0	6
3	MTH 336	Differential Geometry	5	1	0	6

Course Title: Calculus
Course Code: MTH 121A

L	T	P	Credits
4	0	0	4

Course Objective: Calculus is one of the major branches of mathematics that finds application in almost all the fields of science. This course is an introduction to calculus. Students will be introduced to the concepts of limits, derivatives, integrals and infinite series.

UNIT-A **13 HOURS**

Hyperbolic functions, higher order derivatives, L' Hospital's rule, Leibniz rule and its applications, concavity and inflection points, asymptotes.

UNIT-B **14 HOURS**

Curve tracing in Cartesian coordinates, tracing of standard curves in polar coordinates, Reduction formulae, derivations and illustrations of reduction formulae.

UNIT-C **14 HOURS**

Parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution. Techniques of sketching conics, reflection properties of conics, rotation of axes and second-degree equations, classification into conics using the discriminant, polar equations of conics.

UNIT-D **15 HOURS**

Volumes by slicing; disks and washer's methods, Volumes by cylindrical shells, Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

Books Recommended

1. Thomas, George B., and Finney Ross L. Calculus. Pearson Education, 9th Ed, 2010.
2. Strauss, M.J., and G.L. Bradley and K. J. Smith. Calculus. Delhi: Dorling Kindersley (India) P. Ltd. (Pearson Education), 3rd Ed, 2007.
3. Anton, H., and I. Bivens, and S. Davis. Calculus. Singapore: John Wiley and Sons (Asia) P. Ltd., 7th Ed. 2002.
4. Courant, R., and F. John. Introduction to Calculus and Analysis. New York: Springer-Verlag (Volumes I & II), 1989.

Course Title: Calculus Lab
Course Code: MTH122

L	T	P	Credits
0	0	4	2

Course Objective: The objective of this course is to teach Calculus as a laboratory science with the computer and software. The aim is to use this software as an essential tool in learning and using calculus.

List of Practical's (using any software)

1. Matrix operation (addition, multiplication, inverse, transpose).
2. Plotting of graphs of function $e^{ax+b}, \log(ax+b), \frac{1}{ax+b}, \sin(ax+b), \cos(ax+b), |ax+b|$ and to illustrate the effect of a and b on the graph.
3. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
4. Sketching parametric curves (e.g. Trochoid, cycloid, epicycloids, and hypocycloid).
5. Obtaining surface of revolution of curves.
6. Tracing of conics in Cartesian coordinates/ polar coordinates.
7. Sketching ellipsoid, hyperboloid of one & two sheets, elliptic cone, elliptic, parabolic, hyperbolic paraboloid using Cartesian coordinates.

Books Recommended

1. Thomas, George B., and Finney Ross L. *Calculus*. Pearson Education, 9th Ed, 2010.
2. Strauss, M.J., and G.L. Bradley and K. J. Smith. *Calculus*. Delhi: Dorling Kindersley (India) P. Ltd. (Pearson Education), 3rd Ed, 2007.
3. Anton, H., and I. Bivens, and S. Davis. *Calculus*. Singapore: John Wiley and Sons (Asia) P. Ltd., 7th Ed. 2002.
4. Courant, R., and F. John. *Introduction to Calculus and Analysis*. New York: Springer-Verlag (Volumes I & II), 1989.

L	T	P	Credits
5	1	0	6

Course Title: Algebra
Course Code: MTH 123A

Course Objective: The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

UNIT-A **15 HOURS**

Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications.

UNIT-B **15 HOURS**

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Statement of Fundamental Theorem of Arithmetic.

UNIT-C **15 HOURS**

Rank of a matrix, echelon form of a matrix, normal form of a matrix, linear dependence and independence of vectors, n-vector space, Subspaces of R^n, dimension of subspaces of R^n, introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.

UNIT-D **15 HOURS**

Systems of linear equations (homogeneous and non-homogeneous systems), solution sets of linear systems, applications of linear systems. Eigen values, Eigen Vectors and Characteristic Equation of a matrix, Cayley-Hamilton Theorem.

Books recommended

1. Andreescu, Titu and Dorin Andrica. *Complex Numbers from A to Z*, Birkhauser, 2006.
2. Lay, David C. *Linear Algebra and its Applications, 3rd Ed.* Pearson Education Asia, Indian reprint, 2007.
3. Goodaire, Edgar G. and Michael M. Parmenter. *Discrete Mathematics with Graph Theory, 3rd Ed.* Pearson Education (Singapore) P. Ltd. Indian reprint, 2005.
4. Friedberg, S.H., A.J. Insel and L.E. Spence. *Linear Algebra*. Prentice Hall, 2003.
5. Hoffman, K. and R. Kunze. *Linear Algebra, 2nd Edition*. Prentice-Hall of India, 1989.
6. Lang, S. *Linear Algebra, Undergraduate Texts in Mathematics.* Springer-Verlag, New York, 1989.
7. Lax, P. *Linear Algebra*. John Wiley & Sons, New York. Indian Ed. 1997.

Course Title: Theory of Equations
Course Code: MTH 127

L	T	P	Credits
5	1	0	6

Course Objective: The aim of this course is to study general properties of polynomials and to find the roots of different types of polynomials.

UNIT-A **15 HOURS**

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Fundamental theorem of algebra, Product form of an algebraic equation, Repeated factors, equal roots, Descarte's rule of signs positive and negative rule, Complex root, Relation between the roots and the coefficients of equations.

UNIT-B **15 HOURS**

Symmetric functions, Applications of symmetric function of the roots, Transformation of equations, Reciprocal equations, Binomial equations, Solutions of reciprocal equations, Euclidean construction of the regular polygon, Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

UNIT-C **15 HOURS**

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

UNIT-D **15 HOURS**

Separation of the roots of equations, Strums theorem, Applications of Strum's theorem, Conditions for reality of the roots of an equation and biquadratic. Solution of numerical equations. Newton's method and Horner's method for solving an equation.

Books Recommended

1. Burnside, W. S. and A. W. Panton. The Theory of Equations. Dublin & London: Dublin University Press, 1954. Print
2. MacDuffee, C. C. Theory of Equations. John Wiley & Sons Inc., 1954. Print
3. Turnbull, H.W. Theory of equations. London & New York, Interscience Publishers, Inc., 1947 Print

Course Title: Differential Equations
Course Code: MTH 128

L	T	P	Credits
4	0	0	4

Course Objective: The objective of this course is to equip the students with knowledge of some advanced concepts related to differential equations and to understand some basic approach to mathematical oriented differential equations.

UNIT-A **15 HOURS**

Basic definitions: order and degree of differential equation, formulation of differential equations. General, particular, explicit, implicit and singular solutions of a differential equation, integral curves, isoclines.

First order differential equations: Linear differential equation, variables separable and equations reducible to this form, homogeneous equations and equations reducible to homogeneous form. Exact differential equations and integration factors. Bernoulli equations and Geometrical interpretation of first order differential equation, applications.

UNIT-B **12 HOURS**

Non-linear differential equation of first order- Equations solvable for p, equations solvable for x, equations solvable for y, equations in Clairaut's form and equations reducible to Clairaut's form.

Extraneous Loci: Definition, Tac locus, the Node locus, Cusp locus.

UNIT-C **13 HOURS**

General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

UNIT-D **12 HOURS**

Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

Books Recommended

1. Ross S.L. *Differential Equations,* 3rd edition. India: John Wiley and Sons, 2004.
2. Rai B., Choudhury D. P. and Freedman H. I. *A Course in Ordinary Differential Equations.* Alpha Science International Ltd. 2012.
3. Codington E.A. *An Introduction to Ordinary Differential Equation*. New York: Dover Publications, 1989.
4. Barnes, Belinda and Glenn R. Fulford. *Mathematical Modeling with Case Studies: A Differential Equation Approach using Maple and MATLAB, 2nd Ed.* London and New York: Taylor and Francis group, 2009.

Course Title: Differential Equations Lab
Course Code: MTH 129

L	T	P	Credits
0	0	4	2

Course Objective: The objective of this course is to teach Differential as a laboratory science with the computer and software. The aim is to use this software as an essential tool in learning and using Differential.

1. Plotting of first order differential equation.
2. Plotting of second order solution family of differential equation.
3. Plotting of third order solution family of differential equation.
4. Growth model (Exponential case only).
5. Decay model (Exponential case only).
6. Lake pollution model (with constant/seasonal flow and pollution concentration).
7. Case of single cold pill and a course of cold pills.
8. Limited growth of population (with harvesting).
9. Limited growth of population (without harvesting).

Books Recommended

1. Barnes, Belinda and Glenn R. Fulford. *Mathematical Modeling with Case Studies: A Differential Equation Approach using Maple and MATLAB, 2nd Ed.* London and New York: Taylor and Francis group, 2009.
2. Edwards, C.H. and D.E. Penny. *Differential Equations and Boundary Value problems Computing and Modeling.* India: Pearson Education, 2005.
3. Abell, Martha L and James P Braselton. *Differential Equations with MATHEMATICA, 3rd Ed.* Elsevier Academic Press, 2004.

Course Title: Group Theory I
Course Code: MTH 222

L	T	P	Credits
5	1	0	6

Course Objective: Group Theory is a mathematical concept which is used as a tool in almost all branches of science. The aim of this course is to make the students learn fundamental concepts of Groups.

UNIT-A **15 HOURS**

Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups, Subgroups and examples of subgroups.

UNIT-B **15 HOURS**

Centralizer, normalizer, center of a group, product of two subgroups, properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group.

UNIT-C **15 HOURS**

Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

UNIT-D **15 HOURS**

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Books Recommended

1. Bhattacharya, P.B., S.K. Jain, and S.R. Nagpal. *Basic Abstract Algebra*. New Delhi: Foundation Books. Print.
2. Herstein, I.N. *Topics in Algebra*, Wiley Eastern Limited, India, 1975. Print.
3. Fraleigh J.B. *A First Course in Abstract Algebra*, 7th Ed. Pearson, 2002**.** Print.
4. Gallian J.A. *Contemporary Abstract Algebra*, 4th Ed. New Delhi: Narosa Publishing House, 1999. Print.
5. Rotman J.J. *An Introduction to the Theory of Groups*, 4th Ed. Springer Verlag, 1995. Print.

Course Title: Real Analysis
Course Code: MTH 229

L	T	P	Credits
5	1	0	6

Course Objective: The aim of this course is to introduce the basic properties of the field of real numbers, concepts of limit and convergence (of real sequences, series) and to indicate how these are treated rigorously, and then show how these ideas are used in the development of real analysis.

UNIT-A **16 HOURS**

Review of Algebraic and Order Properties of $\mathbb{R}$, neighborhood of a point in $\mathbb{R}$, Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$.

Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of $\mathbb{R}$, The Archimedean Property, Density of Rational (and Irrational) numbers in $\mathbb{R}$. Characterization of intervals, Cantor Nested Interval Theorem.

UNIT-B **14 HOURS**

Sets in IR (Intervals): Neighborhood of a point. Properties of Neighbourhoods. Interior point. Open set. Union and Intersection of open sets. Limit point and isolated point of a set. Definition of derived set. Illustrations of Bolzano-Weierstrass theorem for sets. Closed set. Complement of open set and closed set. Union and intersection of closed sets as a consequence. No nonempty proper subset of $\mathbb{R}$ is both open & closed. Dense set in $\mathbb{R}$ as a set having non-empty intersection with every open interval. Q and $\mathbb{R}$ - Q are dense in $\mathbb{R}$.

UNIT-C **13 HOURS**

Sequences: Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

UNIT-D **15 HOURS**

Infinite series: Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Books Recommended

1. Bartle, R.G. and D.R. Sherbert. *Introduction to Real Analysis,* 4th Ed. Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2002.
2. Rudin, W. *Principles of Mathematical Analysis*, *3rd Edition*. New Delhi: McGraw-Hill Inc., 1976.
3. Berberian, S.K. *A First Course in Real Analysis*. New York: Springer Verlag, 1994.
4. Thomson, B.S., A.M. Bruckner and J.B. Bruckner. *Elementary Real Analysis.* Prentice Hall, 2001.

Course Title: Partial Differential Equations
Course Code: MTH 231

L	T	P	Credits
4	0	0	4

Course Objective: The objective of this course is to equip the students with knowledge of some advanced concepts related to differential equations and partial differential equations.

UNIT-A **14 HOURS**

Partial Differential Equations– Basic concepts and definitions, Mathematical problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations.

UNIT-B **12 HOURS**

Nonlinear equations of first order (four standard forms). Charpit method for finding complete integral of a non-linear PDE. Homogeneous linear equations with constant coefficients. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.

UNIT-C **12 HOURS**

Derivation of Heat equation, Wave equation and Laplace equation, Classification of second order linear equations as hyperbolic, parabolic or elliptic, Reduction of second order Linear Equations to canonical forms.

UNIT-D **13 HOURS**

The Cauchy problem, the Cauchy-Kowaleewskaya theorem, Cauchy problem of an infinite string, Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions, Non-Homogeneous Wave Equation. Method of separation of variables, solving the vibrating string problem, solving the heat conduction problem.

Books Recommended

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.
2. Ross S.L., *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.
3. Abell Martha L., and James P. Braselton, *Differential Equations with Mathematica*, 3rd edition. Elsevier Academic Press, 2004.
4. Singhania R., *Ordinary and Partial Differential Equations*. New Delhi: S. Chand and Company, 2006.
5. Kreyszig, Erwin, *Advanced Engineering Mathematics*. New Delhi: John Wiley & Sons, 1999.

L	T	P	Credits
0	0	4	2

Course Title: Partial Differential Equations Lab
Course Code: MTH 232

Course Objective: The aim of this course is to write Programs in MATLAB for the problems based on the methods studied in theory paper and to run the Program on PC.

List of Practical's (using any software)

1. Solving system of ODEs.
2. Solution of Cauchy problem for first order PDE.
3. Finding and plotting the characteristics for the first order PDE.
4. Plot the integral surfaces of a given first order PDE with initial data.
5. Solution of one dimensional heat equation.
6. Solution of wave equation with associated conditions.

Books Recommended

1. Pratap, R. Getting Started with MATLAB, Oxford University Press, New Delhi, 2015.
2. Chapman, S.J., MATLAB Programming for Engineers, 4th Edition, Cengage Learning, Boston, USA. 2015.
3. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
4. Ross S.L., Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
5. Abell Martha L., and James P. Braselton, Differential Equations with Mathematica, 3 rd edition.Elsevier Academic Press, 2004.
6. Singhania R., Ordinary and Partial Differential Equations. New Delhi: S. Chand and Company, 2006.
7. Kreyszig, Erwin, Advanced Engineering Mathematics. New Delhi: John Wiley & Sons, 1999.

Course Title: Theory of Real Functions
Course Code: MTH 221

L	T	P	Credits
5	1	0	6

Course Objective: The aim of this course is to introduce the concepts of limit, continuity, uniform continuity of a real function and to explore the concept of differentiation and study its applications.

UNIT-A **16 HOURS**

Limit of a function (epsilon-delta approach), sequential criterion for limits, divergence criteria, Limit theorems, one sided limits, Infinite limits and limits at infinity, Continuous functions, sequential criterion for continuity and discontinuity, Algebra of continuous functions, Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem.

UNIT-B **15 HOURS**

Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.
Differentiation: Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions, Relative extrema, interior extremum theorem, Inverse of Strictly Monotone Functions.

UNIT-C **15 HOURS**

Rolle's Theorem, Mean value theorem, First derivative test for extrema, intermediate value property of derivatives, Darboux's theorem, Applications of mean value theorem to inequalities and approximation of polynomials, Cauchy's mean value theorem, L'Hospital's Rules.

UNIT-D **13 HOURS**

Taylor's theorem and its application to inequalities, Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema, Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1+x)$, $1/(ax+b)$ and $(1+x)^n$.

Books Recommended

1. Bartle, R.G. and D.R. Sherbert. *Introduction to Real Analysis,* 3rd Ed. Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2002.
2. Apostol, T. M. *Mathematical Analysis*, 2nd Edition, Narosa Publishing House, Reprint 2002.
3. Ross K. A., *Elementary Analysis: The Theory of Calculus*. Springer, 2004.
4. Mattuck A., *Introduction to Analysis*. Prentice Hall, 1999.
5. Ghorpade S.R. and B.V. Limaye, *A Course in Calculus and Real Analysis.* Springer, 2006.
6. Malik, S. C. and Savita Arora. *Mathematical Analysis*, 3rd Edition. New Age International Publishers, 2008.

Course Title: Numerical Methods
Course Code: MTH 225A

L	T	P	Credits
4	0	0	4

Course Objective: The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to understand the basic concepts in Numerical Analysis of differential equations.

UNIT-A **15 HOURS**

Approximate numbers, Significant figures, rounding off numbers, Inherent errors, Rounding errors, Truncation errors, Absolute, Relative and Percentage error.

Non-Linear Equations: Transcendental and Polynomial equations. Bisection method, Secant method, Regula-Falsi method, Newton's method, Order of convergence of these methods

UNIT-B **14 HOURS**

System of linear algebraic equations: Matrix inversion method, Gauss Elimination method, Gauss Jordan method and its application to find A^{-1} , Jacobi method, Gauss Seidel method.

UNIT-C **13 HOURS**

Operators: Forward, Backward and Shift (Definitions and relations among them).

Interpolation: Divided difference operators. Newton's forward and backward difference interpolation. Newton's divided difference formula, Lagrange's interpolation, Inverse Interpolation

UNIT-D **14 HOURS**

Numerical Integration: General integration formula and its particular cases for n=1, 2 and 3. (Order of Error in each case)

Numerical solutions to first order ordinary differential equations: Picard method of successive approximations, Taylor series method**,** Euler's method, Modified-Euler's method, Runge-Kutta methods.

Books Recommended

1. Shastry, S. S. *Introductory Methods of Numerical Analysis*. New Delhi: PHI Learning Private Limited, 2005.
2. Jain, M.K., Iyenger, S. R. K. and R. K. Jain. *Numerical Methods for Scientific and Engineering Computation.* Delhi: New Age International Publishers, 2012.
3. Gerald C. F., and P. O. Wheatley. *Applied Numerical Analysis.* India: Pearson Education, 2008.
4. Mathews, John H., and D. Fink Kurtis. *Numerical Methods using Matlab 4th Edition.* New Delhi: PHI Learning Private Limited, 2012.
5. Grewal B. S. *Numerical Methods in Engineering and Science.* New Delhi: Khanna Publishers, 2014

Course Title: Numerical Methods Lab
Course Code: MTH 226

L	T	P	Credits
0	0	4	2

Course Objective: The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to understand the basic concepts in Numerical Analysis of differential equations.

List of Practicals (using any programming software)

1. Introduction to MATLAB.
2. Averaging of numbers.
3. Magnitude of a vector.
4. Sum of Sine/Cosine series.
5. Sorting of numbers.
6. Bisection Method.
7. Secant Method.
8. Regula Falsi Method.
9. Gauss-Elimination
10. Newton Interpolation.
11. Lagrange interpolation.
12. Trapezoidal rule.
13. Simpson's $1/3^{rd}$ and $3/8^{th}$ rule.
14. Euler's method.

Books Recommended

1. Shastry, S.S. *Introductory Methods of Numerical Analysis*. New Delhi: PHI Learning Private Limited, 2005. Print.
2. Iyenger, S.R.K., R.K. Jain, and Mahinder Kumar. *Numerical Methods for Scientific and Engineering Computation.* Delhi: New Age International Publishers, 2012. Print.
3. Gerald C.F., and P.O. Wheatley. *Applied Numerical Analysis*. India: Pearson Education, 2008. Print.
4. Mathews, John H., and D. Fink Kurtis. *Numerical Methods using Matlab*, 4th Ed. New Delhi: PHI Learning Private Limited, 2012. Print.
5. Grewal B.S. *Numerical Methods in Engineering and Science.* New Delhi: Khanna Publishers, 2014. Print.

Course Title: Analytical Geometry
Course Code: MTH 234

L	T	P	Credits
5	1	0	6

Course Objective: The course is an introductory course on Analytical Geometry so as to provide basic understanding of the geometry of two and three dimensions.

UNIT-A **14 HOURS**

Preliminary- Cartesian co-ordinates, polar co-ordinates and their transformations, straight line in $2-D$, positive and negative side of a line, bisectors of angles; Change of Axes- Translation and rotation of axes, general transformation, invariants; Pair of Straight lines- Homogeneous equation of second degree, angle between pair of straight lines, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve; Circle: General equation of circle, tangents and normal, pair of tangents from a given point, chord of contact, pole and polar, equation of chord in terms of mid-point, angle of intersection and orthogonality of two circles, radical axis, coaxial family of circles.

UNIT-B **14 HOURS**

Conics- Standard equations of conics (parabola, ellipse, hyperbola), tangent and normal, tangents from a point, chord of contact, pole and polar, equation of chord in terms of midpoint, diameter, conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, asymptotes of a hyperbola, conjugate hyperbola, , rectangular hyperbola; Tracing of conics- The second degree equation $S = ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, reduction of the second degree equation into standard form, principal axes and eccentricity of a conic, identification of curves represented by $S = 0$ (including pair of lines); Polar equation of a conic- Polar equations of straight lines, circles and conics, polar equation of chords, tangents and normal, director circle.

UNIT-C **14 HOURS**

The plane- Equation of a plane and its different forms, system, two sides of a plane, bisector of angles between two planes, joint equation of two planes, distance of a point from a plane; The line- Equation of line in $3-D$ and its symmetrical & unsymmetrical forms, angle between line and a plane, conditions for a line to lie in a plane, co-planarity of lines, shortest distance between two lines, length of perpendicular from a point to a line; Sphere- Equation of a sphere and its properties, the tangent plane, plane of contact, the polar plane, angle of intersection of two spheres,

UNIT-D **14 HOURS**

Cone and Cylinder- Equation of a cone, enveloping cone of sphere, intersection of cone with a line, right circular cone, equation of cylinder, enveloping cylinder, right circular cylinder; Conicoids- General equation of the second degree in three variables, equations of central conicoids (the ellipsoid, hyperboloid of one and two sheets), intersection of line with a conicoid, directorsphere, normals from a given point, elliptic and hyperbolic paraboloid.

Books Recommended

1. Jain, P.K., and A. Khalil, *A textbook of Analytical Geometry*. New Age International Publishers, Edition 3rd, New Delhi, 2014.
2. Narayan, S. and P.K. Mittal, *Analytical Solid Geometry*. S. Chand & Company Pvt. Ltd., New Delhi, 2008.

Course Title: Mechanics I
Course Code: MTH 341

L	T	P	Credits
5	1	0	6

Course Objective: The objective of this paper is to make students understand the concepts and basics of Mechanics and to clarify the foundations of Statics. The students will be made familiar about the forces and their consequences when acting on bodies, the forces being so arranged that the bodies remain at rest. One Unit has also been devoted to center of gravity and friction.

UNIT-A **14 HOURS**

Preliminary concepts; Force and System of forces - parallel, coplanar, collinear, concurrent, equivalent; Composition and Resolution of forces- parallelogram law, resolved part of a force, triangle law, $\lambda - \mu$ theorem, Lami's theorem; Polygon law, resultant of number of coplanar concurrent forces and their equilibrium conditions; Parallel forces.

UNIT-B **14 HOURS**

Moments- definition, sign conventions, geometrical representation, Varignon's theorem, resultant of number of coplanar forces, generalized theorem of moments, moment about a line; Couples- definition, zero couple, moment of a couple, equilibrium of two couples, resultant of coplanar couples, resultant of a force and a couple, triangle theorem of moments, conditions for a system of coplanar forces to reduce to a single force or a single couple.

UNIT C **14 HOURS**

Equilibrium of a rigid body acted on by three coplanar forces, $m - n$ theorem; General conditions of equilibrium of a body acted upon by coplanar forces; Virtual work- Definition, principle of virtual work and related problems.

UNIT D **14 HOURS**

Centre of Gravity (C.G.)-definition and concept, C.G. of different rigid bodies via uniform rod, laminas with specific geometrical shapes, tetrahedron, cone, hemisphere etc.; Friction- definition and nature of friction, types and laws of friction, angle of friction, coefficient of friction, and equilibrium of a particle on a rough inclined plane.

Books Recommended

1. S.L. Loney, *The elements of statics and dynamics*, 5th edition, Cambridge University Press, 1947.

2. Nelson E.W., Best C.L. and Mclean W.G., *Schaum's outline of theory and problems of engineering mechanics-statics and dynamics*, 5th edition, Mc Graw Hill Book Company, New Delhi, 1997.

L	T	P	Credits
5	1	0	6

Course Title: Riemann Integration and Series of Functions
Course Code: MTH 345

Course Objective: The aim of this course is to introduce Riemann Integration, Improper Integrals, Uniform Convergence and Power Series.

UNIT-A **15 HOURS**

Riemann integration: inequalities of upper and lower sums, Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions, Riemann integrability of monotone and continuous functions, The Class of Riemann integrable functions.

UNIT-B **15 HOURS**

Properties of the Riemann integral, definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals, Fundamental theorems of Calculus.

Improper Integrals: Convergence of Beta and Gamma Functions, Properties of Beta Function. Recurrence Formula for Gamma Function, Relation between Beta and Gamma Functions, Duplication Formula.

UNIT-C **14 HOURS**

Pointwise and Uniform convergence of sequence of functions. Weierstrass M-Test, Uniform Convergence and Continuity, Uniform convergence and Integration, Uniform convergence and differentiation, A Continuous nowhere differentiable function, Weierstrass Approximation Theorem.

UNIT-D **16 HOURS**

Power series, Radius of convergence, Cauchy Hadamard Theorem, Differentiation and Integration of Power Series, Abel's Theorem, Multiplication of Two Series, Exponential, Logarithmic and Trigonometric functions, Weierstrass Approximation Theorem.

Books Recommended

1. Ross, K.A. *Elementary Analysis, The Theory of Calculus*. Undergraduate Texts in Mathematics, Indian reprint: Springer (SIE), 2004. Print.
2. Bartle, R.G., and D.R. Sherbert. *Introduction to Real Analysis.* 3rd Ed., Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2002. Singapore
3. Denlinger, Charles G. *Elements of Real Analysis*.Massachusetts: Jones & Bartlett (Student Edition), 2011. Print.
4. Malik, S. C. and Savita Arora. *Mathematical Analysis*, 3rd Edition. New Age International Publishers, 2008.

Course Title: Number Theory
Course Code: MTH 324

L	T	P	Credits
5	1	0	6

Course Objective: The objective is for the students to obtain a foundational knowledge of elements of Number Theory through step-by-step proofs of classical theorems, as well as to sharpen their skills through problem-solving. The material of the course will be such that one can be initiated to the subject gradually and thus future study will be made more natural.

UNIT-A **15 HOURS**

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.

UNIT-B **15 HOURS**

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function.

UNIT-C **15 HOURS**

Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity.

UNIT D **15 HOURS**

Quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last theorem.

Books Recommended

1. Burton, David M. *Elementary Number Theory*, 7th Ed., Delhi: Tata McGraw-Hill, 2007. Print.
2. Robinns, Neville. *Beginning Number Theory*, 2nd Ed., Delhi: Narosa Publishing House Pvt. Ltd., Delhi, 2007. Print.
3. Jones, G.A., and J.M. Jones. *Elementary Number Theory*, Springer, 1998, Print.

Course Title: Discrete Mathematics
Course Code: MTH 327

L	T	P	Credits
5	1	0	6

Course Objective: The objective of this course is to acquaint the students with the basic concepts in Discrete Mathematics and Graph Theory. It also includes the topic like Mathematical Logic, Recursive relations and Boolean algebra.

UNIT-A **15 HOURS**

Set Theory, Relations and Functions: Natural Numbers- Well Ordering Principle, Principle of Mathematical Induction, Sets, Algebra of Sets, Ordered Sets, Subsets, Relations, Equivalence Relations and Partitions, Hasse diagram, Lattices, Functions, Special functions, Composition of Functions, one-one, onto and Inverse of a function, Number of one-one functions.

UNIT-B **15 HOURS**

Basic Counting Principles and Recurrence Relations: Permutation, Combinations, Pigeonhole Principle, Inclusion-exclusion Principle, Number of onto functions, Partitions, Recurrence Relations, Characteristic Equation, Homogeneous and non-homogeneous linear recurrence relations with constant coefficients, Generating Functions for some standard sequences.

UNIT-C **15 HOURS**

Graphs and Trees: Basic Terminology, Special Graphs, Handshaking Theorem, Isomorphism of Graphs, Walks, Paths, Circuits, Eulerian and Hamiltonian Paths, Planar and Non Planar Graphs, Coloring of Graph, Directed graphs, Travelling Salesman Problem, Binary Trees, Tree Traversing: Preorder, Post-order and In-order Traversals, Minimum Spanning Trees, Shortest path problems, Prim's and Kruskal's Algorithm.

UNIT-D **15 HOURS**

Logic and Boolean algebra: Propositions, Basic logic operators, Logic equivalence involving Tautologies and Contradiction, Conditional Propositions, Quantifiers, Introduction to Boolean algebra, laws of Boolean algebra, Boolean function, Sum of product form, K-map, logic gates and circuits.

Books Recommended

1. Rosen, K. H. *Discrete Mathematics and its Applications*, 6th Edition, McGraw Hill, 2007. Print.
2. Malik, D.S., and M.K. Sen. *Discrete Mathematical Structures: Theory and Applications*, New Delhi: Thomson Cengagae Learning, 2004. Print.
3. Lipschutz, S. and M. L. Lipson. *Schaum's Outline of Discrete Mathematics*. New Delhi: Schaum's Outlines, 2007. Print.
4. Ram, B. *Discrete Mathematics*. Pearson Publications, 2011. Print.
5. Liu, C. L., *Elements of Discrete Mathematics***.** McGraw Hill, International Edition, Computer Science Series.1986. Print.
6. Trembley, J.P. and R.P. Manohar. *Discrete Mathematical Structures with Applications to Computer Science*. McGraw Hill, 1975. Print.

Course Title: Industrial Mathematics
Course Code: MTH 326

L	T	P	Credits
5	1	0	6

Course Objective: Industrial Mathematics is to enable students to acquire the fundamentals of applied mathematics in areas of classical and numerical analysis, differential equations and dynamical systems, and probability and statistics.

UNIT-A **15 HOURS**

Medical Imaging and Inverse Problems. The content X-Ray is based on Mathematics of complex numbers and matrices and CT scan based on the knowledge of equations.
Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations.

UNIT-B **15 HOURS**

Geological anomalies in Earth's interior from measurements at its surface (Inverse problems for Natural disaster) and Tomography.
X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction) Lines in the place.

UNIT-C **15 HOURS**

Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom - Mathematical phantoms).
Back Projection: Definition, properties and examples.

UNIT-D **15 HOURS**

CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.

Books Recommended

1. Feeman, Timothy G. *The Mathematics of Medical Imaging. A Beginners Guide*, Springer Under graduate Text in Mathematics and Technology, Springer, 2010. Print.
2. Groetsch, C.W. *Inverse Problems*. Activities for Undergraduates, The Mathematical Association of America, 1999. Print.
3. Kirsch, Andreas. *An Introduction to the Mathematical Theory of Inverse Problems* 2nd Ed. Springer, 2011. Print.

Course Title: Group Theory II
Course Code: MTH 346

L	T	P	Credits
5	1	0	6

Course Objective: The objective of this course is to understand the structure of finite groups and some properties of finite groups.

UNIT-A **15 HOURS**

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.

UNIT-B **15 HOURS**

Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

UNIT-C **15 HOURS**

Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.

UNIT-D **15 HOURS**

Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, *p*-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for $n \geq 5$, non-simplicity tests.

Books Recommended

1. Bhattacharya, P.B., S.K. Jain, and S.R. Nagpal. *Basic Abstract Algebra*. UK: Cambridge University Press, 2006, Print.
2. Fraleigh, John B. *A First Course in Abstract Algebra*. 7th Ed., India: Pearson, 2002**.** Print.
3. Gallian, Joseph A. *Contemporary Abstract Algebra.* 4th Ed., Delhi: Narosa Publishing House, 1999.
4. Dummit, David S., and Richard M. Foote. *Abstract Algebra*. 3rd Ed., Singapore: John Wiley and Sons (Asia) Pvt. Ltd., 2004. Print.
5. Rotman Joseph J. *An Introduction to the Theory of Groups*, 4th Ed. Springer Verlag, 1995. Print.

Course Title: Probability and Statistics
Course Code: MTH 328

L	T	P	Credits
5	1	0	6

Course Objective: The course is designed to develop greater skill and understanding of statistics and probability and to explore properties of probability distributions.

UNIT-A **14 HOURS**

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function.

UNIT-B **15 HOURS**

Joint distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, correlation coefficient, joint moment generating function (jmgf).

UNIT-C **14 HOURS**

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial. Continuous distributions: uniform, normal, exponential.

UNIT-D **16 HOURS**

Correlation: Partial correlation and multiple correlation, Scatter Diagram, Karl Pearson coefficient of correlation, Rank Correlation. Linear regression, Regression coefficients and their properties, angle between two lines of regression, Curvilinear regression.

Books Recommended

1. Gupta, S.C., and V.K. Kapoor. *Fundamentals of Mathematical Statistics*. New Delhi: S. Chand & Sons, 2002. Print.
2. Mood, A.M., F.A. Graybill, and D.C., Boes. *Introduction to the theory of Statistics*. Delhi: McGraw Hill, 1974. Print.
3. Hogg, Robert V., Joeseph McKean and Allen T Craig. *Introduction to Mathematical Statistics.* London : Pearson Education Limited, 2014. Print.
4. Baisnab, A. P., and M. Jas. *Elements of Probability and statistics*. Delhi: Tata McGraw Hill, 2004. Print.
5. Meyer, P.L., *Introductory Probability and Statistical Applications.* Delhi: Addison-Wesley Publishing Company, 1970. Print.
6. Ross, Sheldon. *Introduction to Probability Models,* 9th Ed., Academic Press, Indian Reprint, 2007. Print.

Course Title: Multivariate Calculus
Course Code: MTH 321

L	T	P	Credits
5	1	0	6

Course Objective: This course includes the study of multivariable calculus; including partial derivatives, multiple integrals, and their applications; parametric curves and surfaces in 3-space; solid analytic geometry; and the calculus of vector-valued functions, including line integrals and flux integrals.
Use of Scientific calculator is allowed.

UNIT-A **16 HOURS**

Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability, symmetry of mixed partial derivatives. Chain rule for one and two independent parameters, partial derivatives with constrained variables.

UNIT-B **14 HOURS**

Directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes and normal lines. Extreme values and saddle points: Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.
Banach Contraction principle, Inverse function theorem and implicit function theorem.

UNIT-C **15 HOURS**

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

UNIT-D **15 HOURS**

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.
Definition of vector field, divergence and curl. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Books Recommended

1. Thomas, G.B. and R.L. Finney. *Calculus*. 9th Ed., Delhi: Pearson Education, 2005. Print.
2. Strauss, M.J., G.L. Bradley, and K. J. Smith. *Calculus.* 3rd Ed., Delhi: Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2007. Print.
3. Anton, H., I. Bivens, and S. Davis. *Calculus Multivariable*. 9th Ed., Singapore: John Wiley and Sons (Asia) P. Ltd., 2009. Print.
4. Marsden, E., A.J. Tromba, and A. Weinstein. *Basic Multivariable Calculus*. Indian reprint: Springer (SIE), 2005. Print.
5. Stewart, James. *Multivariable Calculus, Concepts and Contexts*. 2nd Ed., USA: Brooks /Cole, Thomson Learning, 2001. Print.

Course Title: Mechanics II
Course Code: MTH 344

L	T	P	Credits
5	1	0	6

Course Objective: The objective of this paper is to get acquainted the students about the different mathematical concepts and laws during the motion of bodies under the action of forces.

UNIT-A **14 HOURS**

Basis definitions and preliminary concepts; Motion in a straight line with constant acceleration, velocity-time curve; Vertical motion under gravity; Newton's laws of motion, absolute and gravitational units of force, concept of weight and mass, motion on a smooth inclined plane; Relative motion.

UNIT-B **14 HOURS**

Applications of laws of motion- motion of two particles connected by a string passing over a smooth pulley considering different situations *via* two particles hanging freely, one particle being placed on a smooth table and the other hanging freely, one particle being placed on a smooth inclined plane, both particles being placed on two equally rough inclined planes placed back to back etc., weight carried by a lift; Motion under variable acceleration; Simple harmonic motion- center of attraction, mean position, extreme positions; SHM as a periodic motion, time period and frequency.

UNIT-C **14 HOURS**

Projectile motion in a vertical plane under gravity - equation of trajectory, range, time of flight, greatest height achieved and related problems; Projectile on an inclined plane; Curvilinear motion of particle-expressions of velocity and acceleration in Rectangular components, in tangential and normal components, in radial and transverse components; motion along a smooth circle as special case.

UNIT-D **14 HOURS**

Angular velocity and angular acceleration, Centripetal and centrifugal forces, Central force motion-areal velocity and angular momentum, differential equation of central orbit, law of force, Kepler's laws of planetary motion; Work, power and energy- absolute and gravitational units of work and power, kinetic and potential energy, principle of work and energy, principle of conservation of energy.

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Books Recommended

1. S.L. Loney, *The elements of statics and dynamics*, 5th edition, Cambridge University Press, 1947.
2. Nelson E.W., Best C.L. and Mclean W.G., *Schaum's outline of theory and problems of engineering mechanics-statics and dynamics*, 5th edition, Mc Graw Hill Book Company, New Delhi, 1997.
3. Synge, J. L., Griffth, B. A., *Principles of mechanics*, 2nd edition, Mc-Graw Hill Book Comapny, 1947.
4. Chorlton, F.,*Text book of Dynamics*. CBS Publishers, Reprint 2002.

L	T	P	Credits
5	1	0	6

Course Title: Metric Spaces and Complex Analysis
Course Code: MTH 343

Course Objective: The aim of this course is to introduce the theory of metric and the theory of analytic functions. The aim is to show how the theory and concepts grow naturally from problems and examples.

UNIT-A **15 HOURS**

Metric spaces: definition and examples, balls and bounded sets. Sequences in metric spaces, convergent and Cauchy sequences. Complete Metric Spaces. Open and closed sets: neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor intersection theorem. Subspaces, dense sets, separable spaces, totally bounded sets.

UNIT-B **15 HOURS**

Compact sets, Heine Borel theorem, sequential compactness, Bolzano Weierstrass property, finite intersection property, continuity and compactness, uniform continuity, Dense sets, separable sets.

UNIT-C **15 HOURS**

Axiomatic approach to complex numbers, Complex plane, Polar form of complex numbers, Stereographic projection, Simply Connected regions, Branches of multi-valued functions, Principle Logarithm, complex exponents, Trigonometric and Hyperbolic Functions.

UNIT-D **15 HOURS**

Limit, Continuity, Differentiability of a complex function, Cauchy-Riemann equations, sufficient conditions for differentiability, Differentiation of Elementary functions, Analytic functions, Harmonic functions and their Conjugates, Analyticity at Infinity.

Books Recommended

1. Jain, P. K. Jain and Khalil Ahmad. *Metric Spaces,* Alpha Science International, 2nd Revised Edition, 2004
2. Copson, E.T. *Metric Spaces,* London: Cambridge University Press, 1988. Print.
3. Copson, E.T. *Theory of the function of the complex variable*, London: Oxford Clarendon Press, 1970, Print.
4. Zill, G. Dennis., and Patrick. D. Shanahan. Complex Analysis: A first Course with Applications: Burlington: Jones & Bartlett Learning, 2015. Print.
5. Brown, J. W. and R. V. Churchill. *Complex Variables and Applications,* 8th Ed. Delhi: McGraw Hill International Edition, 2009. Print
6. Bak, Joseph and D. J. Newman. *Complex Analysis*, 2nd Ed. *Undergraduate Texts in Mathematics*. New York: Springer-Verlag New York, Inc, 1997. Print.

Course Title: Bio-Mathematics
Course Code: MTH 332

L	T	P	Credits
5	1	0	6

Course Objective: Biomathematics is contributing both in its basic research and the development of specialized computer software to support investigation and healthcare.

UNIT-A **15 HOURS**

Mathematical Biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, Bacterial growth in a Chemostat, Harvesting a single natural population, Prey predator systems and Lotka Volterra equations, Populations in competitions, Epidemic Models (SI, SIR, SIRS, SIC), Activator-Inhibitor system, Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation.

UNIT-B **15 HOURS**

Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria, Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

UNIT-C **15 HOURS**

Spatial Models: One species model with diffusion, two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, travelling wave solutions, spread of genes in a population.

UNIT-D **15 HOURS**

Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting, Host-Parasitoid systems (Nicholson-Bailey model), Numerical solution of the models and its graphical representation. Case Studies: Optimal Exploitation models, Models in Genetics, Stage Structure Models, Age Structure Models.

Books Recommended

1. Keshet, L.E. *Mathematical Models in Biology*. SIAM, 1988.Prinnt.
2. Murray, J. D. *Mathematical Biology*. Springer, 1993.Print.
3. Fung, Y.C. *Biomechanics*. Springer-Verlag, 1990.Print.
4. Brauer, F., P.V.D. Driessche, and J. Wu. *Mathematical Epidemiology*. Springer, 2008. Print.
5. Kot, M. *Elements of Mathematical Ecology*. Cambridge University Press, 2001.Print.

Course Title: Linear Programming
Course Code: MTH 333

L	T	P	Credits
5	1	0	6

Course Objective: The aim of this course is setting up optimization models from problem description and solving linear programming problems using the simplex method. The role of duality for linear programming problems is examined.

UNIT-A **16 HOURS**

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables. Two-phase method, Big-M method and their comparison.

UNIT-B **14 HOURS**

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. Theorem of Weak duality, strong duality, Basic duality theorem, Weak complementary slackness theorem, Strong complementary slackness theorem, their applications, Application of Duality to Farkas' lemma and solutions of linear inequalities.

UNIT-C **15 HOURS**

Transportation problem and its mathematical formulation, Northwest-corner method, Least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

UNIT-D **14 HOURS**

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, and linear programming solution of games.

Books Recommended

1. Bazaraa,Mokhtar S, John J. Jarvis and Hanif D. Sherali. *Linear Programming and Network Flows,* India: John Wiley and Sons, 2004. Print.
2. Hillier, F.S. and G.J. Lieberman. *Introduction to Operations Research,* Singapore: Tata McGraw Hill, 2009.Print.
3. Taha, Hamdy A. *Operations Research, An Introduction,* India: Prentice-Hall, 2006.Print.
4. Hadley,G. *Linear Programming,* New Delhi: Narosa Publishing House , 2002.Print.

Course Title: Mathematical Modeling
Course Code: MTH 334

L	T	P	Credits
5	1	0	6

Course Objective: The objective of the course is to introduce mathematical modelling, that is, the construction and analysis of mathematical models inspired by real life problems. The course will present several modelling techniques and the means to analyze the resulting systems.

UNIT-A **15 HOURS**

Power series solution of a differential equation about an ordinary point, solution about a regular singular point, Bessel's and Legendre's equations, orthogonal properties & recurrences relation, Generating Function.

UNIT-B **15 HOURS**

Laplace transform and inverse transform, application to initial value problem up to second order.

UNIT-C **15 HOURS**

Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence.

UNIT-D **15 HOURS**

Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution, algebraic solution, simplex method, sensitivity analysis

Books Recommended

1. Tyn Myint, U, and Lokenath Debnath, *Linear Partial Differential Equation for Scientists and Engineers*. Indian: Springer, 2006.

2. Giordano Frank R., Maurice D. Weir, and William P. Fox, *A First Course in Mathematical Modeling*. London and New York: Thomson Learning, 2003.

3. Kapur, J.N, *Mathematical Modelling,* New Age International (P) limited, New Delhi: 2005.

Course Title: Ring Theory and Linear Algebra I
Course Code: MTH 347

L	T	P	Credits
5	1	0	6

Course Objective: The main objective is to introduce basic notions in linear algebra and ring theory that are often used in mathematics, importantly in abstract algebra.

UNIT-A **15 HOURS**

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

UNIT-B **15 HOURS**

Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III. Field of quotients.

UNIT-C **15 HOURS**

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT-D **15 HOURS**

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphism, Isomorphism theorems, invertibility and change of coordinate matrix.

Books Recommended

1. Bhattacharya, P.B., S.K.Jain, and S.R.Nagpal. *Basic Abstract Algebra, 2nd edition.* U.K: Cambridge University Press, 2004.
2. Hoffman, Kenneth, and Ray Alden Kunze. *Linear Algebra, 2nd edition.* Prentice-Hall of India Pvt. Ltd., 1971.
3. Fraleigh, John B. *A First Course in Abstract Algebra*, 7th *edition*. Pearson, 2002.
4. Artin, M. *Abstract Algebra*, *2nd Ed.*, Pearson, 2011.
5. Gallian, Joseph A. *Contemporary Abstract Algebra*, *4th Ed.*, Narosa Publishing House, 1999.
6. Lang, S. I*ntroduction to Linear Algebra, 2nd Ed.*, Springer, 2005.
7. Strang, Gilbert. *Linear Algebra and its Applications*, Thomson, 2007.

Course Title: Differential Geometry
Course Code: MTH 336

L	T	P	Credits
5	1	0	6

Course Objective: To introduce students to Differential Geometry. Surfaces; the shape operator; principal, Gaussian and mean curvatures; minimal surfaces; geodesics.

UNIT-A **15 HOURS**

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

UNIT-B **15 HOURS**

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula, Conjugate and Asymptotic lines.

UNIT-C **15 HOURS**

Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

UNIT-D **15 HOURS**

Tensors: Summation convention and indicial notation, Coordinate transformation and Jacobian, Contra-variant and Covariant vectors, Tensors of different type, Algebra of tensors and contraction, Metric tensor and 3-index Christoffel symbols, Parallel propagation of vectors, Covariant and intrinsic derivatives, Curvature tensor and its properties, Curl, Divergence and Laplacian operators in tensor form, Physical components.

Books Recommended

1. Willmore, T.J. *An Introduction to Differential Geometry*. Dover Publications, 2012.
2. O'Neill B., *Elementary Differential Geometry*, 2nd edition. Academic Press, 2006.
3. Weatherburn C.E., *Differential Geometry of Three Dimensions*. Cambridge: Cambridge University Press, 2003.
4. Struik D.J., *Lectures on Classical Differential Geometry*. Dover Publications, 1988.
5. Lang S., *Fundamentals of Differential Geometry*. Springer, 1999.
6. Spain B., *Tensor Calculus: A Concise Course*. Dover Publications, 2003.

Course Title: Finite Element Methods
Course Code: MTH 140

L	T	P	Credits
5	1	0	6

Course Objective: The objective of this course is to learn basic principles of finite element analysis procedure.

UNIT-A **15 HOURS**

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin's method.Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.
Applications to solving simple problems of ordinary differential equations.

UNIT-B **12 HOURS**

Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.

UNIT-C **13 HOURS**

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, Discretization with curved boundaries.

UNIT-D **12 HOURS**

Interpolation functions, numerical integration, and modeling considerations**.**
Solution of two dimensional partial differential equations under different Geometric conditions.

Books Recommended

1. Reddy, J.N. *Introduction to the Finite Element Methods*. Tata McGraw-Hill, 2003.Print.
2. Bathe, K.J. *Finite Element Procedures*. Prentice-Hall, 2001**.**Print.
3. Cook, R.D., D.S. Malkus and M.E. Plesha. *Concepts and Applications of Finite Element Analysis*. John Wiley and Sons, 2002.Print.
4. Hughes, Thomas J.R. *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*. Dover Publication, 2000.Print.
5. Buchanan, George R. *Finite Element Analysis*. McGraw Hill, 1994.Print.

Course Title: Mathematical Finance
Course Code: MTH 141

L	T	P	Credits
5	1	0	6

Course Objective: The objective of this course is to demonstrate a broad, systematic and critical knowledge of the mathematical, statistical and computing methods appropriate for specifying mathematical problems in banks and other financial institutions.

UNIT-A **15 HOURS**

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson Methods), comparison of NPV and IRR. Bonds, bond prices and yields.

UNIT-B **15 HOURS**

Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

UNIT-C **15 HOURS**

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

UNIT-D **15 HOURS**

Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

Books Recommended

1. Luenberger, David G. *Investment Science.* Delhi: Oxford University Press, 1998.Print.

2. Hull, John C. *Options, Futures and Other Derivative.* India: Prentice-Hall, 2006.Print.

3. Ross, Sheldon. *An Elementary Introduction to Mathematical Finance*. USA: Cambridge University Press, 2003.Print.

L	T	P	Credits
2	0	0	2

Course Title: Logic and Sets
Course Code: MTH 142

Course Objective: The objective of this course is to acquaint the students with the basic concepts in Discrete Mathematics, which includes the topic like Mathematical Logic, Recursive Relations and Boolean algebra.

UNIT-A **8 HOURS**

Logic: Introduction, propositions, truth table, negation, conjunction and disjunction, implications, bi-conditional propositions, converse, contra positive, inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

UNIT-B **7 HOURS**

Set Theory: Natural Numbers- Well Ordering Principle, Principle of Mathematical Induction, Sets, subsets, Set operations and the laws of set theory and Venn diagrams, examples of finite and infinite sets, Finite sets and counting principle. Empty set, properties of empty set.

UNIT-C **8 HOURS**

Set Operations: Standard set operations, classes of sets, power set of a set, difference and symmetric difference of two sets, set identities, generalized union and intersections.

UNIT-D **9 HOURS**

Relations and Functions: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, Hasse diagram, Functions, Special functions, Composition of Functions, one-one, onto and Inverse of a function, Number of one-one functions.

Books Recommended

1. Grimaldi, R.P. *Discrete Mathematics and Combinatorial Mathematics*. Pearson Education, 1998.
2. Halmos, P.R. *Naive Set Theory*. Springer, 1974.
3. Kamke, E. *Theory of Sets*. Dover Publishers, 1950.
4. Rosen K.H., *Discrete Mathematics and its Applications*, 6th edition. McGraw Hill, 2007.
5. Malik D.S., and M.K. Sen. *Discrete Mathematical Structures: Theory and Applications*. New Delhi: Thomson Cengagae Learning, 2004.
6. Ram, B. *Discrete Mathematics*. Pearson Publications, 2011.

Course Title: Applications of Algebra
Course Code: MTH 143

L	T	P	Credits
5	1	0	6

Course Objective: The aim of this course is to make the students learn about the applications of algebra such as Coding theory, Fibonacci numbers.

UNIT-A **15 HOURS**

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields, Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

UNIT-B **15 HOURS**

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs, Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem.

UNIT-C **15 HOURS**

Positive Semi-definite matrices: positive semi-definite matrices, square root of apositive semi- definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

UNIT-D **15 HOURS**

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations, Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an m×n matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Books Recommended

1. Herstein, I. N., and D. J. Winter. *Primer on Linear Algebra*. New York: Macmillan Publishing Company, 1990.Print.
2. Nagpaul, S. R, and S. K. Jain. *Topics in Applied Abstract Algebra*. Belmont: Thomson Brooks and Cole, 2005.Print.
3. Klima, Richard E, Neil Sigmon, and Ernest Stitzinger. *Applications of Abstract Algebra with Maple*. CRC Press LLC: Boca Raton, 2000.Print.
4. C Lay, David. *Linear Algebra and its Applications* 3rd Ed. Pearson Education Asia Indian Reprint, 2007.print.
5. Zhang, Fuzhen. *Matrix theory*. Springer-Verlag New York Inc: 1999.Print.

Course Title: Latex and HTML
Course Code: MTH 144

L	T	P	Credits
0	0	4	2

List of Practicals:

1. Elements of LaTeX
2. Hands-on-training of LaTex
3. Graphics in LaTeX
4. PSTricks
5. Beamer presentation
6. HTML
7. Creating simple web pages, images and links, design of web pages.

Books Recommended

1. J. Erickson, Martin, and Donald Bindner. *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press: Boca Raton FL, 2011.Print.
2. Lamport, L. *A Document Preparation System User's Guide and Reference Manual.* New York: Addison-Wesley, 1994.Print.

L	T	P	Credits
5	1	0	6

Course Title: Combinatorial Mathematics
Course Code: MTH 145

Course Objective: An introduction to fundamental combinatorial objects, their uses in other fields of mathematics and its applications, and their analysis.

UNIT-A **15 HOURS**

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers

UNIT-B **15 HOURS**

Principle of Inclusion and Exclusion, Derangements, Inversion formulae
Generating functions: Algebra of formal power series, Generating function models, calculating generating functions, Exponential generating functions.

UNIT -C **15 HOURS**

Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.
Integer partitions, Systems of distinct representatives.

UNIT-D **15 HOURS**

Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

Latin squares, Hadamard matrices, Combinatorial designs: *t* designs, BIBDs, Symmetric designs.

Books Recommended

1. Van Lint, J.H, and R.M. Wilson. *A Course in Combinatorics* 2nd Ed. Cambridge University Press, 2001.Print.
2. Krishnamurthy, V. *Combinatorics Theory and Application*. Affiliated East-West Press, 1985.Print.
3. Cameron, P.J. *Combinatorics Topics, Techniques, Algorithms*. Cambridge University Press, 1995. Print.
4. Hall, M. Jr. *Combinatorial Theory* 2nd Ed. John Wiley & Sons, 1986. Print.
5. Sane, S.S. *Combinatorial Techniques*. Hindustan Book Agency, 2013. Print.
6. Brualdi, R.A. *Introductory Combinatorics* 5th Ed. Pearson Education Inc, 2009.Print.

Course Title: Vedic Mathematics
Course Code: MTH 146

L	T	P	Credits
2	0	0	2

Course Objective: The objective of this course is to teach students the shortcut techniques which carries out numerical calculations in faster way. This will help students to develop their mental abilities.

UNIT-A **8 HOURS**

Addition, Subtraction, Multiplication, Division, Divisibility.

UNIT-B **8 HOURS**

Square and Square root, Cube and Cube root, Decimal, Factorization, Highest Common Factor (HCF)

UNIT-C **8 HOURS**

Simple Equations, Quadratic Equations, Cubic Equations, Biquadratic Equations, Simultaneous Equations

UNIT-D **8 HOURS**

Factorizations and Differential Calculus, Partial Fractions, Integration by Partial Fractions, Pythagoras Theorem, Appolonius Theorem, Analytical Geometry

Books Recommended

1. Shashtri, P.R. *Vedic Mathematics*. Meerut: Arihant Publications, 7th Ed. 2011.
2. Maharaja, B.K.T. *Vedic Mathematics.* Delhi:Motilal Banarasidass Publishers Pvt. Lt. 1998.