A.D.M COLLEGE FOR WOMEN (AUTONOMOUS),

(Nationally Re-accredited with 'A' Grade by NAAC- 3rd Cycle)

NAGAPATTINAM-611 001

PG & RESEARCH DEPARTMENT OF MATHEMATICS

(for the candidates admitted from the academic year 2021-2023)

M.Sc., MATHEMATICS

SYLLABUS

2021-2023

A.D.M COLLEGE FOR WOMEN (AUTONOMOUS),
Nagapattinam

PG Programme - M.Sc Mathematics

(For the candidates admitted from 2021 – 2024 onwards)

Bloom's Taxonomy Based Assessment Pattern

Knowledge Level

K1 – Acquire/Remember	**K2** – Understanding	**K3** – Apply	**K4** – Analyze	**K5** – Evaluate	**K6** – Create

1. Part I, II and III

Theory (External + Internal = 75 + 25 = 100 marks)

External/Internal					
Knowledge Level	**Section**	**Marks**	**Hrs.**	**Total**	**Passing Mark**
K1-K3	A (Answer all)	10 ×2 = 20	3	75	50
K3-K6	B (Either or pattern)	5 × 5 = 25			
K3-K6	C (Answer 3 out of 5)	3 × 10 = 30			

PG DEPARTMENT OF MATHEMATICS

(for the candidates admitted from the academic year 2021-2023)

M.Sc., Mathematics

Programme Educational Objectives (PEO):

PEO 1:	To gain analytical skills in the field of Mathematics.
PEO 2:	To develop the logical thinking skills.
PEO 3:	To understand the concepts of real and complex analysis.
PEO 4:	To use the knowledge of pure and applied mathematics to solve complex Mathematical Problems.
PEO 5:	To invent innovative and novel ideas in modelling the real world problems.
PEO 6:	To crack the exam approved by UGC namely CSIR – NET (JRF/Lectureship) & SET.

Programme Outcomes(POs) PG

On completion of the course the learner will be able to

PO 1:	understand the fundamental axioms in mathematics and capable of developing ideas based on them.
PO 2:	maintain and develop the problem-solving skills.
PO 3:	use the mathematical ideas in modelling the real world problems
PO 4:	analyse mathematical reasoning.
PO 5:	demonstrate and communicate the mathematical concepts clearly.
PO 6:	perform research activities independently towards Ph.D Degree in Mathematics

Programme Specific Outcomes(PSO) M.Sc.,

On completion of the course the learner will be able to

PSO 1:	connect mathematics to real life problems in their lives.
PSO 2:	do intensive research in pure and applied mathematics.
PSO 3:	analyse problems of industry and society.
PSO 4:	model and provide solutions to scientific and real life situations.
PSO 5:	prepare for a career in which critical thinking is a central feature.
PSO 6:	sportively attend the examinations approved by UGC namely CSIR – NET (JRF/Lectureship) & SET.

PG AND RESEARCH DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE OF THE PG PROGRAMME-M.Sc.,MATHEMATICS

M.Sc. Mathematics 2021- 2023 Batch

STRUCTURE OF THE PROGRAMME

Course	No. of Papers	Hours	Credit
Core Course	14	84	66
Elective Course	5	30	20
Project	1	6	4
Total	**20**	**120**	**90**

ADD ON COURSES

1. MOOC/SWAYAM

2. INTERNSHIP TRAINING

Year	Semester	Name of the Extra Credit Course	Credit
I PG	II	MOOC/SWAYAM	2
II PG	III	Internship Training	2

Passing Minimum

A candidate shall be declared to have passed in each course if she secures not less than 50% marks out of 75 marks (i.e., 40 marks) in the End Semester Examination (SE) and 40% out of 25 marks (i.e., 10 marks) in the Continuous Internal Assessment.(CIA).

A.D.M. COLLEGE FOR WOMEN (AUTONOMOUS), NAGAPATTINAM
DEPARTMENT OF MATHEMATICS
M.Sc. Mathematics 2021- 2023 Batch

SCHEME OF THE PROGRAMME

Course Structure under CBCS

(for the candidates admitted from the academic year 2021-2024 onwards)

Sem.	Course Code	Course	Ins. Hrs	Credit	Exam Hours	Marks		Total Marks
						CIA	SE	
I	**Core Course – I**	Algebra	6	5	3	25	75	100
	Core Course – II	Real Analysis	6	5	3	25	75	100
	ore Course – III	Ordinary Differential Equations	6	5	3	25	75	100
	Core Course – IV	Advanced Graph Theory	6	4	3	25	75	100
	Elective Course – I	Advanced Numerical Analysis/ Financial Mathematics	6	4	3	25	75	100
		TOTAL	**30**	**23**	**15**	**125**	**375**	**500**
II	**Core Course - V**	Complex Analysis	6	5	3	25	75	100
	Core Course – VI	Linear Algebra	6	5	3	25	75	100
	Core Course – VII	Partial Differential Equations	6	5	3	25	75	100
	Core Course – VIII	Classical Dynamics	6	4	3	25	75	100
	Elective Course – II	Fuzzy sets and its Applications / Non Linear Differential Equations	6	4	3	25	75	100
		TOTAL	**30**	**23**	**15**	**125**	**375**	**500**
III	**Core Course – IX**	Measure and Integration	6	5	3	25	75	100
	Core Course – X	Topology	6	5	3	25	75	100
	Core Course – XI	Integral Equations and Transforms	6	4	3	25	75	100
	Elective Course – III	Mathematical Modelling / Combinatorics	6	4	3	25	75	100
	Elective Course – IV	Advanced Operations Research / Discrete Mathematics	6	4	3	25	75	100
		TOTAL	**30**	**22**	**15**	**125**	**375**	**500**

IV	**Core Course – XII**	Functional Analysis	6	5	3	25	75	100
	Core Course – XIII	Advanced Probability Theory	6	5	3	25	75	100
	Core Course – XIV	Fluid Dynamics	6	4	3	25	75	100
	Elective Course – V	Differential Geometry / Stochastic Processes	6	4	3	25	75	100
	Project		6	4	3	20	80	100
		TOTAL	**30**	**22**	**15**	**120**	**380**	**500**
		GRAND TOTAL	**120**	**90**	**60**	**495**	**1505**	**2000**

Semester-I / Core Course-I(CC)	ALGEBRA	Course Code: PGMA
Instruction Hours: 5	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To Study advanced concepts in Group Theory. • To gain the knowledge about Polynomial Rings over Fields. • To learn about dual spaces. • To understand the extension fields and finite fields. • To interpret the elements of Galois Theory.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Group Theory:** A Counting Principle – Normal Subgroups and Quotient Groups –Homomorphism – Permutation Groups – Another Counting Principle– Sylow's theorems.**(Chapter II : Sec 2.5 – 2.7, 2.9 – 2.12)**	**18 Hours**
UNIT II	**Ring Theory:** Polynomial Rings – Polynomial Rings over Rational Field – Polynomial Rings over Commutative Rings**. (Chapter III: Sec. 3.9 , 3.10 & 3.11)**	**18 Hours**
UNIT III	**Vector Spaces and Modules:** Dual Spaces – Inner Product Spaces - Modules.**(Chapter IV: Sec 4.3, 4.4 &4.5)**	**18 Hours**
UNIT IV	**Fields:** Extension Fields – Roots of Polynomials –More About Roots. **(Chapter V :Sec 5.1 , 5.3 , 5.5)**	**18 Hours**
UNIT V	**Fields:** The Elements of Galois Theory – Finite Fields. **(Chapter V: Sec 5.6 & Chapter 7: Sec 7.1)**	**18 Hours**
UNIT VI Self-Learning	**Linear Transformations:** The Algebra of Linear Transformations –Characteristic Roots - Matrices – **Canonical Forms:** Triangular Form – **Canonical Forms:** Nilpotent Transformations. **(Chapter VI: Sec 6.1 – 6.5)**	

Text Books:

1. I.N. Herstein , Topics in Algebra , Second Edition , John Wiley & Sons Pvt. Ltd, 1975

Reference Books:

1. Serge Lang , Algebra, Revised 3rd Edition, Springer Verlang, 2002.
2. A.R. Vasistha, Modern Algebra, 3rd Edition, 1973.

Web – Resources:

1. https://library.rcc.edu/algebra
2. http://mathandmultimedia.com/2010/01/18/free-algebra-ebooks

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : understand Sylow's theorem and its applications
CO2 : analyze the various types of polynomials
CO3 : develop the knowledge about modules
CO4 : evaluate the roots and characteristics of polynomials.
CO5 : apply finite fields in Galois Theory

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	M	M	S	S	M	S	M	M	M	S
CO2	S	S	S	M	S	S	S	S	S	S	S	S
CO3	M	S	M	M	W	M	M	S	M	M	M	S
CO4	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	M	M	S	S	M	S	M	M	M	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-I / Core Course-II(CC)	REAL ANALYSIS	Course Code: PGMB
Instruction Hours:	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To study the basic topological concepts. • To determine the limits and continuity of functions. • To learn about Riemann –Stieltjes integral. • To know the uniform convergence of functions and the Stone – Weierstrass Theorem. • To discuss about Inverse and Implicit Function Theorems.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Basic Topology:** Finite, Countable and Uncountable sets - Metric spaces – Compact sets – Perfect sets – Connected sets**.** **(Chapter II)**	**18 Hours**
UNIT II	**Continuity:** Limits of Functions – Continuous Functions – Continuity and Compactness – Continuity and Connectedness – Discontinuities – Monotonic Functions – Infinite Limits and Limits at infinity. **(Chapter IV)**	**18 Hours**
UNIT III	**The Riemann - Stieltjes Integral:** Definition and Existence of the integral – Properties of the integral – Integration and Differentiation – Integration of Vector – valued Functions – Rectifiable Curves.**(Chapter VI)**	**18 Hours**
UNIT IV	**Sequences and Series of Functions:** Discussion of Main Problem – Uniform Convergence – Uniform Convergence and Continuity – Uniform Convergence and Integration – Uniform Convergence and Differentiation – Equicontinuous Families of Functions – The Stone - Weierstrass Theorem. **(Chapter VII)**	**18 Hours**
UNIT V	**Functions of Several Variables:** Linear Transformations – Differentiation – The Contraction Principle – The Inverse Function Theorem – The Implicit Function Theorem. **(Chapter IX: Sec 9.1 – 9.29)**	**18 Hours**
UNIT VI Self-Learning	**Some Special Functions:** Power Series – The Exponential and Logarithmic Functions – The Trigonometric Functions – The Algebraic Completeness of the Complex Field. **Chapter 8: Sec. 8.1 – 8.8**	

Text Books:

Walter Rudin, Principles of Mathematical Analysis, Third Edition , Mc Graw Hill International Book Company, New York, 1976

Reference Books:

1. R .G. Bartle, The Elements of Real Analysis , 3rd Edition, Wiley International, 1994 .
2. Tom M Apostol , Mathematical Analysis , Second Edition , Narosa Publishing House,1974.

Web – Resources:

1. http://www.freebookcentre.net/Mathematics/Real-Analysis-Books.html
2. https://carma.newcastle.edu.au/resources/jon/Preprints/Books/Other/TimesReal.pdf.

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : acquire the basic topological properties on metric spaces.
CO2 : interpret the continuity and discontinuity of functions.
CO3 : analyze the Riemann - Stieltjes integral and their properties.
CO4 : develop the knowledge of sequence and series of functions.
CO5 : understand functions of several variables.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	S	S	S	S	M	M	S	S
CO2	S	S	M	S	S	S	S	S	M	S	S	S
CO3	S	S	M	S	S	S	S	S	M	S	S	S
CO4	S	S	M	S	S	S	S	S	M	S	S	S
CO5	S	S	M	S	S	S	S	S	M	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-I / Core Course-III (CC)	ORDINARY DIFFERENTIAL EQUATIONS	Course Code: PGMC
Instruction Hours:	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To give an in-depth knowledge of differential equations and their applications. • To study the special functions and their properties. • To understand the existence, uniqueness, stability behavior of the solutions of the ODE. • To analyze about the boundary value problems. • To learn about stability nature of nonlinear systems of equations.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Second Order Linear Equations & Power Series Solutions and Special Functions:** The General Solution of the Homogeneous Equation– The Use of a Known Solution to Find Another – The Method of Variation of Parameters – Introduction: A Review of Power Series – Series Solutions of First Order Equations – Second Order Linear Equations; Ordinary Points. **(Chapter III: Sec 15, 16, 19 and Chapter V: Sec 26 To 28)**	**18 Hours**
UNIT II	**Power Series Solutions and Special Functions & Some Special Functions of Mathematical Physics** Regular Singular Points – Regular Singular Points (Continued) – Gauss's Hypergeometric Equation – The Point at Infinity - Legendre Polynomials – Properties Of Legendre Polynomials – Bessel Functions - The Gamma Function – Properties of Bessel Functions. (**Chapter V : Sec 29 to 32 and Chapter VIII: Sec 44 to 47)**	**18 Hours**
UNIT III	**Systems of First Order Equations & The Existence and Uniqueness of Solutions:** Linear Systems – Homogeneous Linear Systems with Constant Coefficients – The Method of Solutions of Successive Approximations – Picard's Theorem. **(Chapter X: Sec 55,56 and Chapter XIII: Sec 68, 69)**	**18 Hours**
UNIT IV	**Qualitative Properties of Solutions & Partial Differential Equations and Boundary Value Problems:** Oscillations and the Sturm Separation Theorem – The Sturm Comparison Theorems –Eigen Values, Eigen Functions and The Vibrating	**18 Hours**

	String. **(Chapter IV: Sec 24, 25 and Chapter VII: Sec 40.)**	
UNIT V	**Nonlinear Equations:** Autonomous Systems: The Phase Plane and Its Phenomena –Types of Critical Points; Stability – Critical Points and Stability for Linear Systems – Stability by Liapunov's Direct Method – Simple Critical Points of Nonlinear Systems. **(Chapter XI: Sec 58 to 62)**	**18 Hours**
UNIT VI **Self-Learning**	**Numerical Methods:** Introduction – The Method of Euler – Errors – An Improvement to Euler – Higher Order Methods. **(Chapter 14: Sec. 71 – 75)**	

Text Books:

G.F. Simmons, Differential Equations with Applications and Historical Notes, TMH, New Delhi, 1991.

Reference Books:

1. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, New York, 1971.
2. E.A. Codington and N. Levinson, Theory of Ordinary Differential Equations, McGraw Hill Publishing Company, New York, 1955.
3. S.G. Venkatachelapathy, Ordinary Differential Equations, Margham Publications, 2005.

Web – Resources:

1. **https://users.math.msu.edu/users/gnagy/teaching/ode.pdf**
2. **https://www.math.ucla.edu/~yanovsky/handbooks/ODEs.pdf**

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : obtain the solutions of ordinary differential equations.
CO2 : evaluate the special functions.
CO3 : analyze the behavior of the solutions of the ODE
CO4 : discuss the properties of boundary value problems
CO5 : solve the system of nonlinear equations.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	M	S	S	S	S	S	M	S
CO2	M	S	S	M	M	S	S	S	S	S	M	S
CO3	S	S	M	M	S	M	M	M	M	M	S	S
CO4	M	S	M	S	S	M	M	M	M	M	S	S
CO5	M	M	S	M	S	S	S	M	M	S	S	S

S - Strongly Correlated
M - Moderately Correlated
W-Weakly Correlated
N – No Correlation

Semester-I / Core Course-I(CC)	ADVANCED GRAPH THEORY	Course Code: PGMD
Instruction Hours:	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To understand the basic concepts of graph theory. • To study the connectivity and characterization of graphs. • To learn matching and coverings in graphs. • To know about graph coloring and chromatic polynomial. • To gain the knowledge of planarity of graphs.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Basic Results & Directed Graphs:** Introduction - Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness- Automorphism of a Simple Graph – Line Graphs - Operations on Graphs - Directed Graphs: Basic Concepts - Tournaments.**(Chapter I: Sec 1.0 – 1.7 , 2.0 – 2.2)**	**18 Hours**
UNIT II	**Connectivity & Trees:** Introduction - Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Trees: Introduction – Definition, Characterization and Simple Properties – Centers and Centroids - Counting the Number of Spanning Trees - Cayley's Formula. **(Chapter III: Sec 3.0– 3.2, 4.0 -4.4)**	**18 Hours**
UNIT III	**Independent Sets and Matchings & Eulerian and Hamiltonian Graphs:** Introduction - Vertex Independent Sets and Vertex Coverings – Edge - Independent Sets – Matchings and Factors – Introduction - Eulerian Graphs - Hamiltonian Graphs.**(Chapter V: Sec 5.0 – 5.3, 6.0 – 6.2)**	**18 Hours**
UNIT IV	**Graph Colourings:** Introduction - Vertex Colourings - Critical Graphs - Triangle - Free Graphs - Edge Colourings of Graphs - Chromatic Polynomials. (**Chapter VII: Sec 7.0 – 7.4, 7.7)**	**18 Hours**
UNIT V	**Planarity:** Introduction - Planar and Nonplanar Graphs - Euler Formula and its Consequences - K_5 and $K_{3,3}$ are Nonplanar Graphs - Dual of a Plane Graph - The Four-Colour Theorem and the Heawood Five-Colour Theorem- Kuratowski'sTheorem.**(Chapter VIII: Sec 8.0 – 8.6)**	**18 Hours**
UNIT VI Self-Learning	**Applications :** Introduction – The Connector Problem – Kruskal's Algorithm – Prim's Algorithm – Shortest Path Problems. **(Chapter X: Sec 10.0 – 10.4)**	

Text Books: R. Balakrishnan, K. Ranganathan, A Text book of Graph Theory, Springer International Edition, New Delhi, 2008.

Reference Books:

1. J.A. Bondy, U.S.R. Murty, Graph Theory with Applications, Mac Milan Press Ltd.,1976.
2. Gary Chartrand, Linda Lesniak, Ping Zhang, Graphs and Digraph,CRC press,2010.
3. F.Harary, Graph Theory, Addison - Wesley, Reading, Mass., 1969.

Web – Resources:

1. https://www.maths.ed.ac.uk/~v1ranick/papers/wilsongraph.pdf
2. https://www.math.ust.hk/~mabfchen/Math2343/Graph-General.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : analyze the automorphism and operations on graphs.
CO2 : discuss the characterization, centers and centroids of trees.
CO3 : find the independent sets and matchings of graphs, Eulerian and Hamiltonian graphs.
CO4 : colour the graphs and find the chromatic polynomial.
CO5 : the planar and non-planar graphs.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	M	M	M	S	S	M	M	M	S	S	M
CO2	S	M	M	M	S	S	S	S	M	S	M	M
CO3	S	M	S	M	S	S	S	S	S	S	M	S
CO4	S	M	S	M	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	M	S

S - Strongly Correlated
M - Moderately Correlated
W-Weakly Correlated
N – No Correlation

Semester-I / Elective Course-I (EC)	ADVANCED NUMERICAL ANALYSIS	Course Code: PGME1
Instruction Hours:	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3 -** Apply **K4 -** Evaluate **K5 -** Analyze **K6** – Create	
Course Objectives	**The Course aims** • To demonstrate the concepts of Numerical methods. • To study the iteration methods for solving matrices. • To know about interpolations. • To learn the methods based on interpolation. • To study the ordinary differential equations numerically.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Transcendental and Polynomial Equations:** Introduction – Bisection Method – Iteration Methods Based on First Degree Equation – Iteration Methods Based on Second Degree Equation – Rate of Convergence – Polynomial Equations. **(Chapter II: Sec. 2.1- 2.5, 2.9)**	**18 Hours**
UNIT II	**System of Linear Algebraic Equations and Eigen Value Problems:** Iteration Methods - Eigen values and Eigenvectors: Jacobi Method for Symmetric Matrices – Givens Method for Symmetric Matrices – Power Method. **(Chapter III: Sec. 3.4, 3.5, 3.7, 3.8, 3.11)**	**18 Hours**
UNIT III	**Interpolation and Approximation:** Higher Order Interpolation - Hermit Interpolations – Bivariate Interpolation – Least Squares Approximation .**(Chapter IV: Sec. 4.5, 4.7, 4.9)**	**18 Hours**
UNIT IV	**Differentiation and Integration:** Methods Based on Interpolation – Extrapolation Methods – Partial differentiation – Numerical Integration – Methods Based on Interpolation – Methods Based on Undetermined Coefficients –Composite Integration Methods. **(Chapter V: Sec. 5.4 - 5.9)**	**18 Hours**
UNIT V	**Ordinary Differential Equations:** Numerical Methods – Single Step Methods – Multistep Methods. **(Chapter VI: Sec. 6.3, 6.4, 6.6)**	**18 Hours**
UNIT VI Self-Learning	**Ordinary Differential Equations Boundary Value Problems:** Introduction – Initial Value Problem Method (Shooting Method) – Finite Difference Methods – Finite Element Methods. (Chapter 7: Sec. 7.1 – 7.4)	

Text Books:

M.K.Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation , New Age International (P) Limited , New Delhi,2003.

Reference Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India PVT Limited, New Delhi, 1994.
2. Joe D. Hoffman, Numerical Methods for Engineers and Scientists, Second Edition, CRC Press, 2001.

Web – Resources:

1. **https://web.njit.edu/~jiang/math614/atkinson2.pdf**
2. **https://www.epfl.ch/labs/anchp/index-html/teaching/advancedna/**

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : solve transcendental and polynomial equations.
CO2 : determine the solution of linear equations.
CO3 : evaluate the higher order interpolation.
CO4 : estimate the numerical differentiation and integration.
CO5 : interpret the methods of solving integration numerically

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	M	S	M	S	M	M	M	M	S	S	M	S
CO2	M	S	M	S	M	M	M	M	S	S	M	M
CO3	S	S	S	S	M	M	M	M	S	S	M	S
CO4	M	S	S	M	S	M	S	S	S	S	S	S
CO5	S	S	M	M	M	M	S	M	S	M	S	S

S - Strongly Correlated
M - Moderately Correlated
W-Weakly Correlated
N – No Correlation

Semester-II / Core Course-V	COMPLEX ANALYSIS	Course Code: PGME
Instruction Hours: 6	Credits:5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To introduce the fundamentals of metric and topological spaces. • • To study the concept of complex integration. • To analyze singular points and Taylor's series • To gain the knowledge of Cauchy's Theorem • To learn about harmonic functions and power series	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Analytic functions as mappings:** elementary point set topology: sets and elements – metric spaces – connectedness – compactness – continuous functions – topological spaces; conformality: arcs and closed curves – analytic functions in regions – conformal mapping – length and area; linear transformations: the linear group – the cross ratio – symmetry. (chapter iii: sec 1.1-1.6, 2.1-2.4,3.1-3.3)	**18 Hours**
UNIT II	**Complex Integration**: Fundamental theorems: Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk; Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives. **(Chapter IV: Sec 1.1-1.5, 2.1-2.3)**	**18 Hours**
UNIT III	**Complex Integration**: Local Properties of Analytic Functions : Removable Singularities - Taylor's Theorem –Integral representation of the nth term - Zeros and Poles – The Local Mapping - The Maximum Principle. **(Chapter IV: 3.1, 3.2, 3.3,3.4)**	**18 Hours**
UNIT IV	**Complex Integration& Series and Product Developments**: Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series.**(Chapter IV: 6.1-6.5 and Chapter V: 1.1-1.3)**	**18 Hours**
UNIT V	**Complex Integration& Series and Product Developments**: Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series.**(Chapter IV: 6.1-6.5 and Chapter V: 1.1-1.3)**	**18 Hours**

UNIT VI **Self Learning**	The Riemann Zeta Function: The Product Development – Extension of ς(s) to the Whole Plane – The Functional Equation – The Zeros of the Zeta Function. (Chapter 5: Sec 4: 4.1 – 4.4)	

Text Book:

Lars.V. Ahlfors ,Complex Analysis , Third Edition - Mc Graw Hill Book Company, New York**, 1979.**

Reference Books:

1. 1.V.Karunakaran, Complex Analysis, 2nd Edition, Narosa, New Delhi, 2005.
2. R.Priestely, Introduction to Complex Analysis, Oxford India, 2008.
3. Serge Lang, Complex Analysis, Addison Wesley, 1977.
4. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi, 1997

Web – Resources:

1. https://www.coursera.org/learn/complex-analysis
2. https://www.math.ucdavis.edu/~romik/data/uploads/notes/complex-analysis.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : understand the topological spaces
CO2 : acquire the knowledge of complex integration
CO3 : interpret zeros and poles.
CO4 : apply Cauchy's theorem in complex valued functions
CO5 : analyse harmonic functions

Mapping of Course outcomes with Programme outcomes/Programmes Specific outcomes

CO/PO	**PO**						**PSO**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
O1	M	S	S	M	S	S	S	S	M	S	M	S
CO2	S	S	S	S	M	S	S	M	M	S	S	S
CO3	M	S	M	M	M	M	S	M	M	S	M	S
CO4	S	S	S	S	M	S	S	S	M	S	M	S
CO5	M	S	S	S	S	M	M	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-II / Core Course-VI (CC)	LINEAR ALGEBRA	Course Code: PGMF
Instruction Hours: 6	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To learn the various aspects of systems of linear equations. • To know the representations of transformations by matrices. • To study the algebra of polynomials. • To acquire the knowledge of determinants and its properties. • To interpret the importance of diagonalization and the primary decomposition theorem.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Linear Equations & Vector Spaces:** Systems of Linear Equations - Matrices and Elementary Row Operations -Row-Reduced Echelon Matrices - Matrix Multiplication - Invertible Matrices - Bases and Dimension. (Only revision of Vector spaces and subspaces). **(Chapter I : Sec. 1.2 – 1.6 & Chapter II: Sec 2.3 only)**	**18 Hours**
UNIT II	**Linear Transformations:** The Algebra of Linear Transformations - Isomorphism - Representations of Transformations by Matrices - Linear Functionals - The Double Dual – The Transpose of a Linear Transformation. **(Chapter III: Sec 3.2 – 3.7)**	**18 Hours**
UNIT III	**Polynomials & Determinants:** The Algebra of Polynomials - Lagrange Interpolation - Polynomial Ideals -The Prime Factorization of a Polynomial - Commutative Rings – Determinant Functions.**(Chapter IV&V: 4.1-4.5 and 5.1- 5.2)**	**18 Hours**
UNIT IV	**Determinants & Elementary Canonical Forms:** Permutations and the Uniqueness of Determinants – Additional Properties of Determinants - Characteristic values – Annihilating polynomials. **(Chapter V: Sec 5.3 – 5.4& Chapter VI : Sec 6.2 – 6.3)**	**18 Hours**
UNIT V	**Elementary Canonical Forms:** Invariant Subspaces - Simultaneous Triangulation and Simultaneous Diagonalization Direct-Sum Decompositions - Invariant Direct Sums – The Primary Decomposition Theorem. **(ChapterVI : Sec 6.4 -**	**18 Hours**

	6.8)	
UNIT VI Self Learning	The Rational and Jordan Forms: Cyclic Subspaces and Annihilators – Cyclic Decomposition and the Rational Form - The Jordan Form.(Chapter 7: Sec. 7.1 – 7.3)	

Text Books:

Kenneth Hoffman and Ray Alden Kunze, Linear Algebra, Second Edition, Prentice Hall of India Private Limited, New Delhi, 1975**.**

Reference Books:

1. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd,2004.
2. A.R.Rao, P.Bhimashankaram, Linera algebra, Second edision, Tata McGraw Hill, 2000.

Web – Resources:

1. **https://people.revoledu.com/kardi/tutorial/LinearAlgebra/Resources.html .**
2. **https://www.math.ucdavis.edu/~linear/linear-guest.pdf**

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : develop the knowledge about application of matrices in solving linear equations.
CO2 : represent the linear transformations by matrices.
CO3 : acquire the knowledge of Algebra of polynomials.
CO4 : determine the uniqueness of determinants and annihilating polpolynomials.
CO5 : apply the concepts of the Primary Decomposition Theorem.

Mapping of COs with PSOs & POs:

CO/PO	PO						PSO					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	S	S	S	M	S	S	S	S	M	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S	S	S
CO3	S	S	S	M	S	S	S	S	M	S	S	S
CO4	S	S	S	M	S	S	S	S	M	S	S	S
CO5	S	S	S	M	S	S	S	S	M	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-II / Core Course-VII(CC)	**PARTIAL DIFFERENTIAL EQUATIONS**	**Course Code: PGMG**
Instruction Hours: 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks:25	**External Marks:75**	**Total Marks: 100**

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To gain the knowledge of partial differential equations. • To study the characteristics of first order partial differential equations. • To learn the characteristics of second order partial differential equations. • To know the concepts of equations in three variables. • To acquire the knowledge of boundary value problems.	
UNIT	**CONTENT**	**HOURS**
UNIT I	Partial differential equations- origins of first order Partial differential equations- Cauchy's problem for first order equations- Linear equations of the first order- Integral surfaces Passing through a Given curve- surfaces Orthogonal to a given system of surfaces -Non linear Partial differential equations of the first order. **(Chapter II :Sec 1 - 7)**	**18 Hours**
UNIT II	Cauchy's method of characteristics - compatible systems of first order equations- Charpits method- Special types of first order equations- Solutions satisfying given conditions- Jacobi's method.**(Chapter II: Sec 8** - 1**3)**	**18 Hours**
UNIT III	Partial differential equations of the second order : The origin of second order equations–second order equations in Physics – Higher order equations in Physics - Linear partial differential equations with constant co-efficient- Equations with variable coefficients- Characteristic curves of second order equations. **(Chapter III: Sec 1 - 6)**	**18 Hours**
UNIT IV	Characteristics of equations in three variables- The solution of Linear Hyperbolic equations-Separation of variables. The method of Integral Transforms – Non Linear equations of the second order.**(Chapter III : Sec 7 - 11)**	**18 Hours**
UNIT V	Laplace equation : Elementary solutions of Laplace's equations- Families of equipotential Surfaces - Boundary value problems- Separation of variables – Problems with Axial Symmetry. **(Chapter IV : Sec 2 - 6)**	**18 Hours**

UNIT VI Self-Learning	**The Wave Equation: Energy Methods :** Conservation of Energy – The Domain of Dependence – **Applications to Light and Sound :** Electromagnetism – Acoustics. **(Chapter 3 : Sec. 3.3 & 3.5)**

Text Books:

1. Ian N. Sneddon, Elements of Partial Differential Equations**,** Dover Publication –INC, New York, 2006.
2. Robert C.McOwen, Partial Differential Equations Methods and Applications, Pearson Education (Singapore) Pte.Ltd. , Second Edition 2004.

Reference Books:

1. M.D.Raisinghania, Advanced Differential Equations , S.Chand and Company Ltd., New Delhi,2001.
2. E.T.Copson,Partial Differential Equations, Cambridge University Press **,** 1973.

Web – Resources:

1. **http://www.freebookcentre.net/Mathematics/Differential-Equations-Books_1.html**
2. https://www.math.ucla.edu/~yanovsky/handbooks/PDEs.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : classify the PDE.
CO2 : apply Charpit's and Jacobi's method for solving PDE.
CO3 : solve second order and higher order PDE.
CO4 : evaluate non Linear equations of the second order.
CO5 : compute boundary value problems

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-II / Core Course-VIII (CC)	CLASSICAL DYNAMICS	Course Code: PGMH
Instruction Hours: 6	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To give a detailed knowledge of the mechanical system of particles. • To understand Lagrange's Equations of motion for the set of generalized coordinates. • To study special applications of Lagrange's Equations. • To learn the applications of Hamilton's equations. • To inculcate the applications of Hamilton – Jacobi Equation.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Introductory Concepts:** The Mechanical System – Generalized Co-ordinates – Constraints – Virtual Work – Energy & Momentum. **(Chapter I: Sec 1.1 to 1.5)**	**18 Hours**
UNIT II	**Lagrange's Equations:** Derivation of Lagrange's Equations – Examples – Integrals of the Motion – Small Oscillations. **(Chapter II : Sec 2.1 to 2.4)**	**18 Hours**
UNIT III	**Special Applications of Lagrange's Equations:** Rayleigh's Dissipation function – Impulsive Motion – Gyroscopic Systems – Velocity – Dependent Potentials. **(Chapter III: Sec 3.1 to 3.4)**	**18 Hours**
UNIT IV	**Hamilton's Equations:** Hamilton's Principle – Hamilton's Equations – Other Variational Principles – Phase Space. **(Chapter IV: Sec 4.1 to 4.4)**	**18 Hours**
UNIT V	**Hamilton - Jacobi Theory:** Hamilton's Principle function – The Hamilton - Jacobi Equation – Separability. **(Chapter V: Sec 5.1 to 5.3)**	**18 Hours**
UNIT VI Self-Learning	**Canonical Transformations:** Differential forms and Generating Functions – Special Transformations – Lagrangian and Poisson Brackets. **(Chapter 6: Sec. 6.1 – 6.3)**	

Text Books:

T.Greenwood, Classical Dynamics, PHI Pvt Ltd., New Delhi, 1985.

Reference Books:

1. C.R.Mondall , Classical Mechanics, Prentice Hall of India, 2001.
2. Herbert Goldstein, Classical Mechanics, Third Edition, Addison Wesley Publications, Massachusetts, 2002.

Web – Resources:

1. **http://www.damtp.cam.ac.uk/user/tong/dynamics/clas.pdf**
2. http://www.freebookcentre.net/Physics/Classical-Mechanics-Books.html

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : analyze the mechanical system of particles.
CO2 : solve the Lagrange's equations of motion for the set of generalized coordinates.
CO3 : apply Lagrange's equations on various functions.
CO4 : interpret Hamilton's equations and its principles.
CO5 : retrieve Hamilton – Jacobi Equation.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	S	S	S	M	S	S	S	S
CO2	S	S	S	M	S	S	S	M	S	S	S	S
CO3	S	S	S	M	S	S	S	M	S	S	S	S
CO4	S	S	S	M	S	S	S	M	S	S	S	S
CO5	S	S	S	M	S	S	S	M	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-II / Elective Course-II (EC - II)	FUZZY SETS AND ITS APPLICATIONS	Course Code: PGME2
Instruction Hours: 6	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To introduce the fundamental of fuzzy set theory and its connection with fuzzy logic. • To emphasis the comprehensive coverage of operations on fuzzy sets. • To analyze the types of fuzzy arithmetic operations. • To introduce the various relations of fuzzy relations. • To study the applications of fuzzy in decision making problems.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**From Classical (Crisp) Sets To Fuzzy Sets : A Grand Paradigm Shift And Fuzzy Sets Versus Crisp Sets:** Fuzzy sets: Basic types – Fuzzy sets: Basic Concepts –Additional Properties of α – cuts -Extension Principle for fuzzy sets. **(Chapter I: Sec 1.3, 1.4, Chapter II: Sec 2.1, 2.3.)**	**18 Hours**
UNIT II	**Operations On Fuzzy Sets:** Types of operations– Fuzzy complements- Fuzzy Intersection: t-Norms – Fuzzy Unions: t-Conorms – Combinations of Operations. **(Chapter III: Sec 3.1 - 3.5)**	**18 Hours**
UNIT III	**Fuzzy Arithmetic:**Fuzzy numbers - Linguistic variables - Arithmetic operations on intervals –Arithmetic operations on Fuzzy numbers. **(Chapter IV: Sec 4.1 – 4.4)**	**18 Hours**
UNIT IV	**Fuzzy Relations:**Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations –Fuzzy Ordering Relations – Fuzzy Morphisms. **(Chapter V : Sec 5.3 - 5.8)**	**18 Hours**
UNIT V	**Fuzzy Decision Making :**Individual Decision Making – Multiperson Decision Making – Fuzzy Ranking Methods – Fuzzy Linear Programming.(**Chapter XV : 15.2, 15.3,15.6,15.7**)	**18 Hours**
UNIT VI Self-Learning	**Pattern Recognition**: Introduction – Fuzzy Clustering – Fuzzy Pattern Recognition Fuzzy Image Processing. **(Chapter 13: Sec. 13.1 – 13.4)**	

Text Books:

George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India, 2008.

Reference Books:

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, 1991.
2. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, Prentice Hall of India, New Delhi , 2006

Web – Resources:

1. https://link.springer.com/content/pdf/bfm%3A978-94-015-7949-0%2F1.pdf
2. https://www.eng.buffalo.edu/~nagi/papers/fuzzy.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : discuss the properties and extension principles of fuzzy sets.
CO2 : apply the mathematical operations on fuzzy sets.
CO3 : construct the arithmetic operations on fuzzy numbers.
CO4 : interpret the relations on fuzzy sets.
CO5 : analyze fuzzy concepts in decision making problems

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	S	S	S	S	S	S	S	W
CO2	S	S	S	M	S	S	S	S	S	S	S	W
CO3	S	S	S	M	S	S	S	S	S	S	S	W
CO4	S	S	S	M	S	S	S	S	S	S	S	W
CO5	S	S	S	M	S	S	S	S	S	S	S	W

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester- III / Core Course-IX (CC)	MEASURE AND INTEGRATION	Course Code: PGMI
Instruction Hours: 6	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To understand the concepts of integration using measures. • To introduce the concept of measure in real line. • To gain the knowledge of abstract measure spaces. • To study different types of decompositions. • To learn the facts of product measure spaces.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Measure on The Real Line** Lebesgue Outer Measure - Measurable Sets - Regularity - Measurable Functions – Borel and Lebesgue Measurability .**(Chapter II: Sec 2.1 - 2.5)**	**18 Hours**
UNIT II	**Integration of Functions of a Real Variable** Integration of Non-Negative Functions - The General Integral - Integration of Series – Riemann and Lebesgue Integrals. **(Chapter III: Sec 3.1 - 3.4)**	**18 Hours**
UNIT III	**Abstract Measure Spaces** Measures and Outer Measures – Extension of a Measure – Uniqueness of The Extension - Completion of a Measure - Measure Spaces - Integration with Respect to a Measure. **(Chapter V: Sec 5.1 - 5.6)**	**18 Hours**
UNIT IV	**Convergence & Signed Measures and Their Derivatives** Convergence in Measure- Almost uniform convergence- Signed Measures and The Hahn Decomposition –The Jordan Decomposition. **(Chapter VII: Sec 7.1 and 7.2, Chapter VIII: Sec 8.1 and 8.2)**	**18 Hours**
UNIT V	**Measure and Integration In A Product Space** Measurability in a Product space – The product Measure and Fubini's Theorem. **(Chapter X: Sec 10.1 &10.2)**	**18 Hours**
UNIT VI Self-Learning	**Lebesgue Stieltjes Integration:** Lebesgue Stieltjes Measure – Applications to Hausdorff Measures – Absolutely Continuous Functions – Integration by Parts – Change of Variable – Riesz Representation Theorem for C(I). **(Chapter 9: Sec 9.1 – 9.6)**	

Text Books:

G. De Barra, Measure Theory and Integration, Willey Eastern Limited, 1991.

Reference Books:

1. P.K. Jain, V.P. Gupta, Lebesgue Measure and Integration, New Age International Pvt Limited Publishers, New Delhi, 1986, Reprint 2000.
2. Richard L. Wheeden and Antoni Zygmund, Measure and Integral: An Introduction to Real Analysis, Marcel Dekker Inc. 1977.
3. Inder, K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, New Delhi, 1997.

Web – Resources:

1. https://www.researchgate.net/publication/321069885_Measure_Theory_and_Integration_By_and For_the learners
2. https://www.iisc.ac.in/wp-content/uploads/2017/12/MA222.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1	:	find the Lebesgue measure of measurable sets.
CO2	:	discuss the integration of non-negative functions.
CO3	:	analyze abstract measure spaces.
CO4	:	demonstrate Hahn decomposition theorem and signed measure
CO5	:	compute product measure.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	M	M	S	S	M	S	M	M	S	S
CO2	S	S	S	M	S	S	S	S	M	S	S	S
CO3	S	S	M	M	S	S	M	S	M	M	S	S
CO4	S	S	M	M	S	S	M	S	M	M	S	S
CO5	S	S	M	M	S	S	M	S	M	M	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Core Course X - (CC)	TOPOLOGY	Course Code: PGMJ
Instruction Hours: 6	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To study the concepts of deformation of objects with its properties.. • To learn connectedness and compactness of topological spaces. • To know the essentials of countability and separation axioms . • To understand the Tychonoff theorem and Stone – Cech Compactification. • To acquire knowledge about complete metric spaces.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Topological Spaces and Continuous Functions** Topological spaces – basis for a topology – the order topology – The Product topology of XxY – The subspace topology –Closed sets & Limit points – Continuous Functions. **(Chapter II: Sec 12 - 18)**	**18 Hours**
UNIT II	**Topological Spaces and Continuous Functions & Connectedness and Compactness** The product topology – The Metric topology - The metric topology Continued - Connected spaces – Connected subspaces of the real line – Compact spaces. **(Chapter II: Sec 19 – 21 Chapter III: Sec 23,24 and 26)**	**18 Hours**
UNIT III	**Countability and Separation Axioms** The countability axioms – The separation axioms – Normal Spaces - the Urysohn's lemma – Urysohn'sMetrization Theorem – The Tietze Extension Theorem**.** **(Chapter IV: Sec 30 - 35) (Chapter IV: Sec 30 - 35)**	**18 Hours**
UNIT IV	**The Tychonoff Theorem** The Tychonoff theorem – The Stone – Cech – Compactification.**(Chapter V: Sec 37,38)**	**18 Hours**
UNIT V	**Complete Metric Spaces and Function Spaces** Complete Metric spaces – Compactness in Metric spaces **(Chapter VII: Sec 43 & 45)**	**18 Hours**

UNIT VI **Self Learning**	**Baire Spaces and Dimension Theory :** Baire Spaces – A Nowhere Differentiable Function – Introduction to Dimension Theory. **(Chapter 8: Sec. 48 – 50)**

Text Books:

James R. Munkress, Topology - A First course, Second Edition, Prentice-Hall of India (P) Ltd. New Delhi, 2006.

Reference Books:

1. James Dugundji, Topology, Prentice Hall of India Pvt. Ltd., 1975.
2. G.F. Smmons, Introduction to Topology and Modern Analysis, M.C.Graw Hill Company, 1963.

Web – Resources:

https://nptel.ac.in/content/storage2/courses/111106054/Topology%20complete%20course.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : analyze the fundamental concepts of general topology.
CO2 : determine the types of topological spaces and their properties.
CO3 : discuss Uryzohn's lemma and the Tietze Extension Theorem.
CO4 : demonstrate Tychonoff theorem
CO5 : compute the complete and compactness in metric spaces

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	M	S	M	S	S	S	S	M	S	S	S
CO2	S	M	S	M	S	S	S	S	M	S	S	S
CO3	S	M	S	M	S	S	S	S	M	S	S	S
CO4	S	M	S	M	S	S	S	S	M	S	S	S
CO5	S	M	S	M	S	S	S	S	M	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Core Course- XI (CC)	INTEGRAL EQUATIONS AND TRANSFORMS	Course Code: PGMK
Instruction Hours: 6	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To introduce the concept of integral equations and their applications. • To learn the different types of transforms and their properties. • To develop Fourier Transformations, method of successive approximations, • To understand the Finite Fourier Transform. • To study the boundary value problems under Fourier transform.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Integral Equations With Separable Kernels:**Reduction to a system of Algebraic equations – Definition Regularity conditions – Special kind of kernels – Eigen values and Eigen functions – convolution integral – the inner of scalar product of two functions – Notation — Equations – Fredholm alternative – examples. **(Chapter II: Sec 2.1 – 2.4)**	**18 Hours**
UNIT II	**Method of Successive Approximations:**An Approximate Method – Method of Successive Approximations Iterative Scheme - Examples – Volterra Integral Equation – Examples – Some Results About The Resolvent Kernel. **(Chapter II & Chapter III : Sec 2.5 & 3.1– 3.5)**	**18 Hours**
UNIT III	**Fourier Transform:**Fourier Transform – Integral Formula Complex Transform – Cosine – Sine Transform – Property – Linearity, Change of Scale, Shifting – Modulation Theorem – Convolution Theorem – The Convolution or Falting Theorem for Fourier Transform. **(Chapter VI : Sec 6.1 to 6.18)**	**18 Hours**
UNIT IV	**Finite Fourier Transform:**Finite Fourier transform – Inversion Formula for Sine Transform – Finite Fourier Cosine Transforms – Inversion Formula for Cosine Transforms – Operational property of Finite Fourier Sine Transform – Operational property of Finite Fourier Cosine Transform - Combined properties of Finite Sine and Cosine Transforms – Convolution. **(Chapter VII: Sec 7.1 to 7.4, 7.6 to 7.9)**	**18 Hours**

UNIT V	**Application of Fourier Transform in Initial and Boundary Value Problems** Applications of Infinite Fourier Transform – Choice of Infinite Sine or Cosine Transforms – Finite Fourier Transform of Partial Derivatives – Choice of Finite Sine and Cosine Transforms. **(Chapter VIII: Sec 8.1, 8.2, 8.4 & 8.5)**	**18 Hours**
UNIT VI Self-Learning	**Steady State Heat Flow in Two Dimensions [Cartesian Coordinates]:** Introduction – Equation of variable Heat Flow in two Dimensions in Cartesian Coordinates – Variable Separable Solutions of Laplace Equation – Choice of Proper Solution. (**Chapter 4C: 4. C1 – 4.C4)**	

Text Books:

1. For Units I & II - Ram P. Kanwal,Linear Integral Equations Theory and Practice Academic press, 1971.
2. For Units III, IV & V - A.R. Vasista and R.K. Gupta Krishna, Integral transforms, Pragasam Publications.
3. T.Veerarajan, Transforms and Partial Differential Equations, Tata MCGraw Hill Education Private Limited, New Delhi, 2011. (Self-learning)

Reference Books:

Andrei D.Polyanin, Alexander V. Manzhirov ,Hand book of Integral Equations, Second Edition,Chapman/CRC Press.,2008.

Web – Resources:

1. https://www.usna.edu/Users/physics/tank/Other/MathMethods/MethodsAdditions/IntegralTransforms.pdf-
2. http://www.hep.caltech.edu/~fcp/math/integralEquations/integralEquations.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : solve the linear integral equations.
CO2 : find the solutions of Volterra and Fredholm integral equations.
CO3 : demonstrate the variational problems on moving boundaries and fixed boundaries.
CO4 : evaluate the Fourier transform, finite sine and cosine transforms.
CO5 : apply Fourier transform in initial and boundary value problems.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Elective Course-III (EC III)	MATHEMATICAL MODELLING	Course Code: PGME3
Instruction Hours: 6	Credits: 3	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To introduce different mathematical models in ordinary differential equations. • To study mathematical modelling of epidemics through systems of ordinary differential equations of first order. • To understand mathematical modelling through linear differential equations of second order. • To develop mathematical modelling through difference equations. • To learn mathematical modelling through graph theoretical models	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Mathematical Modelling through Ordinary Differential Equations of First Order:** Mathematical Modelling Through Differential Equations – Linear Growth and Decay Models – Non-Linear Growth and Decay Models – Compartment Models – Mathematical Modelling in Dynamics Through Ordinary Differential Equations of First Order. (Chapter 2: Sec. 2.1 to 2.5)	**18 Hours**
UNIT II	**Mathematical Modelling Through Systems of Ordinary Differential Equations of the First Order:** Mathematical Modelling in Population Dynamics – Mathematical Modelling of Epidemics Through Systems of Ordinary Differential Equations of First Order – Mathematical Modelling in Economics Based on Systems of Ordinary Differential Equations of First Order - Mathematical Models in Medicines, Arms Race , Battles and International Trade in Terms of Systems of Ordinary Differential Equations. (Chapter 3 : Sec. 3.1 – 3.2, 3.4 – 3.5)	**18 Hours**

UNIT III	**Mathematical Modelling Through Ordinary Differential Equations of Second Order :**Mathematical Modelling of Planetary Motions – Mathematical Modelling of Circular Motion and Motions of Satellites – Mathematical Modelling Through Linear Differential Equations of the Second Order – Miscellaneous Mathematical Models Through Ordinary Differential Equations of Second Order. (Chapter 4 : Sec. 4.1 to 4.4)	**18 Hours**
UNIT IV	**Mathematical Modelling Through Difference Equations:** The Need for Mathematical Modelling Through Difference Equations : Some Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Mathematical Modelling Through Difference Equations in Economics and Finance – Mathematical Modelling Through Difference Equations in Population Dynamics and Genetics – Mathematical Modelling Through Difference Equations in Probability Theory. (Chapter 5 : Sec. 5.1 to 5.5)	**18 Hours**
UNIT V	**Mathematical Modelling Through Graphs:**Situations that can be Modelled Through Graphs – Mathematical Models in Terms of Directed Graphs – Mathematical Models in Terms of Signed Graphs – Mathematical Modelling in Terms of Weighted Digraphs – Mathematical Modelling in Terms of Unoriented Graphs. (Chapter 7 : Sec. 7.1 to 7.5)	**18 Hours**
UNIT VI Self-Learning	**Mathematical Modelling Through Partial Differential Equations:** Situations giving raise to partial Differential equation Models – **Mass Balance Equations:** First Method of getting PDE Models. **Momentum – Balance Equations:** The Second Method of obtaining PDE Models. **(Chapter 6: Sec. 6.1 – 6.3)**	

Text Book:

J.N.Kapur, Mathematical Modelling, Second Edition, New Age International Private Limited, New Delhi,2018.

Reference Book:

J.N.Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt Limited, New Delhi.

Web – Resources:

1. **https://people.maths.bris.ac.uk/~madjl/course_text.pdf**
2. **http://mtm.ufsc.br/~daniel/matap/IntMatMod.pdf**

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : create models on linear growth and decay of any system.
CO2 : form mathematical modeling in epidemics in population.
CO3 : design mathematical modelling in any type of motions.
CO4 : solve problems in dynamics and genetics using modelling.
CO5 : demonstrate various real life situations through graphs

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	S	S	S	S	S	S	S	S	M
CO2	S	S	S	S	S	S	S	S	S	S	S	M
CO3	S	S	S	S	S	S	S	S	S	S	S	M
CO4	S	S	S	S	S	S	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	S	M

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III/ Elective Course-IV (EC IV)	ADVANCED OPERATIONS RESEARCH	Course Code: PGME4
Instruction Hours: 6	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To introduce the applications and algorithms in the field of operations research. • To understand the OR techniques in business and management problems. • To know the optimization techniques like integer programming, dynamic programming, decision theory and game theory. • To learn the concept of inventory models. • To study the non-linear programming algorithms.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Integer Linear Programming** Introduction - Illustrative Applications – Integer Programming Solution Algorithms – Branch and Bound Method – Zero – One Implicit enumeration Algorithm – Cutting Plane Algorithm. (Chapter IX : Sec 9.1 - 9.3)	**18 Hours**
UNIT II	**Deterministic Dynamic Programming** Introduction - Recursive Nature of Computations in DP – Forward and Backward Recursion – Selected DP Applications – Cargo Loading Model – Work Force Size Model – Equipment Replacement Model – Investment Model – Inventory Models (Chapter X : Sec 10.1 - 10.4)	**18 Hours**
UNIT III	**Decision Analysis and Games** Decision Environments – Decision Making under Certainty – Analytical Hierarchy Approach - Decision Making under Risk – Expected Value Criterion – Variation of the Expected Value Criterion – Decision under uncertainty – Game Theory – Optimal Soultion of two Person Zero Sum Games – Solution of Mixed Strategy Games. (Chapter XIV : Sec 14.1 - 14.5)	**18 Hours**
UNIT IV	**Deterministic Inventory Models** Introduction - General Inventory Model – Static EOQ Models – Classic EOQ Models – EOQ with Price Breaks – Multi Item EOQ with Storage Limitation.(Chapter XI : Sec 11.1 -11.3)	**18 Hours**

UNIT V	**Nonlinear Programming Algorithms** Unconstrained Nonlinear Algorithms – Direct Search Method – Gradient Method – Constrained Algorithms – Separable Programming – Quadratic Programming – Geometric Programming. (Chapter XXI : Sec 21.1 – 21.2.3)	**18 Hours**
UNIT VI Self-Learning	**Markovian Decision Process:** Scope of the Markovian Decision Problem: The Gardener Example – Finite – Stage Dynamic Programming Model.**(Chapter 19: Sec. 19.1 – 19.2)**	

Text Books:

Hamdy A. Taha , Operations Research, Prentice hall of India, Sixth Edition.

Reference Books:

1. O.L. Mangasarian, Non Linear Programming, McGraw Hill, New York.
2. S. MoktherBazaraa and C.M. Shetty, Non Linear Programming, Theory and Algorithms, Willy, New York .
3. Prem Kumar Gupta and D.S. Hira, Operations Research-An Introduction, S.Chand and Company.

Web – Resources:

http://www.ru.ac.bd/stat/wp-content/uploads/sites/25/2019/03/405_01_Srinivasan_Operations-Research_-Principles-and-Applications-Prentice-Hall-of-India-2010.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : write the algorithms in integer programming problem.
CO2 : apply the OR techniques in various models.
CO3 : analyse the problems on decision theory and game theory
CO4 : optimize solutions of inventory models.
CO5 : intrepret the concepts of non-linear programming problems.

Mapping of Course outcomes with Programme Outcomes/ Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated
M - Moderately Correlated
W-Weakly Correlated
N – No Correlation

Semester-IV / Core Course XII - (CC)	FUNCTIONAL ANALYSIS	Course Code: PGML
Instruction Hours: 6	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create
Course Objectives	**The Course aims** • To learn the concepts of Banach Spaces, Bounded linear operators, Reflexive spaces. • To study the structure theorems of Functional Analysis viz., Hahn-Banach theorem, Open mapping theorem and Uniform boundedness principle. • To acquire the knowledge about Hilbert spaces and operator theory on Hilbert spaces. • To know the proof of well-known spectral mapping theorem. • To gain knowledge of Gelfand- Neumark theorem.

UNIT	CONTENT	HOURS
UNIT I	**Banach Spaces:** The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N** - The open mapping theorem – The conjugate of an operator . (Chapter IX)	**18 Hours**
UNIT II	**Hilbert Spaces:** The definition and some simple properties – Orthogonal complements – Orthonormal sets – The conjugate space H*– The adjoint of an operator – Self-adjoint operators – Normal & unitary operators - Projections (Chapter X)	**18 Hours**
UNIT III	**Finite – Dimensional Spectral Theory:** Matrices – Determinants and the spectrum of an operator – The spectral theorem – A survey of the situation. (Chapter XI)	**18 Hours**
UNIT IV	**General Preliminaries on Banach Algebras:** The definition & some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The Formula for the spectral radius – The radical & semi-simplicity. (Chapter XII)	**18 Hours**
UNIT V	**The Structure of Commutative Banach Algebras:** The Gelfand mapping – Applications of the formula $r(x) = lim\|x^n\|^{1/n}$- Involutions in Banach Algebras – The Gelfand- Neumark theorem. (Chapter XIII)	**18 Hours**

UNIT VI **Self-Learning**	**Some Special Commutative Banach Algebras:** Ideals in $\mathcal{C}(X)$ and the Banach Stone Theorem – The Stone – Cheh Compactification (Continued) – Commutative $\mathcal{C}^*$ - algebras. **(Chapter XIV: Sec 74 – 76)**

Text Books:

G.F.Simmons, Introduction to Topology & Modern Analysis, Mc Graw Hill, ISE, 1963.

Reference Books:

1. E. Kreyszig, Introductory Functional Analysis with applications, John Wiley, 1978.
2. B.V.Limaye, Functional Analysis, Wiley Easter Limited, Bombay, 2nd edition, 1985

Web – Resources:

1. **http://www.math.nsc.ru/LBRT/g2/english/ssk/fa_e.pdf**
2. https://docs.ufpr.br/~eidam/2019/2/CM075/Kreyszig.pdf

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : disuss the concept of normed linear spaces, dual spaces, weak convergence.
CO2 : apply the idea of the Hahn Banach theorem and open mapping theorem.
CO3 : analyze linear operators on Hilbert space.
CO4 : evaluate orthonormal basis.
CO5 : demonstrate the commutative Banach algebras.

Mapping of Course Outcomess with Programme Outcomes / Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	M	S	M	S	S	S	S	M	S	S	S
CO2	S	M	S	M	S	S	S	S	M	S	S	S
CO3	S	M	S	M	S	S	S	S	M	S	S	S
CO4	S	M	S	M	S	S	S	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-IV / Core Course-XIII (CC)	ADVANVED PROBABILITY THEORY	Course Code: PGMM
Instruction Hours: 6	Credits: 5	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To understand the fields, σ -fields and random variables. • To provide the knowledge of the probability space. • To learn the distribution functions. • To gain knowledge about expectations and moments. • To study the convergence in distributions.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Fields and σ – Fields:** Class of events –Functions and Inverse functions – Random variables – Limits of random variables. (Chapter I and II : Omit (1.1&1.2))	**18 Hours**
UNIT II	**Probability Space :** Definition of probability – some simple properties – discrete probability space – General probability space – Induced probability space. (Chapter III (Omit 3.6))	**18 Hours**
UNIT III	**Distribution Functions:** Distribution functions of a random variable –Decomposition of distributive functions- Distributive functions of vector random variables – Correspondence theorem. (Chapter IV)	**18 Hours**
UNIT IV	**Expectation and Moments:** Definition of Expectation – Properties of expectation – Moments, Inequalities. (Chapter V)	**18 Hours**
UNIT V	**Convergence of Random Variables:** Convergence in Probability –Convergence almost surely – Convergence in distribution –Convergence in the rth mean -Convergence theorems for Expectations Chapter VI (6.1 to 6.5)	**18 Hours**
UNIT VI Self-Learning	Limit Theorems: Chebyshev's Inequality – Other Useful Inequalities - Convergence in Distribution – Convergence in Probability. (Chapter 5: Sec 5.1 – 5.4)	

Text Books:

1. B.R. Bhat , Modern Probability Theory, 3rd Edition, New Age International private ltd, New Delhi, 2007**.**
2. T.K.Chandra & D. Chatterjee, A First Course in Probability , Narosa Publishing House Pvt. Ltd, Third Edition, 2005.**(Self Learning)**

Reference Books:

1. Chandra T.K and Chatterjee D. (2003), A first course in probability , 2nd Edition, Narosa Publishing House, New Delhi.
2. Kailai Chung and Farid Aitsahlia, Elementary Probability, Springer Verlag 2003, New York.
3. Capinski and Thomasz Zastawniak(2003), Probability through problems, Springer Verlag, New York.
4. Sharma .T.K(2005), A text book of probability and theoretical distribution, Discovery publishing house, New Delhi.

Web – Resources:

1. **https://ieeexplore.ieee.org/document/6813036?arnumber=6813036**
2. **https://www.degruyter.cpcom/document/doi/10.1515/9783110466195/html?lang=en**

Course Outcomes

On Completion of the Course, Students should be able to

CO1 : interpret the field and σ – fields
CO2 : analyze the probability spaces.
CO3 : apply the concepts of random variables and distributions.
CO4 : describe the ideas of expectation and characteristic functions
CO5 : demonstrate the convergence of random variables

Mapping of Course Outcomes with Programme Outcomes / Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-IV / Core Course-XIV (CC)	FLUID DYNAMICS	Course Code: PGMN
Instruction Hours:	Credits:	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To know the behavior of fluids in motion. • To study the analysis is of the flow of liquids. • To introduce the concepts of two dimensional flow. • To learn the stress components on viscous flow. • To understand the energy dissipation due to viscosity.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**Kinematics of Fluids in Motion:** Real fluids and Ideal Fluids – Velocity of a Fluid at a point – Streamlines and Path lines; Steady and Unsteady Flows – Velocity potential – Vorticity vector – Local and Particle Rates of Change – Equation of continuity – Worked examples – Acceleration of a Fluid **Equations of Motion of a Fluid:** Pressure at a point in a Fluid at Rest-Pressure at a point in Moving Fluid – Conditions at a Boundary of Two Inviscid Immiscible Fluids – Euler's equation of motion – Bernoulli's equation – worked examples.	**18 Hours**
UNIT II	**Equations of Motion of a Fluid:** Discussions of a case of steady motion under conservative body forces – Some potential theorems – Some Flows Involving Axial Symmetry – Some special two- Dimensional Flows-Impulsive Motion. **Some Three Dimensional Flows:** Introduction – Sources, Sinks and Doublets – Images in a Rigid infinite Plane – Axi-Symmetric Flows; Stokes stream function.	**18 Hours**
UNIT III	**Some Two Dimensional Flows:** Meaning of a Two-Dimensional Flow – Use of cylindrical polar co-ordinates – The stream function – The Complex Potential for Two Dimensional, Irrotational, Incompressible Flow – complex velocity potentials for Standard Two Dimensional Flows – Some worked examples – The Milne- Thomson circle theorem and applications – The theorem of Blasius.	**18 Hours**

UNIT IV	**Some Two Dimensional Flows:** The use of conformal Transformation and Hydrodynamical Aspects – Vortex rows. **Viscous flow:** Stress components in a real fluid - relations between cartesian components of stress - Translational Motion of Fluid element – The Rate of Strain Quadraic and Principle Stresses – Some further properties of the rate of strain quardric - Stress analysis in fluid motion – Relations between stress and rate of strain - The coefficient of viscosity and laminar flow – The Navier- Stokes equations of motion of a viscous fluid. (5.9 & 8.1-8.8)	**18 Hours**
UNIT V	**Viscous flow:** Some solvable problems in viscous flow – Steady viscous flow in tubes of uniform cross section – Diffusion of vorticity – Energy Dissipation due to viscosity – Steady Flow past a Fixed Sphere – Dimensional Analysis; Reynolds Number – Prandtl's Boundary Layer.	**18 Hours**
UNIT VI Self-Learning	**Magneto hydrodynamics :** Nature of Magneto hydrodynamics – Maxwell's Electromagnetic Field Equations: Medium at Rest – Maxwell's Electromagnetic Field Equations: Medium in Motion – The Equations of Motion of a Conducting Fluid – Rate of Flow of Charge – Simplification of the Electromagnetic Field Equations – The Magnetic Reynolds Number – Alfven's Theorem – The Magnetic Body Force – Ferraro's Law of Isorotation	

Text Books: F. Chorlton,Text Book of Fluid Dynamics,CBS Publisher & Distributors, Delhi-110 002.

Reference Books:

1. J.F. Wendt J.D. Anderson, G. Degrez and E. Dick, Computational Fluid Dynamics: An Introduction, Springer – Verlag, 1996.
2. J. D. Anderson, Computational Fluid Dynamics - The Basics with Applicatios , McGraw Hill, 1995.
3. G. K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1984.
4. A. J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer- Verlag, New York, 1993.
5. S. W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Pvt Limited, New Delhi, 1976.
6. R. K. Rathy , An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.

Web – Resources:

1. **https://www.degruyter.com/document/doi/10.1515/9783110466195/html?lang=en**
2. https://www.ldeo.columbia.edu/~martins/hydro/lectures/fluid_dynamics.html

Course Outcomes

On Completion of the Course, Students should be able to

CO 1: discuss the behavior of fluids in motion.

CO 2: demonstrate the changes in flow when sphere of cylinder is introduced.

CO 3: estimate the applications of two dimensional flow

CO 4: apply the stress components on viscous flow

CO 5: solve problems in viscous flow and describe the energy dissipation.

Mapping of Course Outcomes with Programme Outcomes / Programme Specific Outcomes

CO/PO	PO						PSO					
	1	2	3	4	5	6	1	2	3	4	5	6
CO1	S	S	S	M	S	S	S	M	S	S	S	S
CO2	S	S	S	M	S	S	S	M	S	S	S	S
CO3	S	S	S	M	S	S	S	M	S	S	S	S
CO4	S	S	S	M	S	S	S	M	S	S	S	S
CO5	S	S	S	M	S	S	S	M	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-IV / Elective Course-V (CC)	DIFFERENTIAL GEOMETRY	Course Code: PGME5
Instruction Hours: 6	Credits: 4	Exam Hours: 3
Internal Marks:25	External Marks:75	Total Marks: 100

Cognitive Level	**K 1 -** Acquire/ Remember **K2 -** Understand **K3** - Apply **K4** - Evaluate **K5** - Analyze **K6** - Create	
Course Objectives	**The Course aims** • To understand the basic concepts of space curves. • To introduce the notion of surfaces and their properties. • To learn geodesics and its properties. • To study developable, minimal and ruled surfaces. • To acquire the knowledge of compact surfaces and Hilbert's theorem.	
UNIT	**CONTENT**	**HOURS**
UNIT I	**The Theory of Space Curves:** Introductory remarks about space curves - Definitions - Arc length – Tangent , normal and binormal – Curvature and torsion of a curve given as the intersection of two surfaces - contact between curves and surfaces- Tangent surface, involutes and evolutes- Intrinsic equations, Fundamental Existence Theorem for space curves - Helics (Chapter I: Sec 1 – 9)	**18 Hours**
UNIT II	**The Metric : Local Intrinsic Properties of a Surface:** Definition of a surface - Curves on a surface - Surface of revolution - Helicoids - Metric- Direction coefficients - Families of curves- Isometric correspondence- Intrinsic properties. (Chapter II: Sec 1 – 9)	**18 Hours**
UNIT III	**The Metric : Local Intrinsic Properties of a Surface:** Geodesics - Canonical geodesic equations - Normal property of geodesics- Existence Theorems - Geodesic parallels - Geodesics curvature- Gauss- Bonnet Theorem - Gaussian curvature- Surface of constant curvature. (Chapter II: Sec 10 – 18)	**18 Hours**
UNIT IV	**The Second Fundamental Form: Non Intrinsic Properties of a Surface:** The second fundamental form- Principal curvature - Lines of curvature - Developables – Developable associated with space curves and with curves on surfaces – Minimal surfaces - Ruled surfaces. (Chapter III: Sec 1 – 8)	**18 Hours**

UNIT V	**Differential Geometry of Surfaces:** Introduction - Compact surfaces whose points are umbilicus- Hilbert's lemma - Compact surface of constant Gaussian or mean curvature - Complete surfaces - Characterization of complete surfaces - Hilbert's Theorem - Conjugate points on geodesics.(Chapter IV: Sec 1 – 8)	**18 Hours**
UNIT VI **Self-Learning**	**The Fundamental Equations of Surface Theory:** Introduction – Tensor notations – Gauss Equations – Weingarten Equations - Mainardi – Codazzi Equations. **(Chapter 5: Sec. 5.1 – 5.5)**	

Text Books:

T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press, (17th Impression) , New Delhi ,2002**.**

Reference Books:

1. D.T. Struik, Lectures on Classical Differential Geometry, Addison - Wesley, Mass. 1950.
2. S. Kobayashi and K. Nomizu, Foundations of Differential Geometry, Interscience Publishers, 1963.
3. Wihelm K lingenberg ,A Course in Differential Geometry, Graduate Texts in Mathematics, Springer Verlag, 1978.
4. J.A. Thorpe, Elementary Topics in Differential Geometry, Under - graduate Texts in Mathematics, Springer - Verlag 1979

Web – Resources:

1. **http://mysite.science.uottawa.ca/rossmann/Differential%20Geometry%20book_files/Diffgeo.pdf**

Course Outcomes

On Completion of the Course, Students should be able to

CO1	:	discuss the concept of graphs and level sets-vector fields
CO2	:	analyze surfaces and vector field on surfaces.
CO3	:	apply the properties of geodesics.
CO4	:	interpret the scope of developables, minimal and ruled surfaces.
CO5	:	compute the compactness and completeness of surfaces.

Mapping of Course Outcomes with Programme Outcomes / Programme Specific Outcomes

CO/PO	PO						PSO					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	S	M	M	W	M	M	M	M	S	M	S	S
CO2	S	M	S	M	S	M	S	M	S	S	M	S
CO3	S	M	S	M	S	M	S	M	S	S	M	S
CO4	S	S	M	W	M	M	M	S	S	M	M	S
CO5	S	M	S	W	M	S	S	M	M	S	M	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation