Holy Cross College (Autonomous), Nagercoil-629004

Kanyakumari District, TamilNadu.

Nationally Re-Accredited with A+ by NAAC IV Cycle – (CGPA 3.35)

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

DEPARTMENT OF MATHEMATICS

SYLLABUS FOR UNDERGRADUATE PROGRAMME

Issued from the Deans Office

(With effect from the Academic year 2020– 2021)

DEPARTMENT OF MATHEMATICS

Vision

To empower women globally competent with human values and ethics acquiring academic and entrepreneurship skills through holistic education.

Mission

- To create opportunities which will ensure academic excellence in critical thinking,humanistic and scientific inquiry.
- To develop application oriented courses with the necessary input of values.
- To create a possible environment for innovation, team spirit and entrepreneurial leadership.
- To form young women of competence, commitment and compassion.

Programme Educational Objectivities (PEOs)

PEO – 1	The graduates use scientific and computational technology to solve social issues and pursue research.
PEO– 2	The graduates will continue to learn and advance their careers in industry both in public and private sectors, government and academia.
PEO– 3	Our graduates will have the ability to apply analytical and theoretical skills to model and solve mathematical problems and work as efficient professionals.

Programme Outcomes (POs)

PO	**Upon completion of M.Sc Degree Programme, the graduates will be able to :**
PO – 1	prepare successful professionals in industry, government, academia, research, entrepreneurial pursuits and consulting firms.
PO – 2	face and succeed in high level competitive examinations like NET, GATE and TOFEL.
PO – 3	carry out internship programmes and research projects to develop scientific skillsand innovative ideas.
PO – 4	utilize the obtained scientific knowledge to create eco-friendly environment.

Programme Specific Outcomes (PSOs)

PSO	Upon completion of M.Sc. Degree Programme, the graduates of Mathematics will be able to :	PO Addressed
PSO – 1	utilize the knowledge gained for entrepreneurial pursuits.	PO 1
PSO – 2	sharpen their analytical thinking, logical deductions and rigour in reasoning.	PO 2
PSO – 3	use the techniques, skills and modern technology necessary to communicate effectively with professional and ethical responsibilities.	PO 3

Duration of Programme: 2Years
Medium of Instruction: English

Passing Minimum

A minimum of 50% in the external examination and an aggregate of minimum 50% is required. There is no minimum pass mark for the Continuous Internal Assessment.

Course Structure

Distribution of Hours and Credits

Course	Sem. I	Sem. II	Sem. III	Sem. IV	Total	
					Hours	Credits
Academic Courses						
Major Core – Theory	6 (5) + 6 (4) + 6 (4)+ 6 (4)+	6 (5) + 6 (5) + 6 (4) + 6 (4)+	6 (5) + 6 (5)+ 6 (5) +	6 (5) + 6 (5) + 6 (5) + 6 (4) +	114	95
Major Elective	6 (4)	6 (4)	6 (4)	6 (4)	24	20
Major Project	–	–	6 (5)		6	5
Total	**30(21)**	**30 (22)**	**30 (24)**	**30 (23)**	**120**	**90**
Non Academic Courses						
Life Skill Training – I	–	(1)	–	–	–	1
Life Skill Training – II	–	–	–	(1)	–	1
Service– Learning Programme (SLP) – Community Engagement Course		–	(2)	–	–	2

Summer Training Programme	–	–	–	(1)	–	1
TOTAL		**(1)**	**(2)**	**(2)**	**–**	**5**

- Non-Academic Courses are mandatory and conducted outside the regular workinghours
- **SLP (Service Learning Programme) – Community Engagement Course is** conducted outside the regular working hours on Saturdays and holidays, during the II and III Semesters for all the PG students. No. of hours allotted for each of this programme is 30 and is supervised by the faculty in charge
- **STP (Summer Training Programme)** (Mandatory Course – 30 hours) will beoffered in the second year for all the students.

Courses Offered

Semester	Course code	Title of the paper	Hours/week	Credits
I	PM2011	Core I - Algebra I	6	5
	PM2012	Core II - Analysis I	6	4
	PM2013	Core III - Probability and Statistics	6	4
	PM2014	Core IV - Ordinary Differential Equations	6	4
	PM2015 PM2016	Elective I - (a) **Numerical Analysis** (b) Fuzzy sets and Fuzzy logic	6	4
	LST201	Life Skill Training (LST) - I	-	-
II	PM2021	Core V- Modules and Vector Spaces	6	5
	PM2022	Core VI - Analysis II	6	5
	PM2023	Core VII - Partial Differential Equations	6	4
	PM2024	Core VIII - Graph Theory	6	4
	PM2025 PM2026	Elective II - (a) **Classical Dynamics** (b) Differential Geometry	6	4
	LST201	Life Skill Training (LST) - I	-	1
	SLP201	Service Learning Programme (SLP): Community Engagement Course	-	-
	STP201	Summer Training Programme	-	1
III	PM2031	Core IX –Field Theory and Lattices	6	5

	PM2032	Core X - Topology	6	5
	PM2033	Core XI - Measure Theory and Integration	6	5
	PM2034 PM2035	Elective III - (a) **Algebraic Number Theory and Cryptography** (b) Stochastic Processes	6	4
	PM20PR	Project	6	5
	LST202	Life Skill Training (LST) - II	-	-
	SLP201	Service Learning Programme (SLP): Community Engagement Course	-	2
IV	PM2041	Core XII - Complex Analysis	6	5
	PM2042	Core XIII - Functional Analysis	6	5
	PM2043	Core XIV - Operations Research	6	5
	PM2044	Core XV -Algorithmic Graph Theory	6	4
	PM2045 PM2046	Elective IV - (a) **Combinatorics** (b) Coding Theory	6	4
	LST202	Life Skill Training (LST) - II	-	1
		TOTAL	**120**	**90+5**

Self– Learning Courses– Extra Credit Course

Semester	**Course Code**	**Title of the Course**	**Credits**
III	PM20S1	Algebra for SET/NET Examinations	2
IV	PM20S2	Analysis for SET/NET Examinations	2
II– IV	PM20S2	Online courses (Swayam/NPTL)	2

Question Pattern

Internal Test	Marks	External Exam	Marks
Part– A(10x1) (No Choice– simple objective type)	10	Part– A(20x1) (No Choice– simple objective type)	20
Part B (5x2) (No Choice objective type)	10	Part B (10x2) (No Choice objective type)	20
Part C(5x4) (No Choice objective type) Higher order thinking skills	20	Part C(5x4) (No Choice objective type) Higher order thinking skills	20
Total	**40**	**Total**	**60**

Summer Training Program

Semester	Name of the Course	Total hours	Credit
III/IV	–H20STP	30	1

Internal Component

Component	Marks
Assignment	20
Summer Training Program Attendance	30
Total	**50**

External Component

Course	Summative Examinations	Marks
Summer TrainingProgram	Project report (15– 20 pages print)	**50**
	Total	**50**

Instruction for Course Transaction Theory (Major Core / Elective)

Component	**Sem. I**	**Sem. II**	**Sem. III**	**Sem. IV**
Lecture hours	70/55	70/55	70/55	70/55
Continuous Internal Assessment (2)	5	5	5	5
Quiz (2)	1	1	1	1
Class Test (2)	2	2	2	2
Seminar	10	10	10	10
Problem solving/Open book test/ Group Discussion	2	2	2	2
Total hours / semester	**90/75**	**90/75**	**90/75**	**90/75**

Examination Pattern:

Allotment of Marks for PG Programme

Ratio ofInternal and External (Core/Elective): 40:60

(a). Major / Elective Internal:

External - 40:60

Component	**Marks**	
	Internal	**External**
Core & Elective Courses Theory Papers	40	60
Practicals	40	60
Project	40	60
Life Skill Training (I & II)	50	50

- Each paper carries an internal component.
- There is a passing minimum for external component.

Continuous Internal Assessment

Component	Marks
Internal Test (2)	20
Quiz (2)	4
Class Test (2)	4
Seminar	4
GD/Open Book test/ Article Review/ Book Review	4
Online Home Assignment	4
Total	**40**

External Component

Internal Test	Marks	External Exam	Marks
Part A(4x1) (No Choice)	4	Part A(10x1) (No Choice)	10
Part B (5x3) (Internal Choice)	15	Part B (5x3) (Internal Choice)	15
Part C(3x7) (Internal Choice)	21	Part C (5x7) (Internal Choice)	35
Total	**40**	**Total**	**60**

Project

Distribution of marks for project

Internal : External = 40:60

Internal Components

Internal Viva = 20 marks

Regularity and Systematic work = 20 marks

External Components

Dissertation = 30 marks

Innovation = 10 marks

Presentation and Viva = 20 marks

Evaluation	Marks
Proposed title, review of literature and objectives.	-
I Review	10
II Review	10
Internal	20
Final External (Dissertation and Innovation)	40
* Final Project Viva (group & open)	20
Total marks	**100**

Life Skill Training– I

Internal Component

Component	Marks
Album (20 pages)	40
Group Song, Mime, Skit (Group of 5 students)	20
Total	**60**

External Component

Course	Summative Examinations	Marks
Life Skill Training– I	Questions are of open choice. Students must answer 5 out of 7 questions. Each question carries 8 marks (5x8=40 marks)	**40**
	Total	**40**

Life Skill Training– II (II Year)

Internal Component

Component	Marks
Case Study (30 page)	60
Total	**60**

External Component

Course	Summative Examinations	Marks
Life Skill Training–II	Questions are of open choice. Students must answer out of 7 questions. Each question carries 8 marks (5x8=40 marks)	**40**
	Total	**40**

Community Engagement Programme– SLP Extension Activity (II & III sem)

Courses / Programmes conducted outside the regular working hours on Saturdays andholidays.

No. of hours allotted for each of these programmes is 30 and is supervised bythe faculty in charge. Field work : 15 hours; Class hours: 15 hours

Internal Component

Component	Marks
Assignment	10
Group Discussion	10
Field work Attendance	30
Total	**50**

External Component

Course	Summative Examinations	Marks
Community Engagement Programme	Project report/ Case study(10– 15 pages print)	**50**
Total		**50**

Semester I

Major Core I - Algebra I

Course Code: PM2011

No. of hours per week	Credit	Total No. of hours	Marks
6	5	90	100

Objectives: 1. To study abstract Algebraic systems.

2. To know the richness of higher Mathematics in advanced application systems.

CO No.	Course Outcomes Upon completion of this course, students will be able to	PSOs addressed	CL
CO -1	understand the fundamental concepts of abstract algebra and give illustrations.	PSO- 1	U
CO -2	analyze and demonstrate examples of various Sylow p-subgroups, automorphisms, conjugate classes, finite abelian groups, characteristic subgroups, rings, ideals, Euclidean domain, Factorization domain.	PSO- 2	An
CO -3	develop proofs for Sylow's theorems, finite abelian groups, direct products, Cauchy's theorem, Cayley's Theorem, automorphisms for groups.	PSO- 2	C
CO -4	develop the way of embedding of rings and design proofs for theorems related to rings, polynomial rings, Division Algorithm, Gauss' lemma and Eisenstein Criterion	PSO- 2	C
CO -5	apply the concepts of Cayley's theorem, Counting principles, Sylow's theorems, Rings and Ideals in the structure of certain groups of small order.	PSO-4	Ap
CO -6	compare Euclidean domain and Unique factorization domain, Polynomial Rings, Polynomial Rings over Commutative Rings and various concepts in Abstract Algebra	PSO- 3	E

Unit I

Automorphisms – Inner automorphisms – Cayley's Theorem – Applications – Another Counting principles – Conjucacy - Cauchy's theorem – Conjugate Classes.

Unit II

Sylow's first theorem(Second Proof) – *p*-Sylow subgroups - Second Part of Sylow's theorem - Third Part of Sylow's theorem - Direct products - Finite abelian groups.

Unit III

Rings: Some special classes of Rings - Characteristic of a Ring – Homomorphisms - Ideals and Quotient Rings - More Ideals and Quotient Rings.

Unit IV

The field of Quotients of an integral domain - Embedding of Rings - Euclidean Rings - Unique Factorization theorem – A particular Euclidean Ring – Fermat's Theorem.

Unit V

Polynomial Rings – The Division Algorithm – Polynomials over the Rational Field - Gauss' lemma – The Eisenstein Criterion - Polynomial Rings over Commutative Rings - Unique Factorization Domains.

Text Book:

Herstein, I. N. (1992). Topics in Algebra. (2^{nd} Edition). New Delhi, Wiley Eastern Ltd.

Chapter 2: Sections 2.8, 2.9, 2.11 to 2.14.

Chapter 3: Sections 3.2 to 3.11.

Reference Books:

1. Vijay K. Khanna., & Bhambri, S. K. (2013). A Course in Abstract Algebra. (Fiffth Edition). Vikas Publishing House Pvt. Ltd.
2. Joseph A.Gallian. (1999). Contemporary Abstract Algebra. (4^{th} Edition). Narosa Publishing House.
3. John B. Fraligh. (1977). A first course in Abstract Algebra. (2^{nd} Edition). Addition Wesley Publishing Company.
4. John R. Durbin. (2005). Modern Algebra. (5^{th} Edition). John wiley & Sons.
5. Rudolf Lidl., & Gunter Pilz. (2009). Applied Abstract Algebra. (2^{nd} Edition). Springer International Edition.

Semester I

Major Core II - Analysis I

Course Code: PM2012

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To understand the basic concepts of analysis.

2. To formulate a strong foundation for future studies.

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO -1	explain the fundamental concepts of analysis and their role in modern mathematics.	PSO-3	U, Ap
CO -2	deal with various examples of metric space, compact sets and completeness in Euclidean space.	PSO- 2	An
CO -3	utilize the techniques for testing the convergence of sequence and series	PSO-1	Ap
CO -4	understand the important theorems such as Intermediate valued theorem, Mean value theorem, Roll's theorem, Taylor and L'Hospital theorem	PSO-3	U
CO -5	Apply the concepts of differentiation in problems.	PSO- 4	Ap

Unit I

Basic topology - Metric spaces - Open and closed sets - Dense sets - Compact sets - Weierstrass theorem - Perfect sets - Cantor set - Connected sets.

Unit II

Convergent sequences - Subsequences - Cauchy sequences - Complete metric space - Upper and lower limits - Some special sequences.

Unit III

Series - Cauchy criterion for convergence of series - series of nonnegative terms - The root and ratio tests - Power series - Summation by parts - Absolute convergence - Addition and multiplication of series - Rearrangements of series.

Unit IV

Continuity - Limits of functions - Continuity and compactness - Continuity and connectedness, discontinuities - Monotonic functions - Infinite limits and limits at infinity.

Unit V

Differentiation - Mean value theorems - The continuity of derivatives - L' Hospital's rule - Taylor's theorem - Differentiation of vector valued functions.

Text Book:

Walter Rudin. (1976). Principles of Mathematical Analysis. (3^{rd} Edition). McGraw Hill Education (India) Private Limited.

Chapter 2 : 2.15 - 2.47;

Chapters 3, 4, 5.

Reference Books:

1. Charles G. Denlinger. (2011). Elements of Real Analysis. (1^{st} Edition). Jones & Burtlett Learning.
2. Tom M. Apostlal. (2002). Mathematical Analysis. (2^{nd} Edition). New Delhi: Narosa Publishing House.
3. Somasundaram, D., & Choudhary, B.A. (2010). First Course in Mathematical Analysis. (5^{th} Edition). Narosa Publishing House.
4. Gupta S. L., and Nisha Rani (1975). Fundamental Real Analysis. (2^{nd} Edition). Vikas Publishing house Pvt. Ltd.
5. Richard R. Goldberg. (1970). Methods of Real Analysis. (2^{nd} Edition). Oxford & IBH Publishing Co. Pvt. Ltd.

Semester I

Major Core III- Probability and Statistics

Course code : PM2013

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To upgrade the knowledge in Probability theory
2. To solve NET / SET related Statistical problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	recall the basic probability axioms,conditional probability, random variables and related concepts	PSO -2	R
CO - 2	compute marginal and conditional distributions and check the stochastic independence	PSO -2	U, Ap
CO - 3	recall Binomial, Poisson and Normal distributions and learn new distributions such as multinomial, Chi square and Bivariate normal distributions.	PSO - 4	R,U
CO - 4	learn the transformation technique for finding the p.d.f of functions of random variables and use these techniques to solve related problems	PSO – 3,1	U, Ap
CO - 5	employ the relevant concepts of analysis to determine limiting distributions of random variables	PSO - 5	Ap
CO - 6	eearn Estimation , Point estimation and Confidence Intervals for Means, difference of means and variances.	PSO-2	U,Ap
CO - 7	design probability models to deal with real world problems and solve problems involving probabilistic situations.	PSO – 1,3	C,Ap

Unit I Conditional Probability and Stochastic Independence

Conditional probability - Marginal and conditional distributions, Correlation coefficient - Stochastic independence - Necessary and sufficient conditions for stochastic independence.

Unit II Some Special Distributions

The Binomial, Trinomial and Multinomial distributions - Poisson distribution - Gamma, Chi-square, Normal and Bivariate Normal distributions.

Unit III Distributions of Functions of Random Variables

Sampling theory - Transformations of variables of discrete and continuous type - Beta distribution, the t and F distributions.

Unit IV Limiting Distributions

Limiting distributions - Stochastic convergence - Limiting moment generating functions - Central limit theorem - Some theorems on limiting distributions.

Unit V Estimation

Estimation- Point Estimation- Measures of quality of Estimators- Confidence Intervals for Means- Confidence intervals for difference of Means- Confidence intervals for Variances.

Text Book:

Robert V. Hogg., & Allen T. Craig. (2004). Introduction to Mathematical Statistics. (4^{th} edition). New Delhi, Pearson Education.

Chapters 2: 2.1 to 2.4

Chapter 3 : 3.1 to 3.5

Chapter 4 : 4.1 to 4.4

Chapter 5 : 5.1 to 5.5

Chapter 6 : 6.1 to 6.5

Reference Books:

1. Kapur, J.N., & Saxena, H.C. (2010). Mathematical Statistics. (12^{th} Edition). S. Chand & Co.
2. Kadarkarai Thangam, K., & Subas Chandra Bose, A. (1995). Probability and Statistics. (1^{st} Edition). Jeyalakshmi Publishers.
3. Morris H. DeGroot. (1975). Probability and Statistics. Addison Wesley Publishing Company.
4. Suddhendu Biswass., & Sriwastav, G.L. (2011). Mathematical Statistics. Narosa Publishing House.
5. Murthy, T.S.R. (1995). Probability and Statistics.(1^{st} Edition). I.K. International Publishing House.

Semester I
Major Core IV - Ordinary Dfferential Equations
Course code: PM2014

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives:

1. To study mathematical methods for solving differential equations.
2. Solve dynamical problems of practical interest.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	recall the definitions of degree and order of differential equations and determine whether a system of functions is linearly independent using the Wronskian definition.	PSO - 2	R,U
CO - 2	solve linear ordinary differential equations with constant coefficients by using power series expansion.	PSO - 3	Ap
CO - 3	determine the solutions for a linear system of first order equations.	PSO - 2	U
CO - 4	learn properties of Legendre polynomials and Properties of Bessel Functions.	PSO - 4	U
CO - 5	analyze the concepts of existence and uniqueness of solutions of the ordinary differential equations.	PSO - 2	An
CO - 6	create differential equations for a large number of real world problems.	PSO - 1	C

Unit I

Second order Linear Equations: The general solution of a homogeneous equation - The use of a known solution to find another - The method of variation of parameters.

Unit II

Power series solutions and special functions: A review of power series - Series solutions of first order equations - Second order linear equations - Ordinary points - Regular singular points.

Unit III

Systems of first order equations: Linear systems - Homogeneous Linear systems with constant coefficients.

Unit IV

Legendre polynomials - properties of Legendre polynomials - Bessel's functions - The Gamma functions - Properties of Bessel Functions.

Unit V

The Existence and Uniqueness of solutions: The method of Successive approximations - Picard's theorem - Systems - The second order linear equations.

Text Books:

1. George F. Simmons. (1991). Differential equations with Applications and Historical Notes. (Second edition). McGraw Hill International Editions.
   Chapter 3: Sections - 14, 15, 16, 19.
   Chapter 5: Sections - 26 to 30.
   Chapter 8: Sections - 44, 45, 46, 47.
   Chapter 10: Sections - 55, 56.

Reference Books:

1. Sharma, A.,K. (2010). Advanced Differential Equations. Discovery publishing house.
2. Raisinghania, M. D. (2012). Ordinary and Partial Differential Equations. (Fourteenth Revised Edition). Ramnagar, New Delhi, S. Chand and company Ltd.
3. Arnold, V. I. (2009). Ordinary Differential Equations. New Delhi, PHI Learning Private limited.
4. John C. Polking., & David Arnold. (2011). Ordinary Differential Equations. (Second Impression). Dorling Kindersley India Pvt. Ltd.
5. Doshi, J. B. (2009). Differential Equations for Scientists & Engineers. Narosa Publishing House.

Semester I

Elective I (a)-Numerical Analysis

Course Code: PM2015

No. of hours per week	Credits	Total No. of hours	Marks
6	4	90	100

Objectives:

1. To study the various behaviour pattern of numbers.

2. To study the various techniques of solving applied scientific problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	recall the methods of finding the roots of the algebraic and transcendental equations.	PSO - 2	R
CO - 2	understand the significance of the finite, forward, backward and central differences and their properties.	PSO - 3	U
CO - 3	learn the procedures of fitting straight lines and curves.	PSO - 2	U
CO - 4	compute the solutions of a system of equations by using appropriate numerical methods.	PSO - 1	Ap
CO - 5	solve the problems in ODE by using Taylor's series method, Euler's method etc.	PSO - 4	Ap

Unit I

Solution of Algebraic and Transcendental Equations - Introduction - Bisection Method - Method of False Position - Ramanujan's Method - Secant Method - Muller's Method.

Unit II

Differences of a polynomial - Newton's formulae for Interpolation - Central Difference Interpolation formulae - Gauss's central difference formulae - Stirling's formula - Bessel's formula - Everett's formula - Relation between Bessel's and Everett's formulae - Practical Interpolation.

Unit III

Least squares and Fourier Transforms - Introduction - Least squares Curve Fitting Procedure - Fitting a straight line - Multiple Linear Least squares - Linearization of Nonlinear laws - Curve fitting by Polynomials.

Unit IV

Numerical Linear Algebra - Introduction - Triangular Matrices - LU Decomposition of a matrix - Solution of Linear systems - Direct Methods - Gauss elimination - Necessity for Pivoting - Gauss - Jordan method - Modification of the Gauss method to compute the inverse - LU Decomposition method - Solution of Linear systems - Iterative methods.

U**nit V**

Numerical Solution of Ordinary Differential Equations - Solution by Taylor's series - Picard's method of successive approximations - Euler's method - Runge - Kutta methods - II order and IV order.

Text Book:

Sastry, S. S. (2000). Introductory Methods of Numerical analysis. (5^{th} Edition). New Delhi, Prentice Hall of India PVT. Ltd.

Chapter 2 : 2.1 to 2.3, 2.6 to 2.8.

Chapter 3 : 3.5 to 3.8.

Chapter 4 : 4.1, 4.2 (4.2.1 to 4.2.4)

Chapter 7 : 7.1 to 7.3, 7.5 (7.5.1 to 7.5.4, 7.5.6), 7.6.

Chapter 8 : 8.1 to 8.5.

Reference Books:

1. Balagurusamy, E. (2002). Numerical Methods. New Delhi: Tata McGraw Hill Publishing Company Ltd.
2. Rao, H. S. G. (2011). Numerical Methods. New Delhi: IK International publishing House PVT. Ltd.
3. Goel Mittal. (2011). Numerical Anaysis. (21^{st} Edition). Pragati Prakashan Educational Publishers.
4. Vedamurthy, V. N., & N. ch. S. N. Iyengar. (2009). Numerical Methods. New Delhi,Vikas Publising House PVT. LTD.
5. Devi Prasad. (2010). An Introduction to Numerical Anaysis. Narosa Publishing House

Semester I

Elective I (b) - Fuzzy Sets and Fuzzy Logic

Course Code: PM2016

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To understand Fuzzy logic.

2. To apply Fuzzy concepts in other branches of Mathematics.

Unit I

Crisp set - Operations on crisp set - Fuzzy sets - Basic types - Basic concepts -Additional properties of α-Cuts - representation of Fuzzy sets - Extension principle for Fuzzy sets.

Unit II

Operations on Fuzzy sets - Types of operations - Fuzzy complements - Fuzzy intersections: t-Norms - Fuzzy unions: t-Conorms - Combinations of operations - Aggregation operations.

Unit III

Fuzzy arithmetic - Fuzzy numbers - Operations on Fuzzy number - Linguistic variables - Arithmetic operations on intervals - Arithmetic operations on Fuzzy numbers.

Unit IV

Fuzzy relations - Relations on Fuzzy set - Composition of Fuzzy relation - Lattice of Fuzzy numbers - Fuzzy equations - Crisp versus Fuzzy relations - Projections.

Unit V

Binary Fuzzy relations - Binary relations on a single set - Fuzzy equivalence relations - Fuzzy compatibility relations - Fuzzy ordering relations.

Text Book:

George J. KlirBo Yuan. (2012). Fuzzy Sets and Fuzzy Logic Theory and Applications. New Delhi: PHI Learning Private Limited.
Chapter 1 : Sections 1.3, 1.4 ; Chapter 2: Sections 2.1 - 2.3;
Chapter 3 : Sections 3.1 - 3.6; Chapter 4: Sections 4.1 - 4.6;
Chapter 5 : Sections 5.1 - 5.7.

Reference Books:

1. Hooda, D. S. (2015). Fuzzy Set Theory and Fuzzy Controller. Vivek Raich Narosa Publishing House.
2. Bhargava, A. K. (2013). Fuzzy Set Theory Fuzzy logic and their Application. S. Chand Publishing.
3. Ganesh, M. (2006). Fuzzy sets and Fuzzy logic. Prentice Hall India learning private limited.
4. Shinghal. (2012). Introduction to Fuzzy logic. Prentice Hall India learning private limited.
5. Nanda, S., & Das, N. R. (2015). Fuzzy Mathematical Concepts. Narosa Publishing House Pvt. Ltd.

Semester I

Life Skill Training - I

Course Code: LST201

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

- To understand the fundamental rules of success
- To practice integrity in day to day life

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	Understand the human values to lead a successful life	PSO-	U
CO-2	Applythe ethics in real life situation	PSO-	A
CO-3	Analyseand improve one's attitude	PSO-	Y

Unit I

Success - Success formulae.

Goals - The law of Karma, The law of clarity, and The law of flexibility.

Positive Mental Attitude - The law of optimism and self-confidence.

Unit II

Purposeful-Burning desire - The law of desire and The law of energy.

Planning and Preparation - The law of planning.

Unit III

Resources - The law of maximization - Time and its management: health, courage, strengths and weaknesses, attitude, will and skill, enthusiasm, initiative, creativity/resourcefulness/ingenuity, experience, appearance, orderliness and neatness, courtesy, politeness and manners, charisma, live life, have luck and skills.

Unit IV

Self-discipline -The law of time preference and The law of direction.

Action - The law of applied effort and The law of compensation.

Persistence.

Unit V

Prayers - The partnership with God - work with commitment towards the goal - work and prayer.

Values - to attain stability in life -Benjamin Franklin’s thirteen virtues.

Text Book

Rao, C.N. (2014). 10 Fundamental Rules of Success. India: V &S Publisher.

ReferenceBooks:

1. Bellamy, D.R. (1999). 12 Secrets for Manifesting your Vision, Inspiration and Purpose. India: Master Mind Books.
2. Iyer, S.S. (2009). Managing for Value. New Delhi: New Age International Publishers.
3. Sharma, S.P. (1999). Success Through Positive Thinking. Delhi: Pustak Mahal
4. Raj, A.S. (2015). Personality Development. Delhi: Firewall Media.

Semester II

Major Core V - Modules and Vector Spaces

Course Code : PM2021

No. of hours per week	Credit	Total no. of hours	Marks
6	5	90	100

Objective:

To understand the concept of Modules and the advanced forms of Matrices related to Linear Transformations.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSOs addressed	CL
CO - 1	recall the definitions and properties of Vector Spaces and Subspaces	PSO - 2	R
CO - 2	analyze the concepts Linear Independence, Dependence and Basis	PSO - 2	An
CO - 3	apply the definition and properties of Linear transformation and Matrices of Linear transformation	PSO - 3	Ap
CO - 4	gain knowledge about characteristic polynomial, eigen vectors, eigen values and eigen spaces as well as the geometric and the algebraic multiplicities of an eigen value	PSO - 1	U
CO - 5	learn and apply Jordan form and triangular form for computations	PSO - 4	U

Unit I

Introduction to Module Theory: Basic definitions and examples, Quotient modules and module homomorphisms, Generation of Modules, Direct sums and Free Modules

Unit II

Vector Spaces: Elementary basic concepts, Linear Independence and Basis, Dual Spaces

Unit III

The Algebra of Linear Transformations, Characteristic Roots, Matrices, Canonical Forms:Triangular Form, Canonical Forms: Nilpotent Transformations

Unit IV

Canonical Forms: A Decomposition of V: Jordan Form, Canonical Forms: Rational Canonical Form, Trace and Transpose

Unit V

Detrminants, Hermitian, Unitary and Normal Transformations, Real Quadratic forms

Text Books:

1. Herstein, I. N. (1992). Topics in Algebra. (Second Edition). New Delhi, Wiley Eastern Ltd.
   Chapter 4: 4.1, 4.2, 4.3
   Chapter 6: 6.1 to 6.11
2. David S. Dummit, Richard M. Foote. (2004) Abstract Algebra. (Third Edition). John Wiley& Sons, Inc
   Chapter 10: 10.1,10.2, 10.3

Reference Books:

1. Kenneth Hoffman., & Ray Kunze. (2016). Linear Algebra. (Second Impression). Pearson India Education Services Pvt. Ltd.
2. Vijay K. Khanna., & Bhambri, S. K. A. (2013). Course in Abstract Algebra. (4^{th} Edition). Vikas Publishing House Pvt. Ltd.
3. Nathan Jacobson. (1984). Basic Algebra. Hindustan Publishing Corporation.
4. Joseph A. Gallian. (1999). Contemporary Abstract Algebra. (Fourth Edition). Narosa Publishing House. Reprint.
5. John B. Fraligh. (1977). A first course in Abstract Algebra. (Second Edition). Addition Wesley publishing company.

Semester II

Major Core VI - Analysis II
Course Code: PM2022

No. of hours per week	Credit	Total No. of hours	Marks
6	5	90	100

Objectives: 1. To make the students understand the advanced concepts of Analysis.

2. To pursue research in Analysis related subjects.

CO	Upon completion of this course the students will be able to :	POs/PSOs addressed	CL
CO -1	recall the definition of continuity, boundedness and some results on uniform convergence	PSO-1	R
CO -2	recognise the difference between pointwise and uniform convergence of a sequence of functions and Riemann Stieltjes integrals.	PSO-2	An
CO -3	understand the close relation between equicontinuity and uniform convergence of sequence of continuous function and rectifiable curves	PSO-3	U
CO -4	learn Parseval's theorem, Stone Weierstrass theorem and know about its physical significance in terms of the power of the Fourier components.	PSO-4	U
CO -5	utilize the definition of differentiation and partial derivative of function of several variables to solve problems	PSO-3	Ap
CO -6	Interpret the concept of the contraction principle and the inverse function theorem	PSO-2	U

Unit I

The Riemann Stieltjes integrals - Definition and Existence of the Integral - Properties of the integral - Integration of vector-valued function - Rectifiable curves .

Unit II

Sequences and series of functions - Uniform convergence - Continuity - Integration - Differentiation.

Unit III

Equicontinuous families of functions - Wierstrass theorem - Stone Wierstrass theorem.

Unit IV

Some special functions - Power series - The algebraic completeness of the Complex field - Fourier series - Parseval's theorem.

Unit V

Differentiation - Partial derivatives - The contraction principle - The inverse function theorem.

Text Books:

Walter Rudin. (1976). Principles of Mathematical Analysis. (3^{rd} Edition). McGraw Hill Education (India) Private Limited.

Chapters 6, 7

Chapter 8 : 8.1 to 8.5 & 8.8 to 8.16

Chapter 9 : 9.10 to 9.25.

Reference Books:

1. Charles G. Denlinger. (2011). Elements of Real Analysis. (1^{st} Edition). New Delhi: Jones & Burtlett Learning.
2. Tom M. Apostlal. (2002). Mathematical Analysis. (2^{nd} Edition). New Delhi: Narosa Publishing House.
3. Mittal. (2012). Real Analysis. (7^{th} Edition). Pundir Pragati Prakashan Educational Publishers.
4. Mainak Mukherjee. (2011). A Course in Real Analysis. New Delhi: Narosa Publishing house.
5. Bali, N.P. (2016). Real Analysis. (1^{st} Edition). New Delhi: Firewall media.

Semester II

Major Core VII - Partial Differential Equations

Course Code: PM2023

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To formulate and solve different forms of partial differential equations.

2. Solve the related application oriented problems.

Course Outcome

CO	Upon completion of this course the student will be able to:	PSOs addressed	CL
CO-1	recall the definitions of complete integral, particular integral and singular integrals.	PSO-2	R
CO-2	learn some methods to solve the problems of non- linear first order partial differential equations. homogeneous and non homogeneous linear partial differential equations with constant coefficients and solve related problems.	PSO-1	U
CO-3	analyze the classification of partial differential equations in three independent variables – cauchy's problem for a second order partial differential equations.	PSO-3	An
CO-4	solve the boundary value problem for the heat equations and the wave equation.	PSO-4	Ap
CO-5	apply the concepts and methods in physical processes like heat transfer and electrostatics.	PSO-5	Ap

Unit I

Non linear Partial Differential Equations of order one - complete integral, particular integral, singular integral - Compatible system of First Order Equations - Charpit's Method.

Unit II

Homogeneous and Non Homogeneous Linear Partial Differential Equations with constant coefficients - Solution of Homogeneous and Non Homogeneous Linear Partial Differential Equations with constant coefficients - Method of finding Complementary Function of Linear Homogeneous Partial Differential Equations with constant coefficients - Particular Integral of Homogeneous Partial Differential Equations - General method of finding Particular Integral of Linear Homogeneous Partial Differential Equations.

Unit III

Non Homogeneous Linear Partial Differential Equations with constant coefficients - Reducible and Irreducible Linear Differential operators - Reducible and Irreducible Linear Differential Equations with constant coefficients - Determination of Complementary Function of Reducible Non Homogeneous Linear Partial Differential Equations with constant coefficients - General Solution of Non Homogeneous Linear Partial Differential Equations with constant coefficients - Determination of Particular Integral of Non Homogeneous Linear Partial Differential Equations with constant coefficients.

Unit IV

Classification of Partial Differential equations of second order - Classification of P.D.E. in three independent variables – Cauchy's problem for a second order P.D.E. Characteristic equation and Characteristic curves of the second order P.D.E. – Laplace transformation. Reduction to Canonical (or normal) forms.

Unit V

Boundary Value Problem - Solution by Separation of variables - Solution of One dimensional Wave Equation - Solution of Two dimensional Wave Equation - Vibration of Circular Membrane - Solution of One Dimensional Heat Equation - Solution of Two Dimensional Laplace's Equation - Solution of two dimensional heat equation.

Text Books:

1.M.D. Raisinghania (1988) Advance Differential Equations. (16 th Revised and Corrected Edition). New Delhi: S. Chand and company Ltd.

Chapter 3 : 3.1, 3.4 to 3.8B.
Chapter 4 : 4.1 to 4.6, 4.12, 4.13.
Chapter 5 : 5.1 to 5.3, 5.5, 5.10 to 5.13.
Chapter 8: 8.1 to 8.11

2. Sharma, A. K. (2010). Advanced Differential Equations. Dicovery Publishing House.
Chapter 12: 12.1 to 12.8.

Reference Books:

1. Amaranath, T. An Elementary Course in Partial Differential Equations. (2nd Edition). New Delhi: Narosa Publishing House.
2. Ian Sneddon. (1957). Elements of Partial Differential Equations. International Edition.
3. Kevorkian, J. (2006). Partial Differential Equations. Springer International Edition.
4. Sharma, I. N., & Kehar Singh. (2009). Partial Differential Equations for Engineers and Scientists. (Second Edition). Narosa Publishing House PVT. LTD.
5. Lawrence C. Evans. (2009). Partial Differential Equations. (1st Indian Edition). Rhode Island, American Mathematical Society Providence.

Semester II
Major Core VIII -Graph Theory
Course Code: PM2024

No. of hours per week	Credits	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To introduce the important notions of graph theory.

2. Develop the skill of solving application oriented problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	identify cut vertices and understand various versions of connectedness of a graph.	PSO-1	An
CO - 2	understand the concept of Digraphs and characterize Eulerian Digraphs.	PSO-4	U,C
CO - 3	recall the definitions of Matchings and design proof for characterization of graphs containing a 1-factor.	PSO-1	R
CO - 4	solve problems involving coloring and learn necessary conditions for planar graphs.	PSO-2,3	Ap
CO - 5	learn the basic definitions of domination and review the concept of distance in a graph.	PSO-4	U

Unit I

Connectivity: Cut vertices - Blocks - Connectivity - edge connectivity - Geodetic Sets.

Unit II

Digraphs: Strong Digraphs - The First Theorem of Digraph Theory - Eulerian digraph - Tournaments.

Unit III

Matchings and Factorization: Matchings - Gallai Identities - Factorization - Petersen's Theorem - Hamiltonian Factorization - Decompositions and Graceful Labelings - Steiner triple system.

Unit IV

Planarity: Planar Graphs - The Euler Identity - Kuratowski's Theorem, Coloring : Vertex Coloring - Brook's Theorem - Edge Coloring - The Heawood Map Coloring Theorem - The Five Color Theorem.

Unit V

Distance: The center of a graph - Distant Vertices, Domination: The Domination Number of a Graph, Exploration: Stratification.

Text Book:

Gary Chartrand., & Ping Zhang. (2006). Introduction to Graph Theory. McGraw Hill Education (India).

Chapter 5: 5.1 - 5.3 and 5.5.

Chapter 7: 7.1and 7.2.

Chapter 8: 8.1 - 8.3.

Chapter 9: 9.1.

Chapter 10: 10.2 - 10.4.

Chapter 12: 12.1and 12.2.

Chapter 13: 13.1 and 13.2.

Reference Books:

1. Bondy, J. A., & Murty, U. S. R. (1976). Graph Theory with Applications. (1^{st} Edition). Macmillan Press Ltd.
2. Douglas B.West. (2003). Introduction to Graph Theory. (2^{nd} Edition). Pearson Education services.
3. Frank Harary. (2001). Graph Theory. Narosa Publishing House.
4. Balakrishnan, R., & Ranganathan, K. (2013). A Text Book of Graph Theory. Springer International Edition.
5. Reinhard Diestel. (2006). Graph Theory. (2^{nd} Edition). Springer International Edition.

Semester II

Elective II(a)-Classical Dynamics

Course Code: PM2025

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To gain deep insight into concepts of Dynamics.

2. To do significant contemporary research .

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO – 1	recall the concepts of Newton's laws of motion, momentum, acceleration, motion of a particle.	PSO - 4	R
CO – 2	understanding the generalized co-ordinates of the Mechanical system.	PSO - 1	U
CO – 3	apply D'Alembert's Principle to solve the problems involving system of particles.	PSO - 2	Ap
CO - 4	solve the Newton's equations for simple configuration using various methods.	PSO - 1	C
CO - 5	transforming the Lagrangian equations to Hamiltonian equations.	PSO - 2	U
CO - 6	define the canonical transformations and Lagrange and Poisson brackets.	PSO - 4	R
CO -7	evaluate the system of particles by deriving the Jacobi equation and Jacobi's theorem.	PSO - 1	E
CO - 8	understand the foundation of Hamilton's Principle and differential forms.	PSO - 2	U

Unit I

The Mechanical System - Generalized coordinates - Constraints - Virtual work and D' Alembert's Principle - Energy and Momentum.

Unit II

Derivation of Lagrange's equations - Problems using Lagrange's equation - Integrals of the motion.

Unit III

Hamilton's Principle - Hamilton's Equations - Legendre transformation - Other Variational Principles - Modified Hamilton's Principle - Principle of least action - Examples.

Unit IV

Hamilton's Principal function - The canonical integral - Pfaffian differential forms - The Hamilton - Jacobi equation - Jacobi's theorem - Conservative systems and ignorable coordinates - Examples.

Unit V

Canonical Transformations - Differential forms and generating functions - Special transformations - Lagrange and Poisson brackets.

Text Book:

Greenwood G. T. (1979). Classical Dynamics. Prentice Hall.

Chapter 1: 1.1 - 1.5; Chapter 2: 2.1 - 2.3; Chapter 4:4.1 - 4.3

Chapter 5: 5.1, 5.2; Chapter 6: 6.1 - 6.3

Reference Books:

1. Goldstein, H. (1994). Classical Mechanics. (2^{nd} Edition). Narosa Publishing.
2. Synge, J. L., & Griffith, B. A. (1959). Principle of Mechanics. McGraw Hill.
3. Rutherford, D. E. (2000). Classical Mechanics. New York: Oliver Boyd.
4. Chorlton, F. (1969). Text book of Dynamics. Van Nostrand.
5. Javier E. Hasbun. (2009). Classical Mechanics. Jones and Bartlett Publishers.

Semester II

Elective II(b)- Differential Geometry

Course Code: PM2026

No. of hours per week	Credit	Total No. of hours	Marks
6	4	90	100

Objectives: 1. To study coordinate free geometry.

2. Apply the theory in Tensors and theory of relativity.

Unit I

Theory of space curves - Arc length - Tangent, normal, principal normal, Curvature, torsion.

Unit II

Contact between curves and surfaces - Osculating circle and osculating sphere - Locus of centres of spherical curvature - tangent surfaces, involutes, evolutes - intrinsic equation of space curves - fundamental theorem for space curves - helices.

Unit III

The first fundamental form and local intrinsic properties of a surface - introduction - Definition of a surface - Curves on surfaces - General surfaces of revolution - Helicoids - Metric on a surface - Direction coefficients on a surface.

Unit IV

Families of curves - Orthogonal trajectories - Double family of curves - Isometric correspondence - Intrinsic properties - Geodesics on a surface - Introduction and its differential equations - Canonical geodesic equations.

Unit V

The second fundamental forms - Principal and lines of curvature - The Dupin'sindicatrix - Developable surfaces - Developable associated with space curves and curves on surfaces.

Text Book:

Willmore, T. J. (1959). An introduction to Differential Geometry. (1^{st} Edition). Oxford Press.

Chapter 1 (except section 5); Chapter 2 : Sections 1 to 11; Chapter 3 : Sections 1 to 5.

Reference Books:

1. Somasundaram, D. (2010). Differential geometry - A First Course. Narosa Publishing House.
2. Auslander, L., Harper., & Row. (1965). Differential Geometry. J London Mathematical Society
3. Khanna, M. L. (1975 - 76). Differential geometry. Jai prakash Nath & Co.
4. Gupta., & Malik Pundir. (2012). Differential Geometry. Pragathi Prakashan.
5. Martin M. Lipschutz. (1969). Differential geometry - Theory and Problems. McGraw - Hill Book Company.

Semester III

Major Core IX -Field Theory and Lattices

Course code : PM2031

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To learn in depth the concepts of Field Theory , Galois Theory and Lattices.

2. To pursue research in pure Mathematics.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	Recall the definitions and basic concepts of field theory and lattice theory	PSO - 2	U
CO - 2	Express the fundamental concepts of field theory, Galois theory	PSO - 2	U
CO - 3	Demonstrate the use of Galois theory to construct Galois group over the rationals	PSO - 3	E
CO - 4	Distinguish between field theory and Galois theory	PSO - 3	Ap
CO - 5	Interpret distributivity and modularity and apply these concepts in Boolean Algebra	PSO - 4	Ap
CO - 6	Understand the theory of Frobenius Theorem	PSO -2	U
CO - 7	Develop the knowledge of lattices and establish new relationships in Boolean Algebra	PSO - 1	C

Unit I

Extension fields – finite extension, algebraic extension.

Unit II

Roots of polynomials- More about roots.

Unit III

Elements of Galois theory- Galois group over the rationals.

Unit IV

Finite fields – Wedderburn's theorem (First proof only)- A Theorem of Frobenius.

Unit V

Partially ordered sets and lattices, Distributivity and modularity- Boolean algebra.

Text Books

1. Topics in Algebra, I.N. Herstein, (2^{nd} Edition, Wiley Eastern Ltd,Reprint 2011).
   Chapter 5 : 5.1,5.3,5.5,5.6,5.8
   Chapter 7: 7.1,7.2 (Theorem 7.2.1 only),7.3
2. Basic Algebra, Nathan Jacobson, Vol: I (Hindustan Publishing Corporation, Indian Edition,1984).
   Chapter 8: 8.1,8.2, 8.5.

Reference Books:

1. Joseph A.Gallian. (1999). Contemporary Abstract Algebra. (4^{th} Edition). Narosa Publishing House.
2. Nathan Jacobson. (1984). Basic Algebra. (Indian Edition). Hindustan Publishing Corporation.
3. Joseph Rotsman. (2010). Galois Theory. (2^{nd} Edition). Springer International Edition.
4. John R. Durbin. (2005). Modern Algebra. (5^{th} Edition). John wiley & Sons.
5. Rudolf Lidland Gunter Pilz. (2009). Applied Abstract Algebra. (2^{nd} Edition). Springer International edition.

Semester III

Major Core X - Topology

Course code : PM2032

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To distinguish spaces by means of simple topological invariants.

2. To lay the foundation for higher studies in Geometry and Algebraic Topology.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	Understand the definitions of topological space, closed sets, limit points, continuity, connectedness, compactness, separation axioms and countability axioms.	PSO - 3	U
CO - 2	Construct a topology on a set so as to make it into a topological space	PSO - 4	C
CO - 3	Distinguish the various topologies such as product and box topologies and topological spaces such as normal and regular spaces.	PSO - 3	U, An
CO - 4	Compare the concepts of components and path components, connectedness and local connectedness and countability axioms.	PSO - 2	E, An
CO - 5	Apply the various theorems related to regular space, normal space, Hausdorff space, compact space to other branches of mathematics.	PSO - 1	Ap
CO - 6	Construct continuous functions, homeomorphisms and projection mappings.	PSO - 4	C

Unit I

Topological spaces and Examples - Basis for a topology - The order topology - The product topology on $X \times Y$- The subspace topology - Closed sets and Limit points - Continuous function.

Unit II

The Product Topology – The metric topology – Sequence lemma – Uniform limit theorem - Connected spaces – Connected subspaces of the Real Line –Components and Local connectedness.

Unit III

Compact spaces - Compact subspacesof the Real Line – Uniform Continuity theorem – Limit point Compactness – Complete metric spaces – Compactness in metric spaces.

Unit IV

First and Second countable spaces –Lindeloff and Separable spaces -Countability axioms - The separation axioms - Normal spaces - The Urysohn's Lemma

Unit V

The UrysohnMetrization Theorem - Tietze Extension Theorem – The Tychonoff theorem – Stone Cechcompactifications

Text Book:

James R. Munkres. (2002). Topology.(2^{nd} Edition). Pearson Education Inc.

Sections : 12 - 21, 23- 28, 30 - 35, 37, 38, 43, 45

Reference Books:

1. Gupta, K. P. (2013). Topology. (21^{st} Edition). Pragati Prakashan Publishers.
2. Kelley, J. L. (2009). General Topology. (3rd Indian reprint). Springer - Verlag.
3. George F. Simmons. (2004). Introduction to Topology and Modern Analysis. (2^{nd} Indian reprint). McGraw Hill.
4. Willard, S. (1970). General Topology. Addison - Wesley Publishing Co Inc.
5. Joshi, K. D. (1983). Introduction to General Topology. Wiley Eastern Ltd.

Semester III

Major Core XI -Measure Theory and Integration

Course code : PM2033

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To generalize the concept of integration using measures.

2. To develop the concept of analysis in abstract situations.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSOs addressed	CL
CO - 1	Define the concept of measures and Vitali covering and recall some properties of convergence of functions,	PSO - 1	R
CO - 2	Cite examples of measurable sets , measurable functions, Riemann integrals, Lebesgue integrals.	PSO - 3	U
CO - 3	Apply measures and Lebesgue integrals to various measurable sets and measurable functions	PSO - 2	Ap
CO - 4	Apply outer measure, differentiation and integration to intervals , functions and sets.	PSO - 2	Ap
CO - 5	Compare the different types of measures and Signed measures	PSO - 3	An
CO - 6	Construct L^p spaces and outer measurable sets	PSO - 4	C

Unit I

Lebesgue Measure - Introduction, outer measure - Measurable sets and Lebesgue measure - Measurable functions - Littlewood's three principles (no proof for first two).

Unit II

The Lebesgue integral - The Riemann Integral - The Lebesgue integral of a bounded function over a set of finite measure - The integral of a non-negative function - The general Lebesgue integral .

Unit III

Differentiation and integration - Differentiation of monotone functions - Functions of bounded variation - Differentiation of an integral - Absolute continuity.

Unit IV

Measure and integration - Measure spaces - Measurable functions - Integration - general convergence theorems - Signed measures.

Unit V

The L^P spaces - Measure and outer measure - Outer measure and measurability - The extension theorem.

Text Book:

Royden, H. L. (2004). Real Analysis. (3^{rd} Edition). Prentice Hall of India.

Chapters : 3, 4, 5, 11 (except 3.4, 4.5, 5.5, 11.6)

Chapter : 12 (sections 1 and 2)

Reference Books :

1. De Barra, G. (2009). Measure Theory and Integration. New Age International (P) Limited Publishers.
2. Jain, P. K., Gupta, V. P., & Pankaj Jain. (2015). Lebesgue Measure and Integration. (2^{nd} Edition). New Age International Publishing.
3. Inder K. Rana. (2014). An Introduction to Measure and Integration. (2^{nd} Edition). Narosa Publishing House.
4. Jain P. K., & Pankaj Jain. (2014). General Measure and Integration. (1^{st} Edition). New Age International Publishers.
5. Chandrasekhar Rao, K. (2009). Topology. Narosa Publishing House.

Semester III

Elective III (a)-Algebraic Number Theory and Cryptography

Course code : PM2034

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	4	90	100

Objectives:

1. To gain deep knowledge about Number theory

2. To study the relation between Number theory and Abstract

3. To know the concepts of Cryptography.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	Recall the basic results of field theory	PSO - 1	R
CO - 2	Understand quadratic and power series forms and Jacobi symbol	PSO - 2	U
CO - 3	Apply binary quadratic forms for the decomposition of a number into sum of sequences	PSO - 3	Ap
CO - 4	Determine solutions using Arithmetic Functions	PSO - 3	Ap
CO - 5	Calculate the possible partitions of a given number and draw Ferrer's graph	PSO - 2	An
CO - 6	Identify the public key using Cryptography	PSO - 4	An

Unit I

Quadratic Reciprocity and Quadratic Forms: Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol.

Unit II

Binary Quadratic Forms - Equivalence and Reduction of Binary Quadratic Forms - Sum of Two Squares.

Unit III

Some Functions of Number Thoery: Arithmetic functions- The Mobius Inversion Formula- Multiplicative functions. Some Diophantine Equations: Pythagorean Triangles.

Unit IV

The Partition Function - Ferrers Graphs - Formal Power Series - Eulers Identity - Eulers Formula.

Unit V

Public Key Cryptography – Concepts of public key Cryptography – RSA –Discrete logarithm - Basic facts - Elliptic curve cryptosystems.

Text Book:

1. Ivan Niven., Herbert S. Zuckerman., & Hugh L. Montgomery. (2006). An Introduction to the Theory of Numbers. (5^{th} Edition). John - Wiley & Sons.
   Chapter 3 : 3.1 - 3.6; Chapter 4 : 4.2 and 4.3;
   Chapter 5 : 5.3; Chapter 10 : 10.1 - 10.4
2. Neal Koblitz, A Course in Number Theory and Cryptography Second Edition, Springer-Verlag, New York 1987.
   Chapter 4 : 1-3; Chapter 6 : 1 and 2

Reference Books:

1. Hardy, G. H., & Wright E. M. (1975). An Introduction to the Theory Of Number. (4^{th} Edition). Oxford at the Clarendon Press.
2. David M.Burton, Elementary Number Theory, Wm.C.Brown Publishers, Dubuque,lowa,1989.
3. Tom. M. Apostol. (1998). Introduction to Analytic Number Theory. Narosa Publishing House.
4. Kenneth Ireland., & Michael Rosen. (1990). A classical Introduction to Modern Number Theory. (2^{nd} Edition). Springer International Edition.
5. Graham Everest., & Thomas Ward. (2008). An Introduction to Number Theory. Springer International Edition.
6. John Stillwell. (2008). Elements of Number Theory. Springer International Edition.
7. Cryptography and Network Security Principles and Practice by William Stallings , Prentice Hall, Fifth Edition, New Delhi , 2011.

Semester III
Elective III (b)- Stochastic Processes
Sub. Code: PM2035

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	4	90	100

Objectives: 1. To understand the stochastic models.
2. To relate the models studied to real life probabilistic situations.

Unit I

Stochastic processes - Specification of Stochastic processes - Stationary processes - Markov chain - Transition probabilities - Random walk - Higher transition probabilities.

Unit II

Classification of states and chains - Transient and recurrent states - Stability of a Markov system.

Unit III

Markov process with discrete state space - Poisson process-Generalizations of Poisson process - Poisson Cluster process - Pure birth process - Yule-Furry process - Birth Immigration Process - Birth and death process.

Unit IV

Renewal processes - Renewal process in Discrete time - Renewal process in continuous time - Renewal equation-Renewal theorems - Residual and current life times.

Unit V

Stochastic processes in queuing - Queuing processes - Steady state behaviour of M/M/1 queuing model-Non-Markovian queuing models-Queues with Poisson input- M/G/1 and GI/M/1 queuing models.

Text Book :

Medhi, J. (1994). Stochastic Processes.(Second Edition).New Age International Publishers. New Delhi.

Chapter 2: Sections 2.1,2.2,2.3; Chapter 3: Sections 3.1,3.2,3.4,3.6.

Chapter 4: Sections 4.1, 4.3 (except 4.3.5 - 4.3.7), 4.4.

Chapter 6: Sections 6.1.1- 6.1.3, 6.2 (except example 2(b)), 6.3, 6.5 (except 6.5.2), 6.7.

Chapter 10: Sections 10.1(except 10.1.4), 10.2 (except 10.2.3.1),10.7 (except examples 7(a),7(b) & sections 10.7.3,10.7.4), 10.8 (except example 8(a)).

Reference Books :

1. Narayan Bhat, U. (1972). Elements of Applied Stochastic Processes. (Second Edition). John Wiley & Sons. New York.
2. Prabhu, N.V. (1970). Stochastic Processes. Mac Millon. New York.
3. Bhat, B.R. (2010). Stochastic Models Analysis and Applications. New Age International (P) Limited Publishers.
4. Veerarajan, T. (2006). Probability, Statistics and Random Processes. Tata McGraw - Hill Publishing Company Limited.
5. Salil Kumar Chaudhri., & Ashis K. Chakraborthy. (2009). Statistical Methods. Asian Books Private Ltd.

Semester III

Project
Course Code : PM20PR

No. of hours per week	Credits	Total No. of hours	Marks
6	**5**	90	100

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	choose a new topic of their interest	PSO - 1	U
CO - 2	develop the attitude of studying a topic in depth independently	PSO - 4	An
CO - 3	express their views with confidence in a group	PSO - 1	U
CO - 4	relate with the group members and reap the best harvest	PSO - 3	Ap
CO - 5	develop communication skills through oral presentation	PSO - 4	An
CO - 6	create a taste for research in mathematics	PSO - 5	C
CO - 7	develop confidence to face interviews	PSO - 5	C
CO - 8	Interpret and analyze data mathematically	PSO - 4	An

Guidelines

- All the students must undertake dissertation work at the final year (III semester).
- The students, with the consent of the Supervisor, HoD and the Principal can pursue their project in another institution, especially with MoU/ Collaboration for the successful completion of the project work.
- Evaluation

Evaluation	Marks	Month/ Date	Evaluator
Proposed title, review of literature and objectives.	-	3rd Week of III Semester	-
I Review	10	July	Supervisor
II Review	10	August	Supervisor
Final- Internal	20	September/ October	Supervisor
External - Dissertation *Viva-voce (individual & open)	40 20	October /November	Ext. examiner
Total marks	100		

* Mode of presentation by Power Point

Dissertation framework

1. The Project format should be in:

o **Font - Times New Roman**

o **Heading - Font size 14 (Bold) - Uppercase**

o **Sub headings - Font size 12 (Bold) — Lowercase; should be numbered.(Eg: Introduction 1; Subheading 1.1; 1.2)**

o **Text, the content of the dissertation — Font size -12 (Normal).**

o Citation - Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

i) A paper, a monograph or a book with single author may be designated by the name of the *fast* author followed by the year of publication, placed inside brackets at the appropriate places in the text.

ii) A paper, a monograph, or a book with two authors may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.

iii) A paper, a monograph, or a book with more than two authors may be designated by the name of the first author followed by et al, and the year of publication, placed inside brackets at the appropriate places in the text.

o **Line space - 1.5**

o **Margin - 2" on the left and 1" on the right, Gutter -0.5.**

o **Page Numbering — Bottom middle alignment; excluding initial pages and reference** o **Total number of pages - Minimum 30 - Maximum 50 (excluding initial pages andreference).**

o **The Tables and Figures should be included subsequently after referring them in thetext of the Thesis.**

o **The thesis from Chapters should be printed on both sides.**

II. Project Report must be completed within the stipulated time.

III Submission of Project Report:

o one soft copy (PDF format in CD)

o three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

The Project Report **will have three main parts:**

I. Initial Pages - in the following sequence

i. Title Page

ii. Certificate from the Supervisor

iii. Declaration by the candidate endorsed by the Supervisor and HOD.

iv. Acknowledgement (within one page - signed by the candidate).

v. Table of Contents

vi. List of abbreviations

vii. Abstract

II. Main body of the dissertation

i. Introduction with Literature review and Objectives

ii. Methodology

iii. Results

iv. Discussion

v. Summary

vi. References

III Reference

The guidelines for reference

Journal Article : with Single Author

Waldron, S 2008, "Generalized Welch bound equality sequences are tight frames", IEEE Transactions on Information Theory, vol. 49, no. 9, pp. 2307-2309.

Journal Article : with Two Authors

Conley, TG & Galeson, DW 1998, "Nativity and wealth in mid-nineteenth century cities", Journal of Economic History, vol. 58, no. 2, pp. 468-493. **Journal Article : with more than two Authors**

Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009, „Bounds on the sum capacity of synchronous binary CDMA channels", Journal of Chemical Education, vol. 55, no. 8, pp. 3577-3593.

Books

Holt, DH 1997, Management Principles and Practices, Prentice-Hall, Sydney. Centre forResearch, M S University - Ph.D. Revised Guidelines Page | 39 / 41

E-book

Aghion, P &Durlauf, S (eds.) 2005, Handbook of Economic Growth, Elsevier, Amsterdam.Available from: Elsevier books. [4 November 2004]. **Conference Proceeding**

Paper with editors

Riley, D 1992, „Industrial relations in Australian education", in Contemporary Australasian

industrial relations: proceedings of the sixth AIRAANZ conference, ed. D. Blackmur, AIRAANZ, Sydney, pp. 124-140. **Conference Proceeding Paper without editors**

Fan, W, Gordon, MD & Pathak, R 2000, "Personalization of search engine services for effective retrieval and knowledge management", Proceedings of the twenty-first internationalconference on information systems, pp. 20-34. **Website**

Australian Securities Exchange 2009, Market Information. Available from: . [5 July 2009].

Thesis

Unpublished Hos, JP 2005, Mechano chemically synthesized nano materials for intermediatetemperature solid oxide fuel cell membranes. Ph.D. thesis, University of Western Australia.

Newspaper Print Ionesco, J 2001, 'Federal election: new Chip in politics', The Advertiser 23 October, p. 10.

Semester III
Life Skill Training - II
Course Code: LST202

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:
1. To aid students in making right choices and decisions
2. To create awareness on practical methods that lead to personal and societal development

Course Outcome (CO)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	Identify the root cause of social evils and it's consequences	PSO-	An
CO-2	Understand the importance of personal and emotional well being	PSO-	Un
CO-3	Empathise with the needy and disabled	PSO-	Ap

Unit I

Corruption - causes and types. Seeds and remedies of corruption.

Casteism - causes and consequences.

Communalism - characteristics - causes and remedial measures.

Regionalism - characteristics - causes and remedial measures.

Unit II

Abortion - reason and methods. Birth control

Alcoholism - alcoholism and causes of drinking. Harmful effects of liquor.

Drug addiction - causes - effects and control of drug addiction.

Unit III

Depression - signs - causes and treatments.

Suicide - signs and treatments. Child labour.

Unit IV

Divorce - causes and effects. Steps to avoid divorce.

Dowry system in India - Legislations to inhibit dowry system. Cases and problems.

Unit V

Care and concern for the aged and disabled - need to take care of elders. Caring of someone with physical disability.

HIV and aids - basic facts - causes - prevention and treatment.

Text Book:

(Compilation will be provided to the students)

Reference Books:

CN. Shankar Rao, India Social Problems - A Sociological Perspective. S. Chand and Company Limited. New Delhi. 2015.
CN. Shankar Rao, Sociology of Indian Society. S. Chand and company limited. New Delhi. 2004
Gawain, Shakti and Laurel King. Living in the Light. - A Guide to Personal Transformation. Natraj Publishing. Canada. 1998.

Self Learning Course

Algebra for SET/CSIR-NET Exam

Course Code: PM20S1

Objectives: 1. To enhance problem solving skills.

2. To enable the students to clear the CSIR - NET/SET Exams.

Unit I

To solve NET/SET based problems in

Vector spaces - Subspaces - linear dependence - Basis and dimension - Algebra of linear transformations.

Unit II

To solve NET/SET based problems in

Algebra of matrices - Rank and determinant of matrices - linear equations.

Unit III

To solve NET/SET based problems in

Eigen values and Eigen vectors - Cayley-Hamilton theorem.

Unit IV

To solve NET/SET based problems in

Matrix representation of linear transformations - Change of basis - Canonical forms-Diagonal forms - Triangular forms - Jordan forms.

Unit V

To solve NET/SET based problems in

Inner product spaces - Orthonormal basis Quadratic forms - Reduction and classification of quadratic forms.

Reference Books:

1. Vijay K. Khanna., & Bhambri, S.K. (2017). A Course in Abstract Algebra. Vikas Publishing House Pvt. Ltd.
2. Dr. Alok Kumar. Mathematical Sciences for CSIR-UGC NET/JRF/SET. Upkar Prakashan. Code No - 1587.
3. Joseph A. Gallian. (1999). Contemporary Abstract Algebra. (Edition). Narosa Publishing House.
4. Kenneth Hoffman., & Ray Kunze. (2016). Linear Algebra. (Edition). Pearson India Education Services Pvt. Ltd.
5. John B. Fraleigh. (2003). A first course in Abstract Algebra. (Edition). Narosa Publishing House.

Semester IV

Complex Analysis (Major Core XII)

Course code : PM2041

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To impart knowledge on complex functions.

2. To facilitate the study of advanced mathematics.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	Understand the fundamental concepts of complex variable theory	PSO - 1	U
CO - 2	Effectively locate and use the information needed to prove theorems and establish mathematical results	PSO - 3	R
CO - 3	Demonstrate the ability to integrate knowledge and ideas of complex differentiation and complex integration	PSO - 4	U
CO - 4	Use appropriate techniques for solving related problems and for establishing theoretical results	PSO - 3	Ap
CO - 5	Evaluate complicated real integrals through residue theorem	PSO – 2, 4	E
CO - 6	Know the theory of conformal mappings which has many physical applications and analyse its concepts	PSO – 3, 4	An

Unit I

Power series - Abel's theorem, Abel's limit theorem, The periodicity.
Conformality - Arcs and closed curves, Analytic Functions in Regions, Conformal Mapping, Length and Area.

Unit II

Complex Integration - Fundamental theorems : 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, Local Properties of Analytic Functions: Removable singularities, Taylor's theorem, Zeros and poles.

Unit III

Complex Integration: The local mapping, The maximum principle, The General Form of Cauchy's Theorem : Chains and Cycles, Simple Connectivity, Homology, The General Statement of Cauchy's Theorem (statement only), Residue Theorem, The Argument Principle, Evaluation of Definite Integrals.

Unit IV

Series and Product developments: Partial Fractions and Entire Functions: Partial Fractions, Infinite products, Canonical products, Gamma functions, Jensen's formula, Hadamard's Theorem

Riemann Theta Function and Normal Families: Product development, Extension of $\zeta(s)$ to the whole plane, The zeros of zeta function, Equicontinuity, Normality and compactness, Arzela's theorem, Families of analytic functions, The classical Definition.

Unit V

Conformal Mappings: Riemann mapping theorem: Statement and proof, Boundary Behaviour, Use of the Reflection Principle.

Conformal mappings of Polygons: Behaviour at an angle, Schwarz-Christoffel formula, Mapping on a rectangle.

Harmonic Functions: Functions with mean value property, Harnack's Principle.

Text Book:

Ahlfors.(1979). Complex Analysis.(3^{rd} Edition). Tata McGraw-Hill, New York.
Chapter 2: sections 2.4,2.5, 3.3
Chapter 3: sections 2.1 - 2.4
Chapter 4: sections 1.4, 1.5, 2.1 - 2.3, 3.1 - 3.4, 4.1 - 4.5, 5.1 - 5.3
Chapter 5: sections 2.1-2.4, 3.1, 3.2, 4.1, 4.2, 4.4, 5.1-5.5
Chapter 6: sections 1.1-1.3, 2.1-2.3, 3.1, 3.2

Reference Books:

1. H.A. Presfly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Corway, Functions of one Complex Variables, Springer-Verlag,
International student Edition, Narosa Publishing Co.
3. E. Hille, Analytic function Theory (2 vols.), Gonm & Co, 1959.
4. M. Heins, Complex function Theory, Academic Press, New York,1968.
5. Karunakaran, V. (2002). Complex Analysis.Narosa Publishing House.
6. Shanthi Narayanan., & Mittal, P.K. (2011). Theory of Functions of a Complex Variable.S.Chand& Co Publication.
7. Ponnusamy, S. (2011). Foundations of Complex Analysis.(2^{nd} Edition). Narosa Publishing House.

Semester IV

Major Core XIII -Functional Analysis

Course code : PM2042

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To study the three structure theorems of Functional Analysis and to introduce Hilber Spaces and Operator theory.
2. To enable the students to pursue research.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSOs addressed	CL
CO - 1	Learn and understand the definition of linear space , normed linear space, Banach Space and their examples	PSO - 1	R
CO - 2	Explain the concept of different properties of Banach Spaces, Hahn Banach theorem	PSO -2	U
CO - 3	Compare different types of operators and their properties, Natural imbedding	PSO - 2	Ap
CO - 4	Explain the ideas needed for open mapping theorem , Open Mapping theorem	PSO - 1	C
CO - 5	Construct the idea of projections , the spectrum of an operator and develop problem solving skills , Matrices, Determinants	PSO - 1	Ap
CO - 6	Learn and understand the definition of Hilbert Spaces ,Orthogonal Complements	PSO - 4	R
CO - 7	Explain the concept of the adjoint of an operator, Normal and Unitary operators, Spectral Theory	PSO - 2	An

Unit I

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

Unit II

The natural imbedding of N into N** - The open mapping theorem - The conjugate of an operator.

Unit III

Hilbert spaces - Definition and properties - Orthogonal complements - Orthonormal sets - The conjugate space.

Unit IV

Adjoint of an operator, self adjoint operators - Normal and unitary operators – Projections - Spectral theory - Spectrum of an operator - The spectral theorem.

Unit V

Banach Algebras: The definition and some examples – Regular and singular elements – The spectrum – The formula for the spectral radius.

Text Book:

Simmons, G. F. (1963). Introduction to Topology and Modern Analysis.
Tata McGraw Hill.

Sections : 46 to 59,61,62, 64,65,67,68.

Reference Books:

1. Soma Sundaram, D. (2014). A first course in Functional Analysis. Narosa Publishing House Pvt. Ltd.
2. Chandra Sekhara Rao, K. (2002). Functional Analysis. Narosa Publishing House.
3. Thamban Nair, M. (2002). Functional Analysis. A First Course. Prentice Hall of India.
4. Erwin Kreyzig. (2006). Introductory Functional Analysis with Applications. John Wiley and Sons Publication.
5. Casper Goffman., & George Pedrick. (1974). First course in Functional Analysis. Prentice/ Hall of India Private Limited.

Semester IV

Major Core XIV - Operations Research

Course code : PM2043

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To learn optimizing objective functions.

2. To solve life oriented decision making problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	Explain the fundamental concept of DP model , Inventory model and Queuing model	PSO - 2	U
CO - 2	Relate the concepts of Arrow (Network)diagram representations, in critical path calculations and construction of the Time chart	PSO - 3	U
CO - 3	Distinguish deterministic model and single item	PSO - 3	E
CO - 4	Interpret Poisson and Exponential distributions and apply these concepts in Queuing models	PSO - 4	Ap
CO - 5	Solve life oriented decision making problems by optimizing the objective function	PSO - 1	C

Unit I

Elements of the DP Model - The Capital Budgeting Example - More on the definition of the state - Examples of DP Models and computations - Solution of Linear Programming by Dynamic programming - Game theory.

Unit II

Arrow (Network) Diagram Representations - Critical Path Calculations - Construction of the Time Chart and Resource Leveling - Probability and Cost Considerations in Project Scheduling .

Unit III

A Generalised Inventory model - Types of Inventory Models - Deterministic Models - Single Item Static Model - Single Item Static - Model with Price Breaks - Multiple - Item static Model with Storage Limitations - Single - Item .

Unit IV

Basic Elements of the Queueing Model - Roles of Poisson and Exponential Distributions - Queue with Combined Arrivals and Departure - Queueing Models of Type : (M/M/1): (GD/∞/∞) , (M/M/1): (GD/N/∞) .

Unit V

Queueing Models of Types : (M/G/1): (GD/∞/∞) - The Pollaczek - Khintchine Formula, (M/M/C) : (GD/∞/∞) - (M/M/∞) : (GD/∞/∞) Self service Model, (M/M/R) : (GD/K/K) R < K - Machine Service -Tandem or series queues .

Text Book:

Handy .A. Taha. (1989). Operations Research - An Introduction. (3^{rd} Edition). MacMillan Publishing Co. Inc.

Chapter 9 : Section 9.1 - 9.3, 9.5; Chapter 11 : Section 11.4 ;

Chapter 12 : Section 12.1 - 12.4; Chapter 13 : Section 13.1 - 13.3 (except 13.3.5); Chapter 15 : Section 15.1, 15.2 (only 15.2.1, 15.2.2), 15.3 (15.3.1, 15.3.2, 15.3.3, 15.3.4, 15. 3.6, 15.3.7), 15.5 - (only15.5.1).

Reference Books:

1. Er . Prem Kumar Gupta., & Dr. Hira, D.S. (2014). Operations Research. (7^{th} Edition). S. Chand and company private ltd.

2. Sharma, J.K. (2009). Operations Research : Theory and Applications. (4th Edition). Macmillian Publishers India ltd.
3. Panneerselvam, R. (2009). Operations Research. (2nd Edition). PHI Learning private ltd.
4. Prem Kumar Gupta., Dr. Hira, D. S., & AartiKamboj. (2012). Introduction to Operations Research. S. Chand and Company ltd.
5. Naidu, N. V. R., Rajendra, G., & Krishna Rao, T. (2011). Operations Research. (Kindle Edition). IK . International Publishing house private ltd.

Semester IV

Major Core XV - Algorithmic Graph Theory

Course Code: PM2044

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	4	90	100

Objectives: 1. To instill knowledge about algorithms.

2. To write innovative algorithms for graph theoretical problems.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO -1	understand basic algorithms and write algorithms for simple computing.	PSO - 1	U E
CO - 2	analyse the efficiency of the algorithm.	PSO - 2	An
CO - 3	understand and analyze algorithmic techniques to study basic parameters and properties of graphs	PSO - 2	R An
CO - 4	use effectively techniques from graph theory, to solve practical problems in networking and communication	PSO - 3	Ap

Unit I

The Role of Algorithms in Computing - Algorithms, Algorithm as a Technology. Getting Started - Insertion Sort, Analyzing Algorithms, Designing Algorithms.

Unit II

Elementary Graph Algorithms - Representation of Graphs, Breadth-first Search, Depth-first Search, Topological Sort, Strongly Connected Components.

Unit III

Minimum Spanning Trees - Growing a Minimum Spanning Tree, The algorithms of Kruskal and Prim.

Unit IV

Single Source Shortest Paths - The Bellman-Ford Algorithm, Single-source Shortest Paths in Directed acyclic Graphs, Dijkstra's Algorithm, Difference Constraints and Shortest Paths.

Unit V

All-Pairs Shortest Paths - Shortest Paths and Matrix Multiplication, The Floyd-Warshall Algorithm, Johnson's Algorithm for Sparse Graphs.

Text Book:

Thomas H. Cormen., Charles E. Leiserson., Ronald L. Rivest., & Clifford Stein. (2010). Introduction to Algorithms. (3^{rd} Edition). PHI Learning Pvt. Limited.

Chapter I : 1.1 - 1.2 and 2.1 - 2.3

Chapter VI : 22.1 - 22.5, 23.1 - 23.2, 24.1 - 24.4 and 25.1 - 25.3.

Reference Books:

1. Kenneth H Rosen (2012). Discrete Mathematics and its Applications with Combinatorics and Graph Theory (Seventh Edition). Tata McGraw-Hill.
2. Gary Chartrand., &Ortrud R. Oellermann. (1993). Applied and Algorithmic Graph Theory. (International Editions). McGraw-Hill.
3. Bondy, J. A., &Murty, U. S. R. (1976). Graph Theory with Application. Macmillan.
4. Murugan, M. (2003). Graph Theory and Algorithms. Muthali Publishing House.
5. Hu, T. C. (1982). Combinatorial Algorithms. Addison-Wesley Publishing Company.
6. Alan Gibbons. (1985). Algorithmic Graph Theory. Cambridge University.

Semester IV

Elective IV (a) - Combinatorics

Course Code: PM2045

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	4	90	100

Objectives: 1. To do an advanced study of permutations and combinations.

2. Solve related real life problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	Discuss the basic concepts in permutation and combination, Recurrence Relations, Generating functions, The Principle of Inclusion and Exclusion	PSO - 1	U
CO - 2	Distinguish between permutation and combination, distribution of distinct and non-distinct objects	PSO - 2	An
CO - 3	Correlate recurrence relation and generating function	PSO - 2	An
CO -4	Solving problems by the technique of generating functions, combinations, recurrence relations, the principle of inclusion and exclusion	PSO - 3	Ap
CO - 5	Interpret the principles of inclusion and exclusion, equivalence classes and functions	PSO - 4	An E
CO - 6	Develop the concepts of Polya's fundamental theorem and apply in Polya's theory of counting	PSO - 4	C

Unit I

Permutations and combinations-Therules of sum and product- Permutations - Combinations - Distribution of distinct objects- Distribution of nondistinct objects.

Unit II

Generating functions - Generating functions for combinations - Enumerators for permutations- Distributions of distinct objects into nondistinct cells - Partitions of integers- The Ferrers graph.

Unit III

Recurrence relations -Linear recurrence relations with constant coefficients - Solution by the technique of generating functions.

Unit IV

The principle of inclusion and exclusion - The general formula - Derangements - Permutations with restrictions on relative positions - The Rook polynomials.

Unit V

Polya's theory of counting - Equivalence classes under a permutation group - Equivalence classes of function -Weights and inventories of functions - Polya's fundamental theorem.

Text Book:

Liu, C.L. (1988). Combinatorial Mathematics. McGraw Hill.

Chapters 1: 1.1 to 1.6; Chapter 2: 2.1 to 2.6; Chapter 3: 3.1 to 3.3

Chapter 4: 4.1 to 4.6; Chapter 5: 5.3 to 5.6

Reference Books:

1. Anderson. (1974). Combinatorial Mathematics. Elarendon Press.
2. Balaji, G. (2010). Discrete Mathematics. (3^{rd} Edition).G. Balaji Publishers.
3. Robert J. Mceliece., Robert B. Ash., & Carol Ash. (1989). Introduction to Discrete Mathematics. Mcgraw-Hill International Editions.
4. Laszlo lovasz. (1979). Combinatorial problems and Exercises. North - Holland publishing company.
5. Alan Tucker. (1984). Applied Combinatorics. (2^{nd} Edition). John Wiley & sons.
6. Sey Mour Lipsc Hutz., & Marc Lars Lipson. (2010). Discrete Mathematics. (3^{rd} Edition). Tata Mcgraw - Hill.

Semester IV

Elective IV (b) Coding Theory

Course Code: PM2046

No. of Hours per Week	Credit	Total No. of Hours	Marks
6	4	90	100

Objectives: 1. To learn the different procedures of coding and decoding.

2. To avail job opportunities in a number of detective agencies.

Unit I

Mathematical Background: Algebra - Krawtchouk Polynomials - Combinatorial theory - Shannon's Theorem: Introduction - Shannon's Theorem.

Unit II

Linear codes: Block codes - Linear codes - Hamming codes - Majority logic decoding - Weight Enumerators - The Lee metric.

Unit III

Some good codes: Hadamard codes and generalizations - The binary Golay code - The ternary Golay code - Constructing codes from other codes - Reed-Muller code - Kerdock codes.

Unit IV

Bound on codes: The Gilbert bound - Upper bounds - Cyclic codes: Definitions - Generator matrix and check polynomial - Zeros of a cyclic code.

Unit V

The idempotent of a cyclic code - Other Representations of cyclic codes - BCH codes - Decoding BCH codes - Binary cyclic codes of length 2n (n odd).

Text Book:

Van Lint, J. H. (2000). Introduction to Coding Theory. (3^{rd} Edition).S pringer.

Chapters 1 (except 1.4), 2 (Sections 2.1 and 2.2 only), 3, 4, 5 (except 5.3), and Chapter 6 (except 6.8, 6.9 and 6.11).

Reference Books:

1. Borda, M. (2011). Fundamentals in information theory and coding. Springer.
2. Raymond Hill. (1986). A First Course in Coding Theory. Clarendon Press. Oxford.
3. Vera Pless. (1998). Introduction to the Theory of Error - Correcting Codes. (3rd Edition). John Wiley and Sons Inc.
4. Cary Huffman, W., & Vera Pless. (2003). Fundamentals of Error - Correcting codes. Cambridge University Press.
5. Stefan M. Moser., & Po-Ning Chen. (2012). A Student's Guide to Coding and Information Theory. Cambridge University press.

Semester IV

Self Learning Course

Analysis for SET/ CSIR-NET Exam

Course Code: PM20S2

Objectives: 1. To enhance problem solving skills.

2. To enable the students to clear the CSIR-NET/SET Exams.

Unit I

To solve NET/SET based problems in

Real number system as a complete ordered field - Archimedean property - Sequences and series - Convergence - Lim sup, Lim inf.

Unit II

To solve NET/SET based problems in

Metric spaces - Compactness and Connectedness - Normed linear spaces.

Unit III

To solve NET/SET based problems in

Continuity - Uniform continuity - Discontinuity - Monotonic functions.

Unit IV

To solve NET/SET based problems in

Riemann sum - Riemann integrals - Improper integrals.

Unit V

To solve NET/SET based problems in

Sequences and series of functions - Uniform convergence.

Reference Books:

1. Tom M. Apostol. (2002). Mathematical Analysis. (Edition). Narosa Publishing House.
2. Dr. Alok Kumar. Mathematical Sciences for CSIR-UGC NET/JRF/SET. Upkar Prakashan. Code No - 1587.
3. Charles G. Denlinger. (2011). Elements of Real Analysis. Jones and Bartlett Learning.
4. Somasundaram, D., & Choudhary, B. (2010). A First Course in Mathematical Analysis. (corrected Edition). Narosa Publishing house.
5. Richard R. Goldberg. (1970). Methods of Real Analysis. Oxford & IBH Publishing Co. Pvt. Ltd.