Sacred Heart College (Autonomous), Tirupattur District

1.2.1 List of New Courses

M.Sc. Mathematics

Sem	Course Code	Course Title	Type	Hrs/ Week	Credits	Marks		
						Int	SE	Total
I	M745	Abstract Algebra	MC	6	5	50	50	100
	M746	Real Analysis	MC	6	5	50	50	100
	M747	Ordinary Differential Equations	MC	6	5	50	50	100
	M748	Mathematical Statistics	MC	6	5	50	50	100
	M749A M749B M749C	A1. Differential Geometry A2. Skill Enhancement Course I – Algebra A3. Coding Theory	ME	6	3	50	50	100
	Total			30	23	250	250	500
II	M848	Advanced Linear Algebra	MC	6	5	50	50	100
	M849	Partial Differential Equations	MC	6	5	50	50	100
	M850	Advanced Graph Theory	MC	6	5	50	50	100
	M851	Classical Dynamics	MC	6	5	50	50	100
	M852A M852B	B1. Mathematical	ME	6	3	50	50	100

	M852C	Models in Biology B2. Skill Enhancement Course II – Linear Algebra B3. Numerical Analysis						
	Total			30	23	250	250	500
III	M953	Mathematical Analysis	MC	6	5	50	50	100
	M954	Topology	MC	6	5	50	50	100
	M955	Optimization Techniques	MC	6	5	50	50	100
	M956	Fluid Dynamics	MC	6	5	50	50	100
	M957A M957B M957C	C1. Nonlinear Dynamical Systems C2. Skill Enhancement Course III – Real Analysis C3. Mathematical Physics	ME	6	3	50	50	100
	Total			30	23	250	250	500
IV	M1049	Complex Function Theory	MC	6	5	50	50	100
	M1050	Functional Analysis	MC	6	5	50	50	100
	M1051	Difference Equations	MC	5	4	50	50	100
	M1052A M1052B M1052C	D1. Stochastic Processes D2. Skill Enhancement Course IV – Complex Analysis D3. Theory of Transforms	ME	5	3	50	50	100
	VE10XX	Human Rights		2	1	50	50	100
	M1053J	Project	MC	6	3	20	80	100
	Total			30	21	270	330	600
	Grand Total			**120**	**90 +10***	**1020**	**1080**	**2100**

Sacred Heart College (Autonomous), Tirupattur District

1.2.1 List of New Courses

Department: Mathematics

S.No	Course Code	Course Name
1.	M953	Mathematical Analysis
2.	M954	Topology
3.	M955	Optimization Techniques
4.	M957A	Nonlinear Dynamical Systems (Elective)
5.	M957B	Skill Enhancement Course III – Real Analysis
6.	M957C	Mathematical Physics (Elective)
7.	M1049	Complex Function Theory
8.	M1050	Functional Analysis
9.	M1052B	Skill Enhancement Course IV– Complex Analysis (Elective)
10.	M1052C	Theory of Transforms (Elective)

Syllabus:

SEMESTER– III

MATHEMATICAL ANALYSIS

Course Code	**M953**	**Credit**	**5**
Instruction Hours per Week	**6**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To study and analyze the real number system, Fourier series , Fourier Integral, multivariable calculus , Cauchy Theorem and Residue Calculus.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.	K1,K2
CO2	analyze the representation and convergence problems of Fourier series.	K4
CO3	analyze and evaluate the differences between transforms of various functions	K4, K5
CO4	formulate and evaluate complex contour integrals directly and by the fundamental theorem.	K5,K6
CO5	apply the Cauchy integral theorem in its various versions to compute contour integration.	K3

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	2	3	3	3	3	2	2.8
2	3	3	3	3	2	3	3	3	3	2	2.8
3	3	3	3	3	2	3	3	3	3	1	2.7
4	3	3	3	3	1	3	3	3	3	1	2.6
5	3	3	3	3	1	3	3	2	3	1	2.5
										Mean Overall Score	**2.68**
										Result	**High**

Unit – I: Fourier series

Introduction - Orthogonal systems of functions – The theorem on best approximation – The Fourier series of a function relative to an orthonormal system – Properties of the 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 a Fourier series – Riemann's localization theorem – Sufficient conditions for convergence of a Fourier series at a particular point.

(Chapter 11, Sections: 11.1 - 11.12)

Unit – II: Fourier Integral

Cesaro summability of Fourier series – Consequences of Fejer's theorem – The Weierstrass approximation theorem – Other forms of Fourier series – The Fourier integral theorem – The exponential form of the Fourier integral theorem – Integral transforms – Convolutions – The convolution theorem for Fourier transforms – The Poisson summation formula.

(Chapter 11, Sections: 11.13 - 11.22)

Unit – III: Multivariable Differential Calculus

Introduction – The directional derivative –Directional derivatives and continuity –The total derivative - The total derivative expressed in terms of partial derivatives –An application to the complex valued functions–The matrix of a linear function –The Jacobian matrix –The chain rule – Matrix form of the chain rule –The Mean-Value theorem for differentiable functions –A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives – Taylor's formula for functions from R^n to R^1.

(Chapter 12, Sections: 12.1 - 12.14)

Unit – IV: Cauchy Theorem

Analytic functions – Paths and curves in the complex plane – Contour integrals – The integral along a circular path as a function of the radius – Cauchy's integral theorem for a circle – Homotopic curves – Invariance of contour integrals under homotopy – General form of Cauchy's integral theorem – Cauchy's integral formula – The winding number of a circuit with respect to a point – The unboundedness of the set of points with winding number zero – Analytic functions defined by contour integrals – Power-series expansions for analytic functions – Cauchy's inequalities. Liouville's theorem – Isolation of the zeros of an analytic function.

(Chapter 16, Sections: 16.1 - 16.15)

Unit – V: Residue Calculus

The identity theorem for analytic functions – The maximum and minimum modulus of an analytic function – The open mapping theorem – Laurent expansions for functions analytic in an annulus – Isolated singularities – The residue of a function at an isolated singular point – The Cauchy residue theorem – Counting zeros and poles in a region – Evaluation of real-valued integrals by means of residues – Evaluation of Gauss's sum by residue calculus – Application of the residue theorem to the inversion formula for Laplace transforms – Conformal mappings.

(Chapter 16, Sections: 16.16 - 16.27)

Book for Study

1. Tom M. Apostol**,** *Mathematical Analysis*, Indian student second edition, Narosa Publishing House, Chennai, 20th reprint 2002.

Books for Reference

1. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
2. P. N. Arora and Ranjit Singh, *First course in Real Analysis*, Third edition, Sultan Chand and Sons Publishers, New Delhi, 1981.
3. Richard R. Goldberg, *Methods of Real Analysis*, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 1970.
4. Robert G. Bartle and Donald R. Sherbert, *Introduction to Real Analysis*, 2-e John Wiley and Sons, 2000.
5. S. Arumugam, *Modern Analysis*, New Gamma Publishers, Palayamkottai, 1993.

Syllabus:

Semester – III

TOPOLOGY

Course Code	M954	**Credit**	**5**
Instruction Hours per Week	**6**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To develop student's topological and proof writing skills which are essential in the study of advanced mathematics, understand the concepts of topological spaces, analyze and synthesize proofs, understanding the concepts of connectedness and compactness.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	define and illustrate the concept of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space.	K1,K2
CO2	Understand continuity, compactness, connectedness, homeomorphism and topological properties.	K2
CO3	analyze and apply the topological concepts in Functional Analysis.	K3, K4
CO4	Ability to determine that a given point in a topological space is either a limit point or not for a given subset of a topological space.	K5
CO5	develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent (homeomorphic).	K6

Mapping of CO with PO and PSO

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	1	3	3	3	2	1	2.5
2	3	3	3	3	2	3	3	3	2	1	2.6
3	3	3	3	3	2	3	3	3	2	2	2.7
4	3	3	3	3	1	3	3	3	2	1	2.5
5	3	3	3	3	1	3	3	3	2	1	2.5
Mean Overall Score											**2.56**
Result											**High**

Unit – I: Topological Spaces

Topological Spaces –Basis for a Topology–The Order Topology–The Product Topology on X ×Y - The Subspace Topology – Closed Sets and Limit Points.

(Chapter 2,Sections: 12 - 17)

Unit – II: Continuous Functions and Metric Topology

Continuous Functions – The Product Topology – The Metric Topology.

(Chapter 2, Sections: 18 - 21)

Unit – III: Compactness

Compact Spaces – Compact Subspaces of the Real Line – Limit Point Compactness – Local Compactness.

(Chapter 3, Sections: 26 - 29)

Unit – IV:Countability and Separation Axioms

The Countability Axioms – The Separation Axioms – Normal Spaces – The Urysohn Lemma – The Urysohn Metrization Theorem – The Tietze Extension Theorem.

(Chapter 4, Sections: 30 - 35)

Unit – V: Metrization Theorems and Paracompactness

Local Finiteness – The Nagata-Smirnov Metrization Theorem – Paracompactness - The Smirnov Metrization Theorem.

(Chapter 6: Sections 39 - 42)

Book for Study

1. James R. Munkres, *Topology*, 2-e, Prentice Hall of India Private Limited, New Delhi, 2003.

Books for Reference

1. J. Dugundji, (1975), *Topology*, Prentice Hall of India , New Delhi.
2. George F. Simmons, (1963), *Introductions to Topology and Modern Analysis*, McGraw Hill.
3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co, New York.
4. L. Sten and J. Subash, Holt, Rinehart and Winston, *Counter Examples in Topology*.
5. S. Willard,(1970), *General Topology*, Addison Wesley Mass.

Syllabus:

SEMESTER – III

OPTIMIZATION TECHNIQUES

Course Code	M955	**Credit**	**5**
Instruction Hours per Week	**6**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To obtain knowledge on linear programming problems, queuing models, inventory models, dynamic programming and nonlinear programming problems.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	formulate the primal linear programming problem into standard form and use the simplex method or revised simplex method to solve it.	K6
CO2	modify a primal problem and use the fundamental insight of linear programming to identify the new solution or use dual simplex method.	K3
CO3	understand the concept of complementary slackness and its role in solving primal/dual problem pairs.	K2
CO4	examine and evaluate classical linear programming problems such as dynamic programming problem and non-linear programming problem.	K1, K5
CO5	categorize queueing models	K4

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	2	3	3	3	2	2	2.7
2	3	3	3	3	2	3	3	3	2	1	2.6
3	3	3	3	3	2	3	3	3	2	2	2.7
4	3	3	3	3	1	3	3	3	2	1	2.5
5	3	3	3	3	2	3	3	3	2	1	2.6
Mean Overall Score											**2.62**

Unit – II: Queueing Models

Introduction – An Example – General Characteristics – Performance Measures – Relations among the Performance Measures – Markovian Queueing Models – The (M/M/1) Model – Limited Queue Capacity – Multiple Servers.

(Chapter 7, Sections: 7.1 to 7.9)

Unit – III: Inventory Models

Introduction – Deterministic Models – Probabilistic Models.

(Chapter 8, Sections: 8.1 to 8.11)

Unit – IV: Dynamic Programming

Basic concepts – The development of Dynamic Programming – Illustrative Examples – Continuous State Dynamic Programming.

(Chapter 10, Sections: 10.1 to 10.12 (Omit 10.6))

Unit – V: Non Linear Programming

Basic concepts – Unconstrained Optimization – Gradient projection – Constrained Optimization Problems: Equality constraints – Constrained optimization problems: Inequality Constraints.

(Chapter 11, Sections: 11.1 to 11.2 and 11.5 to 11.9)

Book for Study

1. Ravindran, Don. T. Philips, James J. Solberg, *Operations Research Principles and Practice*, 2-e, John Wiley & sons, New York, 2006.

Books for Reference

1. Frederic S. Hillier and Gerald J. Lieberman, *Operations Research*, 2-e, CBS Publishers Distributors, Delhi, 1999.
2. Hamdy A. Taha, *Operations Research*, 5-e, Prentice Hall of India, Pvt. Ltd, New Delhi, 2008.
3. Sasieni, Arthur Yaspan, Lawrence Friedman, *Operations Research Methods and Problems*, Wiley International Edition, 1959.
4. S. D. Sharma, *Operations Research*, 15-e, Kedarnath Ram Nath & Co Publishers, 2007.

Syllabus:

Semester – III

NONLINEAR DYNAMICAL SYSTEMS

Course Code	M957A	**Credit**	**3**
Instruction Hours per Week	**6**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To learn and apply phase plane analysis and stability techniques to problems in Science and technology.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	understand phase plane analysis and stability techniques to evaluate problems in Science and technology.	K2, K5
CO2	describe these concepts with examples.	K1
CO3	propose and solve interesting examples of Dynamical Systems	K3, K6
CO4	establish stability results	K3
CO5	point out the importance of modelling physical systems	K4

Mapping of CO with PO and PSO :

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	1	3	3	3	2	2	2.6
2	3	3	3	3	2	3	3	3	2	1	2.6
3	3	3	3	2	2	3	3	3	2	1	2.5
4	3	3	3	2	1	3	3	3	2	2	2.5
5	3	3	3	3	1	3	3	3	2	2	2.6
Mean Overall Score											**2.56**
Result											**High**

Unit – I: Plane Autonomous Systems and Linearization

The general phase plane - Some population models - Linear approximation at equilibrium points - The general solution of linear autonomous plane systems - The phase paths of linear autonomous plane systems - Scaling in the phase diagram for a linear autonomous system - Constructing a phase diagram.

(Chapter 2, Sections: 2.1 to 2.7)

Unit – II: Periodic Solutions and Averaging methods

An energy-balance method for limit cycles - Amplitude and frequency estimates: polar coordinates - An averaging method for spiral phase paths - Periodic solutions: harmonic balance - The equivalent linear equation by harmonic balance.

(Chapter 4, Sections: 4.1 to 4.5)

Unit – III: Perturbation Methods

Non-autonomous systems: forced oscillations - The direct perturbation method for the undamped Duffing's equation - Forced oscillations far from resonance - Forced oscillations near resonance with weak excitation - The amplitude equation for the undamped pendulum - The amplitude equation for a damped pendulum - Soft and hard springs - Amplitude–phase perturbation for the pendulum equation - Periodic solutions of autonomous equations (Lindstedt's method) - Forced oscillation of a self-excited equation - The perturbation method and Fourier series.

(Chapter 5, Sections: 5.1 to 5.11)

Unit – IV: Stability

Poincaré stability (stability of paths) - Paths and solution curves for general systems - Stability of time solutions: Lyapunov stability - Lyapunov stability of plane autonomous linear systems - Structure of the solutions of n-dimensional linear systems.

(Chapter 8, Sections: 8.1 to 8.5)

Unit – V: Stability (Continued)

Structure of n-dimensional inhomogeneous linear systems –Stability and boundedness for linear systems - Stability of linear systems with constant coefficients - Linear approximation at equilibrium points for first-order systems in n variables – Stability of a class of non-autonomous linear systems in n dimensions - Stability of the zero solutions of nearly linear systems.

(Chapter 8, Sections: 8.6 to 8.11)

Book for Study

1. D. W. Jordan and P. Smith, *Nonlinear Ordinary Differential Equations: An introduction for Scientists and Engineers,* Fourth Edition, Oxford University Press, 2007.

Books for Reference

1. D. A. Sanchez, Freeman, *Ordinary Differential Equations and Stability Theory,* Dover Publications, Inc. New York, 1968.
2. G. F. Simmons, *Differential Equations*, Tata McGraw Hill, New Delhi, 1979.
3. J. K. Agarwal, *Notes on Nonlinear Systems,* Van Nostrand, 1972.
4. M. D. Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd., New Delhi, 2001.

Syllabus:

Semester – III

SKILL ENHANCEMENT COURSE III – REAL ANALYSIS

Course Code	M957B	**Credit**	**5**
Instruction Hours per Week	**5**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To make the students to acquire basic knowledge about the business environment • To impart knowledge on the various environmental aspects in the midst of which a business has to be organized. • To enable the students to understand the difference between Money market and Capital Market • To expose students to Money Market, Capital Market, Stock Exchange and SEBI • To create awareness on various ethical issues in business and consumer rights.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	apply the theoretical knowledge in solving problems.	K3
CO2	attempt competitive examinations such as NET, SET and TRB.	K1
CO3	Extend their knowledge of Lebesgue theory of integration by selecting and applying its tools for further research in this and other related areas	K2, K3
CO4	Recognize the need of concept of measure from a practical view point.	K1
CO5	Understand the nature of abstract mathematics and explore the concepts in further details.	K2

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	2	3	3	3	2	2	2.7
2	3	3	3	3	2	3	3	3	2	1	2.6
3	3	3	3	2	1	3	3	3	2	2	2.5
4	3	3	3	2	2	3	3	3	2	2	2.6
5	3	3	3	2	2	3	3	3	2	2	2.6
Mean Overall Score											**2.6**
Result											**High**

Unit – I: Real number system and Infinite Series

Field Structures and Order Structure – Bounded and Unbounded sets: Supremum, Infimum – Completeness in the Set of Real Numbers – Absolute Value of a Real Number – Limit Points of a set – Closed Sets: Closure of a set – Countable and Uncountable Sets – Sequences - Limits Point of a Sequences – Limits Inferior and Superior – Convergent Sequences – Non-Convergent sequences – Cauchy General Principle of Convergence – Algebra of Sequences – Some Important Theorems – Monotonic Sequences – Positive Term series – Comparison tests for Positive term Series – Cauchy's Root, D'Alembert's Ratio, Raabe's, Logarithmic, Integral and Gauss Tests – Series with Arbitrary terms – Rearrangement of Terms

(Chapters 1 to 4 – Examples and exercises)

Unit – II: Functions of a Single Variable

Limits – Continuous Functions – Functions Continuous on Closed Intervals – Uniform Continuity – Derivative – Continuous Functions – Increasing and Decreasing Functions – Darboux's, Rolle's, Lagrange's Mean Value and Cauchy's Mean Value Theorems - Higher Order Derivatives.

(Chapters 5, 6 – Examples and exercises).

Unit – III: Riemann and Improper Integrals

Definitions and Existence of the Integral – Refinement of Partitions – Darboux's Theorem – Conditions of Integrability – Integrability of the sum and Difference of Integrable Functions – The Integral as a Limit of Sums – Some Integrable Functions – Integration and differentiation – The Fundamental Theorem of Calculus – Mean Value Theorems of Integral Calculus – Integration by Parts – Change of Variables in an Integral – Second Mean Value Theorem –Integration of Unbounded Functions with Finite Limits of Integration – Comparison Tests for Convergence at 'a' in $\int_a^b f(x)\,dx$ – Infinite Range of Integration – Integrand as a Product of Functions – Pointwise Convergence – Uniform Convergence on an Interval – Tests for Uniform Convergence – Properties of Uniformly Convergent Sequences and Series – The Weierstrass Approximation Theorem.

(Chapters 9, 11, 12 – Examples and exercises)

Unit – IV: Functions of Several Variables

Explicit and Implicit Functions – Continuity – Partial derivatives – Differentiability – Partial Derivatives of Higher Order – Differentials of Higher Order – Function of functions – Change of Variables – Taylor's Theorem – Extreme Values: Maxima and Minima – Functions of Several Variables – Jacobians – Stationary Values under Subsidiary Conditions.

(Chapters 15, 16 – Examples and exercises)

Unit – V: Metric Spaces and Lebesgue Integral

Metric Spaces – Measurable Sets – Sets of Measure Zero – Borel Sets – Non-Measurable Sets – Measurable Functions – Measurability of the sum, difference, product and quotient Measurable functions – Lebesgue Integral – Properties of Lebesgue Integral for Bounded Measurable Functions - Lebesgue Integral for Bounded set of finite measure and unbounded Functions – The General Integral – Some Fundamental Theorems – Lebesgue Theorem on Bounded Convergence – Integrability and Measurability – Lebesgue Integral on unbounded sets or intervals – Comparison with Riemann Integral for Unbounded Sets

(Chapters 19,20 – Examples and exercises)

Text book

1. S.C. Malik, Savita Arora, *Mathematical Analysis*, New age International Publishers, New Delhi, 2011.

Reference

1. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
2. P.N. Arora and Ranjit Singh, *First course in Real Analysis*, Third edition, Sultan Chand and Sons Publishers, New Delhi, 1981.
3. Richard R. Goldsberg, *Methods of Real Analysis*, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 1970.
4. Robert G. Bartle and Donald R. Sherbert, *Introduction to Real Analysis*, 2-e John Wiley and Sons, 2000.
5. S. Arumugam, *Modern Analysis*, New Gamma Publishers, Palayamkottai, 1993.

Syllabus:

Semester – III

MATHEMATICAL PHYSICS

Course Code	**M957C**	**Credit**	**3**
Instruction Hours per Week	**6**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• This course intends to introduce applications of various mathematical techniques to problems of Theoretical Physics. Examples could be chosen from all 4 traditional divisions of Modern Fundamental Theoretical Physics – Classical Mechanics, Electrodynamics, Quantum Mechanics and Statistical Physics.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	describe and employ the concepts of Gradient, Divergence, Curl and their typical applications in Physics.	K1, K3
CO2	prioritize special functions like Gamma function, Beta function, Dirac function, Delta function, Bessel function and their relations.	K4
CO3	Illustrate Lagrangian and Hamitonian approaches in classical mechanics.	K2
CO4	adapt to tensors in physics.	K6
CO5	evaluate special type of matrices that are relevant in Physics.	K5

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	2	3	3	3	2	2	2.7
2	3	3	3	3	2	3	3	3	2	1	2.6
3	3	3	3	1	1	3	3	3	2	1	2.3
4	3	3	3	2	2	3	3	3	2	2	2.6
5	3	3	3	1	1	3	3	3	2	2	2.4
Mean Overall Score											**2.52**
Result											**High**

Unit 1:
Vector calculus and applications in electromagnetic theory and fluid mechanics.

Unit 2:

Introduction to tensor calculus: review of basics, index notation, tensors in physics and geometry, Levi-Civita tensor, transformations of vectors, tensors and vector fields, covariance of laws of physics.

Unit 3:

Calculus of variations and extremal problems, Lagrange multipliers to treat constraints, Introduction to the Lagrangian and Hamiltonian

formulations of classical mechanics with applications.

Unit 4:

Gamma and Beta functions, Dirac delta function, Special functions, Review of Legendre, Bessel functions and spherical harmonics (with applications to Quantum mechanics), series solutions, generating functions, orthogonality and completeness,

Unit 5:

Applied linear algebra: Dirac notation, dual vectors, projection operators, symmetric hermitian, orthogonal and unitary matrices in physics, diagonalization, orthogonality and completeness of eigenvectors, spectral decomposition and representation, simultaneous diagonalization, normal matrices, applications to coupled vibrations, Schrodinger equation in matrix form.

Books for Study

1. Arften and Weber, *Mathematical Methods for Physics*, Elsevier, 6th Ed., 2005.
2. Riley, Hobson and Bence, *Mathematical Methods for Physics and Engineering*, Cup, 3rd Edition, 2010.

Books for References:

1. P. K. Chattopadhyay, *Mathematical Physics*, Wiley Eastern, New Delhi, 1992.

2. S. S. Rajput, *Mathematical Physics*, Pragati Pragasan, Meerut, 11th Edition, 1996.

3. Charlie Harper, *Introduction to Mathematical Physics*, California State University, Hayward.

4. B. D. Gupta, *Mathematical Physics*, Vikas Publishing House Pvt. Ltd, New Delhi, 2004.

5. L. A. Pipes and L.R. Harvill, *Applied Mathematics for Engineers and Physicists*, McGraw Hill, London, 1970.

Syllabus:

SEMESTER– IV

Complex Function Theory

Course Code	**M1049**	**Credit**	**5**
Instruction Hours per Week	**6**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To study the Maximum Principle, Schwarz Lemma, Evaluation of Certain Integrals, Analytic Continuation, Representation of Meromorphic and Entire Functions and Mapping Theorems		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	develop the maximum assistance in mastering the fundamental concepts and techniques of Complex Function Theory.	K6
CO2	establish Maximum principle, Schwarz lemma and Liouville's theorem.	K3
CO3	evaluate different Types of Integral.	K5
CO4	examine interesting results concerning certain mapping problems between domains.	K1
CO5	understand and analyze the concept of Analytic Continuation.	K2, K4

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	1	3	3	3	2	2	2.6
2	3	3	3	3	1	3	3	3	2	1	2.5
3	3	3	3	2	1	3	3	3	2	1	2.4
4	3	3	3	3	1	3	3	3	2	1	2.5
5	3	3	3	3	1	3	3	3	2	1	2.5
										Mean Overall Score	**2.5**
										Result	**High**

Unit – I: Maximum Principle, Schwarz' Lemma and Liouville's Theorem

Maximum Modulus Principle - Hadamard's Three Circles/Lines Theorems - Schwarz's Lemma and its Consequences - Liouville's Theorem - Doubly Periodic Entire Function - Fundamental Theorem of Algebra - Zeros of certain Polynomials

(Chapter 6, Sections: 6.1 to 6.7)

Unit – II: Evaluation of Certain Integrals

Integrals of type $\int_{\alpha}^{2\pi+\alpha} R(\cos\theta, \sin\theta)\, d\theta$ – Integrals of type $\int_{-\infty}^{\infty} f(x)dx$– Integrals of type $\int_{-\infty}^{\infty} g(x) \cos mx\, dx$ - Singularities on the Real Axis – Exercises.

(Chapter 9, Sections: 9.1 to 9.4 and 9.7 (9.73 to 9.76))

Unit – III: Analytic Continuation

Direct Analytic Continuation - Monodromy Theorem - Poisson Integral Formula - Analytic Continuation via Reflection.

(Chapter 10, Sections: 10.1 to 10.4)

Unit – IV: Representations of Meromorphic and Entire Functions

Infinite Sums and Meromorphic Functions - Infinite Product of Complex Numbers – Infinite Product of Analytic functions - Factorization of Entire Functions - The Gamma Function - The Zeta Function.

(Chapter 11, Sections: 11.1 to 11.6)

Unit – V: Mapping Theorems

Open Mapping Theorem and Hurwitz' Theorem - Basic Results on Univalent Functions - Normal Families – The Riemann mapping theorem (without proof) - Bieberbach Conjecture - The Bloch-Landau Theorems

(Chapter 12, Sections: 12.1 to 12.6)

Book for Study

1. S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi, 2005.

Books for Reference

1. Lars. V. Ahlfors, *Complex Analysis*, Third Edition, Indian Edition, McGraw Hill, Inc. in 1979.
2. Theodore W. Gamelin, *Complex Analysis*, Springer- Verlag New York, Inc. in 2001.
3. B. Choudhary, *The Elements of Complex Analysis*, 2-e, Wiley Eastern Limited, 1992.
4. Boston, *Complex Variables*, Silverman- Houghton Mifflin Company, 1975.
5. John B. Conway, *Functions of One Complex Variable*, 2-e, Springer International student Edition, 1973.
6. S. Arumugam, A. Thangapandi Isaac, A. Somasundram, *Complex Analysis*, Scitech Publications Pvt. Ltd., New Delhi, 2007.
7. Serge Lang, *Complex Analysis*, 2-e, Springer-Verlag, New York, 1993.

<u>**Syllabus:**</u>

Semester – IV

Functional Analysis

Course Code	**M1050**	**Credit**	**5**
Instruction Hours per Week	**5**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	understand the Banach spaces and Transformations on Banach Spaces.	K2
CO2	prove Hahn Banach theorem and open mapping theorem.	K5
CO3	describe operators and fundamental theorems.	K1
CO4	validate orthogonal and orthonormal sets.	K6
CO5	Analyze and establish the regular and singular elements.	K3, K4

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	2	3	3	3	2	2	2.7
2	3	3	3	3	1	3	3	3	2	1	2.5
3	3	3	3	2	1	3	3	3	2	1	2.4
4	3	3	3	2	2	3	3	3	2	2	2.6
5	3	3	3	2	1	3	3	3	2	1	2.4
Mean Overall Score											**2.52**
Result											**High**

Unit – I: Banach Spaces

Definition and Some examples – Continuous linear transformations – The Hahn-Banach theorem.

(Chapter 9, Sections: 46, 47,48)

Unit – II: Banach Spaces (contd.)

The natural imbedding of $N^* \ in \ N^{**}$ – The Open Mapping theorem – The conjugate of an operator.

(Chapter 9, Sections: 49, 50, 51)

Unit – III: Hilbert Spaces

Definition and some simple Properties –Orthogonal complements – Orthonormal sets – The conjugate spaceH^*.

(Chapter 10,Sections: 52, 53, 54, 55)

Unit – IV: Hilbert Spaces (contd.)

The Adjoint of an operator – Self-Adjoint operators –Normal and Unitary operators – Projections.(Chapter 10, Sections: 56, 57, 58, 59)

Unit – V: Algebras of Operators

The definition and some Examples – Regular and singular elements – Topological divisors of zero – The Spectrum – The formula for the spectral radius.

(Chapter 12,Sections: 64, 65, 66, 67, 68)

Book for Study

1. Simmons G.F., *Introduction to Topology and Modern Analysis*, McGraw – Hill International Book Company, New York, 22nd reprint 2014.

Books for Reference

1. B. Choudhary, Sudarsan Nanda, *Functional Analysis with Applications*, Wiley Eastern Limited, New Delhi, 1989.
2. B. V. Limaye, *Functional Analysis*, 2-e, New Age International Ltd, Publishers, 1996.
3. Chandrasekara Rao. K, *Functional Analysis*, Narosa Publishing House, 2006.
4. E. Kreyszig, *Introductory Functional Analysis with Applications*, John Wiley& Sons, New York, 1978.
5. Ponnusamy. S, *Foundations of Functional Analysis*, Narosa Publishing House, New Delhi, 2002.
6. Somasundaram. D, *A First Course in Functional Analysis*, Narosa Publishing House, New Delhi, 2006.

Syllabus:

Semester – IV

Skill Enhancement Course IV– Complex Analysis

Course Code	**M1052B**	**Credit**	**3**
Instruction Hours per Week	**5**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• Empowering students to crack competitive examinations such as NET, SET and TRB. To complement the theoretical content of the subject with exercise problems		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	analyze and solve problems on Analytic functions, Power Series and Complex Integration.	K3, K4
CO2	Illustrate Conformal Mappings, Mobius Transformation and solve related problems.	K2, K3
CO3	identify Singularities and derive Laurent's series	K1
CO4	formulate Residue Theorem in Contour Integration.	K6
CO5	analyze and evaluate problems based on Rouche's Theorem	K4, K5

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	1	3	3	3	2	2	2.6
2	3	3	3	3	1	3	3	3	2	2	2.6
3	3	3	3	2	1	3	3	3	2	1	2.4
4	3	3	3	2	2	3	3	3	2	2	2.6
5	3	3	3	1	1	3	3	3	2	1	2.3
Mean Overall Score											**2.5**
Result											**High**

Unit – I: Analytic Functions and Power Series

Differentiability and Cauchy–Riemann Equations –Harmonic Functions –Power Series as an Analytic Function – Exponential and Trigonometric Functions – Logarithmic Functions – Inverse Functions.

(Chapter 3, Sections: 3.1 - 3.6)

Unit – II: Complex Integration

Curves in the Complex Plane – Properties of Complex Line Integrals – Winding Number or Index of a Curve – Cauchy Integral Formula –Morera's Theorem– Taylor's Theorem – Zeros of Analytic Functions – Laurent Series.

(Chapter 4, Sections: 4.1, 4.2, 4.5, 4.7, 4.8, 4.10 - 4.12)

Unit – III: Conformal Mappings and Mobius Transformations

Principle of Conformal Mapping – Basic Properties of Mobius Maps – Fixed Points and Mobius Maps – Triples to Triples under Mobius Maps – The Cross-Ratio and its Invariance Property – Conformal Self-maps of Disks and Half-planes.

(Chapter 5, Sections: 5.1 - 5.6)

Unit – IV: Maximum Principle and Singularities

Maximum Modulus Principle – Liouville's Theorem –Doubly Periodic Entire Functions – Fundamental Theorem of Algebra – Zeros of certain Polynomials–Isolated and Non-isolated Singularities – Removable Singularities – Poles – Further Illustrations through Laurent's Series – Meromorphic Functions.

(Chapter 6, Sections: 6.1, 6.4 - 6.7, Chapter 7, Sections: 7.1-7.4, 7.6)

Unit – V: Calculus of Residues

Residue at a Finite Point – Residue at the Point at Infinity – Residue Theorem – Number of Zeros and Poles – Rouche's Theorem.

(Chapter 8, Sections: 8.1 - 8.5)

Book for Study

S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi, 2012.

Books for Reference

1. B. Choudhary, *The Elements of Complex Analysis*, 2-e, Wiley Eastern Limited, 1992.
2. Boston, *Complex Variables*, Silverman- Houghton Mifflin Company, 1975.
3. John B. Conway, *Functions of One Complex Variable*, 2-e, Springer International student Edition, 1973.
4. S. Arumugam, A. Thangapandi Isaac, A. Somasundram, *Complex Analysis*, Scitech Publications Pvt. Ltd., New Delhi.

Syllabus:

Semester – IV

Theory of Transforms

Course Code	M1052C	**Credit**	**3**
Instruction Hours per Week	**5**	**Marks**	**CIA (50) / SE (50)**
Course Objective	• To impart the basic knowledge of principles of Fourier series and Z-Transforms; To give different techniques to solve integral problems using Transforms.		

Course Learning Outcomes

CO Number	CO Statement	Knowledge Level
CO1	summarize knowledge of various mathematical concepts and techniques required for successful application of mathematics in physics and related sciences	K2
CO2	examine application of Z-transform.	K1
CO3	solve differential & integral equations with initial conditions using Laplace transform.	K3
CO4	analyze and evaluate the Fourier transform of a continuous function and be familiar with its basic properties.	K4, K5
CO5	validate solution of integral equation and their application.	K6

Mapping of CO with PO and PSO:

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
1	3	3	3	3	1	3	3	3	2	2	2.6
2	3	3	3	3	2	3	3	3	2	1	2.6
3	3	3	3	2	1	3	3	3	2	2	2.5
4	3	3	3	2	2	3	3	3	2	2	2.6
5	3	3	3	1	1	3	3	3	2	2	2.4
Mean Overall Score											**2.54**
Result											**High**

Unit – I:

Fourier Series - Euler Formulae - Conditions for a Fourier Expansion - Functions having points of discontinuity - Change of Interval - Even and Odd Expansion - Half Range Series – Typical waveforms - Complex Form of Fourier Series - Practical Harmonic Series.

(Chapter 10: Sections 10.1 - 10.11)

Unit – II:

Integral Transforms – Fourier Integral Theorem – Fourier Transforms – Properties of Fourier Transforms – Applications to solve integral problems.

(Chapter 22: Sections 22.1 - 22.5)

Unit – III:

Convolution – Parseval’s Identity for Fourier Transforms – Problems – Relation between Fourier and Laplace Transforms - Fourier Transforms of the derivative of a function – Application of Transforms to boundary Value Problems.

(Chapter 22: Sections 22.6 - 22.9, 22.11)

Unit – IV:

Z – Transform – Some standard Z – Transform – Linearity Property– Damping Rule – Some Standard Results – Shifting u_n to the right and left – Multiplication by n – Two basic theorems – Problems.

(Chapter 23: Sections 23.1 - 23.9)

Unit – V:

Some Useful Z – Transforms – Some Useful Inverse Z-transforms – Convolution Theorem – Convergence of Z-Transforms – Evaluation of Inverse Z-Transforms – Application of Difference Equations – Problems.

(Chapter 23: Sections 23.10 - 23.16)

Book for Study

1. Dr.B.S. Grewal and J.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 40^{th} Edition 2007, Fifth Reprint 2008.

Books for Reference

1. Dr. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, Inc, 8^{th} Edition 1999.
2. James S. Walker, *Fourier Analysis*, Oxford University Press 1988.