MARUDHAR KESARI JAIN COLLEGE FOR WOMEN (AUTONOMOUS)

Vaniyambadi – 635 751

PG & Research Department of Mathematics

for

Postgraduate Programme

Master of Science in Mathematics

Regulations 2026-2027

Course Code	Course Category	Title of the Course	Ins. Hrs/ Week	Credit	Marks		Total
					CIA	ESE	
Semester – I							
26PMAC11	Core – 1	Algebra I	6	5	25	75	100
26PMAC12	Core – 2	Real Analysis I	6	5	25	75	100
26PMAC13	Core – 3	Ordinary Differential Equations	5	3	25	75	100
26PMAE11/ 26PMAE12	DCE – 1	Graph Theory and its Applications / Mathematical Statistics	4	3	25	75	100
26PMAE13/ 26PMAE14	DCE – 2	Resource Management Techniques / Fuzzy sets and their Applications	4	3	25	75	100
26PMAA11	AECC-1	Mathematical Python Programming	3	2	25	75	100
26PCHR11	HR	Human Rights	2	2	25	75	100
Total			**30**	**23**	**175**	**525**	**700**
Semester – II							
26PMAC21	Core – 4	Algebra II	6	5	25	75	100
26PMAC22	Core – 5	Real Analysis II	6	5	25	75	100
26PMAC23	Core – 6	Partial Differential Equations	5	3	25	75	100
26PMAE21/ 26PMAE22	DCE – 3	Tensor Analysis and Relativity Theory / Probability Theory	5	3	25	75	100
26PMAE23/ 26PMAE24	DCE – 4	Difference Equations / Number theory and Cryptography	5	3	25	75	100
26PMAS21P	SEC-1	Advanced Computational Mathematics using Python- Practical	3	2	25	75	100
Total			**30**	**21**	**150**	**450**	**600**
Students must complete at least one online course (MOOC) from platforms like SWAYAM, NPTEL, within the third semester. Additionally, engaging in a specified Self-learning Course is mandatory to qualify for the degree, and successful participation will be acknowledged with an extra credit of 2*.							

CC: Core Course
SEC: Skill Enhancement Course
SLC: Self Learning Course
AECC: Ability Enhancement Compulsory Course
DCE: Discipline Centric Elective
PEC: Professional Enhancement Course
IKS: Indian Knowledge System (Non- Credit Course)

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027									
Course Code	Title of the Course						CIA	ESE	Total
26PMAC11	Algebra I	3	1	2	5	6	25	75	100
Category	Core Course	Theory 80% & Problem 20%							

Learning Objectives	
LO1	To study counting principles, class equations, and Sylow's theorems.
LO2	To understand direct products and the structure of finite Abelian groups.
LO3	To explore polynomial rings over the rational field.
LO4	To introduce modules and canonical forms of linear transformations.
LO5	To learn the concept of Hermitian, Unitary and Normal transformations along with real quadratic forms.

Unit	Content	Hours
1	**Group Theory:** Another Counting Principle - Class equation for finite groups and its applications - Sylow's theorems. **Chapter 2 : Section: 2.11 and 2.12**	18
2	**Group Theory (Contd…):** Direct products - Finite Abelian Groups **Chapter 2 : Section: 2.13 and 2.14**	18
3	**Ring Theory:** Polynomial Rings - Polynomial over the Rational Field **Chapter 3 : Section: 3.9 and 3.10**	18
4	**Modules and Linear Transformations:** Modules; Linear Transformations: Canonical Forms (Nilpotent Transformations, Jordan form, Rational form) **Chapter 4 : Section: 4.5** **Chapter 6 : Section: 6.5 – 6.7**	18
5	**Linear Transformations (Contd…):** Hermitian, Unitary and Normal transformations – Real Quadratic Forms **Chapter 6 : Section: 6.10 and 6.11**	18

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Apply the class equation and Sylow's theorems to analyse finite groups.	K2, K3, K4

2	Construct direct products and classify finite Abelian groups.	KI, K2, K4
3	Work with polynomial rings and study their properties over $\mathbb{Q}$.	KI, K2, K4
4	Understand modules and represent linear transformations in nilpotent, Jordan, and rational forms.	KI, K2, K3, K4
5	Analyse special classes of transformations and apply quadratic forms in real vector spaces.	KI, K2, K3, K4

Recommended Text book:	
1	I. N. Herstein, Topics in Algebra (Second Edition), Wiley Eastern Limited, New Delhi, 1975.
Reference Books:	
1	M. Artin, Algebra, Prentice Hall of India, 2006.
2	P. B. Bhattacharya, S.K. Jain and S.R. Nagpaul. Basic Abstract Algebra (II Edition) Cambridge University Press, (Indian Edition) , 1977.
3	I.S.LutherandI.B.S.Passi,Algebra,Vol.I Groups, 1996;Vol.II Rings, Narosa Publishing House, NewDelhi,1999.
4	D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill(International Edition),NewYork, 1997.
5	N. Jacobson, Basic Algebra, Vol. I & II W. H. Freeman, Hindustan Publishing Company, New Delhi, 1980.
Web Resources:	
1	https://en.wikipedia.org/wiki/Group_theory
2	https://www.mathcity.org/_media/notes/ring-notes-prof-m-dabeer-mughal.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	3	2	3	2	2
CO2	2	3	3	3	3	3	2	2	3	2	3
CO3	3	3	3	2	3	3	3	2	3	2	2
CO4	2	3	3	2	3	3	2	2	3	2	2
CO5	3	3	2	3	3	3	3	2	3	2	3
Total	13	15	14	12	15	15	13	10	15	10	12
Average	2.6	3	2.8	2.4	3	3	2.6	2	3	2	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAC12	Real Analysis I	4	1	1	5	6	25	75	100
Category	Core Course	Theory 80% & Problem 20%							

Learning Objectives	
LO1	To understand the concepts and properties of monotonic functions and functions of bounded variation.
LO2	To study Riemann-Stieltjes Integral and its properties.
LO3	To update the Knowledge on Sufficient and Necessary Conditions for Riemann – Stieltjes Integral.
LO4	To gain knowledge on convergence of Infinite Series and Infinite Products.
LO5	To Distinguish between pointwise and uniform convergence and Work with power series, Taylor series, and related theorems.

Unit	Content	Hours
1	**Functions of bounded variation :** Introduction-Properties of monotonic functions -Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of increasing functions- Continuous functions of bounded variation- Curves and paths-Rectifiable paths and arc lengths. **Chapter 6 : Section: 6.1 - 6.10**	18
2	**The Riemann-Stieltjes Integral :** Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann – Stieltjes integral-Reduction to a Riemann Integral–Step functions as integrators – Reduction of a Riemann Stieltjes integral to a finite sum-Euler's summation formula - Monotonically increasing integrators of upper and lower integrals - Additive and linearity properties of upper and lower integrals-Riemann's condition-Comparison theorems. **Chapter 7: Section: 7.1- 7.14**	18
3	**The Riemann-Stieltjes Integral(Continuation…):** Integrators of bounded variation - Sufficient conditions for the existence of Riemann-Stieltjes Integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -The integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable-Second Mean Value theorem for Riemann integral-Riemann Stieltjes integrals depending on a parameter-Differentiation under integral sign. **Chapter -7: Section: 7.15 - 7.24**	18
4	**Infinite Series and Infinite Products :** Absolute and conditional convergence - Dirichlet's test and Abel's test-Double sequences - Double series - Rearrangement theorem for double series – A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability -Infinite products. **Chapter 8: Section: 8.8, 8.15, 8.20 - 8.26**	18
5	**Sequences of Functions :** Point wise convergence of sequences of functions-Examples of Sequences of real -valued functions-Definition of Uniform convergence -Uniform convergence and continuity-The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions -	18

	Uniform convergence and Riemann - Stieltjes integration - Uniform convergence and differentiation-Sufficient condition for Uniform convergence of a series-Mean convergence-Power series-Multiplication of power series- The Taylor's series generated by a function- Bernstein's Theorem – Abel's limit Theorem – Tauber's theorem. **Chapter 9 : Section: 9.1 to 9.6, 9.8, 9.10, 9.11, 9.13, 9.14, 9.15, 9.19, 9.20, 9.22, 9.23**	

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Analyze and evaluate functions of bounded variation on Continuous functions.	K3, K4
2	Describe the concept of Riemann-Stieltjes integral and its properties.	KI, K2, K4
3	Apply the necessary and sufficient conditions for the existence of the Riemann–Stieltjes integral.	KI, K2, K4
4	Learn and determine the convergence of infinite series and infinite products.	KI, K2
5	Understand convergence concepts of function sequences and series, and apply uniform convergence to continuity, integration, differentiation, and power series expansions.	KI, K2

Recommended Text book:	
1	Tom M. Apostol: Mathematical Analysis, 2nd Edition, Narosa Publishing House, 2002.
Reference Books:	
1	W. Rudin, Principles of Mathematical Analysis, 3rdEdition, Mc Graw Hill Company, New York,1976.
2	S.C. Malik and Savita Arora. Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991.
3	Sanjay Arora and BansiLal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
4	B.R. Gelbaum and J. Olmsted, Counter Examples in Analysis, Holdenday, SanFrancisco, 1964.
5	A.L. Gupta and N.R. Gupta, Principles of Real Analysis, Pearson Education, (Indian print), 2003.
Web Resources:	
1	http://ocw.mit.edu/ocwweb/Mathematics
2	http://www.opensource.org/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	2	3	2	3	2
CO2	2	3	3	3	3	2	2	3	2	3	3
CO3	3	3	2	3	3	3	2	3	2	3	2
CO4	2	3	2	3	3	2	2	3	2	3	2
CO5	3	2	3	3	3	3	2	3	2	2	3
Total	13	14	12	15	15	13	10	15	10	14	12
Average	2.6	2.8	2.4	3	3	2.6	2	3	2	2.8	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAC13	Ordinary Differential Equations	3	1	1	3	5	25	75	100
Category	Core Course	Theory 20% & Problem 80%							

Learning Objectives	
LO1	To define a linear ordinary differential equation and to distinguish homogeneous and non-homogeneous linear ODE's with Constant Coefficients.
LO2	To use methods for solving nth order differential equations.
LO3	To understand the Problem-solving techniques in Wronskian and Legendre Polynomials.
LO4	To formulate the Euler's Second order equations with regular singular points.
LO5	To Learn Various theoretical ideas on successive approximations.

Unit	Content	Hours
1	**Linear Equations with Constant Coefficients :** Introduction - The Second order homogeneous equation –Initial value problems for second order equations – Linear dependence and independence – A formula for the Wronskian – The non-homogeneous equation of order two – Applications. **Chapter 2: Section: 1 – 6**	**15**
2	**Linear Equations with Constant Coefficients (Contd...):** The homogeneous equation of order n – Initial value problems for nth order equations – Equations with real constants-The non-homogeneous equation of order n- A special method for solving the non - homogeneous equation. **Chapter 2: Section:7 – 11**	**15**
3	**Linear Equations with Variable Coefficients :** Introduction-Initial value problems for the homogeneous equation – Solutions of the homogeneous equation –The Wronskian and linear independence – Reduction of the order of a homogeneous equation – The non- homogeneous equation - Homogeneous equations with analytic coefficients -The Legendre equation. **Chapter 3: Section: 1 – 8**	**15**
4	**Linear Equations with Regular Singular Points :** Introduction-The Euler equation – Second order equations with regular singular points (an example) - Second order equations with regular singular points(the general case) – The exceptional cases – The Bessel equation - The Bessel equation(continued). **Chapter 4: Section: 1 – 4, 6 - 8**	**15**
5	**Existence and Uniqueness of Solutions to First Order Equations :** Introduction - Equations with variables separated – Exact equations – The method of successive approximations –The Lipschitz condition – Convergence of the successive approximations. **Chapter 5 : Section: 1 – 6**	**15**

CO	**Course Outcomes**	**Knowledge Level**
The students will be able to		
1	Use the Wronskian to test whether a set of functions is linearly independent or dependent.	K1,K2, K3, K4
2	Obtain solutions to differential equations.	KI, K2, K4
3	Apply various techniques to solve problems involving Legendre polynomials.	KI, K2, K3
4	Formulate and solve second-order Euler differential equations using appropriate techniques.	KI, K2, K4
5	Explain the theory behind the methods of successive approximations.	KI, K2, K3, K4

Recommended Text book:	
1	E. A. Coddington, An introduction to ordinary differential equations, PHI Learning Private Limited, New Delhi, 2010.
Reference Books:	
1	William E. Boyce, Richard C. DiPrima and Douglas B. Meade, Elementary differential equations and boundary value problems, John Wiley and Sons, New York, 1967.
2	George F. Simmons, Differential equations with applications and Historical notes, Tata McGraw Hill, New Delhi, 1974.
3	N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.
4	W.T. Reid. Ordinary differential equations, John Wiley and Sons, New York,1971.
5	B.Rai, D.P. Choudary and H.I. Freeman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.
Web Resources:	
1	http://mathforum.
2	www.mathpages.com

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	2	3	2	3	2
CO2	2	2	3	3	3	2	2	3	2	3	3
CO3	3	3	2	3	3	3	2	3	2	3	2
CO4	3	2	2	3	3	2	2	3	2	3	2
CO5	3	3	3	3	3	3	2	3	2	2	3
Total	14	13	12	15	15	13	10	15	10	14	12
Average	2.8	2.6	2.4	3	3	2.6	2	3	2	2.8	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE11	Graph Theory and its Applications	2	1	1	3	4	25	75	100
Category	DCE	Theory 80% & Problem 20%							

Learning Objectives	
LO1	To study the concept of graphs, path and connections,
LO2	To demonstrate the ideas on Trees and Bonds.
LO3	To develop the application of Euler graph and Hamilton graph
LO4	To provide the knowledge on Matching's and Edge colourings.
LO5	To Explicate the applications of Planarity and colourability

Unit	Content	Hours
1	**Graphs and Sub graphs:** Graphs and simple graphs- Graph Isomorphism- The Incidence and Adjacency Matrices-Sub graphs-Vertex Degrees-Paths and Connection-Cycles. **Chapter: 1 Section: 1.1 - 1.7**	12
2	**Trees:** Trees -Cut Edges and Bonds-Cut Vertices. **Connectivity :**Connectivity-Blocks **Chapter 2: Section: 2.1 - 2.3** **Chapter 3: Section: 3.1 and 3.2**	12
3	**Euler Tours and Hamilton Cycles** Euler tours – Hamilton cycles. **Chapter 4: Section: 4.1 and 4.2**	12
4	**Matchings :** Matchings - Matchings and Coverings in Bipartite Graphs **Edge Colourings :**– Edge Chromatic Number – Vizing Theorem **Chapter 5: Section: 5.1 and 5.2** **Chapter 6: Section: 6.1 and 6.2**	12
5	**Planar Graphs** Plane and planar Graphs - Dual graphs - Euler's Formula - The Five- Colour Theorem and the Four colour Conjecture **Chapter 9: Section: 9.1 - 9.3, 9.6**	12

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Grasp features and properties of graphs, path and connections	K2, K4
2	Apply the concepts of Trees and Bonds.	KI, K2, K4
3	Demonstrate the concepts of Eulerian and Hamiltonicity in graphs.	K1, K2, K4

4	Understand and apply the properties of Matching and Edge colourings.	KI, K3, K4
5	Explicate the applications of planarity and colorability.	KI, K2, K3

Recommended Text book:	
1	J.A. Bondy and U.S.R. Murthy, Graph Theory and Applications, Macmillan, London,1976.
Reference Books:	
1	S. Arumugam. S. Ramachandran , Invitation to Graph Theory, , SCITECH Publications (India) Pvt. Ltd
2	J. Clark and D.A. Holton, A First look at Graph Theory, Allied Publishers, NewDelhi, 1995.
3	A. Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge, 1989.
4	Narsingh Deo, Graph theory with applications to Engineering and Computer Science, Prentice Hall of India, 2005
5	R.J. Wilson and J.J. Watkins, Graphs: An Introductory Approach, John Wiley and Sons, New York,1989
Web Resources:	
1	https://roam.libraries.psu.edu/system/files/e-books/MATH485-Graph_Theory.pdf
2	https://cse.iitkgp.ac.in/~bivasm/cnt_notes/Basic-graph-theory-1.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	2	2	2	2	2
CO2	3	3	2	2	2	3	2	2	2	2	2
CO3	3	3	2	2	3	3	2	2	2	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	2	3	2	3
Total	15	15	12	11	13	15	12	11	12	11	13
Average	3	3	2.4	2.2	2.6	3	2.4	2.2	2.4	2.2	2.6

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE12	Mathematical Statistics	2	1	1	3	4	25	75	100
Category	DCE	Theory 60% & Problem 40%							

Learning Objectives	
LO1	To introduce the basic notions of sample, population, sample moments and their functions.
LO2	To give an insight about the parametric and non-parametric tests for small and large samples.
LO3	To educate the various measures of estimation theory.
LO4	To inculcate the concepts of ANOVA test and hypothesis testing.
LO5	To understand the sequential analysis and its consequences.

Unit	Content	Hours
1	**Sample Moments and Their Functions :** Notion of a Sample and a Statistic – Distribution of the Arithmetic Mean of Independent Normally Distributed Random Variables – The Chi-Square Distribution – The Distribution of the Statistics – Student's t -Distribution – Fisher's Z-Distribution. **Chapter 9 : Section: 9.1 – 9.7**	12
2	**Significance Tests :** Kolmogorov Theorem – Smirnov Theorem – The Concept of a Statistical Test – Parametric Tests for Small Samples and Large Samples – Chi- Square Test – Tests of Kolmogorov and Smirnov type. **Chapter10: Section: 10.11** **Chapter 12 : Section: 12.1 – 12.5**	12
3	**Estimation Theory :** Preliminary Notion – Consistent Estimates – Unbiased Estimates – Sufficiency of an Estimate – Efficiency of an Estimate – Asymptotically Most Efficient Estimates – Methods of Finding Estimates – Confidence Interval. **Chapter 13 : Section: 13.1 – 13.8**	12
4	**Analysis of Variance and Hypotheses Testing :** ANOVA Test: One-Way Classification and Two-Way Classification. Hypotheses Testing: The Power Functions and OC Function–Most Powerful Test – Uniformly Most Powerful Test – Unbiased Test. **Chapter15 : Section: 15.1 and 15.2, Chapter 16 : Section: 16.2 - 16.5**	12
5	**Elements of Sequential Analysis :** SPRT–Auxiliary Theorem – Wald's Fundamental Identity – OCF unction and SPRT – The Expected Value of (n) – Determination of A and B – Testing a Hypothesis Concerning of Zero – One Distribution **Chapter 17 : Section: 17.1 – 17.8**	12

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Know the basic notions of sample, population, sample moments and their functions.	KI, K2, K4
2	Comprehend the parametric and non-parametric tests for small and large samples	KI, K2, K3,
3	Understand the various measures of estimation theory.	KI, K3, K4
4	Acquire the concepts of ANOVA test and hypothesis testing.	KI, K2, K3, K4
5	Procure the strong background about the sequential analysis and its consequences.	K2, K3, K4

Recommended Text book :	
1	M. Fisz, Probability Theory and Mathematical Statistics, 3rd Edition, John Wiley and Sons Inc., New York, 1963.
Reference Books :	
1	G.G.Roussas,AFirstCourseinMathematicalStatistics,2ndEdition,AcademicPress,USA,1997
2	B. L. V. D. Waerden, Mathematical Statistics,Springer-Verlag,NewYork,1969.
3	R.E. Walpole, R. H. Myers, S. L. Mayers and K. Ye, Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson Education Inc., 2012.
4	S.P. Gupta, Statistical Methos, Sultan Chand & Sons, New Delhi, 2001.
5	S.C. Gupta & V.K. Kapoor, Fundamental of Mathematical Statistics, Sultan Chand, New Delhi.
Web Resources :	
1	https://ocw.mit.edu/courses/mathematics/18-655-mathematical-statistics-spring2016//
2	https://swayam.gov.in/nd1_noc20_ma19/preview//

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	2	3	2	3	2
CO2	2	3	3	3	3	2	2	3	2	3	3
CO3	3	3	2	3	3	3	2	3	2	3	2
CO4	2	3	2	3	3	2	2	3	2	3	2
CO5	3	2	3	3	3	3	2	3	2	2	3
Total	13	14	15	15	15	13	10	15	10	14	12
Average	2.6	2.8	3	3	3	2.6	2	3	2	2.8	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE13	Resource Management Techniques	2	1	1	3	4	25	75	100
Category	DCE	Theory 40% & Problem 60%							

Learning Objectives	
LO1	To solve integer linear Programming problems.
LO2	To learn Decision making under different types and Decision Making with Utilities.
LO3	To study queuing system structure, performance, and models.
LO4	To classify various types of replacement problems and maintenance techniques.
LO5	To use differential calculus-based methods to obtain the optimal solutions.

Unit	Content	Hours
1	**Integer linear Programming:** Introduction - Types of integer programming problems – Enumeration and cutting plane solution concept - Gomory's all integer cutting plane method - Gomory's mixed integer cutting plane method-Problems. **Chapter 7: Section: 7.1-7.5**	12
2	**Decision Theory:** Introduction - Steps of decision making process - Types of decision making environments - Decision making under uncertainty – Decision making under risk. **Chapter 11 : Section: 11.1-11.5**	12
3	**Queuing Theory:** Introduction - The Structure of a Queuing System – Performance of a Queuing system – Probability distributions in Queuing systems – Classification of Queuing Models – Single Server Queuing Models **(M/M/1)** – Multi Server Queuing Models(**M/M/S).** **Chapter 16 : Section: 16.1-16.7**	12
4	**Replacement and Maintenance Models:** Introduction - Types of failure -Replacement of items whose efficiency deteriorates with time- Replacement of items that completely fail. **Chapter 17 : Section: 17.1-17.4**	12
5	**Classical Optimization Methods:** Introduction – Unconstrained Optimization – Constrained multivariable Optimization with equality constraints: Direct substitution method, Lagrange multipliers methods - constrained multivariable optimization with inequality constraints: Kuhn–Tucker Necessary and Sufficient conditions. **Chapter 23 : Section: 23.1-23.4**	12

CO	Course Outcomes	Knowledge Level
The students will be able to		
1	Formulate and analyze optimization problems.	KI, K2, K4

2	Make efficient decisions and applying various decision-making criteria.	KI, K3, K4
3	Explain, classify and solve single- and multi- server queuing problems.	K2, K3, K4
4	Solve replacement problems and maintenance models.	KI, K2, K3
5	Classify optimization problems and work on Kuhn–Tucker problems.	KI, K2, K3, K4

Recommended Text book :	
1	J. K. Sharma, Operations Research Theory and Applications (6thEdition), Trinity Press, Laxmi Publications Pvt. Ltd., New Delhi, Reprint 2017.
Reference Books:	
1	R. Panneerselvam, Operations Research, Prentice Hall of India, NewDelhi, 2008.
2	Anderson, Quantitative Methods for Business, 8th Edition, Thomson Learning, 2002.
3	Winston, Operations Research, Thomson Learning, 2003.
4	Vohra, Quantitative Techniquesin Management, Tata Mc Graw Hill, 2002.
5	AnandSarma, Operations Research, Himalaya Publishing House, 2003.
Web Resources:	
1	http://mathforum.org//
2	http://ocw.mit.edu/ocwweb/Mathematics//

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	2	2	2	2	2	2	3	2	2
CO3	3	3	3	2	3	3	3	3	3	3	3
CO4	3	2	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	3	3	3	3	3	3	3
Total	15	12	14	13	14	13	14	14	14	13	13
Average	3	2.4	2.8	2.6	2.8	2.6	2.8	2.8	2.8	2.6	2.6

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE14	Fuzzy Sets and their Applications	2	1	1	3	4	25	75	100
Category	DCE	Theory 80% & Problem 20%							

Learning Objectives	
LO1	To know the basic concepts of fuzzy logic.
LO2	To explore the operations on fuzzy sets.
LO3	To study Fuzzy relations.
LO4	To understand decision making in Fuzzy environments.
LO5	To constrain the applications of fuzzy logic in various fields.

Unit	Content	Hours
1	Overview of Classical Sets, Membership Function, Height of a fuzzy set– Normal and subnormal fuzzy sets – Support – Level sets, fuzzy points, α–cuts – Decomposition Theorems, Extension Principle.	12
2	Standard fuzzy operations – Union, intersection and complement–properties De Morgan's laws – fuzzy sets – Support – Level sets, fuzzy points, α–Cuts of fuzzy operations.	12
3	Cartesian Product, Crisp relations – cardinality – operations and properties of Crisp and Fuzzy relations. Image and inverse image of fuzzy sets – Various definitions of fuzzy operations – Generalizations – Non interacting fuzzy sets, Tolerance and equivalence relations.	12
4	Decision making in Fuzzy environments General Discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi Stage decision making–fuzzy ranking methods – fuzzy linear programming.	12
5	Applications Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Inter personal Communication – Other Applications.	12

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	The basic concepts of fuzzy logic and Extension Principle	K2, K3, K4
2	Know the operations on fuzzy sets.	KI, K3, K4
3	Learn Fuzzy relations.	KI, K2, K4
4	Understand decision making in Fuzzy environments.	KI, K2, K3,
5	Apply the applications of fuzzy logic in various fields.	KI, K2, K3, K4

Recommended Text book:	
1	G.J. Klir and Bo Yuan, Fuzzy Sets and fuzzy Logic Theory and Applications, Prentice Hall of India Ltd., New Delhi,2005
Reference Books:	
1	George J. KlirandBo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, PHI Leaning Private Limited, New Delhi 2009.
2	A.K. Bhargava, Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt. Limited 2013.
3	K. Pundir and R. Pundir, Fuzzy sets and their application, Published by A Pragati Edition 2012
4	H.J. Zimmermann, Fuzzy set theory and its applications, Springer, 2012.
5	Bhargava A.K, Fuzzy Set Theory, Fuzzy Logic and their Application, 1987.
Web Resources:	
1	http://mathforum.org,http://ocw.mit.edu/ocwweb/Mathematics,http://www.opensource.org,
2	https://www.nature.com/research-intelligence/nri-topic-summaries/fuzzy-decision-making-and-multi-criteria-analysis-micro-1056

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	2	2	2	2	2	2	3	2	2
CO3	3	3	3	2	3	3	3	3	3	3	3
CO4	3	2	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	3	3	3	3	3	3	3
Total	15	12	14	13	14	13	14	14	14	13	13
Average	3	2.4	2.8	2.6	2.8	2.6	2.8	2.8	2.8	2.6	2.6

3 – Strong, 2- Medium, 1- Low

I YEAR: FIRST SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027									
Course Code	Title of the Course						CIA	ESE	Total
26PMAA11	Mathematical Python Programming	2	1	0	2	3	25	75	100
Category	AECC	Theory 20% and Problem 80%							

Learning Objectives	
LO1	To Understand basic Python concepts such as data types, variables, and control statements.
LO2	To Develop programs using functions, including recursive and lambda functions.
LO3	To Apply sequences, tuples, sets, and dictionaries to solve problems.
LO4	To Work with files, streams, and generator functions for data handling.
LO5	To Understand relations, graphs, and basic database operations in Python.

Unit	Content	Hours
1	**Python :** Introduction – Values, types and names – Integers – Floating-point numbers – Strings. **Python programs:** Statements – Conditionals – Iterations.**Working With Numbers** - Calculate the factors of Numbers - Generate Multiplication Tables - Converting Units of Measurements	9
2	**Python functions:** Function definitions – Recursive functions – Functions as values – Lambda expressions. **Tuples:** Ordered pairs and n-tuples – Tuples in Python – Files and databases.	9
3	**Sequences:** Properties of sequences – Monoids – Sequences in Python – High-order sequence functions – Parallel processing. **Streams:** Dynamically-generated sequences – Generator functions – Endless streams – Programming with streams – Distributed processing.	9
4	**Sets:** Mathematical sets – Sets in Python – Flats, files, sets and tuples – Other representation of sets. **Mappings:** Mathematical mappings – Python dictionaries – Dictionary or function – Multisets.	9
5	**Relations:** Mathematical terminology and notation – Representation in programs – Graphs – Paths and transitive closure – Relational database operations **Describing Data With Statistics :** Find Mean, Median - Finding the mode and creating a frequency Tables - Measuring Dispersion.	9

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Explain fundamental Python concepts including data types, variables, expressions, and control structures.	K1,K2,K3,K4
2	Develop Python programs using functions, recursion, and lambda expressions.	K1,K2,K3,K4
3	Apply appropriate data structures such as tuples, sequences, sets, and dictionaries in problem-solving.	K1,K2,K3,K4

4	Analyze and process data using files, streams, generator functions, and basic database operations.	K1,K2,K3,K4
5	Interpret and implement mathematical concepts like relations, graphs, and mappings in Python programs.	K1,K2,K3,K4

Recommended Text books:	
1	Programming and Mathematical Thinking – A gentle introduction to Discrete Math featuring Python", Allan M. Stavely, First Edition, The New Mexico Tech Press, USA(2014). (Unit-1 to 5)
2	"Doing Math with Python" , Amit Saha, No Starch Press, USA. (Unit-1 & 5)
Reference Book:	
1	Maria Litvin and Gary Litvin, "Coding in Python and Elements of Discrete Mathematics" Skylight Publishing, USA(2019)
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc22_cs26/preview?
2	https://www.geeksforgeeks.org/python/numpy-tutorial/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	2	3	3	3
CO3	3	3	2	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3
Total	15	14	14	15	15	15	15	14	14	15	15
Average	3	2.8	2.8	3	3	3	3	2.8	2.8	3	3

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAC21	Algebra II	3	1	2	5	6	25	75	100
Category	Core Course	Theory 80% & Problem 20%							

Learning Objectives	
LO1	To introduce extension fields and the concept of transcendence.
LO2	To study the structure and properties of polynomials and their roots.
LO3	To explain the elements of Galois theory and solvability by radicals.
LO4	To explore finite fields and division rings.
LO5	To connect solvability with Frobeniu's theorem, quaternions, and the four-square theorem.

Unit	Content	Hours
1	**Field Theory:** Extension fields–Transcendence of e **Chapter 5 : Section: 5.1 and 5.2**	18
2	**Polynomials and Roots:** Roots of Polynomials –More about roots. **Chapter 5 : Section: 5.3 and 5.5**	18
3	**Galois Theory:** The Elements of Galois theory - Solvability by Radicals **Chapter 5: Section: 5.6 and 5.7**	18
4	**Finite Fields:** Finite fields- Wedderburn's theorem on finite division rings. **Chapter 7: Section: 7.1 and 7.2**	18
5	**Finite Fields [Contd..]:** A theorem of Frobenius - Integral Quaternions and the Four-Square theorem. **Chapter 7: Section: 7.3 and 7.4**	18

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Understand extension fields and prove the transcendence of e.	K2, K3
2	Analyse roots of polynomials and explore deeper results about factorization and splitting fields.	KI, K2, K4
3	Apply Galois groups to determine solvability of polynomials by radicals.	KI, K2, K4
4	Construct finite fields and state Wedderburn's theorem on finite division rings.	KI, K2, K3
5	Study Frobenius' theorem, integral quaternions, and prove the four-square theorem.	KI, K2, K3

Recommended Text book:	
1	I. N. Herstein, Topics in Algebra (Second Edition) Wiley Eastern Pvt. Limited, New Delhi, 1975.
Reference Books:	
1	M. Artin, Algebra, Prentice Hall of India, 1991.
2	P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra(IIEdition) Cambridge University Press(IndianEdition), 1997
3	I. S. Luther and I.B. S. Passi, Algebra, Vol. I – Groups (1996); Vol.II Rings, Narosa Publishing House, New Delhi,1999
4	D.S.Malik, J.N.Mordeson and M.K.Sen, Fundamental of Abstract Algebra, Mc Graw Hill (International Edition), NewYork, 1997.
5	N.Jacobson, Basic Algebra, Vol. I & II Hindustan Publishing Company, New Delhi.
Web Resources:	
1	https://math.bembew.com/en/article/field-theory/basic-transcendental-and-algebraic-bases-of-extension-fields.html
2	https://www.maths.tcd.ie/~mascotn/teaching/2021/MAU34101/4%20Solvability.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	3	3	3	2	2
CO2	2	2	3	3	3	3	2	3	3	2	2
CO3	3	3	3	2	3	3	3	3	3	2	3
CO4	2	2	3	3	3	3	2	3	3	2	2
CO5	3	3	3	3	3	3	3	3	3	2	3
Total	13	12	15	14	15	15	13	15	15	10	12
Average	2.6	2.4	3	2.8	3	3	2.6	3	3	2	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAC22	Real Analysis II	4	1	1	5	6	25	75	100
Category	Core Course	Theory 80% & Problem 20%							

Learning Objectives

LO1	To work on Measurable functions on Real line.
LO2	To develop the concept of integration of functions of a real variable on Riemann Integrals.
LO3	To update the basic concepts on Fourier Series and Fourier Integrals.
LO4	To study multivariable differential functions and Matrix functions.
LO5	To gain knowledge on Implicit functions and Extremum problems with side conditions.

Unit	Content	Hours
1	**Measure on the Real line :** Lebesgue Outer Measure – Measurable sets – Regularity – Measurable Functions – Borel and Lebesgue Measurability. **Chapter 2 : Section: 2.1 - 2.5**	18
2	**Integration of Functions of a Real variable :** Integration of Non-negative functions – The General Integral– Riemann and Lebesgue Integrals. **Chapter 3 : Section: 3.1, 3.2 and 3.4**	18
3	**Fourier Series and Fourier Integrals :** Introduction – Orthogonal system of functions – The theorem on best approximation – The Fourier series of a function relative to an orthonormal system – Properties of Fourier Coefficients – The Riesz-Fischer Theorem – The convergence and representation problems for trigonometric series –The Riemann - Lebesgue Lemma – The Dirichlet Integrals – An integral representation for the partial sums of Fourier series –Riemann's localization theorem –Sufficient conditions for convergence of a Fourier series at a particular point – Cesaro sumability of Fourier series. **Chapter 11 : Section: 11.1 - 11.13**	18
4	**Multivariable Differential Calculus :** Introduction-The Directional derivative –Directional derivative and continuity – The total derivative – The total derivative expressed in terms of partial derivatives –An application to complex valued function – The matrix of linear function – The Jacobian matrix – The chain rule – Matrix form of chain rule –The mean value theorem for differentiable functions – Taylor's formula for functions of R^n to R^1 **Chapter 12 : Section: 12.1 - 12.11 and 12.14**	18
5	**Implicit Functions and Extremum Problems :** Introduction - Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem – Extrema of real valued functions of one and severable variables – Extremum problems with side conditions. **Chapter 13 : Section: 13.1- 13.7**	18

CO	Course Outcomes	Knowledge Level
The students will be able to		
1	Describe measurable functions and Borel and Lebesgue Measurability functions and theorems.	K2, K3, K4
2	Integrate Non-negative functions, The General Integral, Riemann and Lebesgue Integral theorems.	KI, K2, K4
3	Understand and describe the basic concepts o Fourier series and Fourier integrals with respect to orthogonal system.	KI, K3, K4
4	Formulate and evaluate Differentiable functions and matrix in linear form.	KI, K2, K3 K4
5	Work on implicit functions and extremum real valued functions.	K2, K3, K4

Recommended Text books:	
1	G. De Barra, Measure Theory and Integration, New Age International Pvt.Ltd Ltd., New Delhi, 2008. (Units 1 and 2)
2	Tom M.Apostol : Mathematical Analysis, 2nd Edition, Narosa Publishing House , 2002. (Units 3, 4 and 5)
Reference Books:	
1	Burkill,J.C. The Lebesgue Integral, Cambridge University Press, 1951.
2	Munroe, M.E, Measure and Integration.Addison-Wesley,Mass. 1971.
3	Roydon,H.L.Real Analysis, Macmillan Pub. Company, NewYork, 1988.
4	Rudin,W. Principles of Mathematical Analysis, Mc Graw HilL Company, NewYork,1979
5	Malik,S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited.NewDelhi,1991.
Web Resources:	
1	http://mathforum.org//
2	www.opensource.org//

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	2	3	2	3	2
CO2	2	3	3	3	3	2	2	3	2	3	3
CO3	3	3	2	3	3	3	2	3	2	3	2
CO4	2	3	2	3	3	2	2	3	2	3	2
CO5	3	2	3	3	3	3	2	3	2	2	3
Total	13	14	12	15	15	13	10	15	10	14	12
Average	2.6	2.8	2.4	3	3	2.6	2	3	2	2.8	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAC23	Partial Differential Equations	2	1	2	3	5	25	75	100
Category	Core Course	Theory 20% & Problem 80%							

Learning Objectives	
LO1	To understand the theory and methods of First order Partial Differential Equations (PDEs).
LO2	To get Knowledge to solve Second order PDE.
LO3	To know the concepts of elliptic differential equations.
LO4	To enrich the knowledge about parabolic differential equations.
LO5	To develop Knowledge about the hyperbolic differential equations.

Unit	Content	Hours
1	**Partial Differential Equations of First Order :** Introduction –Formation of partial differential equation – Solution of partial differential equation of first order – Integral surfaces passing through a given curve – The Cauchy problem for first order equations - Surfaces orthogonal to a given system of surfaces – First order non-linear equations – Compatible systems of first order equations – Charpit's Method. **Chapter 0: Section: 0.1,0.4 -0.11 (Exclude 0.11.1)**	15
2	**Fundamental Concepts :** Introduction – Classification of second order PDE – Canonical forms: Hyperbolic, Parabolic, Elliptic equation – Adjoint operators. **Chapter 1: Section: 1.1-1.4**	15
3	**Elliptic Differential Equations :** Occurrence of the Laplace and Poisson equations – Boundary value problem (BVPs) – Separation of variables – Dirichlet and Neumann problem for a Rectangle - Solution of Laplace equation in Cylindrical Coordinates and Spherical Coordinates. **Chapter 2: Section: 2.1-2.2, 2.5 -2.7, 2.11, 2.13**	15
4	**Parabolic Differential Equations :** Occurrence of the diffusion equation - Boundary conditions – Elementary solutions of the diffusion equation - Dirac Delta function – Separation of variables method- Applications. **Chapter 3: Section: 3.1 - 3.5**	15
5	**Hyperbolic Differential Equations :** Occurrence of the wave equation - Derivation of one dimensional wave equation- Solution of one dimensional wave equation by canonical reduction – The initial value problem: D'Alembert's solution – Boundary and initial value problem for two dimensional wave equations – Uniqueness of the solution for the wave equation – Duhamel's principle - Examples **Chapter 4 : Section: 4.1 - 4.4, 4.7, 4.11- 4.12**	15

CO	Course Outcomes	Knowledge Level
The students will be able to		
1	Analyze the methods for first order PDE.	K1,K2,K4
2	Understand the fundamentals of second order PDE.	K1,K2,K3
3	Develop knowledge on the elliptical differential equations.	K1,K3,K4
4	Implement the knowledge to solve the parabolic differential equations.	K1,K2,K4
5	Model and solve the hyperbolic differential equations.	K1,K2,K3

Recommended Text book :	
1	K.Sankara Rao, Introduction to Partial differential equations (Second edition), Prentice Hal of India Private Ltd., New Delhi, 2007
Reference Books:	
1	R. Dennemeyer, Introduction to Partial differential equations and boundary value problems, Mc Graw Hill, NewYork, 1968
2	Paul Duchateau Dacid W. Zachmann, Partial Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi
3	M.D.Raisinghania, Advanced differential equations, S. Chand & Company Ltd. New Delhi, 2001.
4	R.C. Mc Owen, Partial differential equations, 2nd edition, Pearson education, New Delhi,2005
5	A.K.Nandakumaran, P.S.Datti, Partial Differential Equations Classical Theory with a Modern Touch, Cambridge University Press.
Web Resources:	
1	https://nptel.ac.in/courses/111103021/
2	https://onlinecourses.nptel.ac.in/noc21_ma18/preview

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	3	2	3	2	2
CO2	2	3	3	3	3	3	2	2	3	2	3
CO3	3	3	3	2	3	3	3	2	3	2	2
CO4	2	3	3	2	3	3		2	3	2	2
CO5	3	3	2	3	3	3	3	2	3	2	3
Total	13	15	14	12	15	15	13	10	15	10	12
Average	2.6	3	2.8	2.4	3	3	2.6	2	3	2	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE21	Tensor Analysis and Relativity Theory	3	1	1	3	5	25	75	100
Category	DCE	Theory 40 % & Problem 60%							

Learning Objectives

LO1	To learn the system of different orders in Tensor Algebra.
LO2	To gain Knowledge on Symmetric and Skew Symmetric Tensors and Reciprocal Tensor.
LO3	To understand the concept of a Riemannian space and its significance.
LO4	To learn the theory of relativity.
LO5	To Analyze the concept of relativistic Doppler effect.

Unit	Content	Hours
1	**Tensor Algebra:** Introduction - Systems of Different Orders-Summation Convention - Kronecker Symbols – Examples-Tensor Algebra: Introduction – n dimensional Space – Transformation of Coordinates in Sn – Invariants - Vectors : Covariant and Contravariant vectors – Tensors of Second Order : Contravariant Tensors of Order Two – Covariant Tensors of Order Two – Mixed Tensors of Order Two – Mixed Tensors of Type (p,q) – Zero Tensor – Tensor Field – Algebra of Tensors – Equality of Two Tensors **Chapter I: I.0 - I.3, Chapter II: II.0-II.10**	15
2	**Tensor Algebra (Contd..):** Symmetric and Skew Symmetric Tensors:Symmetric Tensors – Skew-Symmetric Tensors – Outer Multiplication and Contraction: Outer Multiplication -Contraction– Inner Multiplication – Quotient Law of Tensors – Quotient Law in General Form - Reciprocal Tensor of a Tensor – Relative Tensor – Cross Product or Vector Product of Two Vectors - Examples **Chapter II: II. 11 - II. 18**	15
3	**Tensor Calculus:** Introduction - Riemannian Space: Riemannian Metric – Reciprocal or Conjugate Tensor of the Fundamental Metric Tensor g_{ij} – Associated Tensors, Lowering and Raising Indices – Magnitude or Length of a Vector – Unit Vector – Null Vector – Angle Between Two Non – Null Vectors – Orthogonal Vectors – Christoffel symbols and their properties. **Chapter III: III. 0 - III.2**	15
4	**Introduction to Relativity:** Introduction- Galilean Transformation, Maxwell's Equation, The Ether theory, The principle of relativity-Relativistic Kinematics: The Lorentz transformation equations, Events and simultaneity– Examples – Einstein's Train. **Chapter 7:7.1-7.2**	15
5	**Introduction to Relativity(Contd.):** Time dilation – Longitudinal contradiction- The invariant interval – Proper time and proper distance - the world line – Example: The twin paradox – Addition of velocities – the relativistic Doppler effect – Examples. **Chapter 7:7 .2**	15

CO	Course Outcomes	Knowledge Level
The student will be able to		
1	Work on systems of different orders in Tensor Algebra.	KI, K2, K3
2	Decompose a given tensor into its symmetric and skew-symmetric parts and apply these concepts in algebraic problems.	KI, K2, K3, K4
3	Gained the knowledge of Tensor Calculus and to analyze Christoffel symbols	KI, K2, K3
4	Describe the concept of theory of relativity.	KI, K2, K3, K4
5	Know about relativistic Doppler effect and its applications.	K2, K3, K4

Recommended Text books:	
1	U.C.De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus (Second Edition), Narosa Publishing House, New Delhi,2008.(For Units 1,2 and 3)
2	Donald T.Greenwood, Classical Dynamics, Dover Publication Inc, NewDelhi,1985. (For Units 4 and 5)
Reference Books:	
1	J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
2	A.S.Eddington. The Mathematical Theory of Relativity, Cambridge University Press, 1930.
3	P.G. Bergman, An Introduction to Theory of Relativity, NewYork, 1942
4	C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938.
5	Goldstein, Classical Mechanics (Addition Wesley)
Web Resources:	
1	http://mathforum.org//
2	http://www.opensource.org/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3	3	3
CO3	2	2	3	2	2	2	2	2	3	2	2
CO4	2	3	2	3	3	3	3	3	2	3	3
CO5	3	2	3	3	2	2	3	2	3	2	2
Total	13	12	14	14	12	13	14	13	14	12	12
Average	2.6	2.4	2.8	2.8	2.4	2.6	2.8	2.6	2.8	2.4	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE22	Probability Theory	3	1	1	3	5	25	75	100
Category	DCE	Theory 60% & Problem 40%							

Learning Objectives	
LO1	To understand the basic concepts of probability, random events, and random variables, and learn how to describe and analyze their distributions and relationships.
LO2	To learn how to measure and interpret key characteristics of probability distributions such as expectation, moments, and variability.
LO3	To construct characteristic functions and how they are used to study distributions, moments, and sums of random variables.
LO4	To familiarize with important discrete and continuous probability distributions and their properties and applications.
LO5	To explore the behavior of random variables in the long run and learn key limit theorems such as laws of large numbers and central limit theorem.

Unit	Content	Hours
1	**Random Events and Random Variables:** Random events –Probability axioms – Combinatorial formulae – conditional probability –Baye's Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables. **Chapter 1: Section: 1.1 – 1.7** **Chapter 2: Section: 2.1 – 2.5**	15
2	**Parameters of the Distribution:** Expectation- Moments –The Chebyshev's Inequality – Absolute moments – Order parameters –Moments of random vectors – Regression of the first and second types. **Chapter 3 : Section: 3.1 – 3.8**	15
3	**Characteristic functions:** Properties of characteristic functions – Characteristic functions and moments – semi invariants –characteristic function of the sum of the independent random variables –Determination of distribution function by the Characteristic function –Characteristic function of multidimensional random vectors –Probability generating functions. **Chapter 4 : Section: 4.1 – 4.7**	15
4	**Some Probability distributions:** One point and two point distribution, Binomial – Polya – Hyper geometric – Poisson (discrete) distributions –Uniform – normal- gamma – Beta – Cauchy and Laplace (continuous) distributions. **Chapter 5 : Section: 5.1 – 5.10**	15
5	**Limit Theorems:** Stochastic convergence – Bernaulli's law of large numbers – Convergence of sequence of distribution functions –Levy-Cramer Theorems – De	15

	Moivre-Laplace Theorem – Poisson, Chebyshev's, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma – Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. **Chapter 6: Section: 6.1 – 6.4, 6.6 – 6.9, 6.11 & 6.12. (Omit Section: 6.5, 6.10)**	

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Apply Random Events, Random Variables and distribution functions.	KI, K2, K4
2	Work on Expectation, Moments and Chebyshev's Inequality and Regression types.	KI, K2, K4
3	Determine Characteristic functions, distribution function and probability generating functions	KI, K2, K3
4	Solve problems on Binomial distributions, Hypergeometric and Poisson distributions	K2, K3, K4
5	Evaluate Stochastic convergence, Bernaulli law of large numbers, Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.	KI, K2, K3, K4

Recommended Text book :	
1	M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.
Reference Books:	
1	R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2	K.L. Chung, A course in Probability, Academic Press, New York, 1974
3	R. Durrett, Probability: Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
4	V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988 (3rd Print).
5	S.I. Resnick, A Probability Path, Birhauser, Berlin, 1999.
Web Resources:	
1	http://mathforum.org//
2	www.opensource.org//

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	3	2	3	3	2	2
CO2	2	2	3	2	3	3	3	2	3	2	2
CO3	3	2	3	3	3	3	2	2	3	2	3
CO4	2	2	3	2	3	3	2	3	3	2	3
CO5	3	3	3	3	3	3	2	2	3	2	2
Total	13	11	15	12	15	15	11	12	15	10	12
Average	2.6	2.2	3	2.4	3	3	2.2	2.4	3	2	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE23	Difference Equations	3	1	1	3	5	25	75	100
Category	DCE	Theory 60% & Problem 40%							

Learning Objectives

LO1	To provide preliminaries and limiting behavior of Difference Equations.
LO2	To describe the solution and Linear Periodic system of Difference Equations.
LO3	To solve the Difference equations using Z-transforms.
LO4	To obtain knowledge on oscillation Theory.
LO5	To articulate asymptotic behaviour of Difference equations.

Unit	Content	Hours
1	**Linear Difference Equations of Higher Order :** Difference calculus – General Theory of Linear Difference Equations – Linear Homogeneous Equations with Constant coefficients – Non-homogeneous Equations: Method of Undetermined Coefficients, the method of variation of constants – Limiting behavior of Solutions. **Chapter 2: Section: 2.1 - 2.5**	15
2	**System of Linear Difference Equations :** Autonomous Systems – The Basic Theory – The Jordan form – Linear periodic systems. **Chapter 3: Section: 3.1 - 3.4**	15
3	**The Z-Transform Method :** Definitions and examples, Properties of Z - transform – The Inverse Z-transform and Solutions, Difference Equations: Power series method, partial fraction method, the inverse integral method – Volterra difference equation of convolution type. **Chapter 5 : Section: 5.1 - 5.3**	15
4	**Oscillation Theory :** Three-term difference Equations – Self-Adjoint – Second Order Equations – Nonlinear Difference Equations. **Chapter 7 : Section: 7.1 - 7.3**	15
5	**Asymptotic Behavior of Difference Equation :** Tools of Approximation – Poincare's Theorem – Asymptotically Diagonal Systems – High-Order Difference Equations – Second Order Difference Equations. **Chapter 8 : Section: 8.1 - 8.5**	15

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Solve problems on Linear Difference Equations of Higher order.	KI, K2, K3
2	Understand the Autonomous system and Linear Periodic systems of Difference Equations.	KI, K2, K3, K4

3	Apply Z-transform techniques in Difference equations	KI, K2, K4
4	Describe on Oscillation Theoryof Difference Equations.	KI, K2, K3,K4
5	Work on Asymptotic Behavior of Difference Equations.	K2, K3,K4

Recommended Text book:	
1	Saber N. Elaydi, An Introduction to Difference Equations, Third Edition, Springer Verlag, New York, 2005 (First Indian Reprint 2008).
Reference Books:	
1	Ronald E. Mickens, Difference Equations Theory, Applications and Advanced Topics, Third Edition,CRC Press,NewYork, 2015.
2	R.P. Agarwal, Difference Equations and Inequalities, Marcel Dekker, 1999.
3	S. Goldberg, Introduction to Difference Equations, Dover Publications,1986
4	V.Lakshmikantham and Trigiante, Theory of Difference Equations Numerical Methods and Applications, Second Edition, Academic Press, NewYork, 1988.
5	Walter G.Kelly, Allan C.Peterson, Difference Equations, An Introduction with Applications, Academic Press, NewYork, 2001 (First Indian Reprint 2006).
Web Resources:	
1	https://www.math.utah.edu/mathcircle/notes/earnshaw.pdf
3	https://assets.cambridge.org/97811070/42728/excerpt/9781107042728_excerpt.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	2	3	3	2	3
CO2	3	2	3	2	2	2	2	3	3	2	3
CO3	3	2	3	2	2	2	2	3	3	2	3
CO4	2	2	3	3	3	2	3	2	2	3	2
CO5	3	2	3	3	2	2	2	3	2	2	3
Total	13	12	13	14	13	11	12	13	12	12	12
Average	2.6	2.4	2.6	2.8	2.6	2.2	2.4	2.6	2.4	2.4	2.4

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P/S	Credits	Hours	Marks		
Regulation 2026-2027							CIA	ESE	Total
Course Code	Title of the Course								
26PMAE24	Number Theory and Cryptography	3	1	1	3	5	25	75	100
Category	DCE	Theory 40% & Problem 60%							

Learning Objectives	
LO1	To demonstrate ability to learn elementary ideas from number theory which will have applications in cryptography.
LO2	To understand the structure and properties of finite fields.
LO3	To introduce various cryptosystems and apply them in the necessary fields.
LO4	To learn the public key cryptography and RSA algorithm.
LO5	To get the knowledge about Factoring concepts.

Unit	Content	Hours
1	**Some topics in Elementary Number Theory :** Time Estimates for doing arithmetic–Divisibility and Euclidean Algorithm–Congruence's–Some applications to Factoring. **Chapter I : Section: 1- 4**	15
2	**Finite Fields and Quadratics Residues :** Quadratics–Residues and reciprocity. **Chapter II: Section: 1 and 2**	15
3	**Cryptography :** Some simple cryptosystems–Enciphering matrices. **Chapter III : Section: 1 and 2**	15
4	**Public Key :** The idea of Public key Cryptography–RSA–Discrete Law– Knapsack **Chapter IV: Section: 1- 4**	15
5	**Primality and Factoring :** Pseudo–primes–The rho method –Fermat factorization and factor bases–The continued fraction method–The quadratic sieve method. **Chapter V: Section: 1- 5**	15

CO	Course Outcomes	Knowledge Level
The Students will be able to		
1	Apply elementary number theory concepts such as primes, modular arithmetic, and GCD in cryptographic contexts.	KI, K2, K4
2	Apply concepts of quadratic residues in practical domains such as cryptography and coding theory.	KI, K2, K3
3	Differentiate cryptosystems (symmetric, asymmetric, hybrid) and identify their practical applications.	KI, K2, K4
4	Implement RSA algorithm for encryption and decryption using modular arithmetic.	KI, K2, K3
5	Analyze factoring methods and their impact on the security of RSA and related cryptosystems.	KI, K2, K4

Recommended Text book :	
1	Neal Koblitz, A Course in Number Theory and Cryptography (II Edition), Springer-Verlag, NewYork,1987
Reference Books :	
1	I.Niven and H.S. Zuckermann, An Introduction to Theory of Numbers (Edn.3),Wiley Eastern Ltd.,New Delhi,1976.
2	David M. Burton, Elementary Number Theory, Brown Publishers, Iowa,1989.
3	K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag,1972
4	N. Koblitz, Algebraic Aspects of Cryptography, Springer 1998.
5	An Introduction to the theory of numbers, Ivan M.Niven,1991.
Web Resources:	
1	https://archive.nptel.ac.in/courses/106/103/106103015/
2	https://onlinecourses-archive.nptel.ac.in/noc17_cs36/preview

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	2	3	3	2	3
CO2	3	3	2	2	3	3	3	3	3	3	3
CO3	3	3	2	2	2	3	2	3	3	2	3
CO4	3	3	2	2	3	3	3	3	3	3	3
CO5	3	3	2	2	3	3	3	3	3	3	3
Total	15	15	10	10	13	15	13	15	15	13	15
Average	3	3	2	2	2.6	3	2.6	3	3	2.6	3

3 – Strong, 2- Medium, 1- Low

I YEAR: SECOND SEMESTER

Department of Mathematics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PMAS21P	Advanced Computational Mathematics using Python - Practical	0	0	3	2	3	25	75	100
Category	Practical	Practical							

Learning Objectives	
LO1	To apply Python programming to perform basic mathematical operations and unit conversions.
LO2	To visualize mathematical functions (like quadratic functions) using plotting tools such as Matplotlib.
LO3	To implement numerical methods such as Bisection Method and LU Decomposition to solve mathematical problems.
LO4	To use libraries like NumPy and SymPy for matrix operations and symbolic computations.
LO5	To analyze data using statistical techniques such as generating random numbers and computing mean and standard deviation, and visualize results using tools like GeoGebra.

Unit	Content	Hours
1	Write a Program that can perform the basic mathematical operations on two fractions and also Unit Converter Ex: Kilograms and pounds.	45
2	Write a Program to Exploring a Quadratic Function Visually.	
3	Write a program to customize a 2D plot by adding grid, axis labels, title, and changing line styles and colors.	
4	Develop a program to find the root of a nonlinear equation using the Bisection Method with a given tolerance.	
5	Write a Python program to implement the LU Decomposition method and solve a system of linear equations.	
6	Write a Python program using NumPy to perform matrix addition and multiplication.	
7	Write a Python program using SymPy to compute partial derivatives of multivariable functions.	
8	Write a Python program to generate random numbers from a normal distribution.	
9	Calculate mean and standard deviation of generated data and compare with theoretical values.	
10	Generate points for $y = x^2$ using Python and import them into GeoGebra for visualization.	

CO	Course Outcomes	Knowledge Level
The students will be able to		
1	Develop Python programs to solve mathematical and scientific problems efficiently.	K3,K4
2	Demonstrate the use of numerical methods for solving equations and linear systems.	K1, K2
3	Apply data visualization techniques to represent mathematical functions and datasets.	K1, K2, K3
4	Utilize Python libraries such as NumPy, SymPy, and Matplotlib for computational tasks.	K1, K2, K3,
5	Integrate computational tools with visualization platforms like GeoGebra for enhanced understanding of mathematical concepts.	K4,K5,K6

Recommended Textbooks:	
1	Allan M. Stavely, Programming and Mathematical Thinking – A gentle introduction to Discrete Math featuring Python", First Edition, The New Mexico Tech Press, USA,2014.
2	Amit Saha, Doing Math with Python, No Starch Press, USA.
Reference Books:	
1	Maria Litvin and Gary Litvin, Coding in Python and Elements of Discrete Mathematics Skylight Publishing, USA, 2019.
2	Jian Wang, Qiqi Wang, Daniel Gould , Python Programming and Numerical Methods, University of California, Berkeley,2020
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc22_cs26/preview?
2	https://www.geeksforgeeks.org/python/numpy-tutorial/
3	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cs01

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	2
Total	15	14	14	15	15	15	15	15	15	15	14
Average	3	2.8	2.8	3	3	3	3	3	3	3	2.8

3 – Strong, 2- Medium, 1- Low