

Effective from Session: 2024-25									
Course Code	B030501T / MT320	Title of the Course	Group and Ring Theory & Linear Algebra	L	Т	Р	С		
Year	Third Semester Fifth								
Pre-Requisite	Knowledge of Sets, Relations and Matrices	Co-requisite	4	1	0	5			
Course Objectives	The objective of the course is to develop the skills to apply the basic knowledge of Group and Ring theory. The course will further develop understanding the concepts of Linear Algebra and their applications. The topics introduced will serve as basic tools for specialized studies in science field. After successfully completion of course, the student will able to explore subject knowledge into their respective dimensions.								

	Course Outcomes						
CO1	Liner algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the						
	basics of linear algebra and some of its applications.						
CO2	Students will be able to know the concepts of group, ring and other related properties which will prepare the students to take up						
	further applications in the relevant fields.						
CO3	The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics.						
	After completion of this course students appreciate its interdisciplinary nature.						

Part-A Group and Ring Theory								
Unit No.	Content of Unit	Contact Hrs.	Mapped CO					
Ι	Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups.	10	2 & 3					
II	Conjugacy classes, The class equation, <i>p</i> -groups, The Sylow theorems and consequences, Applications of Sylow theorems; Finite simple groups, Non-simplicity tests; Generalized Cayley's theorem, Index theorem, Embedding theorem and applications.	10	2 & 3					
III	Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion, Unique factorization in $Z[x]$.	9	2 & 3					
IV	IV Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.							
	Part-B Mathematical Methods							
Unit No.	Content of Unit	Contact Hrs.	Mapped CO					
V	Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space.	10	1&3					
VI	Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices.	9	1 & 3					
VII	Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem.	9	1&3					
VIII	Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.	9	1&3					

Refere	Reference Books: Part-A						
1.	I. N. Herstein, Topics in Algebra, John Wiley & Sons.						
2.	Suggested digital plateform: NPTEL/SWAYAM/MOOCS.						
Refere	Reference Books: Part-B						
1.	Linear Algebra by K. Hoffman and R. Kunze.						
2.	Suggested digital plateform:NPTEL/SWAYAM/MOOCs						

PO-PSO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
СО				-					
CO1	3	3	2	1	3	3	2	3	3
CO2	2	2	2	1	3	2	1	2	2

CO3	3	3	2	1	2	3	2	2	2		
1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation											
	Name A	sign of Prog	ram Coordinat		Sign & Seal of HoD						



Effective from Session: 2024-25										
Course Code	B030502T / MT321 Title of the Course Number Theory & Game Theory I			L	Т	Р	С			
Year	Third	Semester	Fifth		1	0	_			
Pre-Requisite	Knowledge of Sets & Co-requisite None		4		0	5				
Course Objectives	The objective of the course is to develop the skills to apply the basic knowledge of Number theory. The course will further develop understanding the concepts of Game theory and their applications. The topics introduced will serve as basic tools for specialized studies in science field. After successfully completion of course, the student will able to explore subject knowledge into their respective dimensions.									

	Course Outcomes							
CO1	Upon successful completion, students will have the knowledge and skills to solve problems in elementary number theory.							
CO2	This course provides an introduction to Game Theory. Game Theory is a mathematical framework which makes possible the analysis of the decision making process of interdependent subjects. It is aimed at explaining and predicting how individual behaves in a specific strategic situation, and therefore help improve decision making.							
CO3	A situation is strategic if the outcomes of decision problem depends n the choice of more than one person. Most decision problems in real life are strategic							
CO4	To illustrate the concept, real-world examples, case studies, and classroom experiments might be used.							

	Part-A Number Theory		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
Ι	Theory of Numbers: Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.	10	1 & 4
II	Congruences: Congruences modulo powers of prime; primitive roots and theirs existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol; quadratic reciprocity law; proofs of various formulations; Jacobi symbol.	9	1 & 4
III	Diophantine Equations: Solutions of $ax + by + c = 0$, $x^n + y^n = z^n$; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of Diophantine equations.	9	1 & 4
IV	Generating Functions and Recurrence relations: Generating Function Models, calculating coefficient of generating functions, partitions, Exponential Generating functions, A summation Method, Recurrence Relation Models, Divide and conquer Relations, solutions of Linear, Recurrence Relations, Solutions with Generating Functions.	9	1 & 4
	Part-B Game Theory		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
V	Introduction, overview, uses of game theory, some applications and examples, and formal definitions of the normal forms, payoffs, mixed strategies, pure strategy, Nash equilibrium.	10	2
VI	Introduction, characteristics of game theory, Two-person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.	10	2
VII	Fundamental Theorem of Rectangular games, Concept of Dominance and Graphical method of solving rectangular games.	9	3
VIII	Relationship between rectangular game and Linear Programming Problem, reduction of $m \times n$ game and solution of 2×2 , $2 \times s$ and $r \times s$ cases by graphical method, algebraic and linear programming solution of $m \times n$ games.	9	3 & 4

Refere	Reference Books: Part-A							
1.	Niven, I., Zuckerman, H. S. and Montegomery, H.L. An Int. of the Theory of Numbers John Wiley and sons, 2003.							
2.	Burten, D.M., Elementary Number Theory (4 th edition) Universal Book Stall, 2002.							
3.	B alakrishnan, V.K., Schaum's Outline of Theory and Problems of Combinatorics Including Concept of Graph Theory, McGraw Hill, 1995.							
4.	Balakrishnan, V.K., Introductory Discrete Mathematics, Dover Publications, 1996.							
5.	Suggested digital platform: NPTEL/SWAYAM/MOOCS.							
Refere	nce Books: Part-B							
1.	Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003.							
2.	Prajit Dutta, Strategies and Games, MIT Press, 1999. (WebsiteI: <u>http://www.ece.stevens.tech.edu/~ccomanic/ee*00c.html</u>)							

3.	Allan Mac Kenzie, Game Theory for Wireless Engineers, Synthesis lectures on Communications, 2006.

4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs

PO-PSO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
СО	101	102	100	101	100	1501	1002	1500	1501
CO1	3	2	1	2	3	3	2	3	3
CO2	3	1	2	2	2	3	1	1	2
CO3	2	1	1	1	2	1	2	1	1
CO4	2	2	1	1	2	2	1	1	2

1- Low Correlation; 2- Moderate Correlati	on; 3- Substantial Correlation
Name & Sign of Program Coordinator	Sign & Seal of HoD



Effective from Session: 2024-25							
Course Code	B030503T / MT322	Title of the Course Graph Theory & Discrete Mathematics		L	Т	Р	С
Year	Third	Semester	Fifth				
Pre-Requisite	Knowledge of Sets, Relations and Matrices	Co-requisite	None	4	1	0	5
Course Objectives	The objective of the course is to develop the skills to apply the basic knowledge of Graph theory. The course will further develop understanding the concepts of Discrete Mathematics and their applications. The topics introduced will serve as basic tools for specialized studies in science field. After successfully completion of course, the student will able to explore subject knowledge into their respective dimensions.						

	Course Outcomes
CO1	Upon successful completion, students will have the knowledge of various types of graphs, their terminology and applications.
CO2	After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topic includes path, circuits, adjacency matrix, tree, coloring. After successful completion of this course the student will have knowledge of graph coloring, color problem, vertex coloring.
CO3	After successful completion the student will have knowledge of Logic gates, Karanaugh maps and skills to proof by using truth table. After successful completion of this course the student will be able to apply the basics of the automation theory, transition function and table.
CO4	This course covers the basic concepts of discrete mathematics used in computer science, and other discipline that involve formal reasoning. The topic include logic, counting, relations, Hasse diagram and Boolean algebra. After successful completion of this course the student will have the knowledge in Mathematical reasoning, Combinatorial analysis, Discrete structures and Applications.

	Part-A Graph Theory		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
I	Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graph, Bipartite, regular, planar and connected components in graph, Euler graphs, Directed, Undirected, multi graph, mixed graph.	10	1
II	Walk and unilateral components, unicircle graphs, Hamiltonian path and circuits, Graph coloring, chromatics number, isomorphism and homomorphism of graphs, Incidence relation and degree of graph.	9	2
III	Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, shortest path, Dijkstra's algorithm.	9	2
IV	Tree, Binary and Spanning trees, coloring, color problems, Vertex coloring and important properties.	9	2
	Part-B Discrete Mathematics		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
V	Propositional Logic- Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truth table.	10	3
VI	Relation - Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation, Representation of POSETS using Hasse diagram, Chains, Maximal and Minimal point, Glb, lub, Lattices and Algebraic system, basic properties, Sublattice.	10	4
VII	Boolean Algebra- Basic definitions, Sum of products and products of sums, Boolean Functions, Disjunctive normal form, Complete Disjunctive normal form, Conjugate normal form, Logic circuits, Logic networks, Design of circuits from given properties, Logic gates and Karnaugh maps.	9	4
VIII	Combinatories- Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.)	9	4

Refe	Reference Books: Part-A				
1.	Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Dover Publications, 2017.				
2.	Douglas B West, Introduction to Graph Theory, Pearson 2018.				
3.	Santanu Saha Ray, Graph Theory with Algorithm and Its Applications: In Applied Science and Technology, Springer India, 2012.				
4.	Suggested digital plateform: NPTEL/SWAYAM/MOOCS.				
Refei	rence Books: Part-B				
1.	C. L.Liu., Discrete Mathematics, Tata McGraw Hill, 1986.				
2.	Trembley and Manohar, Discrete Mathematics with computer application Tata McGraw Hill, 2008.				
3.	Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Companies, 2012.				
4.	Suggested digital plateform: NPTEL/SWAYAM/MOOCs				

PO-PSO	PO1	PO2	PO3	PO4	PO5	5 PSO1 PSO2 PS	SO2 PSO3	PSO4	
CO				-					
CO1	3	2	1	1	2	2	2	3	3
CO2	2	3	2	1	3	2	2	2	3
CO3	1	2	3	1	2	1	2	3	3
CO4	3	3	3	1	3	2	2	3	3

Name & Sign of Program Coordinator	Sign & Seal of HoD



Effective from Session: 2024-25							
Course Code	B030504T / MT323	Title of the Course	Title of the Course Differential Geometry & Tensor Analysis		Т	Р	С
Year	Third	Semester	Fifth		1	0	_
Pre-Requisite	Knowledge of Geometry	Co-requisite	None	4	1	U	5
Course Objectives	The objective of the course is to develop the skills to apply the basic knowledge of Differential Geometry. The course will further develop understanding the concepts of Tensor Analysis and their applications. The topics introduced will serve as basic tools for specialized studies in science field. After successfully completion of course, the student will able to explore subject knowledge into their respective dimensions.						

	Course Outcomes
CO1	After successful completion of this course, students should be able to determine and calculate curvature of curves in different
	coordinates systems.
CO2	This course covers the Local theory of Curves, Local theory of surfaces, Geodesics, Geodesics curvature, Curvature of curves,
	on surfaces, Gaussian curvature, Normal curvature etc.
CO3	After Successful completion of this course, students should have the knowledge of tensor algebra, different types of tensors,
	Riemannian space, Ricci tensor, Einstein space and Einstein tensor etc.

	Part-A Differential Geometry		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
Ι	Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal and binormal, osculating Plane, normal plane and rectifying plane, osculating circle, osculating sphere Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Bertrand curves, Intrinsic equations, fundamental existence theorem for space curves.	10	1
II	Local theory of Surfaces-Tangent plane, Normal, Parametric patches on surface curve of a surface, family of surfaces (one parameter). Edge of regression, rues surfaces, skew ruled surfaces and developable surfaces.	9	2
III	Metric-first fundamental form and second fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties.	9	2
IV	Gauss-Bonnet theorem, curvature of curves on surfaces, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem	9	1 & 2
	Part-B Tensor Analysis		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
V	Tensor Algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensors, symmetric tensor, inner product.	10	3
VI	Tensor Analysis: Contravariant and Covariant vectors and tensors, Mixed tensors, symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Law of transformation of Christoffel's symbols	10	3
VII	Gradient of scalars, Divergence of a contravariant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector	9	3
VIII	Riemannian space, Riemannian curvatures and their properties, Geodesics, Geodesics curvature, geometrical interpretation of curvature ensor.	9	3

Refere	Reference Books: Part-A				
1.	T. J. Willmore, An Introduction in Differential Geometry, Dover Publications, 2012.				
2.	B. O'Neill, Elementary Differential Geometry, 2 nd Ed., Academic Press, 2006.				
3.	C. E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.				
4.	D. J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.				
5.	S. Lang, Fundamentals of Differential Geometry, Springer, 1999.				
6.	B. Spain, Tensor Calculus: A Concise course, Dover Publications, 2003.				
7.	L. P. Eisenhart, An Introduction to Differential Geometry (with the use of tensor Calculus), Princeton University Press, 1940.				
8.	I. S. Sokolnikoff, Tensor Analysis, Theory and Applications to Geometry and Mechanics of Continaa, 2 nd Edition, John Wiley and Sons, 1964.				

9.	Suggested digital plateform: NPTEL/SWAYAM/MOOCS.
Refer	ence Books: Part-B
1.	Z. Ahsan, Tensors-Mathematics of Differential Geometry, PHI, 2015.
2.	David C. Kay, Tensor Analysis, Schaum's Outline Series, McGraw Hill 1988.
3.	R. S. Mishra, A Course in Tensors with Applications to Riemannian Geometry, Pothishala Pvt Ltd, 1965.
4.	Suggested digital plateform:NPTEL/SWAYAM/MOOCs

PO-PSO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
СО	101	102	105	101	105	1501	1502	1505	1501
CO1	3	3	1	2	2	3	2	2	3
CO2	3	3	1	1	2	3	2	2	2
CO3	3	3	1	2	3	3	2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator

Sign & Seal of HoD



Effective from Session: 2024-25											
Course Code	B010501T/PY311	Title of the Course	Classical & Statistical Mechanics	L	Т	Р	С				
Year	Third	Semester	Fifth	4	0	0	4				
Pre-Requisite	10+2 with Physics	0+2 with Physics Co-requisite Passed B.Sc. 2 nd Year									
Course Objectives		his course aims to give students the competence in the basic Classical Mechanics and Statistical Mechanics. At the end of the course he students are expected to the thorough knowledge of basic concepts of Classical Mechanics and Statistical Mechanics.									

	Course Outcomes
CO1	Understand the concepts of generalized coordinates and D'Alembert's principle.
CO2	Understand the Lagrangian dynamics and the importance of cyclic coordinates.
CO3	Comprehend the difference between Lagrangian and Hamiltonian dynamics.
CO4	Study the important features of central force and its application in Kepler's problem.
CO5	Recognize the difference between macrostate and microstate.
CO6	Comprehend the concept of ensembles.
CO7	Understand the classical and quantum statistical distribution laws.
CO8	Study the applications of statistical distribution laws

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Constrained Motion	Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle	6	CO1
2	Lagrangian Formalism	Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.	9	CO2
3	Hamiltonian Formalism	Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.	8	CO3
4	Central Force	Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace-Runge-Lenz vector (Runge-Lenz vector) and its applications.	7	CO4
5	Macrostate and Microstate	Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.	6	CO5
6	Concept of Ensemble	Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.	6	CO6
7	Distribution Laws	Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in ith state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi- Dirac statistics. Comparison of statistical distribution laws and their physical significance. Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.	10	CO7
8	Applications of Statistical Distribution Laws	Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law. Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).	8	CO8
Referen	ce Books:			
		s P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e assical Mechanics", McGraw Hill, 2017		
	/	k, "Introduction to Classical Mechanics", McGraw Hill, 2017		
		s (In SI Units): Berkeley Physics Course Vol 5", McGraw Hill, 2017, 1e		
		s of Statistical Mechanics", New Age International Private Limited, 2020, 2e "Statistical Mechanics", New Age International Private Limited, 2007, 2e		
	ing Source:	Statistical internations, file international i fivate Lillineu, 2007, 20		
		ssachusetts Institute of Technology, https://openlearning.mit.edu/		
		echnology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd		
3. Uttar	r Pradesh Higher Edu	cation Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx		
4. Sway	yam Prabha - DTH Cl	nannel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		
[Course Articulation Matrix: (Manning of COs with POs and PSOs)		

		Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO1	3	2	-	-	-	-	3	2	-	1	2	
CO2	3	2	-	-	-	-	3	3	-	1	2	
CO3	3	2	-	-	-	-	3	3	-	2	2	
CO4	3	2	-	-	-	1	3	3	-	3	2	
CO5	3	2	-	-	-	-	3	3	-	3	2	
CO6	3	2	-	-	-	-	3	2	-	1	2	
CO7	3	2	-	-	-	-	3	3	-	1	2	
CO8	3	2	-	-	-	-	3	3	-	2	2	



Effective	from Session: 2024-2	25								
Course C	Code	B010502T/PY312	Title of the Course	Quantum Mechanics and Spectroscopy	LI	1	P	С		
Year		Third	Semester	Fifth	4 0		0	4		
Pre-Requ	uisite	10+2 with Physics	Co-requisite	Co-requisite Passed B.Sc. 2 nd Year						
Course C	Course Objectives This course aims to give students the competence in the basic Quantum Mechanics and Spectroscopy. At the end of the course the students are expected to gain the thorough knowledge of basic Quantum Mechanics and Spectroscopy.									
Course Outcomes										
CO1	CO1 Understand the significance of operator formalism in Quantum mechanics.									
CO2	Study the eigen and expectation value methods.									
CO3	Understand the basis an	d interpretation of Uncertainty	principle.							
CO4	Develop the technique	of solving Schrodinger equation	for 1D and 3D problems.							
CO5	Comprehend the succes	ss of Vector atomic model in the	theory of Atomic spectra.							
CO6	Study the different aspe	ects of spectra of Group I and II	elements.							
CO7	Study the production ar	nd applications of X-rays.								
CO8	Develop an understandi	ing of the fundamental aspects o	f Molecular spectra.							
Unit No.	Title of the Unit		Content of Unit Contact Hrs.							

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Operator Formalism	Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables. Commutators: Definition, commutator algebra and commutation relations among position, linear momentum and angular momentum and energy and time. Simple problems based on commutation relations.	5	CO1
2	Eigen and Expectation Values	Eigen and Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate and Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. Hermitian Operators: Definition, properties and applications. Prove of the Hermitian nature of various physical-dynamical operators.	6	CO2
3	Uncertainty Principle and Schrodinger Equation	 Uncertainty Principle: Commutativity and simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical- dynamical parameters and its applications. Schrodinger Equation: Derivation of time independent and time dependent forms, Schrodinger equation as an eigen equation, Deviation and interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation. 	7	CO3
4	Applications of Schrodinger Equation	 Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted). 	12	CO4
5	Vector Atomic Model	Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical and geometrical interpretations of various quantum numbers for single and many valence electron systems. LS and JJ couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.	10	CO5
6	Spectra of Alkali and Alkaline Elements	Spectra of Alkali Elements: Screening constants for s, p, d and f orbitals; sharp, principle, diffuse and fundamental series; doublet structure of spectra and fine structure of Sodium D line. Spectra of Alkaline Elements: Singlet and triplet structure of spectra.	6	CO6
7	X – Rays and X – Ray Spectra	Nature and production, Continuous X-ray spectrum and Duane-Hunt's law, Characteristic X-ray spectrum and Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.	7	CO7
8	Molecular Spectra	Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Rotational-Vibrational spectra; transition rules; fundamental band and hot band; O, P, Q, R, S branches.	7	CO8
Referenc		Quantum Mechanics", Pearson Education, India, 2004, 2e		
		Quantum Mechanics", Pearson Education, India, 2004, 2e		

E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017 2.

Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012 R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e 3.

4.

5. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934

C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e 6. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e 7.

e-Learning Source:

MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 1

National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 2

Name and Sign of Program Coordinator

3. Uttar Pradesh Higher Education Digital Library, <u>http://heecontent.upsdc.gov.in/SearchContent.aspx</u>

4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

				Course A	rticulation Matr	ix: (Mapping of	COs with POs a	and PSOs)			
PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO	101	102	105	104	105	100	10/	1501	1502	1505	1504
CO1	3	2	-	-	-	-	3	2	-	1	2
CO2	3	2	-	-	-	-	3	3	-	1	2
CO3	3	2	-	-	-	-	3	3	-	2	2
CO4	3	2	-	-	-	-	3	3	-	3	2
CO5	3	2	-	-	-	-	3	3	-	3	2
CO6	3	2	-	-	-	-	3	2	-	1	2
CO7	3	2	-	-	-	-	3	3	-	1	2
CO8	3	2	-	-	-	-	3	3	-	2	2
		1	- Low Correlation	on: 2- Moderate	Correlation: 3-	Substantial Cor	relation				



Effective from Session: 2024-25										
Course Code		B010503P/PY313	Title of the Course	le of the Course Demonstrative Aspects of Optics & Lasers				С		
Year		Third	Semester	Fifth	0	0	4	2		
Pre-Requisite		10+2 with Physics	Co-requisite	Passed B.Sc. 2 nd Year						
Course (Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in Optics through different experiments related to its theoretical course.								
			Course	Outcomes						
CO1	To understand the a	pplication of Fresnel'	s Biprism in determinat	ion of Wavelength of Light and thickness of a thin sh	eet.					
CO2	To understand the a	pplication of Newton ³	's Ring in determination	of Wavelength of Light and Refractive Index of a Ta	ranspa	rent Lic	luid.			

CO3 To find the Resolving Power of a grating and to understand its application in determination of wavelength of different colours of light.

CO4 To find the dispersive power of a prism and refractive index of its material using spectrometer.

CO5 To find the specific resistance of sugar solution using polarimeter and wavelength of Laser light using single slit diffraction.

* A student has to perform at least 7 experiments from the Offline Experiment List and 3 from the Online Virtual Lab Experiment List / Link.

Experiment No.	Title of the Experiment	Content of Unit (*Offline)	Contact Hrs.	Mappe d CO
1	Wavelength by Fresnel's Biprism	Fresnel Biprism: Wavelength of sodium light	4	CO1
2	Thickness by Fresnel's Biprism	Fresnel Biprism: Thickness of mica sheet	4	CO1
3	Wavelength by Newton's Ring	Newton's Rings: Wavelength of sodium light	4	CO2
4	Refractive Index by Newton's Ring	Newton's Rings: Refractive index of liquid	4	CO2
5	Resolving power of Grating	Plane Diffraction Grating: Resolving power	4	CO3
6	Wavelength by Diffraction Grating	Plane Diffraction Grating: Spectrum of mercury light	4	CO3
7	Refractive index of Prism	Spectrometer: Refractive index of the material of a prism using sodium light	4	CO4
8	Dispersive Power of Prism	Spectrometer: Dispersive power of the material of a prism using mercury light	4	CO4
9	Specific Rotation by Polarimeter	Polarimeter: Specific rotation of sugar solution	4	CO5
10	Wavelength of Laser Light	Wavelength of Laser light using diffraction by single slit	4	CO5
Experiment No.	Title of the Experiment	Content of Unit (*Online Virtual Lab)	Contact Hrs.	Mappe d CO
1	Michelson's Interferometer - Working	Michelson's Interferometer	4	CO1
2	Wavelength by Michelson's Interferometer	Michelson's Interferometer: Wavelength of laser beam	4	CO4
3	Wavelength by Newton's Ring	Newton's Rings: Wavelength of light	4	CO1
4	Refractive Index by Newton's Ring	Newton's Rings: Refractive index of liquid	4	CO4
5	Brewster's Law	Brewster's angle determination	4	CO4
6	Laser Beam Divergence	Laser beam divergence and spot size	4	CO2
7	Refractive index of Prism	Spectrometer: Refractive index of the material of a prism	4	CO4
8	Dispersive Power of Prism	Spectrometer: Dispersive power of a prism	4	CO2
9	Cauchy's Constant	Spectrometer: Determination of Cauchy's constants	4	
10	Wavelength by Diffraction Grating	Diffraction Grating	4	
Reference Boo				
		r Students", Methuen & Co., Ltd., London, 1962, 9e		
-	B. Mallick, "Engineering Practical Physics",	· · ·		
-	•	rishna Prakashan Media (Pvt.) Ltd., Meerut, 2019		
	V. Kumar, "Practical Physics", Pragati Prakas	han, Meerut, 2014, 2e		
e-Learning Sou				
	s at Amrita Vishwa Vidyapeetham, https://vla			
	s at Amrita Vishwa Vidyapeetham, <u>https://vla</u>			
3. Digital Plat	forms /Web Links of other virtual labs may b	e suggested / added to this lists by individual Universities.		

		Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	
CO1	2						3	3			3	
CO2	2						3	3			3	
CO3	3						2	3			3	
CO4	2						3	3			3	
CO5	3						2	3		2	3	

Name & Sign of Program Coordinator	
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			mieg	al Univer	sity, Luckno	JW					
Effectiv	re from Session: 202	24-25								1	_
Course	Code		01T/MT327	Title of the Course	Multivariate An Methods	alysis & Noi	n-parametric	L	Т	Р	С
Year		THIRI		Semester	FIFTH			4	0	0	4
Pre-Rec	quisite	10+2		Co-							
			matics	requisite	advanced conce	nts of mult	iveriete enel	veic and n	on noro	motri	
Course	Objectives	tools.		ementary and		pis of mun		ysis and n	JII para	meun	C
<i></i>	L				irse Outcomes						
CO1				concepts of	vector space	and matric	ces in order	tostudy			
GOA	multivariate d										
CO2	U U		1 1		ate normal dis						
CO3	Ability to uno	derstand	d the Maxin	numLikeliho	od Estimates o	f mean ve	ctor and dis	persion n	natrix.		
CO4 CO5	Ability to apr	ly dist	ribution free	ent Analysis tests (Non	and Factor Ana -parametric me	alysis. ethods) for	one and t	wosamnle	cases		
Unit									Contact		ped
No.	Title of the U	nit			Content of U				Hrs.	C	
			-	· •	ace, Linear C		· •		7		
1	Vector Space		Independen	nce, Inner Pi	roduct, Norm, O	Orthogonal	ity, Dimens	sion of		COI	L
			Vector Spa	ice.							
2	Matrices		Row and C	Column Ran	k, Rank of Mat	trix, Eleme	entary opera	tions on	8	001	
2	wattices		Matrices, I	nverse of a 1	natrix.					CO1	Ĺ
	Multivariate		Multivaria	te Normal	Distribution,	Marginal	and Cond	itional	8		
3	Normal Distribution									CO2	2
	Distribution		Maximum				ean vecto		7		
4	Estimation of		Dispersion matrix, Independence and point sufficiency of these							CO3	ł
7	Mean Vector		estimates.	maurx, m	dependence an	iu point s	sufficiency	of these			,
	A 11 .1	C		ng of Mult	ivariate Analy	aia. Drina	inal Comp	ononta	7		
5	5 Applications of Multivariate				•				,	CO4	1
5	Analysis		•		Analysis (Appli		lenteu uisci	ussion,		04	,
	-		derivations not required)						8		
6	Correlations a Regressions							0	CO4	ł	
	Non-parametr	ic	<u> </u>		Fasta for rando	maga and	tast for as	admaga	8		
7	test for one	ie i	-		Fests for randon Sign test, Wil		0		0	COS	;
	sample			1		Ũ			_	<u> </u>	
8	test for two	Non-parametric Two sample tests: Run test, Kolmogorov – Smirnov's test,							7	COS	5
0	sample		Median tes	t and Mann-	Whitney U test					000	
Referen	ce Books:										
1.	Anderson, T.W	7. (2003)): An Introdu	ction to Mul	tivariate Statistic	cal Analysis	s, 3 rd Edn., J	ohnWiley			
C	Muinhaad DI	(1002)	A aposto of M	ultivomiete Of	atistical Theorem	John Wils-	Valinaa				
<u>2.</u> 3.	A.M. (1972): N	· ·	A		atistical Theory,	John whey	. Asmrsagar				
<u> </u>					ed Multivariate A	Analyzia Et	hEdn Door	on & Dron	tico Uo	11	
<u>4.</u> 5.							iieuii., reais			<u>11</u>	
<u> </u>					sis. South Asian e. Academic Pre						
	ive digital platform	,				33.					
	//youtu.be/Ig2qF5B										
					(Monning of CO						
PO-PSO					(Mapping of COs v						
C0	PO1 PO2	PO3	PO4	PO5 PO6	PO7	PSO1	PSO2	PSO3	PSO4	P	SO4
C01	3 2	1		3		3	2	3	2	$-\!$	3
CO2 CO3	3 2 3 2	1	1	3 3		3	3	2 3	2	+	3
C03	3 1	1	1	3		3	2	2	3		3
CO5	3 2	1	1	3		3	3	3	3		2
		1-]	Low Correlatio	n; 2- Moderate	Correlation; 3- Sul	bstantial Cor	relation				
	Name &	Sign of P	rogram Coordi	nator			Sign & Seal	of HoD			
	Name & Sign of Program Coordinator Sign & Seal of HoD										



				Integ	ral Ui	niver	sity, L	uckno)W					
Effectiv	e from Ses	sion: 20	24-25		Title	of 4h o								
Course	Code		B0605	02T/MT328	Cour	of the se	Analysi	s of Vari	ance & Desig	gn of Experim	ents L	T	Р	C
Year			THIRI		Seme	ster	FIFTH				4	0	0	4
Pre-Req	uisite		10+2 v		Co-									
			Mathe:		requi		ming	onductin	a opolyzin	g and extract	ing infor	motion	from	
Course	Objectives	1		mental data.	-	of desig	gning, co	onductin	ig, anaryzin	g and extract	ing inton	mation	nom	
			cxpen	memai uata.		Cou	rse Outco	omes						
CO1	Knowle	dge of	the conc	ept of Analys	sis of V									
CO2				ANOVA for					fication.					
CO3	•			ept of Design		•	•							
CO4										d withoutmis	sing obse	ervation	s.	
CO5	The may be performented with any other symmetric designs of the transmission of the tr													
Unit No.		le of the		1	I			ontent of U	••			Contact Hrs.	Mapp CC	
110.				Definition	n of An	alvsis o	of Varia	nce Ass	umptions a	ndLimitation	sof	<u>1115.</u> 7		
1	ANOVA	1		ANOVA,					umptions u		.5 01		C01	
2	Two wa	y							umber of ob	servations p	er cell.	8	CO 2	
2	classific	ation		Duncan's						•			CO2	
	Principle	es of								on, Replicatio		8		
3	Experim		esigns					• •	• •	t using unifo	ormity		CO3	
				trials. Co						and definiti	on of	7		
4	Differen									and definition			CO3	
	Experim	ental D	esigns	efficiency of design, Comparison of efficiency between CRD and RBD.								0.05		
5	Comparison between Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of							son of	7					
5	experim	ental de	signs	-		•		•	SD and CRI				CO4	
	Missing	nlot		Missing plot technique: Estimation of missing plots by minimizing 8										
6	techniqu				error sum of squares in RBD and LSD with one or two missing							CO4		
	_				observations.							0		
_				Factorial Experiments: General description of factorial experiments,						8				
7	Factoria	l Experi	iments		2^2 , 2^3 factorial experiments arranged in RBD and LSD, Definition of Main effects and Interactions in 2^2 and 2^3 factorial experiments,								CO5	
8	Estimati and inter			^			•	.		mates and ter	sts for	7	CO5	
D. C		action	effects	main and	interac	tion en	tects (Al	nalysis v	vithout cont	rounding).				
Referen 1.	ce Books:	C and	Kanoor	$V K (2014) \cdot 1$	Fundam	antals of	f Appliq	d Statistic	os A th Editiv	on, Sultan Cha	nd & Son	0		
2.										ey & Sons, Inc		3		
3.				, ,	-		5			ernational (P) I		ublisher	s	
													5.	
4.	Goon, A	M., Gt	ipta, M.K.	and Dasgupta	а, В. (20	16): Fu	ndamenta	als of Sta	tistics. Vol.	II, World Press	s, Kolkata	•		
5.	Joshi, D	.D. (19	87). Linea	r Estimation	and Des	sign of l	Experime	ents. Nev	w Age Intern	national (P) Lto	1. New De	elhi.		
6.	Ũ		,	, 0			1		Edition, John	Wiley & Sons	s, Inc.			
				<pre>x/platform: NP</pre>										
https:/	//www.you	tube.coi	<u>m/watch?v</u>	=IEUTRhyoHl	Nc&list=	<u>PLPJSq</u>	TyvDev	<u>vS9Lxp4</u> j	reGJ7eNsxH	<u>xJA8</u>				
				Course Artic	ulation N	Aatrix: (Mapping	g of COs v	with POs and	PSOs)		T		
PO-PSC	D PO1	PO2	PO3	PO4	PO5	PO6]	PO7	PSO1	PSO2	PSO3	PSO4	PS	SO-
CO CO1	3	2	1		3				3	2	3	2		3
CO2	3	1	1		3				3	3	2	2		3
	3	2	1		2 3				3	3	3	2		2
CO3					1				3	2	2	3		3
	3	2 2	1		2				3	3	3	3		2

Sign & Seal of HoD

Name & Sign of Program Coordinator



Effective from Session: 2024	Effective from Session: 2024-25										
Course Code	B060503P/MT329	Title of the Course	Non-Parametric Methods & Design of Experiments Lab	L	Т	Р	С				
Year	Third	Semester	Fifth	0	0	4	2				
Pre-Requisite	10+2 with Mathematics	Co-requisite									
Course Objectives											

	Course Outcomes
CO1	Ability to conduct test of significance based non-parametric tests.
CO2	Ability to deal with multivariate data.
CO3	Knowledge of Principal Component Analysis and Factor Analysis. Ability to perform ANOVA for one way and two
	classifications
CO4	Ability to perform post-hoc analysis.
CO5	Ability to conduct analysis of CRD, RBD and LSD with and without missing observations and
	Ability to conduct analysis for Factorial experiments (without confounding)

Experiment No.	Title of the Experiment	Content of Experiment	Contact Hrs.	Mapped CO
1		Problems based on Non-parametric tests for one sample.	2	1
2		Problems based on Non-parametric tests for two samples.	2	1
3		Problems based on Rank and Inverse of a matrix.	2	2
4		Problems based on Mean vector and Dispersionmatrix of a multivariate normal distribution.	2	2
5		Problems based on Principal Component Analysis.	2	3
6		Problems based on Factor Analysis.	4	3
7		Problems based on Analysis of variance in one-way and two-way classification (with and without interaction terms).	4	4
8		Problems based on Analysis of a Latin square design.	4	4
9		Problems based on Analysis of variance in RBD and LSD with one or two missing observations.	4	5
10		Problems based on Factorial Experiment Practical	4	5
Reference Boo	oks:			
1. Coc	hran, W. G. and	Cox, G. M. (1957). Experimental Design. John Wiley & Sons, New York.		
	rhead, R.J. (198 lysis, 1stEdn. N	2): Aspects of Multivariate Statistical Theory, John Wiley.Kshirsagar, A.M. (1972): M Iarcel Dekker.	ultivariate	

3. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition.Marcel Dekker, CRC

e-Learning Source:

Suggestive digital platforms web link/platform: NPTEL/SWAYAM/MOOCS

		Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3						3	3	3	3	3	3	
CO2	3						2	3	2	3	3	2	
CO3	3						3	3	2	2	2	1	
CO4	3						2	3	2	2	3	2	
CO5	3						2	3	3	3	3	3	
				1- Low	Correlati	on; 2- Mod	erate Correl	ation; 3- Subs	stantial Correla	tion			



Effective from Session: 2024-25														
Course Code	B030502T / MT324 Title of the Course Metric Spaces & Complex Analysis		L	Т	Р	С								
Year	Third	Semester	Sixth											
Pre-Requisite	Knowledge of sets, limit, continuity & Co-requisite None 3					0	4							
Course Objectives	course will further developics introduced will	velop understanding th serve as basic tools	e concepts of Complex Analysis and t for specialized studies in science fiel	heir a d. A	pplicat fter su	The objective of the course is to develop the skills to apply the basic knowledge of Metric Spaces. The course will further develop understanding the concepts of Complex Analysis and their applications. The								

	Course Outcomes							
CO1	The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical							
	phenomena and gives the student the foundation in mathematics.							
	After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in							
CO2	Mathematics. This will be helpful to the student in understanding pure mathematics and in research.							
CO3	Students will be able to know the concepts of metric space, basic concepts and developments of complex analysis which will							
	prepare the students to take up further applications in the relevant fields.							

	Part-A Metric Spaces		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
Ι	Basic Concepts: Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.	8	1 & 3
II	Topology of Metric Spaces: Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.	8	1&3
III	Continuity & Uniform Continuity in Metric Spaces: Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.	7	1 & 3
IV	Connectedness and Compactness: Connectedness, Connected subsets of real numbers, Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces.	7	1 & 3
	Part-B Complex Analysis		
Unit No.	Content of Unit	Contact Hrs.	Mapped CO
V	Analytic Functions and Cauchy-Riemann Equations: Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.	8	1 & 2
VI	Elementary Functions and Integrals: Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.	8	1 & 2
VII	Cauchy's Theorems and Fundamental Theorem of Algebra: Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.	7	1 & 2
VIII	Series and Residues: Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.	7	1 & 2

Refere	ence Books: Part-A
1.	Mathematical Analysis by Shanti Narain.
2.	Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
3.	Kumaresan, S. (2014). Topology of Metric Spaces (2 nd ed.). Narosa Publishing House. New Delhi.
4.	Simmons, G. F. (2004). Introduction to Topology and Modern Analysis. Tata McGraw Hill. New Delhi.

5.	Suggested digital plateform: NPTEL/SWAYAM/MOOCS.
Refere	ence Books: Part-B
1.	Function of Complex Variable by Shanti Narain.
2.	Complex variable and applications by Brown & Churchill.
3.	Suggested digital plateform: NPTEL/SWAYAM/MOOCs

PO-PSO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
СО	101	102	100	101	100	1501	1002	1500	1501
CO1	3	3	2	1	3	3	3	2	3
CO2	3	3	2	1	3	3	2	2	3
CO3	3	3	3	1	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation								
Name & Sign of Program Coordinator	Sign & Seal of HoD							



Effective from Session: 2024-25										
Course Code	B030602T / MT325	Title of the Course	Numerical Analysis & Operation Research	L	Т	Р	С			
Year	Third	Semester	Sixth							
Pre-Requisite	Knowledge of errors and system of linear equations.	nd system of linear Co-requisite None					4			
Course Objectives	course will further dev topics introduced will	velop understanding the serve as basic tools	skills to apply the basic knowledge of Nu e concepts of Operation Research and t for specialized studies in science fiel explore subject knowledge into their resp	heir a ld. A	pplicat fter su	tions. T	The			

	Course Outcomes							
CO1	The aim of this course is to teach the student the application of various numerical technique for variety of problems occurring in							
	daily life. At the end of the course the student will be able to understand the basic concept of Numerical Analysis and to solve							
	algebraic and differential equation.							
CO2	The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can							
	opt for advance course in Numerical Analysis in higher Mathematics.							
CO3	The student will be able to solve various problems based on linear programming. After successful completion of this paper							
	will enable the students to apply the basic concepts of operations research.							

Part-A									
	Numerical Analysis								
Unit No.	it No. Content of Unit								
I	Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Newton's method for multiple roots, Interpolation, Lagrange and Hermite interpolation, Difference schemes, Divided differences, Interpolation formula using differences.	8	1 & 2						
п	Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas, Gaussian Quadrature Formulas, System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods). The Algebraic Eigen value problem: Jacobi's method, Givens method,Power method.	8	1&2						
III	Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method, Types of approximation: Last Square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation.	7	1&2						
IV	Difference Equations and their solutions, Shooting method and Difference equation method for solving Linear second order differential equation with boundary conditions of first, second and third type.	7	1 & 2						
	Part-B Operation Research								
Unit No.	Content of Unit	Contact	Mapped						

Unit No.	Content of Unit	Hrs.	CO
	Introduction, Linear programming problems, statement and formation of general linear	8	2
	programming problems, graphical method, slack and surplus variables, standard and matrix forms		3
V	of linear programming problem, basic feasible solution.		
	Convex sets, fundamental theorem of linear programming, basic solution, Simplex method,	8	3
VI	introduction to artificial variables, two phase method Big-M method and their comparison.		5
VII	Resolution of degeneracy, duality in linear programming problems, primal dual relationships, revised simplex method, sensitivity analysis.	7	3
VIII	Transportation problems, assignment problems.	7	3

Refer	Reference Books: Part-A								
1.	Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.								
1.	Introductory methods of Numerical Analysis by S. S. Sastry								
2.	2. Suggested digital plateform: NPTEL/SWAYAM/MOOCS.								
Refer	Reference Books: Part-B								
1.	1. Taha, Hamdy H, "Opearations Research- An Introduction ", Pearson Education.								

2.	Gupta, Prem Kumar, Initials, " Operations Research", Chand (S) & Co Ltd, India.
3.	Hillier Frederick S and Lieberman Gerald J., "Operations Research", McGraw Hill Publication
4.	Winston Wayne L., "Operations Research: Applications and Algorithms", Cengage Learning, 4th Edition.
5.	Hira D.S. and Gupta Prem Kumar, "Problems in Operations Research: Principles and Solutions", S Chand & Co Ltd
6.	Kalavathy S., "Operations Research", S Chand.
7.	Suggested digital plateform:NPTEL/SWAYAM/MOOCs.

PO-PSO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
СО	101	102	100	101	100	1501	1002	1500	1501
CO1	3	3	3	1	2	2	3	3	3
CO2	3	3	3	1	2	2	3	3	3
CO3	2	2	3	1	2	2	2	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation	on
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Name & Sign of Program Coordinator

Sign & Seal of HoD



Effective from Session: 2024-25										
Course Code	B030603P / MT326	Title of the Course	Practical Using Mathematica/MATLAB	L	Т	Р	С			
Year	Third	Semester Sixth								
Pre-Requisite	Knowledge of numerical analysis. Co-requisite None					4	4			
Course Objectives	equations, system of li	The main objective of the course is to equip the student to solve the transcendental and algebraic quations, system of linear equations, ordinary differential equations, Interpolation, Numerical Integration, Method of finding Eigenvalue by Power method (up to 4×4), Fitting a Polynomial Function (up to								

Unit No.	Topics	No. of Lectures
I	Practical / Lab work to be performed in Computer Lab. List of the practicals to be done using computer algebra software (CAS), for example R/Python/Mathematica/MATLAB/Maple/Maxima/Scilab etc 1. Solution of transcendental and algebraic equations by	
	i) Bisection method	
	ii) Newton Raphson method (Simple root, multiple roots, complex roots).	
	iii) Secant method.	
	iv) Regula Falsi method.2. Solution of system of linear equations	
	i) LU decomposition method	
	ii) Gaussian elimination method	
	iii) Gauss-Jacobi method	
	iV) Gauss-Seidel method 3. Interpolation	
	i) Lagrange Interpolation	
	ii) Newton's forward, backward and divided difference interpolations4. Numerical Integration	
	i) Trapezoidal Rule	
	ii) Simpson's one third rule	
	iii) Weddle's Rule	
	iv) Gauss Quadrature	
	5. Method of finding Eigenvalue by Power method (up to 4×4)	
	6. Fitting a Polynomial Function (up to third degree)	
	7. Solution of ordinary differential equations	
	i) Euler method	
	ii) Modified Euler method	
	iii) Runge Kutta method (order 4) The method of successive approximations (Picard)	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator

Sign & Seal of HoD



Image: Crystal Structure Lattice Translation vectors. Primitive and non-primitive and conspirative and space graps. Dand 3DB argues 120 and 3DB argues 120 and 3DB argues 120 and 3DB argues 120 and 3DB argues 130 argues 130 argues 130 argues 130 argues 130		from Session: 20									-	-		
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Effective from Session: 2024-25												
Course Code	B010602T/PY315	Title of the Course	Analog & Digital Principles & Applications	L	Т	Р	С					
Year	Third	Semester Sixth 4 0 0 4										
Pre-Requisite	10+2 with Physics	with Physics Co-requisite Passed B.Sc. 2 nd Year										
Course Objectives		This course aims to give students the competence in Analog and Digital Electronics. At the end of the course the students are expected o gain the thorough knowledge of Analog and Digital Electronics and their applications in daily life.										

	Course Outcomes
CO1	Study the drift and diffusion of charge carriers in a semiconductor.
CO2	Understand the Two-Port model of a transistor.
CO3	Study the working, properties and uses of FETs.
CO4	Comprehend the design and operations of SCRs and UJTs.
CO5	Understand various number systems and binary codes.
CO6	Familiarize with binary arithmetic.
CO7	Study the working and properties of various logic gates.
CO8	Comprehend the design of combinational and sequential circuits.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Semiconductor Junction	Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.	9	CO1
2	Transistor Modelling	Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).	8	CO2
3	Field Effect Transistors	JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs). MOSFET: Construction and Working of DE-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of DE-MOSFET and E-MOSFET; Comparison of JFFET and MOSFET.	8	CO3
4	Other Devices	5	CO4	
5	Number System	Sawtooth generators). Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.	6	CO5
6	Binary Arithmetic	Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.	5	CO6
7	Logic Gates	Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map.	9	C07
8	Combinational and Sequential Circuits	Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.	10	CO8
	e Books:			
		'Electronic Devices and Circuit Theory'', Prentice-Hall of India Pvt. Ltd., 2015, 11e		
		abrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e		
		e, "Solid State Electronic Devices", Pearson Education India, 2015, 7e mentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e		
		Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e		
		n Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e		
		tal Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e		
8. R.P.J	Jain, "Modern Digital Ele	ectronics", McGraw Hill, 2009, 4e		
e-Learni	ng Source:			
		husetts Institute of Technology, https://openlearning.mit.edu/		
		nology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd		
3. Uttar	Pradesh Higher Education	on Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx		

4. Swayam Prabha - DTH Channel, <u>https://www.swayamprabha.gov.in/index.php/program/current_he/8</u>

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4			
CO1	3	2	-	-	-	-	3	2	-	1	2			
CO2	3	2	-	-	-	-	3	3	-	1	2			
CO3	3	2	-	-	-	-	3	3	-	2	2			
CO4	3	2	-	-	-	-	3	3	-	3	2			
CO5	3	2	-	-	-	-	3	3	-	3	2			
CO6	3	2	-	-	-	-	3	2	-	1	2			
CO7	3	2	-	-	-	-	3	3	-	1	2			
CO8	3	2	-	-	-	-	3	3	-	2	2			

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Effectiv	Effective from Session: 2024-25												
Course	Code	B010603P/PY316	Title of the Course	Analog & Digital Circuits	L	Т	Р	С					
Year		Third	Semester	Sixth	0	0	4	2					
Pre-Req	quisite	10+2 with Physics	Co-requisite	Passed B.Sc. 2 nd Year									
Course	Course Objectives The purpose of this undergraduate course is to impart practical knowledge/measurements in Analog and Digital Electronics through different experiments related to its theoretical course.												
Course Outcomes													
CO1													
COA	T 1 1 1 1 1 1	1	c 1										

CO2 To calculate the hybrid parameter of a transistor from normal parameters. CO3

To study the behaviour of FET and MOSFET from their characteristic curves. To study the behaviour of SCR and UJT from their characteristic curves. CO4 CO5 To study the functioning the working of different logic gates

* A student has to perform at least 7 experiments from the Offline Experiment List and 3 from the Online Virtual Lab Experiment List / Link.

Experiment No.	Title of the Experiment	Aim of the Experiment (*Offline)	Contact Hrs.	Mapped CO						
1	Energy Band Gap	To find the energy band gap of semiconductor by reverse saturation current method.	4	CO1						
2	Four Probe Method	To find the energy band gap of semiconductor by four probe method.	4	CO1						
3	Hybrid parameters of transistor	To find the hybrid parameters (h – parameters) of a transistor in Common Emitter Mode	4	CO2						
4	Field Effect Transistor (FET)	To study the characteristics of FET.	4	CO3						
5	Metal Oxide Field Effect Transistor (MOSFET)	To study the characteristics of MOSFET.	4	CO3						
6	Silicon Controlled Rectifier	To study the characteristics of SCR.	4	CO4						
7	Unijunction Transistor	To study the characteristics of UJT.	4	CO4						
8	 (iv) Ex-OR gate using TTL IC 7486 (v) NAND gate and use as Universal gate using TTL IC 7400 (vi) NOR gate and use as Universal gate using TTL IC 7402 									
Experiment No.	Title of the Experiment	Aim of the Experiment (*Online Virtual Lab)	Contact Hrs.	Mapped CO						
1	Field Effect Transistor (FET)	ID-VD characteristics of Junction Field Effect Transistor (JFET)								
2	Silicon Controlled Rectifier	Silicon Controlled Rectifier (SCR) characteristics								
3	Unijunction Transistor	Unijunction Transistor (UJT) and relaxation oscillator								
4	Logic Gates	Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex- NOR gates								
5	Half Adder and Full Adder	Construction of half and full adder using XOR and NAND gates and verification of its operation								
6	Half Subtractor and Full Subtractor	To study and verify half and full subtractor								
7	Universal Gates	Realization of logic functions with the help of Universal Gates (NAND, NOR)								
8	NOR Gate Latch	Construction of a NOR gate latch and verification of its operation								
9	Flip Flops	Verify the truth table of RS, JK, T and D Flip Flops using NAND and NOR gates								
10	Shift Registers	Design and verify the 4-Bit Serial In - Parallel Out Shift Registers								
11	Decoder and Encoders	Implementation and verification of decoder or demultiplexer and encoder using logic gates								
12	Multiplexer and Demultiplexer	Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates								
13	Synchronous and Asynchronous Counter	Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop								
14	Binary to Gray and Gray to Binary conversion	Verify Binary to Gray and Gray to Binary conversion using NAND gates only								
15	1-Bit and 2-Bit comparator	Verify the truth table of 1-Bit and 2-Bit comparator using logic gates								
Reference Boo										
	, L. Nashelsky, "Electronic Devices and Circuit Theo	-								
· · · · · ·	C. Halkias, Satyabrata Jit, "Electronic Devices and									
	n, S.K. Banerjee, "Solid State Electronic Devices",									
•	lectronic Fundamentals and Applications", Prentice									
-	Kumar, "Hand Book of Electronics", Pragati Praka									
	Aalvino, Goutam Saha, "Digital Principles and App									
		o Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e								
~	dern Digital Electronics", McGraw Hill, 2009, 4e									
e-Learning So										
	t Amrita Vishwa Vidyapeetham, <u>https://vlab.amrita</u>									
	t Amrita Vishwa Vidyapeetham, <u>https://vlab.amrita.</u>									
Digital Platfor	ms /Web Links of other virtual labs may be sugges	ieu / audeu to this lists by individual Universities.								

		Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4				
CO1	2						3	3			3				
CO2	2						3	3			3				
CO3	3						2	3			3				
CO4	2						3	3			3				
CO5	3						2	3		2	3				

Name & Sign of Program Coordinator	Sign & Seal of HoD



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YearTHIRDSensetrSIXTH40Pre-Requisite10+2 with MathematicsCo. requisiteTo introduce the basic concept of computer and data analysis using statistical software. COUE Basic Knowledge of Computer and its number system.EC01Basic Knowledge of Computer and its number system.Basic Knowledge of SPSS.Control and analysis for both univariate and multivariate data sets using SPSS. Ability to perform data analysis for both univariate and multivariate data sets using SPSS.Contact of UaitC03Basic Knowledge of SPSS.Content of UaitContent of UaitContent of UaitNo.Thirdouction to ComputerIntroduction to Computer: Contention of Computer, Sance Structure of Computer, Hexalectinal Systems). Flow chart for simple statistical problems. Introduction to to Regramming and R Studio, Installing R, R as a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Iranes, Factors and Lats.83Introduction to SPSS SAS, STATA, creating new variables, recoding variable, renaming variables,74Graphs and Inferential Statistics with RGraphs using R. Inferential Statistics- Parametric test: Test for Normality, 1-test Regression Simple and Multiple regression85Non-parametric test, Markysio O Variance, Karl Pearson correlation coefficient, Linear Regression Simple and Multiple regression46Statistics with SPSSSpSS Non-parametric test, Analysis of Variance, Correlation and Proparametric test, Analysis of Variance, Press, Inc.87Non-parametric Inforential Statistics with SPSS<	Course	Code		B060	0601T/MT330				miloduction	L	Т	Р	0	
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6. Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Pren Hall. Suggestive digital platforms web link/platform: NPTEL/SWAYAM/MOOCS https://youtu.be/N-DQ8iDIH_U?si=1JEk1k127GtlafH2 Course Articulation Matrix: (Mapping of COs with POs and PSOs) PO-PSO PO1 PO2 PO3 PO4 PO5 PO6 PO7 PS01 PS02 PS03 PS02 CO1 3 2 2 3 3 2 2 3 2 2 3 2 2 3 2 2 3 2 2 3 2 2 3 3 3 3 3 2 2 3	4.	Margan	G A: SP	SS for I	Introductory Stat	istics; Uses an	d Interpretation.							
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Effective	e from Ses	sion: 202	24-25		<u> </u>		• /								
Course	Code		B0606	502T/MT331	Title Cour	of the se	Operati	ons Resea	arch			L	Т	Р	С
Year			THIR		Seme	ester	SIXTH					4	0	0	4
Pre-Req	uisite		10+2 Mathe		Co- requi	isite									
-			Under	rstand the c	lefinitions	s and F	Formulat	ion of lir	near program	mming prob	lem and	diffe	erent		
Course	Objectives							lly comp	oletion of co	ourse, the stu	ident w	ill ab	le exp	olore	
			subjec	et into their	respectiv										
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CO5				blems base				5.							
Unit No.	Title of	the Uni	t				Conter	nt of Unit					ontact Hrs.	Mapp CO	
1	Introduc of OR	ction		istory & ba eir formula						ning proble	ms and		7	CO1	
2	Solution		So	olving LPP	by, Sim	plex r	nethod,			wophase Me	ethod,		8	CO2	
2	LPPDegeneracy and Duality in LTT.3TransportatioTransportatioTransportation problem: North-west corner rule, Least cost method,8														
3	n Problems Vogel's approximation method. Optimum solution: Stepping stone method. COS Assignment Assignment 7														
4Assignment ProblemsAssignment Problem: Hungarian Method, TravellingSalesman Problem,7CO3															
5	Replacement ProblemsReplacement replacement.Individual andGroup												7	CO4	
6	Sequent Problem	cing 1s		b sequenci achines.	ing: n joł	os – 2	machin	es, n joł	-3 mac	hines, 2 jobs	s – n		8	CO4	
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7	Game Theory									Zero-Sum				CO5	
	Theory			ethod, Don	-	· ·		n to rect	angular ga	me using gr	apnicai				
	Properti	ies of						e proper	tv to reduc	e the game	matrix		7	~~~	
8	game th								strategy, Ll					CO5	
Referen	ce Books:														
1.	Swarup,	K., Gu	ıpta P.K.	and ManM	Iohan (20	07). Oj	perations	Research	n, Sultan Ch	and & Sons.					
2.	Taha, H.	A. (200	7). Opera	tions Resea	rch: An Int	troducti	ion, Prent	tice Hall o	of India.Had	ley, G: (2002) : Linea	r			
				blications						•					
3.	-	•			$I_{(2010)}$	Introd	uction to	Operati	one Resear	ch- Concepts	and case	as Of	h Edi	tion 7	Fata
J. McGrav		л, г.л	and Lie	Jerman, O.). (2010).	muou	uction it	o operati	ons Researc	II- Concepts	and case	<i>cs</i> , <i>H</i>	ii Lui	uon, i	i ata
4.		G: (200	2): Linear	Programmi	ing, Naros	a Publi	cations								
5.			_			-			inciples and	Practice, Joh	n Wiley	& So	ns.		
				k/platform:			I/MOOCS	5							
<u>intps.</u>	//www.y	outube.	<u>com/wa</u>	tch?v=bQ5 Course Art			(Manning	of COs v	vith POs and	PSOs)					
PO-PSC) PO1	PO2	PO3	PO4	PO5	PO6		PO7	PSO1	PSO2	PSO3		PSO4	PS	504
CO CO1	3	2		2	3				3	2	3		2		3
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CO3	3	2		2	3				3	3	3		2		2
CO4 CO5	3	22		2 2	3				3	2 3	2	+	3		3 2
05	3	2	1-	—	-	oderate	Correlati	on; 3- Sul	ostantial Cor		3		3	<u> </u>	2
1	1	Name &	Sign of P	rogram Coo	rdinator			1		Sign & Seal	of HoD				



Effective from Session: 2024	Effective from Session: 2024-25												
Course Code	B060603P/MT332	Title of the Course	Operations Research & Statistical Computing Lab	L	Т	Р	С						
Year	Third	Semester	Sixth	0	0	4	2						
Pre-Requisite	10+2 with Mathematics	Co-requisite											
Course Objectives													

	Course Outcomes								
CO1	Knowledge of mathematical formulation of L.P.P								
CO2	Ability of solving LPP using different methods.								
CO3	Ability to solve Allocation Problem based on Transportation and Assignment model.								
CO4	Ability to solve problems based on Game Theory.								
CO5	Ability to use programming language R and SPSS								

Experiment No.	Title of the Experiment	Content of Experiment	Contact Hrs.	Mapped CO				
1		Problem based on Mathematical formulation of L.P.P	2	1				
2		Problem based on solving LPP using GraphicalMethod	2	2				
3		Problem based on solving LPP using Simplex Method						
4		4	2					
5		involving artificial variables. Allocation Problem based on Transportation model.	2	3				
6		2	3					
7		2	4					
8		2	4					
9		Problem based on solving Mixed strategy game.						
10		Problem based on solving game using LPP method.						
11		Problem based on application of R as Calculator.						
12		Problem based on application of R in simple dataanalysis						
13		Problem based on application of SPSS in data analysis	2	5				
Margan G	., Gupta P.K A: SPSS for I	A. and ManMohan (2007). Operations Research, SultanChand & So Introductory Statistics; Uses and Interpretation. rt of R Programming, No Starch Press, Inc.	ns.					
e-Learning Suggestive d		web link/platform: NPTEL/SWAYAM/MOOCS						

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3						3	3	3	3	3	3
CO2	3						2	3	2	3	3	2
CO3	3						3	3	2	2	2	1
CO4	3						2	3	2	2	3	2
CO5	3						2	3	3	3	3	3

Sign & Seal of HoD