UNDER GRADUATE
SYLLABUS (NEP 2020)

BACHELOR OF SCIENCE
MATHEMATICS
(FOUR YEARS)

MIZORAM UNIVERSITY
AIZAWL-796004
MIZORAM, INDIA
MAY, 2023

COURSE STRUCTURE FOR B.Sc. MATHEMATICS

Year	SEM	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
	FIRST SEMESTER												
	SEM	**Course Category**	**Course Code**	**Name of Paper**	**C/A**	**End Sem**	**TT**	**L**	**T**	**P**	**TT**	**Th**	**Pr**
	1st	MAJOR	MAT/1/MJ/100	Vector Analysis	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/1/MJ/101*	Calculus	25	75	100	4	0	0	**4**	3	0
		MINOR	MAT/1/MN/102	From Other Subject	25	75	100				**4**	3	0
		Multidisplinary	MAT/1/MD/103	Quantitative Aptitude	25	75	100	3	0	0	**3**	3	0
		Ability Enhancemen t	MAT/1/AEC/		25	75	100				**3**	3	0
		Value added	MAT/1/VAC/		25	75	100				**2**	3	0
	SECOND SEMESTER												
	SEM	**Course Category**	**Course Code**	**Name of Paper**	**Marks Scale**			**Credit**				**Exam (hrs)**	
					C/A	**End Sem**	**TT**	**L**	**T**	**P**	**TT**	**Th**	**Pr**
	2nd	MAJOR	MAT/2/MJ/150	Elementary Number Theory	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/2/MJ/151*	Algebra	25	75	100	4	0	0	**4**	3	0
		MINOR	MAT/2/MN/152	From Other Subject	25	75	100				**4**	3	0
		Multidisplinary	MAT/2/MD/153	Elementary Mathematic s	25	75	100	3	0	0	**3**	3	0
		Skill Enhancemen t	MAT/2/SEC/		25	75	100				**3**	3	0
		Value added	MAT/2/VAC/		25	75	100				**2**	3	0

COURSE STRUCTURE FOR B.Sc. MATHEMATICS

Year	THIRD SEMESTER												
	SEM	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
					C/A	End Sem	TT	L	T	P	TT	Th	Pr
	3rd	MAJOR	MAT/3/MJ/200	Modern Algebra- I	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/3/MJ/201*	Differential Equation	25	75	100	4	0	0	**4**	3	0
		MINOR	MAT/3/MN/202	From Other Subject	25	75	100				**4**	3	0
		Multidisplinary	MAT/3/MD/203	Environment and Mathematics	25	75	100	3	0	0	**3**	3	0
		Skill Enhancement	MAT/3/SEC/		25	75	100				**3**	3	0
		Value added	MAT/3/VAC/		25	75	100				**2**	3	0
	FOURTH SEMESTER												
	SEM	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
					C/A	End Sem	TT	L	T	P	TT	Th	Pr
	4th	MAJOR	MAT/4/MJ/250	Real Analysis	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/4/MJ/251*	Numerical Analysis - I	25	75	100	4	0	0	**4**	3	0
		MINOR	MAT/4/MN/252	From Other Subject	25	75	100				**4**	3	0
		Ability Enhancement	MAT/4/AEC/		25	75	100				**3**	3	0
		Skill Enhancement	MAT/4/SEC/		25	75	100				**3**	3	0
		Value added	MAT/4/VAC/		25	75	100				**2**	3	0

COURSE STRUCTURE FOR B.Sc. MATHEMATICS

Year	SEM	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
	FIFTH SEMESTER												
					C/A	**End Sem**	**TT**	**L**	**T**	**P**	**TT**	**Th**	**Pr**
	5th	MAJOR	MAT/5/MJ/300	Advanced Calculus	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/5/MJ/301	Analytical Geometry	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/5/MJ/302* (Anyone)	(a) Computer Programming in C	25	75	100	2	0	2	**4**	3	2
				(b) Astronomy	25	75	100	4	0	0	**4**	3	0
		MINOR	MAT/5/MN/303	From Other Subject	25	75	100				**4**	3	0
		Ability Enhancement	MAT/5/AEC/		25	75	100				**2**	3	0
		Internship	MAT/5/INT/		25	75	100				**2**	3	0
	SIXTH SEMESTER												
	SEM	**Course Category**	**Course Code**	**Name of Paper**	**Marks Scale**			**Credit**				**Exam (hrs)**	
					C/A	**End Sem**	**TT**	**L**	**T**	**P**	**TT**	**Th**	**Pr**
	6th	MAJOR	MAT/6/MJ/350	Mechanics	25	75	100	4	0	1	**4**	3	0
		MAJOR	MAT/6/MJ/351	Complex Analysis	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/6/MJ/352 (Anyone)	(a) Modern Algebra -II	25	75	100	4	0	0	**4**	3	0
		MAJOR		(b) Discrete Mathematics	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/6/MJ/353* (Anyone)	(a) Operations Research	25	75	100	4	0	0	**4**	3	0
				(b) FORTRAN Programming	25	75	100	2	0	2	**4**	3	2
		MINOR	MAT/6/MN/354	From Other Subject	25	75	100				**4**	3	0

COURSE STRUCTURE FOR B.Sc. MATHEMATICS

Year	SEVENTH SEMESTER												
	Sem	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
					C/A	End Sem	TT	L	T	P	TT	Th	Pr
	7th	MAJOR	MAT/7/MJ/ 400	Advanced Complex Analysis	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/7/MJ/401* (Anyone)	(a) Ordinary Differential Equation (b) Graph Theory	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/7/MJ/402* (Anyone)	(a) Numerical Analysis - II (b) Metric Space	25	75	100	4	0	0	**4**	3	0
		MINOR	MAT/7/MN/ 403	From Other Subject	25	75	100				**4**	3	0
		MINOR	MAT/7/MN/ 404	From Other Subject	25	75	100				**4**	3	0
	EIGHT SEMESTER (HONOURS WITH RESEARCH)												
	SEM	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
					C/A	End Sem	TT	L	T	P	TT	Th	Pr
	8th	MAJOR	MAT/8/MJ/450	(a) Partial Differential Equation (b) Fluid Dynamics	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/8/MJ/451	(a) Classical Mechanics (b) Linear Algebra	25	75	**100**	4	0	0	**4**	3	0
		Research Project/ Dissertation	MAT/8/MJ/499								**12**	0	0

COURSE STRUCTURE FOR B.Sc. MATHEMATICS

COURSE STRUCTURE FOR B.Sc. MATHEMATICS

Year	EIGHT SEMESTER (HONOURS)												
	Sem	Course Category	Course Code	Name of Paper	Marks Scale			Credit				Exam (hrs)	
					C/A	End Sem	TT	L	T	P	TT	Th	Pr
	8th	MAJOR	MAT/8/MJ/450 (Anyone)	(a) Partial Differential Equation (b) Fluid Dynamics	25	75	100	4	0	0	**4**	3	0
		MAJOR	MAT/8/MJ/451 (Anyone)	(a) Classical Mechanics (b) Linear Algebra	25	75	**100**	4	0	0	**4**	3	0
		MAJOR	MAT/8/MJ/452	Topology	25	75	**100**	4	0	0	**4**	3	0
		MAJOR	MAT/8/MJ/453	Probability Theory	25	75	**100**	4	0	0	**4**	3	0
		MAJOR	MAT/8/MJ/454 (Anyone)	(a) Advaced Mechanics (b) Mathematical Logic	25	75	**100**	4	0	0	**4**	3	0

MARKS & QUESTIONS DISTRIBUTION TABLE

PAPER W ITH 4 U N ITS

Sl No.	CATEGORY	TOTAL MARKS	NO. OF QUESTIONS TO SET	NO. OF QUESTIONS TO BE ANSWERED
1	Multiple Choice Question (1 mark)	15	4 from each unit (Provided 3 from 1 unit)	15
2	Short Answer (3 marks)	12	2 from each unit X 4 = 8	1 from each unit X 4 = 4
3	Descriptive (12 marks)	48	2 from each unit X 4 = 8	1 from each unit X 4 = 4
4	**TOTAL**	**75**		

PAPER W ITH 3 U N ITS

Sl No.	CATEGORY	TOTAL MARKS	NO. OF QUESTIONS TO SET	NO. OF QUESTIONS TO BE ANSWERED
1	Multiple Choice Question (1 mark)	12	4 from each unit X 3 = 12	12
2	Short Answer (3 marks)	18	3 from each unit X 3 = 9	2 from each unit X 3 = 6

3	Descriptive (15 marks)	45	2 from each unit X 3 = 6	1 from each unit X 3 = 3
4	**TOTAL**	**75**		

MARKS & QUESTIONS DISTRIBUTION TABLE

PAPERS WITH PRACTICAL

THEORY EXAM (2 Hours)				
Sl No.	**CATEGORY**	**TOTAL MARKS**	**NO. OF QUESTIONS TO SET**	**NO. OF QUESTIONS TO BE ANSWERED**
1	Multiple Choice Question (1 mark)	6	2 from each unit x 3 = 6	6
2	Short Answer (3 marks)	9	2 from each unit x 3 = 6	1 from each unit x 3 = 3
3	Descriptive (10 marks)	30	2 from each unit x 3 = 6	1 from each unit x 3 = 3
4	**TOTAL**	**45**		

PRACTICAL EXAM (2 Hours)		
Sl No.	CATEGORY	TOTAL MARKS
1	Practical	10 +10 = 20
2	Record Book	5
3	Viva voce	5
4	TOTAL	30

INTERNAL EXAM			
Sl No.	**CATEGORY**	**TOTAL MARKS**	
		Theory	**Practical**
1	C1	6	4

2	C2	6	4
3	Attendance	5	
4	**TOTAL**	**25**	

DISCIPLINARY MAJOR
MAT/1/MJ/100 : VECTOR ANALYSIS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. determine and calculate areas of 2-D figure and volume of 3-D figure.
2. study vector differentiation and integration in two and three dimensional spaces and consequently evaluate the curvature of a curve, tangential and normal component of velocity and acceleration of a moving particle along a space curve.
3. get knowledge about space curves; directional derivative; gradient; multiple integrals; line and surface integrals, vector fields; divergence, curl and flux.
4. get basic knowledge of key topics to study tensor, Differential Geometry and Relativity theory for further studies.

UNIT I : Differentiation of a Vector, Geometrical Interpretation of the Derivative, Differentiation formulae, Differentiation of dot and Cross Products, Partial Derivatives of Vectors, Differentials of Vectors.

UNIT II : Vector Differential Operator Del, Gradient of a Scalar Function, Directional Derivative, Geometric Interpretation, Gradient of the sum of functions, of the product of functions and of a function of function, Operations involving divergence of a vector and its physical interpretation, Curl of a Vector and its Physical Interpretation, Expansion Formulae for Operators involving Del, Solenoidal and Irrotational.

UNIT III: The Line Integral, Surface Integral and its Physical Meaning, Volume integral, Simple problems.

UNIT IV : Statements of Stoke's Theorem, Gauss Divergence Theorem and Green's Theorem and problems.

References :

1. Spiegel Murray : Vector Calculus, Tata McGrow Hill
2. Ghosh, R. K. and Maity, K. C: Vector Analysis(New Central Book Agency), 2001 Edition.
3. Loney, S. L. : The Elements of Coordinate Geometry, (S. Chand & Co., New Delhi).
4. Shanti Narayan, and Mittal, P. K.: A Text Book of Vector Analysis (S. Chand & Co. Ltd., New Delhi), 2003 Edition.
5. B.S.Grewal. *Higher Engineering Mathematics* (2002), Khanna Publishers, New Delhi.

FIRST SEMESTER

DISCIPLINARY MAJOR

MAT/1/MJ/101*: CALCULUS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. sketch different types of graphs in Cartesian coordinate systems. Calculate the limit and examine the continuity of a function at a point and interval, uses of derivatives and successive differentiation.
2. understand the consequences of Rolle's and Mean value theorems for differentiable functions. Know the importance of Taylor's and Maclaurin's expansions.
3. know Fundamental theorem of integral calculus, evaluation of integrals using properties of definite inte- gral and reduction formulae for standard integrals.
4. understanding limits & continuity in two or more variables and their partial derivatives; Euler's theorem on homogeneous functions. Also to assimilate the notions of sequence and series and their convergence.

UNIT I: Functions and graphs of real valued functions; $\varepsilon - \delta$ definition of limit and continuity, standard theorems on limits, L'Hospital's Rule (statements with applications), Properties of continuous functions defined on closed and bounded intervals (statements with illustrations only); Derivatives of real valued functions on intervals : Derivative as a rate measurer, Derivative as the gradient of tangent; Successive differentiation; Leibnitz's theorem;

UNIT II: Sign of the derivatives of a real valued function of a real variable: vanishing of f(x); Rolle's theorem; geometric interpretation, Mean Value Theorems and its applications; Taylor's and Maclaurin's theorem with Cauchy's form of remainders; Taylor's and Maclaurin's series; expansion of standard functions such as e^x, $\sin x$, $\cos x$, $\log(1+x)$, $(1+x)^n$.

UNIT III: Anti-derivative : Fundamental theorem of integral calculus; Differentiability of integrals of continuous functions; Evaluation of integrals; Properties of definite integral and evaluation of integrals; Reduction formulae for the functions $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int e^{ax} x^n dx$, $\int \sin^n x \cos^m x dx$, $\int e^{ax} (\log x)^n dx$, and their combinations.

UNIT IV: Real-valued functions of two or three variables: limits; continuity; partial derivatives of first and second orders; Euler's theorem on homogeneous functions (proof upto three variable case). Sequences of real numbers, Convergent sequence, Monotonic sequence, Cauchy sequence; Cauchy's general principle of convergence; Infinite series, Convergent series, Comparison test, Ratio test, Raabe's test.

References :

1. Das, B.C. & Mukherjee, B.N. : Differential Calculus, U.N. Dhur & Sons (P) Ltd.
2. Maity, K. C. and Ghosh, R. K. : Differential Calculus, New Cental Book Agency Pvt Ltd., 2001 Ed.
3. Das, B.C. & Mukherjee, B.N. : Integral Calculus, U.N. Dhur & Sons (P) Ltd.
4. Maity, K. C. and Ghosh, R. K. : Integral Calculus, New Cental Book Agency Pvt Ltd., 2002 Ed.

FIRST SEMESTER

MULTIDISCIPLINARY

MAT/1/MD/103: QUANTITATIVE APTITUDE

Full Marks: 100 (3 Credits)

Course Learning Outcomes: This course will enable the students to:

1. understand concepts of mathematics with emphasis on analytical ability and computational skill needed in competitive examinations
2. explain the concepts and use equations, formulae and mathematical expression and relationship in a variety of context
3. handle data collection and analyse their representation in terms of graph and interpretation.

UNIT 1: Number series, Surds, Rationalisation of surds, Percentage, Profit and Loss, Ratio and Proportion, Partnership, Simple interest and Compound interest.

UNIT II: Time and distance, Time and work, Pipes and cistern, Boats and stream. Types of data, Methods of collection, Concept of data summarization and condensation.

UNIT III: Methods of data representation, Classification of data and their types, Construction of tables (with one or more factors), their general structure and types, Frequency distribution, Principles governing their repre- sentation and graphical representation and determination.

References :

1. RS Agarwal : Quantitative Aptitude, S.Chand.
2. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
3. Snedecors G.W. and Cochran W.G. (1967): Statistical Methods, Iowa State University Press.
4. Goon A.M., Gupta M.K. and Das Gupta B. (1991): Fundamental of Statistics, Vol. I, World Press, Calcutta
5. Hogg R.V. and Craig A.T. 91972): Introduction to mathematical Statistics, Amerind Publishing
6. Hoel P.G. (1971): Introduction to Mathematical Statistics, Asia Publication.

SECOND SEMESTER

DISCIPLINARY MAJOR

MAT/2/MJ/150: ELEMENTARY NUMBER THEORY

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. know basic properties of integers and fundamental theorem of arithmetic.
2. understand congruences in the set of integers. Eulers function, Fermat's theorem, Wilson's theorem, Lagrange's theorem and their applications.
3. have a knowledge on Lagendre's symbol, Linear congruences, Chinese remainder theorem, congruence of higher degree modulo, Gauss lemma.
4. understand Fibonacci numbers and their properties. Learn about various type of functions. Mobius Inversion formula to solve equations.

UNIT I: Divisibility in the set of integers; Basic properties; the Division algorithm; gcd; Elementary properties; the Euclidean algorithm; LCM; Primes (in the set of natural numbers); Fundamental theorem of arithmetic. Euclid's proof of the infinitude of primes; Arbitrary gaps in the distribution of primes;

UNIT II: Congruences in the set of integers modulo a positive integer; Basic properties; complete residue system; Reduced residue system. Euler's φ - function; Fermat's theorem; Euler's generalization of Fermat's theorem; applications; Wilson's theorem, Lagrange's theorem, Primitive roots; Greatest integer function; Elementary properties.

UNIT III: Lagendre's symbols, Euler's Criterion, Gauss Lemma, Law of Quadratic Reciprocity, Solution of congruences; Linear congruences; Chinese remainder theorem; Congruences of higher degree modulo a prime.

UNIT IV: Fibonacci numbers and their properties; Arithmetic functions; Multiplicative functions; Functions such as $\varphi(n)$, $\mu(n)$, $\tau(n)$, $\sigma(n)$, $\sigma_k(n)$, $\omega(n)$.

<u>References</u> :

1. Niven, I., Zuckerman, H.S., and Montgomery, H. L. : An introduction to the Theory of Numbers (Wiley Eastern Ltd.), 2000 Edition.
2. Burton, David M. : Elementary Number Theory (Universal Book Stall), 2001 Edition
3. Telang, S. G.. : Number Theory (Tata McGraw-Hill, New Delhi), 1996 Edition.
4. Malik S. B. : Basic Number Theory, Vikas Publishing House, 2nd Edition, 1998.

SECOND SEMESTER

DISCIPLINARY MAJOR

MAT/2/MJ/151*:
ALGEBRA

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. understand properties of polynomials over interger, rational, real and complex field and their irreducibiltity.
2. understand the importance of roots of real and complex polynomials and learn various methods of obtain- ing roots.
3. employ De Moivre's theorem in a number of applications to solve numerical problems.
4. enable to solve cubic and biquadratic equations by Cardan's method.

UNIT I : Example and elementary properties of polynomials over □ / □ / □ / □ ; Addition and multiplication; Degree of a polynomial; Degree of sum and product of polynomials; Division algorithm; Remainder theorem. The roots of cubic and biquadratic equations; Simple tests of irreducibility of polynomials with rational / integer coefficients.

UNIT II : Detailed study of roots of a polynomial with real coefficients: Immediate consequence of the fundamental theorem of algebra; Multiple roots, Common roots, Complex roots, Surd roots, the n^{th} roots of unity.

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UNIT III : Descartes' rule of signs - Simple applications; Location of roots using Rolle's theorem, Relation between roots and coefficients of a polynomial; Symmetric function of roots; Formation of equation with given roots.

UNIT IV: De Moivre's theorem for integer and rational indices - Application to solution of equation, Expansion of $\sin n\theta$, $\cos n\theta$ and $\tan n\theta$. Solution of a cubic and biquadratic equations by Cardan's method.

<u>References</u> :

1. Vasishtha A.R. : Modern Algebra, Krishna Prakashan Media (P) Ltd. Meerut. (for Unit I and II)
2. Das B.: Higher Algebra, Ashok Prakashan, Kolkata (for Unit III, IV and V)
3. Singh, Shaligram : Atext book of set theory, Bharati Bhawan Publishers, 1994 Edition.
3. Bhattacharya, P. B., Jain, S. K., and Nagpaul, S. R. : First Course in Linear Algebra (Wiley Eastern), 2001 Edition.
4. Rao,A.R., Karan, Bhimasum:Linear Algebra and its application, TRIM series; Hisdustan Pub., N. Delhi.
5. Fraleigh, John B. : A First Course in Abstract Algebra (Narosa Publishing House), 1999 Edition.

SECOND SEMESTER

MULTIDISCIPLINARY

MAT/2/MN/153: ELEMENTARY MATHEMATICS

Full Marks: 100 (3 Credits)

Course Learning Outcomes: This course will enable the students to:

1. find limit and differentiation of functions.
2. find integrationof functions.
3. find measures of central values, variance, standard deviation, correlation, regression analysis and error.
4. understand elementary idea of calculus and statistics.

UNIT I: Limits of algebraically and transcendental functions; Definition of derivatives, Derivative of function by definition, Derivative of sum, Difference, Product and quotient of functions.

UNIT II: Indefinite integral, Methods of integration, Integration by parts and some special integration.

UNIT III: Mean, Median, Mode, Mean deviation, Variance and Standard deviation of ungrouped/grouped data, Concept and types of correlation, Scatter diagram, Interpretation with respect to magnitude and direction of relationship, Karl Pearson's coefficient of correlation, Concept of regression, Lines of regression for ungrouped data, Regression coefficients and their properties, Absolute, Relative and percentage errors.

References :

1. Calculus: Early Transcendentals, James Stewert, US Naval Academy 7th Edition.
2. The Calculus Primer, William L. Schaaf, Dover Books on Mathematics.
3. Fundamentals of Statistics , A.M. Goon M. K. Gupta, B. Dasgupta, The World Press Private Ltd. Kolkatta.
4. Statistics, M. C. Shukla S. S. Gulshan, S. Chand & Company Ltd.

THIRD
SEMESTER

DISCIPLINARY MAJOR

MAT/3/MJ/200 : MODERN ALGEBRA - I

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. learn about the fundamental concepts of binary operations, groups and their unique features.
2. understand the properties subgroups, order of a group, Lagrange's theorem and its application.
3. learn various groups and their properties - Abelian groups, dihedral groups, quarternian group, general and special linear groups.
4. grasp the concept of cyclic groups, permutation group and their properties; applications of Fermat's theorem.

UNIT I : Binary operations, Examples; Groups - Definition; Detailed study of groups such as $\square$, $\square$, $\square$, $\square$, S_n, $M_2(\square)$, $GL_2(\square)$, Cancellation laws; Uniqueness of identity and inverses; Group tables of groups of low order (up to 4); Elementary properties of groups.

UNIT II : Subgroups and examples, Determination of all subgroups of Z; Product of two subgroups; Cosets and their properties; Cosets as equivalence classes; $\square_n$ as cosets; Order of a group and element of a group, Lagrange's theorem and its applications; Groups of prime order.

Unit-III : Definition and properties of Abelian groups, Examples of groups including D_n (dihedral groups), Q_8 (quarternian group), GL (n, R) (general linear groups) and SL (n, R) (special linear groups).

Unit-IV: Cyclic groups and properties, Classifications of subgroup of cyclic groups, Centralizer, Normalizer, Permutation group and properties, Even and odd permutations, Cayley's theorem; Euler-Phi function, Euler's theorem, Fermat's little theorem.

References :

1. Vasishtha A.R. : Modern Algebra, Krishna Prakashan Media (P) Ltd. Meerut. (for Unit I, II and III)
2. Herstein, I. N. : Topics in Algebra (Vikas Pub. House), 1988 Edition (reprint 1998).
3. Fraleigh, J. B. : A First Course in Abstract Algebra. (Narosa Publishing House), 1999 Edition.

THIRD SEMESTER

DISCIPLINARY MAJOR

MAT/3/MJ/201*: DIFFERENTIAL EQUATION

Full Marks: 100 (4 Credits)

Course Learning Outcomes: The course will enable the students to:

1. understand the genesis of ordinary differential equations.
2. learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
3. grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
4. understanding partial differential equation and apply a range of techniques to solve first & second order partial differential equations.

UNIT I: Formation of differential equations; equations of first order and first degree; solutions by - separation of variables and substitution; homogeneous equations; linear equations; Bernoulli's equation; exact equations; reduction to exact form by integrating factors.

UNIT II : Linear equations of second and third order with constant coefficients - Complementary functions and Particular integrals for $e^{ax} \sin mx$, $e^{ax} \cos mx$, $x^n \sin mx$, $x_n \cos mx$; Equations of type $a x^2 y'' + a xy' + a y = f(x)$, Differential equations of first order but higher degrees; Clairut's equation and singular solution; Geometrical interpretation; orthogonal trajectories

UNIT III : Linear differential equations of Second order with variable coefficients; Homogeneous equations; Exact equations; Method of variation of parameters; Simultaneous equations; Total differential equation $Pdx + Qdy + Rdz = 0$.

UNIT IV : Order and degree of partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Integral surface passing through a given curve, Surfaces orthogonal to a given family of surfaces, Compatible systems of first order equations, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

References :

1. Raisinghania, M.D. : Ordinary and Partial Differential Equations (S. Chand & Co. Ltd., New Delhi), 2002 Edition.
2. Piaggio, I. : An Elementary Treatise on Differential Equations and Applications (G. Bell & Sons), 2000 Edition.
3. Sneddon, I. N. : Elements of Partial Differential Equation (McGraw Hill). International Edition 1957.
4. Coddington, Earl A. : An Introduction to Ordinary Differential Equations (Prentice-Hall, India), 1998 Edition.

MULTIDISCIPLINARY

MAT/3/MD/203: ENVIRONMENTAND MATHEMATICS

Full Marks: 100 (3 Credits)

Course Objective: To provide basic knowledge on concepts of environment wherein we live and calculations pertaining to certain environmental parameters using mathematical models focusing the land, air and water environments.

Course Learning Outcome: This course will enable the students to:

1. understand the basic environmental components such as land, air and water.
2. construct mathematical models on the dynamics of various kinds of physical, chemical and biological measures

UNIT I: ***Soil*** : Soil Forming Processes, Soil Classification, Soil properties, Calculation of Soil Quality Index.

Topographical features : Geomorphology, drainage system, Land elevations and slopes, River basin and watersheds, Mountains, forest and vegetation cover, Stream, lakes, Rivers formation, Reservoirs.

Wildlife conservation **:** Flora and fauna, Biodiversity and forest conservation: Biodiversity, Phyto-sociological study of a given area. Calculation of species density, frequency, frequency class, relative species frequency, relative species density, relative species abundance, relative species dominance. **15 Hrs**

UNIT II : ***Surface water***: Introduction to water quality, Development of Mathematical Models, River Quality Dispersion Modeling: Streeter and Phelps model and its further development.

Groundwater: Groundwater Quality, Sources of groundwater pollution, Groundwater pollution control, Dispersion Modeling of Groundwater Pollutants. **15 Hrs**

UNIT III : Studies on various air quality parameters, Air pollution in and around industrial complexes, Types of sources, scales and steps in model formulation, Input data for dispersion modeling, Gaussian plume models.

15 Hrs

<u>Text Books</u> :

1. Gupta, O.P., Elements of Water Pollution Control, - Technology & Engineering - 924 pages, Khanna Publishing House, 4C/4344, Basement, Ansari Road, Daryaganj New Delhi, New Delhi - 110002.
2. Paolo, Z., Air pollution modelling, Springer,1990.
3. Tripathi, D., Mani, S., Singh, M. (2020). Fundamental of Soil Science, e-Course of ICAR, free download from www.agrimoon.com.

<u>ReferenceBooks</u> :

1. Edward J. Plaster (2013). Soil Science and Management, 6th edition, 2013published by Delmar Cengage Learning.
2. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous Environmental Engineering (Indian Edition) McGraw-Hill, 2017.
3. Steven C. Chapra, Surface Water-Quality Modelling, Waveland Press, 2008.

FOURTH SEMESTER

DISCIPLINARY MAJOR

MAT/4/MJ/250: REAL ANALYSIS

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. understand basic properties of open and closed sets, compact sets, Euclidean spaces and other related important theorems.
2. learn conceptual variations while advancing from one variable to several variables in calculus.
3. relate concepts of partial derivatives with directional derivatives, derivability of a function.
4. gain expertise in extreme values of functions for two variables.

UNIT I: Basic properties of Euclidean distance function in R^n; Neighbourhoods, Open sets, Closed sets, Limit points, Interior points in R^n ($n = 1, 2, 3$); Bolzano-Weierstrass theorem; Cantor intersection theorem (nested interval) Lindelof covering theorem, Compact sets; Heine-Borel theorem.

UNIT II: Real valued function of several variables : Continuity, Elementary properties of continuous functions; Continuous functions on compact sets; Special cases of continuous real valued functions on closed, Bounded intervals of R: Bounds; Intermediate value theorem; Uniform continuity.

UNIT III: Partial derivatives of a real valued function with domain up to R^3; Existence of directional derivatives; Mean value theorem; Derivability of composites, Differentiability at a point, Condition for differentiability, Jacobians and their properties.

UNIT IV: Reversal of order of derivatives, Schwarz's theorem, Young's theorem, Taylor's theorem, extreme values of a function, Necessary condition for extreme value, Sufficient condition for extreme value (for function of two variables).

References :

1. Malik and Arora : Mathematical Analysis, New Age international (P) Ltd.
2. Shanti Narayan: A Course of Mathematical Analysis (S. Chand. Delhi), 2003 Edition.
3. Apostol, Tom A. : Mathematical Analysis (Narosa Publishing House), 2002 Edition
4. Bartle, R.G., and Sherbert, D.R. : Introduction to Real Analysis(John Wiley & Sons, Inc), 2000 Edition.

FOURTH SEMESTER

DISCIPLINARY MAJOR

MAT/4/MJ/251* : NUMERICAL ANALYSIS-I

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. use difference operators and obtain numerical solutions of algebraic and transcendental equations.
2. learn about various interpolation and extrapolation methods.
3. find numerical solutions of system of linear equations and check the accuracy of the solutions.
4. solve initial and boundary value problems in differential equations using numerical methods.

UNIT I: Difference operators and relation between them, Differences of a polynomial, Factorial polynomials. Solutions of Algebraic and Trancendental equations, Bisection method, Iteration method, Regula falsi method, Newton-Raphson method.

UNIT II: Difference tables : Forward difference, Backward difference, Divided difference; Newton's forward and backward interpolation formulae, Newton's divided differences formula for interpolation, Lagrange's interpolation polynomials.

UNIT III: Solution of system of linear equations, Gauss elimination method , Gauss-Jordan method, Gauss-Siedel method, Crout's method.

UNIT IV: Numerical solution of differential equations - Taylor series method, Picard's method, Euler's method, Modified Euler's method (single and multi-step method), Runge-Kutta methods (up to second order).

References :

1. Rajaraman, V. : Computer Oriented Numerical Methods (Prentice-Hall of India Pvt. Ltd., New Delhi), 2002 Edition.
2. Jain, M. K., Iyenger, S. R. K., Jain, R. K.: Numerical Methods (Problems and solutions) Wiley Eastern Ltd., (New Age International Publishers Ltd.) 1995 Edition.
3. Kandasamy, P., Thilagavathy, K., and Gunavathy, K. : Numerical Methods, (S. Chand & Co. Ltd., New Delhi), 2003 Edition.
4. Calculus of finite differences and Numerical analysis by Saxena, S Chand & Co.

FIFTH SEMESTER
DISCIPLINARY
MAJOR

MAT/5/MJ/300: ADVANCED CALCULUS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. learn about Riemann integrability of bounded functions and algebra of R-integrable functions.
2. apply various techniques to identify the convergence of an improper integrals and their condition of abso- lute and conditional convergence.
3. evaluate line integral and double integrals and realize the interrelationship between repeated and double integrals.
4. relate concepts of pointwise and uniform convergence of sequences and series.

UNIT I: Riemann integral of functions of one variable; Darboux's theorem; Conditions for integrability; Classes of bounded and integrable functions; Properties of integrable functions; The R-Integral as a limit of sums (Riemann sums); Inequalities for integrals; Functions defined by integrals- their continuity and differentiability; Proof of Fundamental theorem of integral Calculus, Mean value theorems for integrals.

UNIT II: Improper integrals; Integration of unbounded functions with finite limites of integration, Infinite range of integration; Beta and Gamma functions; Test for convergence - General test, Comparision test, Cauchy's test, Abel's test, Dirichlet's test; Absolute and conditional convergence; Improper integrals as functions of parameters; Continuity, Differentiability and Integrability of such a function; Applications to evaluation of integrals, Uniformly convergent improper integrals involving parameters, Tests of uniform convergence - General and Weierstrass's test.

UNIT III: Evaluation of integrals; Line integral in R^2; Riemann integral of real valued functions of two variables; Evaluation of double integrals, Relation between double and repeated integrals, Change of order of integration in double integrals.

UNIT IV: Sequences of (real valued) functions: Pointwise and uniform convergence; Properties of uniformly convergent sequences of functions; Series of functions; Uniform convergence and continuity; Uniform convergence and integration; Uniform convergence and differentiation.

References :

1. Shanti Narayan : A Course of Mathematical Analysis (S. Chand and Co., Delhi), 2003 Edition.
2. Apostol, T. A.: Mathematical Analysis (Narosa Publishing House), 2002 Edition.
3. Rudin, W. : Principles of Mathematical Analysis (Me Graw - Hill Publications), International Edition 1976 (Reprint 1996).
4. Malik, S. C. and Arora, S. : Mathematical Analysis (New Age International (P) Ltd., Publishers) 1992 Edition (Reprint 2001).

FIFTH SEMESTER
DISCIPLINARY
MAJOR

MAT/5/MJ/301: ANALYTICAL GEOMETRY

Full Marks:100   (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. learn and visualize the fundamental ideas about coordinate geometry, to identify central and non-central conic and their properties like tangent, normal, diameter, asymptotes etc.
2. find relation between Cartesian coordinate, polar coordinate, cylindrical coordinate and spherical coordinate.
3. visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry.
4. gain knowledge about regular geometrical figures and their properties.

UNIT I: Change of axes - Invariants; Pairs of straight lines; General equation of second degree; The standard form; Reduction of the general equation to standard form; Conditions for different conics; General conics : Equations of tangents, Normals, Pairs of tangents.

UNIT II: Diameter, Conjugate diameter, Asymptotes, Polar equation of conics, Equationof directrix, Tangent to a conic in poalr form.

UNIT III: Space co-ordinates: Rectangular, Cartesian, Cylindrical, Spherical, Angle between two planes; Perpendicular distance of a point from a plane; Bisectors of two planes; Equations of straight lines in space; Co- planarity of two straight lines; Perpendicular distance of a point from a straight line; Shortest distance between two straight lines in space.

UNIT IV: Sphere - plane section and its equation; Sphere through a given circle; Tangent plane; Pole and polar plane; Intersection of two spheres; Radical plane; Equation of a cone with a conic as a guiding curve; Enveloping cone; Mutually perpendicular generators; Tangent planes; Reciprocal cone; Right circular cone; Equation of a cylinder with a conic as a guiding curve; Right circular cylinder.

References :

1. Shanti Narayan : Analytical Solid Geometry (S. Chand & Co., New Delhi), 2003 Edition.
2. Loney, S. L. : The Elements of Coordinate Geometry, (S. Chand & Co., New Delhi).
3. Das, B. : Analytical Geometry and vector Analysis (Orient Book Co., Calcutta), 1998 Edition. (For Unit III, IV & V)

FIFTH SEMESTER
DISCIPLINARY
MAJOR

MAT/5/MJ/302* (a) : COMPUTER PROGRAMMING IN C

Full Marks:100 (2+2=4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. understand fundamentals of C, C program structure, process of compiling and running a C program.
2. know input/ output functions, decision making, different types of looping, jumping, different types of functions and functions calls.
3. have knowledge in storage classes, array, multidimensional array, string, different types of string functions, pointers, structure and union.
4. develop skills for developing and running C programs.

UNIT I: C fundamentals: The C character set, identifiers and keywords, Data types, constants, variables and arrays, declarations, symbolic constants, Operators (Arithmetic, unary, relational, logical, bitwise, assignment), expressions, statements, C program structure, Need of header files, Process of compiling and running a C program, I/O functions: Header files (stdio.h, conio.h) getch(), getche(), getchar(), putch(), putchar(), scanf(), printf(), gets(), puts(), clrscr(), window(); Control statements: Decision making and branching (if. .else, switch), Decision making and looping (while, do .. while, for), Jumping (break, continue, goto), Nested loops; Functions: Overview (definition, declaration), defining a function, accessing a function, function prototypes, call by value, call by reference, recursion, iteration, Advantages and disadvantages of recursion over iteration.

UNIT II: Storage classes (Automatic, Register, External, Static), String functions (strcmp (), strlen (), strrev(), strcat (), toupper (), tolower ()), Math functions (sqrt (), abs (), sin (), cos (), Standard function- exit (), Memory allocation functions (malloc (), free (), realloc(), calloc()). Arrays and Pointers: Defining an array, array initialization, processing an array, passing array to a function, multidimensional arrays, arrays and strings, pointer declarations, passing pointer to a function, pointer and one dimensional arrays. Operation on pointers, pointers and multidimensional arrays, arrays of pointers, functions returning pointers; Structures and Unions: Defining a structure, processing a structure, user defined data types, structures and arrays.

UNIT III: PRACTICALS Practice the following programs.

1. Roots of quadratic equation $Ax^2+Bx+C=0$,
2. Arrangement a given set of numbers in increasing/decreasing order; calculation of mean,
3. Evaluation e^x, sin x, cos x, log(l+x) using power series method,
4. Solution of simple/algebraic/transcendental equations; Newton's method (real roots only),
5. Addition, subtraction and multiplication of matrices using function,

UNIT III: PRACTICALS Practice the following programs.

6. Evaluation of factorial of a positive integer and evaluation of binomial coefficients,
7. Determination of the transpose, determinant of the given matrix.(uptoorder4),
8. Determination of the inverse of a given real matrix (up to order 4),
9. Searching a pattern in a given text and replacing every occurrence of it with another given string,
10. Writing a given number in words using function.

References :

1. Kanetkar, Y.: Let us C (B. P. B Publication), 1993 Edition.
2. Gottfried, B. S.: Theory and Problems of Programming with C (Tata McGraw Hill Publication),1998 Edition.
3. Balaguruswamy, E.: Programming in ANSI C (Tata McGraw Hill publication), 2002 Edition.

4. Rajaraman, V.: Computer Programming in C (Prentice Hall of India), 2002 Edition.

FIFTH SEMESTER
DISCIPLINARY
MAJOR

MAT/5/MJ/302* (b): ASTRONOMY

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. have the idea about spherical trigonometry, celestial sphere and conversion of coordinate from one system to another.
2. know about rising and setting of stars, atmospheric refraction, different types of time and its equation.
3. have knowledge about seasons, different types of parallax, effect on right ascension, declination, longitude and latitude, aberration and eclipse.

UNIT I: Spherical Trigonometry : Section of a sphere by a plane, Great and small circle, Spherical triangles; Formula for spherical trigonometry; Solution of spherical triangle; Position of a point of a sphere.

UNIT II: The celestial sphere : Definition, Annual motion of the sun, System of coordinates, Hour angle, Conversion of coordinates from one system to another, Equinoxes and Solstices.

UNIT III: Rising and setting of stars, Rate of change of zenith distance and azimuth, Motion of the sun, Twilight, Atmospheric refraction, Sidereal time and mean time, Correction of time, Equation of time;

UNIT IV: Seasons, Geocentric parallax, Stellar paralax, Effects on right ascension, declination, Longitude and latitude, Paralactic eclipse; Aberation, Eclipses.

References :

1. Todhunter, I. : Spherical Trigonometry (Macmillan Publishing Co), 1996 Edition
2. Kar, J.M. : Astronomy (K.P.Basu Publishing Co.), 2001 Edition.
3. Dey, K.K. : Astronomy (Book Syndicate Pvt. Ltd., Kolkata), 2001 Edition

SIXTH SEMESTER
DISCIPLINARY
MAJOR

MAT/6/MJ/350: MECHANICS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.
2. determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.
3. deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.

UNIT I: Coplanar forces : Reduction and equilibrium of coplanar forces, General condition of equilibrium of any system of coplanar forces; Solution of problems on equilibrium of heavy bodies such as uniform rods, Solid spheres resting on plane surfaces, Friction.

UNIT II: Centre of gravityof - thin uniform rod, Uniform lamina, Triangular lamina, Rectangular lamina, Circular arcs, Sector of a circle and sectoral area; Moments and Products of inertia; Theorems of parallel and perpendicular axes.

UNIT III: Motion in a straight line and a plane, Velocity and acceleration; Radial and tranverse velocities and acceleration, Angular velocity and acceleration, Tangential and normal acceleration, Relative motion, Rectilinear motion, Motion in straight line with constant acceleration, Simple Harmonic Motion (SHM).

UNIT IV: Projectiles - Projectile to pass through a given point, Range on an inclined plane; Motion of a particle in resisting medium whose resistance varies as (i) velocity (ii) square of velocity; Work done by a force, Work energy equation, Conservation of energy.

References :

1. Das, B. C. and Mukherjee, B. N. : Statics (U. N. Dhar & Sons Publications, Kolkata), 2002 Edition.
2. Gupta, P. K., and Juneja, R. : Dynamics (Ramesh Book Depot, Jaipur), 2003 Edition.
3. Ray, M.: A Text Book on Dynamics for B.A./B.Sc. students (S. Chand Publication, Delhi), 2002 Edition.
4. Loney, S. L. : An elementary treatise on the Dynamics of a particle and of rigid bodies (Rahda publishing House, Kolkata), 2000 Edition.
5. Varma, R. S.: Statics (Pothishala, Allahabad), 2001 Edition.
6. Loney, S. L.: An elementary treatise on Statics

SIXTH SEMESTER
DISCIPLINARY
MAJOR

MAT/6/MJ/351: COMPLEX ANALYSIS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: The course will the students to :

1. understand the polar and geometrical representation of complex number, the convergence of Power series, term by term integration and differentiation.
2. understand he significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.
3. relate the concept of Line integral, Green's theorem and Cauchy integral formula.
4. learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.
5. count the number of zeros of analytic function, claculation of residues using Cauchy's residue theorem and maximum modulus theorem.

UNIT I: Complex number as ordered pairs; Polar and geometrical representation of complex number its sum, Difference, Product and division; Algebra of complex numbers; Equation of straight line and circle in term complex number, Inverse point with respect to straight line and circle; Power series; Absolute convergence, Uniform convergence, Cauchy-Hadamard formula for the radius of convergence; Circle of convergence. exponential, logarithmic, sinE and cosine function for complex number.

UNIT-II: Continuity and Differentiability of a complex valued function; Analytic function; Necessary and sufficient conditions for analytic functions; Cauchy-Riemann equations (Cartesian and polar form); Orthogonal system; Harmonic and conjugate harmonic functions; Construction of analytic function (Milne-Thomson's method).

UNIT-III: Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Morera's theorem, Taylor's and Laurent's theorem; Expansion of analytical function in Taylor and Laurent series.

UNIT-IV: Zeroes of an analytic function; Singularities of complex functions, Isolated singularity' removable singularity, poles and essential singularities; Singularity of polynomial function; Residues, Cauchy's residue theorem, residue at infinity; residues at poles and its examples; Maximum modulus theorem.

References :

1. Ponnusamy, S.: Complex Analysis (Narosa Publishing House), 2002 Edition.
2. Goyal, J.K., Gupta, K.P. and Pundir, S.K.: Complex analysis (Pragati Prakashan), 2012 Edition.
3. Shanti Narayan : Theory of a complex variable (S. Chand & Co.; Delhi), 2001 Edition.
4. Conway, J.: Functions of one Complex Variable (Narosa Publishing House), 2000 Edition.
5. Vasishtha, A. R. and Vasishtha, V. : Complex Analysis, Krishna Prakashan Media Ltd. Meerut, India.

SIXTH SEMESTER
DISCIPLINARY
MAJOR

MAT/6/MJ/352 (a) : MODERN ALGEBRA-II

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. know Normal subgroup, Centre of a group, Quotient group and examples.
2. understand theorems of group homomorphism, isomorphism, automorphisms, basic properties of Rings, Finite integral domains and examples.
3. have a knowledge on various type of ideals, quotient ring, fields.
4. understand ring homomorphisms, kernels, isomorphism, determination of ideals in $Z_{p,}$ divisibility in integral domains, units, associates, prime elements, irreducible elements, gcd, Euclidean domain, Principle ideal domain.

UNIT I: Normal subgroups and their properties; Conditions for a subgroup to be normal; Center of a group; Quotient group; Simple groups, Factors groups, Solvable groups.

UNIT II: Fundamental theorem of group homomorphism; First, Second and Third isomorphism theorems for groups; Automorphisms; Inner automorphisms; examples.

UNIT III: Basic properties of rings; Characteristic of rings; Finite integral domains; Subrings. Ideals: Principal ideals; Prime ideals, Maximal ideals in a commutative ring with unity; Determination of ideals in $Z_{p.}$; Quotient ring, Z_n as a quotient ring, fields : Q, R, C.

UNIT IV: Ring homomorphisms; Kernels; Isomorphism; Homomorphisms and Isomorphism theorems including the correspondence theorem; Divisibility in integral domains; Prime and irreducible elements, Euclidean domain, Principal ideal domain, Unique factorisation domains.

References :

1. Vasishtha A.R. : Modern Algebra, Krishna Prakashan Media (P) Ltd. Meerut. (for Unit I, II and III)
2. Gupta K.P. : Linear Algebra, Pragati Prakashan, Meerut (Unit IV & V)
3 Herstein, I. N. : Topics in Algebra (Vikas Pub. House), 1988 Edition (reprint 1998).
4 Fraleigh, J. B. : A First Course in Abstract Algebra. (Narosa Publishing House), 1999 Edition.
5. Hoffman, K. and Kunze, R. : Linear Algebra, second edition,Prentice-Hall, Eglewood Cliffs, New Jersy, 1971 Edition (reprint 1996).

SIXTH SEMESTER
DISCIPLINARY
MAJOR

MAT/6/MJ/352 (b) : DISCRETE MATHEMATICS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. learn about partially ordered sets, lattices and their types.
2. understand Boolean algebra and Boolean functions, logic gates, switching circuits and their applications.
3. solve real-life problems using finite-state and Turing machines.
4. assimilate various graph theoretic concepts and familiarize with their applications.

UNIT I: Definitions, Examples and basic properties of partially ordered sets (poset), Order isomorphism, Hasse diagrams, Dual of a poset, Duality principle, Maximal and minimal elements, Least upper bound and greatest upper bound, Building new poset, Maps between posets.

UNIT II: Lattices as posets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, examples and properties of modular and distributive lattices; Complemented, relativelycomplemented and sectionally complemented lattices.

UNIT III: Boolean algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive and conjunctive normal forms, Minimal forms of Boolean polynomials, Quine-McCluskey method, Karnaugh diagrams, Switching circuits and applications.

UNITIV: Finite-state machines with outputs, and with no output; Deterministic and nodeterministic finite-state automaton; Turing machines: Definition, examples, computations.

References :

1. B. A. Davey & H. A. Priestley (2002). *Introduction to Lattices and Order* (2nd edition). Cambridge University Press.
2. Edgar G. Goodaire & Michael M. Parmenter (2018). *Discrete Mathematics with Graph Theory* (3rd edition). Pearson Education.
3. Rudolf Lidl & Günter Pilz (1998). *Applied Abstract Algebra* (2nd edition). Springer.
4. Kenneth H. Rosen (2012). *Discrete Mathematics and its Applications*: *With Combinatorics and Graph Theory* (7th edition). McGraw-Hill.
5. C. L. Liu (1985). *Elements of Discrete Mathematics* (2nd edition). McGraw-Hill.

SIXTH SEMESTER
DISCIPLINARY
MAJOR

MAT/6/MJ/353* (a) : OPERATIONS RESEARCH

Full Marks: 100   (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. know how to solve optimization problems using simplex method.
2. learn techniques to solve duality in LPP, assignment and transportation problems.
3. solve integer and mixed integer programming problem, different types of game in LPP.
4. have clear understanding about the fundamentals of Operation Research and its techniques used in different fields like optimization problems, transportation, duality, games etc. and can apply concept and knowledge of Operation Research to solve the problems facing in day-today life.

UNIT I: Simplex method of solution, Minimax theorem, Initial simplex table, Terminal simplex table, Pivot entry, Algorithm of simplex method.

UNIT II: Duality in linear programming problem, Assignment problems, Transportation problem.

UNIT III: Integer programming, Branch bound technique, All integer programming problems and mixed integer programming problem.

UNIT IV: Theory of games, Two person zero-sum games, Maximin-minimax principle, Saddle point, Relation between minimax and maximin game without saddle point, Pure and mixed strategies, Dominance property, Modified dominance property, Reduction of game to linear programming problem and its solution.

References :

1. Gupta, P.K. and Hira, D.S. : Operations Research-An introduction (Sultan Chand & Sons, New Delhi), 2002 Edition.
2. Rao, S.S. : Optimisation theory and Applications (Wiley Eastern Ltd., New Delhi), 2001 Edition
3. Maulik, T.N. : Linear programming, (U.N. Dhar & Sons Publications, Kolkata), 2001 Edition.
4. Swarup, K., Gupta, P.K. and Singh, M.M. : Operations Research (Sultan Chand & Sons, New Delhi), 2002 Edition.

SIXTH SEMESTER
DISCIPLINARY
MAJOR

MAT/6/MJ/353* (b) : FORTRAN PROGRAMMING

Full Marks: 100 (2+2 = 4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. have knowledge about algorithms, flowchart and Euclid's algorithm for GCD. FORTAN fundamentals and input / output statements,
2. understand unconditional GO TO statement, branching, loop and nesting of loops.
3. know arrays, input and output of arrays, order of storage, implied Do notation and sub programs.
4. develop skills for developing and running FORTRAN programs.

UNIT I: Flowcharts, Algorithms - definitions and characteristics; Euclid's algorithm for gcd; FORTRAN fundamentals
- characters, variables, variable names, syntax, statements, constants, variables and expressions; names, types, evaluation of expressions. Input-output statements : unformatted and formatted input - output; integers, reals, complex, double precision, logical variables, alphanumeric information, data statements.

UNIT II: Unconditional, computed; assigned GO TO statement. Branches and loops - IF and DO statements; nesting of DO loops, Arrays DIMENSION statement, Order of storage; equivalent statements; input and output of arrays; implied DO notation; subprograms.

UNIT III (PRACTICALS):
1. Evaluation of roots of quadratic equation.
2. Arranging given set of numbers in increasing/decreasing order, calculation of Mean
3. Evaluation of sum of power series eg. e^x, sin x, cos x, log (1 + x)
4. Calculation of HCF/LCM of two integers
5. Evaluation of factorials and binomial coefficients
6. Sieve method for primality test

UNIT IV (PRACTICALS):
7. Generation of twin primes
8. To find product of two polynomials.
9. Evaluation Legendre polynomial from recurrence relation
10. Solving simple/algebraic/transcendental equations; Newton's method (real roots only),
11. Matrix operations : sums and products,
12. Transpose, determinant (up to order 4),
13. Inversion of real matrices (up to order 4).

References :

1. Mukherjee, K.K. : Probability and Statistics (New Central Book Agency Pvt. Ltd.), 1993 Edition.
2. Chandra, T.K. : Probability Theory, Narosa Publishing House
3. Feller, W. : An introduction to Probability theory and its applications, Vol I, Third U.S. Edition(1968), Wiley Eastern Limited, New Delhi.
4. Mayer, P.L. : Introductory Probability and Statistical Applications, 2nd Edition, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

SEVENTH SEMESTER
DISCIPLINARY
MAJOR

MAT/7/MJ/400 : ADVANCED COMPLEX ANALYSIS

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. classify the nature of singularity, poles, residue and application of Residue theorem to evaluation of definite integrals.
2. understand properties and classification of bilinear transformation.
3. know maximum and minimum modulus principle and related functions and theorems such as meromorphic functions, argument principal Schwarz's lemma, Rouche's theorem and inverse function theorem.
4. have knowledge in analytic continuation of a curve, gamma functions and its properties.

UNIT I: Zeros of an analytic function, Singularities of a function, removable singularities, Pole and essential singularities, Fundamental theorem of algebra, Residue theorem and its applications to the evaluation of definite integrals, Contour Integration.

UNIT II: Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings, Necessary and Sufficient condition of conformal maping, Cross-retio, Linear ransformation Bilinear transformation and its normal form, Elliptic, Hyperbolic, and Parabolic transformations, The transformation of

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$w = z^n$, $z =$, $w = e^z$, $w = \log z$, transformation of trigonometric function.

UNIT III: Maximum modulus and Minimum modulus principle, Meromorphic functions. The argument principal Schwarz lemma, Rouche's theorem. Inverse function theorem, Analytic Continuation, Uniqueness of direct analytic continuation.

UNIT IV: Uniqueness of analytic continuation along a curve. Power series method of analytic continuation, Schwarz Reflection principle, Weierstrass' factorization theorem. Gamma function and its properties. Riemann Zeta function. Reimann's functional equation. Runge's theorem. Mittag-Leffler's theorem.

References :

1. Priestly H. A. (1990): Introduction to Complex Analysis, Clarendon Press, Oxford.
2. Titchmarsh E.C. (1939): The Theory of Functions, Oxford University Press, London.
3. Ahlfors L.V. (1979): Complex Analysis, MC Graw Hill.
4. Ponnusamy S. (1997): Foundations of Complex Analysis, Narosa Publishing House.
5. Walter Rudin, Real and Complex Analysis, McGraw Hill Book Co., 1968.
6. Hille E. (1994) : Analytic Function Theory, Hindustan Book Agency, Delhi.

SEVENTH SEMESTER
DISCIPLINARY
MAJOR

MAT/7/MJ/401* (a) : ORDINARY DIFFERENTIAL EQUATION

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
2. understand Picard's method of obtaining successive approximations of solutions of first order differential equations which guarantees a unique solution on some interval of the given differential equation.
3. know the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
4. find solution method for higher order differential equations.
5. formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

UNIT I: Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations. Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients.

UNIT II: Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties.

UNIT III: Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

UNIT IV: Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

References :

1. Belinda Barnes & Glenn Robert Fulford (2015). *Mathematical Modelling with Case Studies*: *A Differential Equation Approach Using* Maple *and* MATLAB (2nd edition). Chapman & Hall/CRC Press, Taylor & Francis.
2. H. I. Freedman (1980). *Deterministic Mathematical Models in Population Ecology*. Marcel Dekker Inc.
3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
4. Daniel A. Murray (2003). *Introductory Course in Differential Equations*, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). *A Course in Ordinary Differential Equations* (2nd edition). Narosa.
6. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India.
7. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.

SEVENTH SEMESTER
DISCIPLINARY
MAJOR

MAT/7/MJ/401* (b) : GRAPH THEORY

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. appreciate the definition and basics of graphs along with types and their examples.
2. understand the definition of a tree and learn its applications to fundamental circuits.
3. know the applications of graph theory to network flows.
4. understand the notion of planarity of a graph.

UNIT I: Paths, Circuits and Graph Isomorphisms Definition and examples of a graph, Subgraph, Walks, Paths and circuits; Connected graphs, disconnected graphs and components of a graph; Euler and Hamiltonian graphs, Graph isomorphisms, Adjacency matrix and incidence matrix of a graph, Directed graphs and their elementary properties.

UNIT II: Trees and Fundamental Circuits Definition and properties of trees, Rooted and binary trees, Cayley's theorem on a counting tree, Spanning tree, Fundamental circuits, Minimal spanning trees in a connected graph.

UNIT III: Cut-Sets and Cut-Vertices Cut-set of a graph and its properties, Fundamental circuits and cut-sets, Cut- vertices, Connectivity and separability, Network flows, 1- isomorphism and 2- isomorphism.

UNIT IV: Planar Graphs Planar graph, Euler theorem for a planar graph, Various representations of a planar graph, Dual of a planar graph, Detection of planarity, Kuratowski's theorem.

References :

1. R. Balakrishnan & K. Ranganathan (2012). ATextbook of Graph Theory. Springer.
2. Narsingh Deo (2016). Graph Theory with Applications to Engineering and Computer Science. Dover Publications.
3. Reinhard Diestel (2017). Graph Theory (5th edition). Springer.
4. Edgar G. Goodaire & Michael M. Parmenter (2018). Discrete Mathematics with Graph Theory (3rd edition). Pearson.
5. Douglas West (2017). Introduction to Graph Theory (2nd edition). Pearson.

SEVENTH SEMESTER
DISCIPLINARY
MAJOR

MAT/7/MJ/402* (a) : NUMERICAL ANALYSIS -II

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. solve algebraic and transcendental equations by numerical method using Bisection, false position, fix point iteration, Newton's and scant methods.
2. learn techniques to solve linear systems by numerical method using Cayley Hamilton theorem, power method and curve fitting.
3. solve differentiation and integration by numerical methods using Trapezoidal rule, Simpson's rule, Weddle rule and Richardson extrapolation.
4. analyze and solve initial and boundary value problems of differential equations by numerical method using Euler, Runge-Kutta, Multi-Step, Finite Difference and Shooting methods.

UNIT I: Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton's method and Secant method for solving equations.

UNIT II: Eigen values and Eigen vectors: Cayley Hamilton theorem, Power method for finding largest Eigen value. Curve fitting: Least square curve fit-Straight line fitting, Parabolic curve fitting, Fitting of exponential curve, Fitting of other curves.

UNIT III: First order and higher order approximation for first derivative,Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rule, Weddle rule and its error analysis, Extrapolation, Richardson extrapolation.

UNIT IV: Euler's method, Runge-Kutta methods, Higher order one step method, Multi-step methods; Finite difference method, Shooting method.

References :

1. Brian Bradie (2006), *A Friendly Introduction to Numerical Analysis.* Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). *Applied Numerical Analysis* (7th edition), Pearson Education, India.
3. M.K. Jain, S. R. K. Iyengar & R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Compu- tation* (6th edition). New Age International Publishers.
4. Robert J. Schilling & Sandra L. Harris (1999). *Applied Numerical Methods for Engineers Using* MATLAB *and C*. Thomson-Brooks/Cole.
5. Atkinson, K. E. An Introduction to Numerical Analysis. John Wiley & Sons, 1989.
6. Conte, S. D. and Boor, C. D. Elementary Numerical Analysis. An Algorithmic Approach, Tata McGraw Hill, New Delhi, 1981.
7. Isacson, E. and Keller, H. B. Analysis of Numerical Methods. John Wiley & Sons, 1994.
8. Thangaraj, P. Computer Oriented Numerical Methods. PHI Learning Pvt. Ltd, 2013.

SEVENTH SEMESTER
DISCIPLINARY
MAJOR

MAT/7/MJ/402* (b) : METRIC SPACE

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. understand several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano-Weierstrass property, compactness, and connectedness.
2. dentify the continuity of a function defined on metric spaces and homeomorphisms.

UNIT I: Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space.

UNIT II: Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

UNIT III: Compact spaces, Sequential compactness, Bolzano-Weierstrass property, Compactness and finite intersection property, Heine-Borel theorem, Totally bounded sets, Equivalence of compactness and sequential compactness, Continuous functions on compact spaces.

UNIT IV: Separated sets, Disconnected and connected sets, Components, Connected subsets of **R**, Continuous functions on connected sets.

References :

1. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.
2. P. R. Halmos (1974). *Naive Set Theory*. Springer.
3. P. K. Jain & Khalil Ahmad (2019). *Metric Spaces*. Narosa.
4. S. Kumaresan (2011). *Topology of Metric Spaces* (2nd edition). Narosa.
5. Satish Shirali & Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
6. Micheál O'Searcoid (2009). *Metric Spaces*. Springer-Verlag.
7. G. F. Simmons (2004). *Introduction to Topology and Modern Analysis*. McGraw-Hill.

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/450 (a) : PARTIAL DIFFERENTIAL EQUATION

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. learn different techniques to solve first and second order partial differential equations.
2. understand and solve homogeneous and non homogeneous equations with constant coefficients.
3. model physical phenomena using partial differential equations such as the heat and wave equations

UNIT I: Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

UNIT II: Classification of linear partial differential equations of second order, Homogeneous and nonhomogeneous equations with constant coefficients.

UNIT III: Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

UNIT IV: Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

References :

1. A. S. Gupta (2004). *Calculus of Variations with Applications*. PHI Learning.
2. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
3. TynMyint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation for Scientists and Engineers* (4th edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on *Differential Equations and Their Applications.* CBS Publishers.
5. S. B. Rao & H. R. Anuradha (1996). *Differential Equations with Applications*. University Press.
6. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/450 (b) : FLUID DYNAMICS

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. understand the various properties of fluids and their influence on fluid motion and analyse a variety of problems in fluid dynamics.
2. adopt the kinematics and kinetics of fluid motions to understand the equation of continuity in cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.
3. deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets
4. understand in detail the vortex motion.

UNIT I: Properties of fluids. Newtonian and Non-Newtonian fluids, Viscous and Inviscid fluids. Some useful results of vector analysis. Methods of describing fluid motion; Langrangian and Eulerian method.Velocity and acceleration of a fluid particle. Equation of continuity in - cartesian co-ordinates, cylindrical coordinates, spherical polar coordinates.

UNIT II: Irrotational motion or motion of potential kind, Stream-lines, Path of a particle, Stream tube, Vortex lines. Potential flow. Euler's equation of motion for inviscid flow; Euler's equation of motion in spherical co- ordinates, cartesian co-ordinates, cylindrical coordinates, spherical polar coordinates. Barotropic flow, Bernoulli's Equation of motion, Helmholtz's equation.

UNIT III: Motion in two-dimensions: Stream function or current function, Physical significance of stream function. Spin components in terms of stream function. Irrotational motion in two-dimension. Complex potential, magnitude of velocity, Complex potential for some uniform flows, Source and sinks**,** Complex potential due to source, Doublet in two dimensions.

UNIT IV: Vortex motion; Vorticity, Vorticity components, Vortex line, Vortex tube and vortex filament, Hemholtz's vorticity theorem. Properties of vortex tube, Rectilinear vortices, two vortex filaments, vortex pair, vortex doublet or diapole, motion of any vortex. Kirchoff vortex theorem, General system of vortex filament. Navier-Stokes equation for viscous fluid.

References :

1. Chorlton, F. (Text Book of Fluid Dynamics).
2. L.D., Landau & E. N. Lipschitz (Fluid Mechanics).
3. G. K., Batchelor (An Introduction to Fluid Mechanics)
4. Kundu and Cohen (Fluid Mechanics).

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/451 (a): CLASSICAL MECHANICS

Full Marks: 100 (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. identify the motion of a mechanical system using Lagrange-Hamilton formalism.
2. apply the formalism of Lagrangian and Hamiltonian in generating equations of motion for complicated mechanical systems of classical mechanics.
3. compare Lagrangian and Hamiltonian formalism.
4. understand and analyse canonical transformations.

UNIT I: Generalized coordinates; Holonomic & non-holonomic systems; D'Alembert's principle; Lagrange's equations; Calculus of variations.

UNIT II: Hamilton's principle, Lagrange's equations from Hamilton's principle, Extension of Hamilton's Principle to non-conservative and non-holonomic systems.

UNIT III: Hamilton's equations of motion, Conservation theorems and physical significance of Hamiltonian, Hamilton's equations from variational principle, Principle of least action.

UNIT IV: Equations of canonical transformation; Integral invariants of Poincare'; Lagrange and Poisson brackets as canonical invariants, Equations of motion in Poisson bracket notation; Infinitesimal contact, Transformations.

References :

1. Goldstein H., Poole, C. and Safko, J., Classical Mechanics, 3rd Edition, Addison Wesley (2002).
2. Doulas Greogory R, Classical Mechnaics, Cambridge University Press

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/451 (b) : LINEAR ALGEBRA

Full Marks: 100 (4 Credits

Course Learning Outcomes: This course will enable the students to:

1. solve the system of linear equations with the help of matrix operations. Learn vector spaces and its basic properties.
2. understand the concept of linear dependence and independence of vectors, homomorphism and isomorphism theorems.
3. learn about properties of vector space axioms for the set L(V, W) of linear maps from V to W and also learn the matrix of linear transformation in L(U, W), change of basis theorem, Rank - Nullity theorem.
4. calculate characteristic roots, characteristic polynomials and characteristic vectors of matrix of a linear transformation and learn Diagonalization theorem.

UNIT I: System of linear equations, Matrices and elementary row operation, Row reduction and Echelon forms, Matrix multiplication, Invertible matrices and the inverse of a square matrix, Trace of a matrix; Rank of a matrix and its applications in solving system of linear equations.

UNIT II: Definitions of field and vector space with examples; Subspaces, Quotient space, Direct sum; Linear independent and dependent sets; Basis, Dimension, Linear span; Homomorphisms or linear maps between vector spaces; Isomorphisms; Standard homomorphism and isomorphism theorems.

UNIT III: Vector space axioms for the set L(V, W) of linear maps from V to W; Dual space; Linear transformation and the matrix of a linear transformation in L(V, W); Change of coordinates, Change of basis theorem; Rank and nullity of a linear transformation; Rank - nullity theorem; Equality of rank of a linear transformation and rank of the associated matrix.

UNIT IV: Characteristic roots, Characteristic polynomial and equation, Characteristic vector of matrix of a linear transformation; Determination of Eigen values and Eigen vectors, Cayley-Hamilton theorem and its applications, Diagonalization theorem.

<u>References</u> :

1. Vasishtha A.R. : Modern Algebra, Krishna Prakashan Media (P) Ltd. Meerut. (for Unit I, II and III)
2. Gupta K.P. : Linear Algebra, Pragati Prakashan, Meerut (Unit IV & V)
3. Herstein, I. N. : Topics in Algebra (Vikas Pub. House), 1988 Edition (reprint 1998).
4. Fraleigh, J. B. : A First Course in Abstract Algebra. (Narosa Publishing House), 1999 Edition.
5. Hoffman, K. and Kunze, R. : Linear Algebra, second edition, Prentice-Hall, Eglewood Cliffs, New Jersy, 1971 Edition (reprint 1996).

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/452 : TOPOLOGY

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. know definition and examples of topological space, subspace topology, continuity and related concepts, product topology, quotient topology, Lendelof spaces and separable space.
2. understand connected space, component and local connectedness.
3. have knowledge about compact spaces, compact and locally compact spaces and Tychonoff's theorem.

UNIT I: Definition and examples of topological spaces; Basis and sub basis; Order topology; Subspace topol- ogy. Continuity and related concepts; Product topology; Quotient topology; Countability axioms; Lindelof spaces and separable spaces.

UNIT II: Connected spaces, Generation of connected sets; Component, Path component; Local connected-ness, local path-connectedness.

UNIT III: Compact spaces; Limit point compact and sequentially compact spaces; Locally compact spaces; One point compactification; Finite product of compact spaces, Statement of Tychonoff's theorem (Proof of finite product only).

UNIT IV: Separation axioms; Urysohn's lemma; Tietze's extension theorem; Urysohn's embedding lemma and Urysohn's metrization theorem for second countable spaces.

References :

1. Munkres, J. R. (2000) Topology: a First Course, Prentice-Hall of India Ltd., New Delhi.
2. J. Dugundji (1990) General Topology, Universal Book Stall, New Delhi.
3. Pervin, W. J. (1964) Foundations of General Topology, Academic Press, New York.
4. Willard, S. (1970) General Topology, Addison-Wesley Publishing Company, Massachusetts.
5. Armstrong, M. A. (2005) Basic Topology, Springer International Ed.
6. Kelley, J. L. (1990) General Topology, Springer Verlag, New York.
7. Joshi, K. D. (2002) An Introduction to General Topology (2nd edition), Wiley Eastern Ltd., New Delhi.

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/453 : PROBABILITY THEORY

Full Marks: 100   (4 Credits)

Course Learning Outcomes: This course will enable the students to:

1. appreciate the importance of probability distribution of random variables
2. establish the joint distribution of two random variables in terms their correlation and regression.
3. understand central limit theorem which shows that the empirical frequencies of so many natural populations exhibit normal distribution.
4. apply various probability distributions.

UNIT I: One-dimentional random variables, Discrete random variables, Binomial distribution, Continuous random variables, Uniformly distributed random variables, Commulative distribution functions.

UNIT II: Two-dimentional random variables, Marginal and conditional probability distribution, Independent random variables, Distribution of product and quotient of independent random variables.

UNIT III: Expected value of a random variable, Properties of expected value, Variance of a random variable, Properties of variance of a random variable, Chebyshev's inequality, Simple problems, Correlation coefficient, Regression of the mean.

UNIT IV: Binomial distribution, Poisson distribution, Poisson distribution as an approximation of the to the binomial distribution, Poisson process, Geometric distribution, Normal distribution, Properties of the normal distribution, Tabulation of the normal distribution.

<u>References</u> :

1. Mukherjee, K.K. : Probability and Statistics (New Central Book Agency Pvt. Ltd.), 1993 Edition.
2. Chandra, T.K. : Probability Theory, Narosa Publishing House
3. Feller, W. : An introduction to Probability theory and its applications, Vol I, Third U.S. Edition(1968), Wiley Eastern Limited, New Delhi.
4. Mayer, P.L. : Introductory Probability and Statistical Applications, 2nd Edition, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/454 (a): ADVANCED MECHANICS

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. know the use of reciprocal coordinates, pedal coordinates.
2. learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.
3. determine the kinetic energy of a rigid body about a fixed axes.
4. analyse impulsive motion using the laws of motion.

UNIT I: Motion on rough curve; Cycloidal motion motion with resistance. Velocity and acceleration in polar co-ordinate

UNIT II: Motion of a particle under central forces, use of reciprocal coordinates, Use of pedal coordinate and pedal equations, Kepler's laws of planetary motion.

UNIT III: Kinetic energy of a rigid body rotating about a fixed axes, Momental ellipsoid; Equimomental system; Coplanar distributions, General motion of a rigid body.

UNIT IV: Two dimensional rigid body dynamics; problems illustrating the laws of motion, Laws of conserva- tion, Impulsive motion.

<u>**Reference**</u> **:**

1. F.Chorton : Textbook of dynamics, CBS Publishers and distributors, Delhi.
2. M.Ray and GC Sharma: Textbook of Dynamics, S.Chand.

EIGHT SEMESTER
DISCIPLINARY
MAJOR

MAT/8/MJ/454 (b): MATHEMATICAL LOGIC

Full Marks: 100 *(4 Credits)*

Course Learning Outcomes: This course will enable the students to:

1. learn the syntax of first-order logic and semantics of first-order languages.
2. understand the propositional logic and basic theorems like compactness theorem and post-tautology theorem.
3. learn proof in first order logic like meta theorem, consistency and completeness

UNIT I: First-order languages, Terms of language, Formulas of language, First order theory.

UNIT II: Structures of first order languages, Truth in a structure, Model of a theory, Embeddings and isomorphism.

UNIT III: Syntax of propositional logic, Semantics of propositional logic, Compactness theorem for propositional logic, Proof in propositional logic, Meta theorem in propositional logic, Post tautology theorem.

UNIT IV: Proof in first-order logic, Meta theorems in first-order logic, Some meta theorem in arithmetic, Consistency and completeness.

References :

1. Richard E. Hodel (2013). *An Introduction to Mathematical Logic.* Dover Publications.
2. Yu I. Manin (2010). *A Course in Mathematical Logic for Mathematicians* (2nd edition). Springer.
3. Elliott Mendelson (2015). *Introduction to Mathematical Logic* (6th edition). Chapman & Hall/CRC.
4. Shashi Mohan Srivastava (2013). *A Course on Mathematical Logic* (2nd edition). Springer.