M. Sc. MATHEMATICS

SYLLABUS - 2016

SCHOOLS OF EXCELLENCE
with
CHOICE BASED CREDIT SYSTEM (CBCS)

SCHOOL OF COMPUTING SCIENCES
St. JOSEPH'S COLLEGE (Autonomous)
Accredited at 'A' Grade (3rd Cycle) by NAAC
College with Potential for Excellence by UGC
TIRUCHIRAPPALLI - 620 002, INDIA

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS)

POST GRADUATE COURSES

St. Joseph's College (Autonomous), a pioneer in higher education in India, strives to work towards the academic excellence. In this regard, it has initiated the implementation of five "Schools of Excellence" from this academic year 2014 – 15, to standup to the challenges of the 21st century. Each School integrates related disciplines under one roof. The school system allows the enhanced academic mobility and enriched employability of the students. At the same time this system preserves the identity, autonomy and uniqueness of every department and reinforces their efforts to be student centric in curriculum designing and skill imparting. These five schools will work concertedly to achieve and accomplish the following Learning Assurance.

- Optimal utilization of resources both human and material for the academic flexibility leading to excellence.
- Students experience or enjoy their choice of courses and credits for their horizontal mobility.
- The existing curricular structure as specified by TANSCHE and other higher educational institutions facilitate the Credit-Transfer Across the Disciplines (CTAD) - a uniqueness of the choice based credit system.
- Human excellence in specialized areas
- Thrust in internship and / or projects as a lead towards research and
- The **multi-discipline** nature of the newly evolved structure (School System) caters to the needs of stake-holders, especially the employers.

What is Credit system?

Weightage to a course is given in relation to the hours assigned for the course. Generally one hour per week has one credit. For viability and conformity to the guidelines credits are awarded irrespective of the teaching hours. The following Table shows the correlation between credits and hours. However, there could be some flexibility because of practical, field visits, tutorials and nature of project work.

For PG courses a student must earn a minimum of 110 credits. The total number of courses offered by a department is given above. However within their working hours few departments / School can offer extra credit courses.

SUMMARY OF HOURS AND CREDITS
PG COURSES - MATHEMATICS

Part	Semester	Specification	No. of Courses	Hours	Credits	Total Credits
1	I-IV	**Core Courses**				
		Theory	13	84	69	
		Practical	-	-	-	
	II	**Self Paced Learning**	1	-	2	**81**
	III	**Common Core**	1	4	4	
	IV	**Comprehensive Examination**	1	-	2	
	IV	**Dissertation & Viva Voce**	1	8	4	
2	III-IV	**Core Electives**	3	12	12	12
3	I-III	**IDC (WS)**	1	4	4	
		IDC (Common)	1	4	4	**12**
		IDC (BS)	1	4	4	
4	I-IV	**Additional Core Courses**	-	-	-	
5	IV	SHEPHERD & Gender Studies	1	-	5	**5**
		TOTAL		**120**		**110**

IDC – Inter Departmental Courses
BS – Between School
WS – Within School
Total Hours : **120**
Total Credits : **110**

However, there could be some flexibility because of practicals, field visits, tutorials and nature of project work. For PG courses a student must earn a minimum of 110 credits. The total number of courses offered by a department is given above. However within their working hours few departments / School can offer extra credit courses.

Course Pattern

The Post Graduate degree course consists of five vital components. They are cores courses, core electives, additional core courses, IDC's and SHEPHERD. Additional Core courses are purely optional on the part of the student. SHEPHERD, the extension components are mandatory.

CORE COURSE

A core course is the course offered by the parent department related to the major subjects, components like theories, practicals, self paced learning, common core, comprehensive examinations, dissertations & viva – voce, field visits, library record form part of the core courses.

CORE ELECTIVE

The core elective course is also offered by the parent department. The objective is to provide choice and flexibility within the School. There are three core electives. It is offered in different semester according to the choice of the school.

ADDITIONAL CORE COURSES (If any)

In order to facilitate the students gaining extra credit, the additional core courses are given. The students are encouraged to avail this option of enriching with the extra credits.

INTER DEPARTMENTAL COURSES (IDC)

IDC is an interdepartmental course offered by a department / School for the students belonging to other departments / school. The objective is to provide mobility and flexibility outside the parent department / School. This is introduced to make every course multi-disciplinary in nature. It is to be chosen from a list of courses offered by various departments.

There are three IDC's. Among three, one is the Soft-Skill course offered by the JASS in the II Semester for the students of all the Departments. The other one is offered "With-in the school" (WS) and the third one is offered "Between the school" (BS). The IDC's are of application oriented and inter disciplinary in nature.

Subject Code Fixation

The following code system (9 characters) is adopted for Post Graduate courses:

14	PXX	X	X	XX
Year of Revision	PG Code of the Dept	Semester of the Part	Specification of Part	Running number in the part
14	**PMA**	**1**	**1**	**01**

For Example :

I M.Sc. Mathematics, first semester, Real Analysis-I

The code of the paper is 16PMA1101.

Thus, the subject code is fixed for other subjects.

Specification of the Part

1. Core Courses: (Theory, Practical, Self paced Learning, Common Core, Comprehensive Examination, Dissertation and Viva-voce)
2. Core Electives
3. Additional Core Courses (if any)
4. Inter Departmental Courses (WS, Soft Skill & BS)
5. SHEPHERD & Gender Studies

EXAMINATION

Continuous Internal Assessment (CIA):

PG - Distribution of CIA Marks	
Passing Minimum: 50 Marks	
Library Referencing	5
3 Components	35
Mid-Semester Test	30
End-Semester Test	30
CIA	**100**

MID-SEM & END – SEM TEST

Centralised – Conducted by the office of COE

1. Mid-Sem Test & End-Sem Test: (2 Hours each); will have Objective + Descriptive elements; with the existing question pattern PART-A; PART-B; and PART-C
2. CIA Component III for UG & PG will be of 15 marks and compulsorily objective multiple choice question type.
3. The CIA Component III must be conducted by the department / faculty concerned at a suitable computer centres.
4. The 10 marks of PART-A of Mid-Sem and End-Sem Tests will comprise only: OBJECTIVE MULTIPLE CHOICE QUESTIONS; TRUE / FALSE; and FILL-IN BLANKS.
5. The number of hours for the 5 marks allotted for Library Referencing/ work would be 30 hours per semester. The marks scored out of 5 will be given to all the courses (Courses) of the Semester.

SEMESTER EXAMINATION

Testing with Objective and Descriptive questions

Part-A: 30 Marks

Objective MCQs only

Answers are to be marked on OMR score-sheet. The OMR score-sheets will be supplied along with the Main Answer Book. 40 minutes after the start of the examination the OMR score-sheets will be collected

Part-B + C = 70

Marks Descriptive

Part-B: 5 x 5 = 25 marks; inbuilt choice;

Part-C: 3 x 15 = 45 marks; 3 out of 5 questions, open choice.

The Accounts Paper of Commerce will have

Part-A: Objective = 25

Part-B: 25 x 3 = 75 marks.

Duration of Examination must be rational; proportional to teaching hours90 minute-examination / 50 Marks for courses of 2/3 hours/week (all Part IV UG Courses) 3-hours examination for courses of 4-6 hours/week.

EVALUATION

Percentage Marks, Grades & Grade Points

UG (Passing minimum 40 Marks)

Qualitative Assessment	Grade Points	Grade	Mark Range %)
Exemplary	10	S	90 & above
Outstanding	9	A+	85-89.99
Excellent	8	A	80-84.99
Very Good	7	B	70-79.99
Good	6	C	60-69.99
Pass (PG)	5	D	50-59.99
RA (PG)	0	RA	< 50

CGPA - Calculation

Grade Point Average for a semester is calculated as indicated here under:

$$\frac{\text{Sum total of weighted Grade Points}}{\text{Sum of Gredits}}$$

Weighted Grade Points is ***Grade point x Course Credits.*** The final CGPA will only include: Core, Core Electives & IDCs.

A Pass in SHEPHERD will continue to be mandatory although the marks will not count for the calculation of the CGPA.

POSTGRADUATE		
CLASS	Mark Range (%)	
	ARTS	SCIENCES
Distinction	75 & above, first attempt	80 & above, first attempt
First	60 - 74.99	60 - 79.99
Second	50 - 59.99	50 - 59.99

Declaration of Result:

Mr./Ms. _____ has successfully completed the Post Graduate in _____ programme. The candidate's Cumulative Grade Point Average (CGPA) is _____ and the class secured _____ by completing the minimum of 110 credits.

The candidate has also acquired _____ (if any) additional credits from courses offered by the parent department.

_____

M. Sc. Mathematics

Course Pattern - 2016 Set

Sem	Subject	Title	Hrs	Credit
	16PMA1101	Real Analysis I	6	5
	16PMA1102	Ordinary Differential Equations	6	5
I	16PMA1103	Classical Dynamics	6	5
	16PMA1104	Linear Algebra	6	5
	16PMA1105	Graph Theory	6	5
		Total for Semester I	***30***	***25***
	16PMA2106	Real Analysis II	7	5
	16PMA2107	Algebra	7	6
II	16PMA2108	Complex Analysis I	4	3
	16PMA2201 A	Elective: Algebraic Number Theory	4	4
	16PMA2201 B	Elective: Optimization Techniques		
	16PSS 2401	IDC: Soft Skills	4	4
	16PCA2401 16PMA2401	IDC(WS): 1. Data Analysis using R-Language 2. MATLAB	4	4
	16PMA2109	Self-Paced Learning – History of Mathematics		2
		Total for Semester II	***30***	***28***
	16PMA3110	Measure and Integration	7	6
	16PMA3111	Topology	7	6
	16PMA3112	Complex Analysis II	4	3
III	16SCS 3103	Design and Analysis of Algorithms	4	4
	16PMA3202 A	Elective: Stochastic Processes	4	4
	16PMA3202 B	Elective: Differential Geometry		
	16PMA3402	IDC(BS): Operations Research	4	4
		Total for Semester III	***30***	***27***
	16PMA4113	Functional Analysis	6	5
	16PMA4114	Fluid Dynamics	6	5
	16PMA4115	PDE and Integral Transforms	6	5
IV	16PMA4203 A	Elective: Automata Theory	4	4
	16PMA4203 B	Elective: Fuzzy Analysis		
	16PMA4116	Comprehensive Examination	-	2
	16PMA4117	Project Dissertation & Viva Voce	8	4
		Total for Semester IV	***30***	***25***
I-IV	14PCW4501	SHEPHERD and Gender studies		5
		Total for all Semesters		**110**

Sem I **Hours/Week: 6**

16PMA1101 **Credits: 5**

REAL ANALYSIS-I

Learning Assurance

- To give the students a thorough knowledge of the various aspects of Real line and Metric Spaces.
- Give knowledge for any advanced learning in Pure Mathematics.
- Inherit the knowledge of Analysing and Approaching life problems.
- To train the students to apply pure into applied problems
- To train the students in problem-solving as a preparatory to NET/SET

Unit I: The Real and Complex Number Systems

Introduction - Ordered Sets - Fields - The Real Field - The Extended Real Number System - The Complex Field - Euclidean Spaces. (Chapter 1)

Unit II: Basic Topology

Finite, Countable and Uncountable Sets - Metric Spaces - Compact Sets -Perfect Sets - Connected Sets. (Chapter 2)

Unit III: Numerical Sequences and Series

Convergent Sequences - Subsequences - Cauchy Sequences - Upper and Lower Limits - Some Special Sequences - Series - Series of non-negative terms - the number e. (Chapter 3 [3.1-3.32])

Unit IV: Convergence of Series

The Root and Ratio Tests - Power Series - Summation by parts - Absolute convergence - Addition and Multiplication of Series - Rearrangements. (Chapter 3 [3.33-3.54])

Unit V: Continuity

Limits of Functions - Continuous functions - Continuity and Compactness-Continuity and Connectedness - Discontinuities - Monotonic functions - Infinite Limits and Limits at Infinity. (Chapter 4)

Textbook

1. Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill International Book Company, New York, 1976.

References

1. Tom M Apostol, Mathematical Analysis, Addison-Wesley Publishing Company, London, 1974.
2. Richard R Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Company, New Delhi, 1970.

Sem. I **Hours/Week: 6**

16PMA1102 **Credits: 5**

ORDINARY DIFFERENTIAL EQUATIONS

Learning Assurance

- To study the method of solving Bessel's and Legendre differential equations.
- To introduce the motion of stability of a solution of ODE.
- To study the Boundary Value Problems.
- To give an in-depth knowledge of solving differential equations that we encounter frequently in various walks of life.
- To introduce existence and uniqueness theorems in Differential equations.

Unit I: Solution in power series

Legendre Equation and Legendre polynomials - Bessel Equation when the index is not an integer - Properties of Bessel functions.(Chapter 3, Sections 3.3, 3.4, 3.5 (Relevant portions only)).

Unit II: Existence Theorems

Existence and uniqueness theorem - Fundamental matrix - Groanwall Inequality - Successive Approximations - Picard's Theorem - Some examples. (Chapter 4, Sections 4.4, 4.5, Chapter 5, Sections 5.1 to 5.5)

Unit III: Analysis and Methods of Nonlinear Differential Equations

Introduction - Existence Theorem - Extremal Solutions - Upper and Lower Solutions - Variation of Parameters (A Nonlinear Version) (Chapter 6, Sections 6.1-6.4, 6.7)

Unit IV: Boundary Value Problems

Sturm - Liouville problem - Green's Function - Sturm's comparison theorem. (Chapter 7, Sections 7.2, 7.3, Chapter 8, Section 8.2)

Unit V: Stability of Linear and Nonlinear Systems

Introduction - Elementary Critical Points - System of Equations with Constant Coefficients - Linear Equation with Constant Coefficients - Lyapunov Stability. (Chapter 9, Sections 9.1-9.5)

Textbook

1. S.G. Deo, Lakshmikanthan, V. Raghavendra, Textbook of Ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1997.

References

1. George F. Simmmons, Differential Equations with Applications and Historical Notes, Tata McGraw-Hill Publishing Company Ltd., 1972.
2. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice-Hall of India, New Delhi, 1992.
3. William E. Boyce, Richard C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 10th Edition, John Wiley and Sons, NY., 2012.

Sem I **Hours/Week: 6**
16PMA1103 **Credits: 5**

CLASSICAL DYNAMICS

Learning Assurance

- To give a detailed knowledge about the mechanical system of particles.
- To study the applications of Lagrange's equations and Hamilton's equations as well as the theory of Hamilton-Jacobi Theory
- It assures to learn Separable Theory.
- Students can learn about Integrals of Motion.
- It gives detailed knowledge about Variational principles.

Unit I: Introductory Concepts

The mechanical system - Generalized coordinates - Constraints- Virtual work - Energy and momentum. (Chapter I: Sections 1.1 to 1.5)

Unit II: Lagrange's Equations

Derivation of Lagrange's equations - examples - Integrals of motion. (Chapter II: Sections 2.1 to 2.3)

Unit III: Special Applications of Lagrange's Equations

Rayleigh's Dissipation function - Impulsive motion - Velocity dependent potentials. (Chapter III: Sections 3.1, 3.2 & 3.4)

Unit IV: Hamilton's Equations

Hamilton's principle, Hamilton equations, other variational principles. (Chapter IV: Sections 4.1 to 4.3)

Unit V: Hamilton - Jacobi Theory

Hamilton's Principal function - The Hamilton - Jacobi equation, separability. (Chapter V: Sections 5.1 to 5.3)

Textbook

1. Donald T. Greenwood, Classical Dynamics, Prentice Hall of India Pvt. Ltd, New Delhi, 1985.

References

1. John L. Synge, Byron A. Griffith, Principles of Mechanics, Third Edition, McGraw-Hill Book, New York, 1959.
2. Herbert Goldstein, Charles P. Poole, John L. Safko, Classical Mechanics, Addison-Wesley Press Inc., 2002.

Sem. I **Hours/Week: 6**
16PMA1104 **Credits: 5**

LINEAR ALGEBRA

Learning Assurance

- To give the students a thorough knowledge of the various aspects of Real line and Metric Spaces.
- Give knowledge for any advanced learning in Pure Mathematics.
- Inherit the knowledge of Analysing and Approaching life problems.
- To train the students to apply pure into applied problems
- To train the students in problem-solving as a preparatory to NET/SET

Unit I: Matrices

Systems of linear Equations - Matrices and Elementary Row operations - Row-reduced echelon Matrices - Matrix Multiplication - Invertible Matrices-Bases and Dimension.(Only revision of Vector spaces and subspaces). (Chapter 1 [1.2-1.6] and Chapter 2 [2.3])

Unit II: Linear transformations

The algebra of linear transformations - Isomorphism of Vector Spaces - Representations of Linear Transformations by Matrices - Linear Functionals - The Double Dual - The Transpose of a Linear Transformation. (Chapter 3)

Unit III: Algebra of polynomials

The algebra of polynomials - Lagrange Interpolation - Polynomial Ideals - The prime factorization of a polynomial - Commutative rings - Determinant functions. (Chapter 4 [4.1 - 4.5] and Chapter 5 [5.1 - 5.2])

Unit IV: Determinants

Permutations and the uniqueness of determinants - Classical Adjoint of a (square) matrix - Inverse of an invertible matrix using determinants - Characteristic values - Annihilating polynomials. (Chapter 5 [5.3,5.4] and Chapter 6 [6.1 - 6.3])

Unit V: Diagonalization

Invariant subspaces - Simultaneous triangulation and simultaneous Diagonalization Direct-sum Decompositions - Invariant Direct sums - Primary Decomposition theorem. (Chapter 6 [6.4 - 6.8])

Textbook

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

References

1. . Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd, 2004.
2. V. Krishnamurthy, V.P. Mainra, J.L. Arora, Introduction to Linear Algebra, East West Press Ltd, 1985.
3. A.R. Rao, P. Bhimashankaram, Linear Algebra, Second Edition, Tata McGraw Hill, 2000.
4. Charles W. Curtis, Linear Algebra: an introductory approach, Springer Verlag, 1984.

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Sem. I **Hours/Week: 6**
16PMA1105 **Credits: 5**

GRAPH THEORY

Learning Assurance

- To study the concepts of Connectivity and vertex and edge connectivity and its applications
- To introduce the concept of colouring and its implication in planar graphs
- To introduce the notion of Eulerian and Hamiltonian graphs
- To give a rigorous introduction to the basic concepts of Graph Theory.
- To give applications of Graph Theory in other disciplines

Note: Theorems, Propositions and results which are starred are to be omitted.

Unit I: Basic Results

Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness - Operations on Graphs - Directed Graphs: Basic Concepts - Tournaments. (Chapter I: 1.1 to 1.4, 1.7, Chapter II: 2.1, 2.2)

Unit II: Connectivity

Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Trees: Definitions, Characterization and Simple Properties - Counting the Number of Spanning Trees - Cayley's Formula. (Chapter III: 3.1, 3.2, Chapter IV: 4.1, 4.3.1 to 4.4)Counting the Number of Spanning Trees - Cayley's Formula. (Chapter III: 3.1, 3.2, Chapter IV: 4.1, 4.3.1 to 4.4)

Unit III: Independent Sets and Matchings

Vertex Independent Sets and Vertex Coverings - Edge Independent Sets - Matchings and Factors - Eulerian Graphs - Hamiltonian Graphs. (Chapter V: 5.1 to 5.4, Chapter VI: 6.1, 6.2)

Unit IV: Graph Colourings

Vertex Colouring - Critical Graphs - Triangle - Free Graphs - Edge Colourings of Graphs - Chromatic Polynomials. (Chapter VII: 7.1 to 7.4, 7.7)

Unit V: Planarity

Planar and Nonplanar Graphs - Euler Formula and its Consequences - K5 and K3,3 are Nonplanar Graphs - Dual of a Plane Graph - The Four-Colour Theorem and the Heawood Five-Colour Theorem-Kuratowski's Theorem. (Chapter VIII: 8.1 to 8.6)

Textbook

1. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, Springer International Edition, New Delhi, 2008.

References

1. J.A. Bondy, U.S.R. Murty, Graph Theory with Applications, Mac Milan Press Ltd., 1976.
2. F.Harary, Graph Theory, Addison - Wesley, Reading, Mass., 1969.

Sem. II **Hours/Week: 7**

16PMA2106 **Credits: 5**

REAL ANALYSIS-II

Learning Assurance

- To give the students a thorough knowledge of the various aspects of Real line and Metric Spaces.
- Give knowledge for any advanced learning in Pure Mathematics.
- Inherit the knowledge of Analysing and Approaching life problems.
- To train the students to apply pure into applied problems
- To train the students in problem-solving as a preparatory to NET/SET

Unit I: Differentiation

The Derivative of a Real Function - Mean Value Theorems - The Continuity of Derivatives - L'Hospital's Rule.- Derivatives of Higher Order - Taylor's Theorem - Differentiation of Vector-valued Functions. (Chapter 5 [5.1- 5.19])

Unit II: R-S Integral

Definition and Existence of the Integral- Properties of the integral - Integration and Differentiation - Integration of Vector-valued functions - Rectifiable curves. (Chapter 6 [6.1 - 6.27])

Unit III: Sequence and Series of Functions

Discussion of Main Problem- Uniform Convergence - Uniform Convergence and Continuity - Uniform Convergence and Integration - Uniform Convergence and Differentiation. (Chapter 7 [7.1 - 7.18])

Unit IV: Some Special functions

Power series -The Exponential and Logarithmic Functions - The Trigonometric Functions - The Algebraic Completeness of the Complex Field - Fourier series - The Gamma function. (Chapter 8 [8.1 - 8.22])

Unit V: Functions of Several Variables

LinearTransformations - Differentiation - The Contraction Principle - The Inverse Function Theorem - The Implicit Function Theorem. (Chapter 9 [9.1 - 9.29])

Textbook

1. Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill International Book Company, New York, 1976.

References

1. Tom M Apostol, Mathematical Analysis, Addison-Wesley Publishing Company, London, 1974
2. Richard R Goldberg, Methods of Real Analysis, Oxford & IBH Publishing Company, New Delhi, 1970

Sem. II **Hours/Week: 7**

16PMA2107 **Credits: 6**

ALGEBRA

Learning Assurance

- To introduce the Algebraic Structures like Ring and Field
- To study Polynomial Rings and its effect in Galois Theory
- To Study Finite Field
- To give foundation in group theory
- To train the students in problem-solving as a preparatory to NET/SET

Unit I:

Normal subgroups and Quotient groups - Homomorphism - Conjugacy - Sylow's theorem. (Chapter 2: 2.6, 2.7, 2.11 and 2.12)

Unit II:

Ideals and quotient rings - More Ideals and quotient rings - The field of quotients of an Integral Domain - Euclidean rings - A particular Euclidean ring. (Chapter 3: 3.4, 3.5, 3.6, 3.7 and 3.8)

Unit III:

Polynomial Rings - Polynomials over the Rational Field - Polynomial Rings over commutative rings. (Chapter 3: 3.9, 3.10 and 3.11)

Unit IV:

Field Extension - Extension Fields - Roots of Polynomials - More about roots. (Chapter 5: 5.1, 5.3, 5.5)

Unit V:

The elements of Galois Theory - Finite Fields. (Chapter 5: 5.6 and Chapter 7: 7.1)

Textbook

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, New Delhi, 1992.

References

1. Serge Lang, Algebra, Third Edition, Springer Graduate Texts in Mathematics, New York, 2002.
2. N.S. Gopala Krishnan, University Algebra, Second Edition, John Wiley & Sons (Asia) Pvt. Ltd., 1986.

Sem. II **Hours/Week:4**
16PMA2108 **Credits: 3**

COMPLEX ANALYSIS I

Learning Assurance

- To be familiar with Cauchy's Integral Formula to apply Contour Integration.
- To learn the various intrinsic concepts and the theory of Complex Analysis.
- To study the concept of Analyticity, Complex Integration and Infinite Products in depth.
- To be familiar with the concept of Complex Integration so as to apply Cauchy's Theorem.

Unit I:**Concept of Analytic Function , Sequence and Series**:

Limits and Continuity –Analytic Functions-Polynomials –Rational Functions- -Sequences –Series- Uniform Convergence. (Chapter: 2 Section 1.1-1.4, 2.1-2.3)

Unit II: **Power series and Conformality**:

Power series- Abel's Limit Theorem, Arcs and Closed Curves- Analytic Functions in Regions-Conformal Mapping- Length and Area. (Chapter: 2 Section 2.4-2.5, Chapter: 3 Section 2.1-2.4)

Unit III: **Linear Transformation**:

The Linear Group- The Cross Ratio- Symmetry, Oriented Circles, Families of Circles.

(Chapter: 3 Section 3.1-3.5)

Unit IV: **Fundamental Theorems**:

Line Integrals- Rectifiable Arcs- Line Integrals as Functions of Arcs- Cauchy's Theorem for a Rectangle- Cauchy's Theorem in a Disk, The Index of a Point with Respect to a Closed Curve.

(Chapter: 4 Section 1.1-1.5, 2.1)

Unit V:**Cauchy Integral Formula** :

The Integral Formula-Higher Derivatives- Removable Singularities. Taylor's Theorem- Zeros and Poles- The Local Mapping- The Maximum Principle. (Chapter: 4 Section 2.2-2.3,3.1-3.4)

Textbook

1. Lars V. Ahlfors, Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, Third Edition, McGraw-Hill Book Company, New York, 1979.

References

1. John B. Conway, Functions of one Complex Variable, Second Edition, Springer Graduate Texts in Mathematics, New York, 1978.
2. S.Ponnusamy, Foundations of Complex Analysis, Second Edition, Narosa Publishing House, India, 2005.

Sem. II **Hours/Week: 4**
16PMA2201A **Credits: 4**

ALGEBRAIC NUMBER THEORY

Learning Assurance

- To expose the students to the charm, niceties and nuances in the world of numbers.
- To highlight some of the Applications of the Theory of Numbers.
- Students can earn knowledge in primitive roots
- To highlight the knowledge on Quadratic residues
- To get the depth knowledge in Jacobi's symbols

Unit I: Congruences

Elementary Properties of Congruences - Complete Residue System - Reduced Residue System - Some Applications of Congruences. (Sec 2.1 - 2.3 Pages 49 - 70)

Unit II:Algebraic Congruences

Solutions of Congruences - Algebraic Congruences - Solutions of the Problems of the Type ax + by + c = 0 - Simultaneous

Congruences. (Sec 2.4 - 2.7 Pages 71 - 97)

Unit III:Primitive Roots

Algebraic Congruence - Primitive Roots -. (Sec 3.1, 3.3, Pages 98 - 100,108 - 122)

Unit IV:Quadratic Residues

Theory of Indices , Quadratic Residues (Sec 3.4,6.1 Pages 122-128,218 - 225)

Unit V: Jacobi's Symbol

Legendre's Symbol, Reciprocity Law - Quadratic Residue for Composite Modules - Jacobi's Symbol. (Sec 6.2 - 6.4 Pages 225 - 246)

Textbook

1. K.C. Chowdhury, A First Course in Theory of Numbers, Asian Books Pvt. Ltd., New Delhi, 2004.

References

1. S.B.Malik, Basic Number Theory, Second Edition, Vikas Publishing House Pvt. Ltd., Noida, 2009.
2. George E. Andrews, Number Theory, Courier Dover Publications, 1994.

Sem. II **Hours/Week: 4**

16PMA2201B **Credits: 4**

OPTIMIZATION TECHNIQUES

Learning Assurance

- To understand the theory behind optimization techniques.
- To introduce the local theory of optimization.
- To study the global theory of optimization.
- To apply Kuhn-Tucker Theorem.
- To highlight some of the applications of optimization techniques.

Unit I: Local theory

Optimisation of functional - Gateaux and Frechet Differentials - Frechet derivatives - Extrema - Euler-Lagrange Equations - Problems with variable end points. (Sec 7.1-7.6 Pages 169-184)

Unit II: Global theory

Convex and concave functionals - Conjugate convex, concave functionals - Dual optimization problems - Min-Max theorem of game theory. (Sec 7.8, 7.10-7.13 Pages 190, 191, 195-208)

Unit III:Local theory of constrained optimisation

Lagrange multiplier theorem - Inverse function theorem - Equality and Inequality constraints - Kuhn-Tucker theorem. (Sec 9.1-9.4 Pages 239-253)

Unit IV:Iterative methods of optimization

Methods of solving equations - Successive approximation - Newton's method - Descent methods - Steepest descent. (Sec 10.1-10.5 Pages 271-289)

Unit V:Conjugate direction methods

Conjugate gradient method - Methods for solving constrained problems - Projection method - The Primal-Dual method - Penalty Functions. (Sec 10.8-10.11 Pages 294-307)

Textbook

1. David G. Luenberger, Optimization by Vector Space Methods, Wiley Professional Paperback series, 1997.

References

1. C. Nelson Dorny, A Vector Space Approach to Models and Optimization, Robert Krieger Publishing Co., 1986.
   Chander Mohan and Kusum Deep, Optimization Techniques, New Age International, 2010

Sem. II **Hours/Week: 4**
16PSS2401 **Credits: 4**

IDC-1:

SOFT SKILLS

Learning Assurance

* Introducing learners to the relevant soft skills at the territory level in order to make them gain competitive advantage both professionally and personally.

Module 1:

Basics of communication and Effective communication

Basics of communication: Definition of communication, Process of Communication, Barriers of Communication, Non-verbal Communication. Effective communication: Johari Window, The Art of Listening, Kinesthetic, Production of Speech, Organization of Speech, Modes of delivery, Conversation Techniques, Dialogue, Good manners and Etiquettes.

Module II:

Resume writing and Interview skills

Resume Writing: What is Resume? Types of Resume? Chronological, Functional and Mixed Resume, Steps in preparation of Resume. Interview Skills: Common interview questions, Attitude, Body Language, The mock interviews, Phone interviews, Behavioral interviews.

Module III:

Group discussion and team building

Group Discussion: Group Discussion Basics, GD Topics for Practice, Points for GD Topics, Case-Based and Article based Group Discussions, Points for Case Studies, and Notes on Current Issues for GDS. Team Building: Team Vs Group - synergy, Stages of Team Formation, the Dabbawala. Leadership - Styles, Work ethics. Personal Effectiveness: Personal Effectiveness: Self Discovery, Self Esteem, and Goal setting. Conflict and Stress Management.

Module IV:

Numerical Ability

Average, Percentage, Profit and Loss, Simple Interest, Compound Interest, Time and Work, Pipes and Cisterns, Time and Distance, Problems on Trains, Boats and Streams Calendar, Rations and Proportions.

Module V:

Test of reasoning

Verbal Reasoning: Series Completion, Analogy, Data Sufficiency, Assertion and Reasoning, Logical Deduction. Non-Verbal Reasoning: Series, Classification

References

1. Aggarwal, R.S. 2010 Quantitative Aptitude, S.Chand& Sons
2. Aggarwal, R.S. 2010. A Modern Approach to Verbal and Non Verbal Reasoning. S.Chand
3. Covey, Stephen. 2004. 7 Habits of Highly effective people, Free Press.
4. Egan, Gerard. 1994. The Skilled Helper (5th Ed). Pacific Grove, Brooks / Cole.
5. Khera, Shiv 2003. You Can Win. Macmillan Books , Revised Edition
6. Murphy, Raymond. 1998. Essential English Grammar. 2nd ed., Cambridge Univ. Press.
7. Prasad, L. M. 2000. Organizational Behaviour, S.Chand
8. Sankaran, K., & Kumar, M. 2010 Group Discussion and Public Speaking. M.I. Pub, Agra, Adams Media.
9. Schuller, Robert. (2010). Positive Attitudes. Jaico Books.
10. Trishna's (2006). How to do well in GDs & Interviews, Trishna Knowledge Systems.
11. Yate, Martin. (2005). Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting.

Sem. II **Hours/Week: 4**
16PCA2401 **Credits: 4**

IDC-II (WS) (OOC)

Data Analysis using R-Language

Learning Assurance

- To understand the basics of the R Language.
- To appreciate the data frames in R.
- To write programs to solve statistical problems.
- To study the regression in data analysis.
- To draw graphics using R Language.

Unit I: Unveiling R for Data Analysis

An overview of R - Vectors, factors, and univariate time series - Data frames and matrices – Functions, operators, and loops - Graphics in R - Graphical user interfaces to R - Working directories, workspaces, and the search list - R system configuration - Data input and output - Functions and operators – some further details – Factors - Missing values - Matrices and arrays - Manipulations with lists, data frames, matrices, and time series - Classes and methods..

Unit II: Knowing about a data

Styles of data analysis - Revealing views of the data - Data summary - Statistical analysis questions, aims, and strategies - Statistical models - Distributions: models for the random component- Creation of R packages - Document preparation – Sweave() and xtable()

Unit III: Inference concepts

Basic concepts of estimation - Confidence intervals and tests of hypotheses - Contingency tables - One-way unstructured comparisons - Response curves - Data with a nested variation structure - Resampling methods for standard errors, tests, and confidence intervals.

Unit IV: Regression with a single predictor & Multiple linear regression

Fitting a line to data - Outliers, influence, and robust regression - Standard errors and confidence intervals -
Assessing predictive accuracy - Regression versus qualitative anova comparisons – issues of power

Basic ideas: a book weight example - The interpretation of model coefficients - Multiple regression assumptions, diagnostics, and efficacy measures - A strategy for fitting multiple regression models - Problems with many explanatory variables – Multicollinearity.

Unit V: Graphs in R

Hardcopy graphics devices - Plotting characters, symbols, line types, and colors - Formatting and plotting of text and equations - Multiple graphs on a single graphics page - Lattice graphics and the grid package - An implementation of Wilkinson's Grammar of Graphics - Dynamic graphics – the rgl and rggobi packages

Textbook

1. John Maindonald& W. John Braun**, Data Analysis and Graphics Using R – an Example-Based Approach,** Third Edition, Cambridge University Press, 2010.

References

1. Paul Teetor, R Cookbook, O'Reilly, 2011.
2. www.coursera.org/learn/r-programming
3. www.r-project.org

Sem. II **Hours/Week: 4**
16PMA2401 **Credits: 4**

IDC-II (WS):

MATLAB

Objectives

- To introduce the Mathematical software MATLAB for high-performance numerical computations and visualization.
- To learn MATLAB built-in functions provided to solve all type of scientific problems.

Unit I:

Basics of MATLAB

Basics, windows, Variables, File types, Matrices and Vectors, Matrix manipulation, Matrix and Array Operations.

Unit II:

Matrix functions

Arithmetic operations, Relational operations, Logical operations, Elementary math functions, Matrix functions, Manipulating character strings, Array Operations, Vectorization.

Unit III:

Built-in functions

Inline functions, Anonymous functions, Built-in functions,

Complex Arithmetic, Solving linear systems, Eigen Values and Vectors, Calculus.

Unit IV:

MATLAB programming

Script Files, Function Files, Curve Fitting and Interpolation, Numerical Integration, Ordinary Differential Equations, Statistics, Nonlinear Algebraic Equations.

Unit V:

Graphics

Basic 2-D Plots, Specialized 2-D plots, 3-D Plots, 3-D Surface Graphics.

Textbook

1. Rudra Pratap, Getting started with MATLAB 7, Oxford University Press, 2008.

References

1. Brain R Hunt, Ronald L Lipsman, Jonathan M Rosenberg, A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press, 2003.

Sem. II **Hours/Week: 0**

16PMA2109 **Credits: 2**

HISTORY OF MATHEMATICS

Learning Assurance

- Knowledge of History of Decimals and Limits.
- Acquaintance with the development of Algebra.
- Familiarity of Invention of Differential Calculus.
- The life of Eratosthenes and Dirichlet .
- The life of Henri Poincare ,EmmyNoether.

Unit I

The Ancient Greeks - Pythagoras - Introduction to Pythagorean Ideas - Euclid - Introduction to Euclid - Archimedes - The Genius of Archimedes-Zeno's Paradox and the Concept of Limit - The Context of the Paradox? - Consideration of the Paradoxes - Decimal Notation and Limits - Infinite Sums and Limits - Finite Geometric Series.

Sections: 1.1,1.1.1,1.2,1.2.1,1.3,1.3.1, 2.1, 2.3, 2.4-2.6

Unit II

The Arabs and the Development of Algebra - The Development of AlgebraAl-Khowarizmi and the Basics of Algebra - The Life of Al-Khwarizmi - Omar Khayyam and the Resolution of the Cubic - Cardano, Abel, Galois, and the Solving of Equations - A Particular Equation - The General Case - The Brief and Tragic Lives of Abel and Galois - The Work of Abel and Galois in Context - Rene Descartes and the Idea of Coordinates - Introductory Remarks

- The Life of Rene Descartes - The Real Number Line - The Cartesian Plane
- Coordinates in Three-Dimensional Space.

Sections: 4.2, 4.2.1, 4.2.2, 4.2.4, 5.6, 5.7, 5.7.1, 5.7.2, 5.8.1, 5.9, 6.0-6.3, 6.5

Unit III

The Invention of Differential Calculus - The Life of Fermat - Fermat's Method - Fermat's Lemma and Maximum/Minimum Problems - Complex Numbers and Polynomials - Progenitors of the Complex Number System - Cardano - Argand - Cauchy - Riemann - Complex Number Basics - The Fundamental Theorem of Algebra - Finding the Roots of a Polynomial - Cauchy and the Foundations of Analysis - Why Do We Need the Real Numbers?

Sections: 7.1, 7.2, 7.4, 8.2, 8.2.1-8.2.5, 8.3, 8.4, 8.5, 10.1, 10.2

Unit IV

The Prime Numbers - The Sieve of Eratosthenes - The Infinitude of the Primes - Dirichlet and How to Count - The Life of Dirichlet - The Pigeonhole Principle - Riemann and the Geometry of Surfaces - Introduction - Georg Cantor and the Orders of Infinity - Introductory Remarks - An Uncountable Set - Countable and Uncountable - The Existence of Transcendental Numbers. Sections: 11.1, 11.2, 12.1, 12.2, 13.0, 14.1, 14.2.1, 14.2.2, 14.3

Unit V

Henri Poincare, Child Prodigy - Introductory Remarks - Emmy Noether and Algebra - The Life of Emmy Noether - Emmy Noether and Abstract Algebra: Groups - Emmy Noether and Abstract Algebra: Rings - The Idea of an Ideal - Cryptography - What is Cryptography?

Sections: 16.1, 18.1, 18.2, 18.3, 18.3.1, 20.3

Textbook

1. Steven G. Krantz, An Episodic History of Mathematics, Mathematical Association of America, 2010.

References

1. C.B. Boyer and U. Merzbach, History of Mathematics, John Wiley & Sons, New York, 1988.
2. E.T. Bell, Men of Mathematics, Penguin Books Ltd., Hardmondsworth, Middlesex, UK, 1953.

Sem. III **Hours/Week: 7**
16PMA3110 **Credits: 6**

MEASURE AND INTEGRATION

Learning Assurance

- To generalize the concept of integration using measures.
- To develop the concept of analysis in abstract situations.
- To learn measure theory
- To understand the concepts of measurable function
- To connect integral of derivative with differentiation of an integral.

Unit I:

Lebesgue Measure

Outer measure - measurable sets and Lebesgue measure - - properties - A non-measurable set - measurable functions - Little wood's three principles. (Proofs of Egoroff 's theorem and Lusin's theorem to be omitted)
(Chapter 3 Sec. 1 - 6)

Unit II:

Lebesgue Integral

Lebesgue Integral of simple function - bounded measurable function - of a nonnegative function - Fatou's lemma - Monotone convergence theorem - General Lebesgue integral - Lebesgue convergence theorem – Convergence in measure.
(Chapter 4 Sec. 1 - 5)

Unit III:

Differentiation and Integration

Differentiation of monotone functions - Vitali's lemma - Integral of derivative - Functions of bounded variation - Differentiation of an integral - absolute continuity-Convex functions-Jensen's inequality.
(Chapter 5 Sec. 1 - 5)

Unit IV:

General measure and Integration

Measure spaces - Measurable functions - Integration - Signed measure - Hahn decomposition theorem - Jordan decomposition theorem - Radon-Nikodym theorem- Lebesgue decomposition theorem (Chapter 11 Sec.1- 6)

Unit V:

Measure and outer measure

Outer measure and Measurability - Extension theorem – product measures-Fubini's theorem – Tonelli's theorem.
(Chapter 12 Sec. 1, 2,4)

Textbook

1. H.L. Royden, Real Analysis, Third Edition, Prentice Hall of India, New Delhi, 2007.

References

1. G. de Barra, Measure Theory and Integration, New Age International Publishers, New Delhi, 2008.
2. Walter Rudin, Real and Complex Analysis, Mc-Graw Hill Book Company, New York, 1970.

Sem. III **Hours/Week: 7**
16PMA3111 **Credits: 6**

TOPOLOGY

Learning Assurance

- To study the concepts concerned with properties that are preserved under continuous deformations of objects.
- To train the students to develop analytical thinking and the study of continuity and connectivity.
- To learn connectedness in topological spaces
- To understand compactness in topological spaces
- To study the separation axioms.

Unit I:Topological Spaces

Topological spaces - Basis for a topology - The order topology - The product topology on XxY - The subspace topology- Closed sets and limit points – Continuous functions.
(Chapter II: Section 12 to 18)

Unit II:Metric topology and Connectedness

The Product topology – The Metric Topology- Connected Spaces - Connected Subspaces of the Real line - Components and local connectedness.
(Chapter II: Sections 19-21 Chapter III: Section 23-25)

Unit III: Compactness

Compact spaces - Compact subspaces of the real line - Limit point compactness
(Chapter III: Sections 26-28)

Unit IV: Separation Axioms

.The Countability axioms - The Separation axioms- Normal spaces.
(Chapter IV: Sections 30-32)

Unit V: Complete Metric Spaces

The Urysohn lemma - The Urysohn Metrization Theorem – Tietz Extension theorem.
(Chapter IV, Sections 33 - 35)

Textbook

1. James R. Munkres, Topology, Second Edition, PHI Learning Pvt Ltd., New Delhi, 2009.

References

1. James Dugundji, Topology, Allyn& Bacon, 1966.
2. Sze-Tsen Hu, Elements of General Topology, Holden-Day Series in Mathematics, 1964.

Sem. III **Hours/Week: 4**
16PMA3112 **Credits: 3**

COMPLEX ANALYSIS-II

Learning Assurance

- To learn the various intrinsic concepts of residues.
- To study Harmonic function and Mean value property to use it in applications
- To study the concept of Partial Fractions, Entire Functions Infinite products in depth

Unit I: **The Calculus Of Residue**:

Chains and Cycles- Simple Connectivity- HomologyThe Residue Theorem- The Argument Principle- Evaluation of Definite Integrals.

(Chapter: 4 Section 4.1-4.3, 5.1-5.3)

Unit II: **Harmonic Function**:

Definition and Basic Properties- The Mean-value Property- Poisson's Formula- Schwarz's Theorem-The Reflection Principle.
(Chapter: 4 Section 6.1-6.5)

Unit III: **Power series expansion**:

Weierstrass's Theorem- The Taylors Series- The Laurent Series.
(Chapter: 5 Section 1.1-1.3)

Unit IV: **Partial Fractions and Entire Functions**:

Partial Fractions- Infinite Products- Canonical Products- The Gamma Function -Jensen's Formula- Hadamard's Theorem.(Chapter: 5 Section 2.1.2.4, 3.1-3.2)

Unit V: **Elliptic Functions**:

Representation by Exponentials- The Fourier Development- Functions of Finite Order-The Period Module- Unimodular Transformations- The Canonical Basis- General Properties Of Elliptic Functions.

(Chapter: 7 Section 1.1-1.3, 2.1-2.4)

Textbook

1. Lars V. Ahlfors, Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, Third Edition, McGraw-Hill Book Company, New York, 1979.

References

1. John B. Conway, Functions of one Complex Variable, Second Edition, Springer Graduate Texts in Mathematics, New York, 1978.
2. S. Ponnusamy, Foundations of Complex Analysis, Second Edition, Narosa Publishing House, India,2005.

Sem. III **Hours/Week: 4**
16SCS3103 **Credits: 4**

DESIGN AND ANALYSIS OF ALGORITHMS

Learning Assurance

- To impart the students the knowledge of design and analysis of algorithms
- To give the basis for the core of computer science.
- To give importance to finding the complexity (order) of algorithms.
- To learn the linked lists and trees
- To understand the searching and sorting methods.

Unit I:

Algorithms

Introduction- Algorithm - Algorithm specification: Pseudocode Conventions, Recursive algorithms - Performance analysis: Space Complexity, Time Complexity, Asymptotic Notation, Practical Complexities. (Sections: 1.1, 1.2, 1.3.1 to 1.3.4)

Unit II:

Data structures and Queues

Arrays – ordered lists- Representation of Arrays-Stack and Queues – Fundamentals-Evaluation of Expressions. (Sections: 2.2,2.4,3.1,3.3)

Unit III: Linked lists and trees

Linked Lists - Singly Linked Lists- Linked Stacks and Queues-More on Linked Lists-Simple algorithms of Doubly Linked Lists (insertion and deletion only).Trees- Binary Trees- Binary Tree Representations- Binary Tree Traversal. (Sections: 4.1,4.2,4.5,4.8,5.2,5.3,5.4).

Unit IV: Search and Sort

Divide and conquer - General method - Binary search - Finding the maximum and minimum in a set of items - Merge sort - Quick sort - Selection sort. Basic Traversal and Search Techniques for graphs: Breadth First Search - Depth First Search. (Sections: 3.1 to 3.5,6.2)

Unit V:

Interpolations

Backtracking - The 8-Queens problem - Algebraic problems - The general method - Evaluation and interpolation - Horner's rule - Lagrange interpolation - Newtonian interpolation.

(Sections: 7.1,7.2,9.1,9.2)

Textbooks:
Unit I, IV, V
1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer algorithms, Galgotia Publications Pvt. Ltd., 2004.

Unit II, III

2. Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures, Galgotia Book Source.,1981.

References

1. A.V. Aho, J.E.Hopcroft, J.D. Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley Publ. Comp., 1974.
2. Seymour E.Goodman and S.T. Hedetniemi, Introduction to the design and analysis of algorithms, McGraw Hill International Edition, 2002.

Sem. III **Hours/Week: 4**
16PMA3202A **Credits: 4**

STOCHASTIC PROCESSES

Learning Assurance

- To understand the stochastic models for many real life probabilistic situations.
- To learn the well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.
- To learn the transition probabilities and its classifications.
- To understand the random walk associated with real life situation to solve.
- To learn the real life queueing problems by comparing the conventional queueing models.

Unit I:Elements of Stochastic processes and Markov chains

Stochastic processes - Specification of Stochastic processes - Stationary processes - Markov chain - Transition probabilities - Random walk (Chapter 2: Sections 2.1, 2.2, 2.3 and Chapter 3: Section 3.1)

Unit II:Higher transition probabilities and classification of states

Higher transition probabilities - Classification of states - Transient and recurrent states. (Chapter 3: Sections 3.2 and 3.4)

Unit III:Markov process with discrete state space

Poisson process - Generalizations of Poisson process - Pure birth process - Yule-Furry process - Birth-Immigration process.
(Chapter 4: Sections 4.1, 4.3 (omit 4.3.5 - 4.3.7)

Unit IV:Renewal processes

Renewal process in discrete time - Renewal process in continuous time - Renewal equation - Renewal theorems. (Chapter 6: Sections 6.1.1 - 6.1.3, 6.2(omit example 2(b)), 6.3, 6.5(omit 6.5.2))

Unit V:Stochastic processes in queueing

Queueing processes - Steady state behaviour of M/M/1 queueing model - Non-Markovianqueueing models - Queues with Poisson input (M/G/1) (Chapter 10: Sections 10.1 (omit 10.1.4), 10.2 (omit 10.2.3.1), 10.7 (omit examples 7(a), 7(b) and Sections 10.7.3, 10.7.4).

Textbook

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

References

1. U. Narayan Bhat, Elements of Applied Stochastic Processes, Second Edition, John Wiley & Sons, New York, 1972.
2. N.V. Prabhu, Stochastic Processes, Macmillan, New York, 1970.

Sem. III **Hours/Week: 4**

16PMA3202B **Credits: 4**

DIFFERENTIAL GEOMETRY

Learning Assurance

- To explain the various intrinsic concepts of Differential Geometry.
- To understand the theory of Differential Geometry.
- To introduce difference surfaces and their uses.
- To study Euler's theorem in Differential Geometry.
- To appreciate the application of the Gauss equation

Unit I:

Analytical representation - Arc length - Tangent - Oscillating plane - Torsion - Formulae for Frenet contact. (Chapter I: sections 1.1 - 1.7)

Unit II:

Natural equations - Helices - General solution of natural equations - Evolutes and involutes - Imaginary curves - Ovals. (Chapter I: sections 1.8 - 1.13)

Unit III:

Analytical representation - First fundamental theorem - Normal, tangent plane - Developable surfaces- Second fundamental form - Meusrier's theorem - Euler's theorem. (Chapter 2: sections 2.1 - 2.6)

Unit IV:

Dupin's indicatrix - Some surfaces - A geometrical interpretation of asymptotic and curvature lines conjugate directions - Triply orthogonal system of surfaces. (Chapter 2: sections 2.7 - 2.11)

Unit V:

Gauss - The equations of Gauss-Weingarten - The theorem of Gauss and the equations of Codazzi curvilinear coordinates in space - Some applications of the Gauss and the Codazzi equations - The fundamental theorem of surface theory. (Chapter 3: Sections 3.1 - 3.6)

Textbook

1. Dirk J. Struik, Lectures on Classical Differential Geometry, Addison Wesley Publishing Company, 1950.

References

1. T.J. Willmore, An introduction to Differential Geometry, Oxford University Press, New York, 1959.
2. Barrett O'Neill, Elementary Differential Geometry, Second Edition, Academic Press, 2006.

Sem. III **Hours/Week: 4**
16PMA3402 **Credits: 4**

IDC-III (BS):
OPERATIONS RESEARCH

Learning Assurance

- To introduce the notion by Transportation problem.
- To study Assignment and LPP.
- To introduce the concept of PERT/CPM.
- To enlighten the students in the field of Operations Research which has many applications in management techniques.
- To help the students to find optimum solution in business management problems.

Unit I:Transportation

Introduction - Finding initial basic feasible solution - North-west corner rule - least cost or matrix minima method - Vogel's approximation method - moving towards optimality - unbalanced transportation problems. (Sections 6.1, 6.5, 6.6, 6.9)

Unit II:Assignment and LPP

Assignment algorithm, Linear programming formulation and graphical method. (Sections 7.3 full, Sections 2.1 to 2.3)

Unit III: Decision analysis

Introduction - decision making environment - the maxmin or minmax criterion - the savage regret criterion - the Hurwitz criterion. (Sections 16.1 to 16.3)

Unit IV: Replacement problem

Introduction - Replacement of equipment or asset deteriorating gradually - replacement of equipment that fails suddenly. (Sections 19.1 to 19.3, no proof of theorems, problems only)

Unit V:Network Scheduling by PERT/CPM

Network and basic components - numbering the events - time calculations in networks - critical path method - PERT/CPM, PERT calculations. (Sections 21.2 to 21.7)

Textbook

1. KantiSwarup, P.K. Gupta and Man Mohan, Operations Research, Eighth Edition, Sulltan Chand & Sons, New Delhi, 1997.

References

1. Hamdy A. Taha, Operations Research: An Introduction, Ninth Edition, Prentice Hall, New Delhi, 2011.
2. V.Sundaresan, K.S. Subramanian, K. Ganesan, Resource Management Techniques, New Revised Edition, A.R.Publications, Sirkali, 2002.

Sem. IV **Hours/Week: 6**
16PMA4113 **Credits: 5**

FUNCTIONAL ANALYSIS

Learning Assurance

- To introduce the concept of Functional Analysis
- To study HannBanach Theorem and its applications.
- To analyse the relevance of Banach spaces.
- To introduce Inner Product Spaces.
- To understand the operator theory in Hilbert Spaces.

Unit I: Normed Linear Spaces

Normed linear spaces - Schauder Basis - Bounded Linear maps - Equivalent norms - Finite dimensional normed spaces - Dual spaces. (Chapter 3)

Unit II: Hahn-Banach Theorem

General form - Continuous extension form- Second dual - Reflexive spaces - Dual of C [0,1] - Separation form of Hahn- Banach theorem. (Chapter 4: sections 1-7)

Unit III: Uniform Boundedness Principle and Open Mapping Theorem

Uniform boundedness principle - Weak Convergence - The Open Mapping Theorem - The Closed Graph Theorem. (Chapter 5: Sections 1, 3 and Chapter 6: Sections 1, 3)

Unit IV: Inner Product Spaces

Parallelogram law - Orothogonality - Orthonormal sets - Complete Orthonormal sets - Riesz Representation Theorem. (Chapter 7)

Unit V: Hilbert Space Operators

Adjoint of an operator - Isometric operator - Unitary Operator - Self-Adjoint operator - Normal operator - Projection operator and its properties (Chapter 8)

Textbook

1. S.C. Bose, Introduction to Functional Analysis, MacMillan Publishers India, Delhi, 2000.

References

1. D. Somasundaram, A First Course in Functional Analysis, Narosa Book Distributors Private Ltd., 2008.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2006.
3. Walter Rudin, Functional Analysis, Tata McGraw-Hill publishing Co. Ltd., New Delhi, 2006.

Sem. IV **Hours/Week: 6**
16PMA4114 **Credits: 5**

FLUID DYNAMICS

Learning Assurance

- Understanding the behaviour of fluids in motion.
- understanding the changes in flow when sphere of cylinder is introduced
- Applying the concept of Complex Analysis in the analysis of the flow of liquids.
- Understanding sources, sinks and doublets
- Learning two-dimensional flows

Unit I: Kinematics of fluids in motion

Real fluids and Ideal fluids - Velocity of a fluid at a point -Stream lines and path lines - Steady and Unsteady flows - The Velocity Potential - The Vorticity Vector - Local and Particle Rates of Change - The Equation of Continuity - Worked Examples (Chapter 2: Sections 2.1 - 2.8)

Unit II: Equations of Motion of a Fluid

Pressure at a point in a fluid at rest - Pressure at a point in a moving fluid - Euler's equations of Motion - Bernoulli's equation - Worked Examples - Discussion of the case of steady motion under Conservative Body Forces - Some flows involving axial symmetry(examples 1 and 2 only). (Chapters 3: Sections 3.1, 3.2, 3.4 - 3.7, 3.9)

Unit III: Some Three-Dimensional Flows

Introduction - Sources, Sinks and Doublets-Images in rigid infinite plane - Images in solid spheres - Axisymmetric flows.
(Chapter 4: Sections 4.1 - 4.4)

Unit IV: Some Two-Dimensional Flows

The Stream Function - The Complex Velocity Potential for Two Dimensional Irrotational, Incompressible Flow - Complex Velocity Potentials for Standard Two-Dimensional Flows - Some Worked Examples - Two Dimensional Image Systems - The Milne-Thomson Circle Theorem. (Chapter 5: Sections 5.3 - 5.8)

Unit V: Viscous Fluid

Stress components in a real fluid - Relation between Cartesian Components of Stress - Translational motion of fluid element - The Coefficient of Viscosity and Laminar flow - The Navier-Stokes

equation of a viscous fluid - Some solvable problems in viscous flow - Steady motion between parallel planes only. (Chapter 8: Sections 8.1 - 8.3, 8.8, 8.9, 8.10.1)

Textbook

1. Frank Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 2004.

References

1. L.M. Milne-Thomson, Theoretical Hydrodynamics, Macmillan, London, 1955.
2. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge Mathematical Library, 2000.

Sem. IV **Hours/Week: 6**

16PMA4115 **Credits: 5**

PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORM

Learning Assurance

- It assures to know about the applications of Fourier Transforms.
- Students can learn about the applications of Euler's Equations.
- To give detailed knowledge about the integrals of equations.
- To give an in-depth knowledge of solving Partial Differential equations that we encounter frequently in various walks of life.
- To introduce existence and uniqueness theorems in Differential equations.

Unit I:First Order Partial Differential Equations

Partial Differential Equations - Origins of partial Differential Equations - Integral surfaces passing through a given curve - Surfaces orthogonal to a given system of surfaces - Non Linear Partial Differential Equations of the first order - Compatible Systems of First order Equations - Charpit's Method - Special types of first order equation. (Book 1: Chapter 2, Sections 1, 2, 5, 6, 7, 8, 9, 10, 11)

Unit II:Second Order Partial Differential Equations

Origin of second order equation - Higher Partial Differential Equations with constant coefficients - Equations with variable coefficients reducible to Elliptic, Parabolic and hyperbolic forms - Problems. (Book 1: Chapter 3, Sections 1, 4, 5)

Unit III:Fourier Transforms

Fourier Transforms - Defn. Inversion theorem - Fourier cosine transforms - Fourier sine transforms - Fourier transforms of derivatives - Fourier transforms of some simple functions - Fourier transforms of rational functions - The convolution integral - convolution theorem - Parseval's relation for cosine and sine transforms - solution of PDE by Fourier transform. Laplace's

equation in half plane - Laplace's equation in an infinite strip - The linear diffusion equation on a semi-infinite line - The two-dimensional diffusion equation. (Book 4: Relevant sections)

Unit IV:Integral Equations

Introduction; integral equations with separable kernels - Reduction to a system of algebraic equations, Fredholm alternative, an approximate method, Fredholm integral equations of the first kind, method of successive approximations - iterative scheme, Volterra integral equation, some results about the resolvent kernel, classical Fredholm theory - Fredholm's method of solution - Fredholm's first, second, third theorems. (Book 2: Relevant sections)

Unit V:Calculus of Variation

Introduction - Variation of a functional, A necessary condition for an extremum. The simplest variation problem - Euler's equation, The case of several variables, A simple variable end point problem, The fixed end point problem for n unknown functions, variational problems in parametric form, functionals depending on higher order derivatives. (Book 3: Relevant sections)

Textbooks

1. Ian.N.Snedden, Elements of Partial Differential Equations, Dover Publications, 2006.
2. R.P.Kanwal, Linear Integral Equations Theory and Technique, Second Edition, Birkhauser, Boston, 1997.
3. I. M. Gelfand and S. V. Fomin, Calculus of Variations, Dover, New York, 2000.
4. Ian.N.Snedden, The Use of Integral Transforms, McGraw-Hill Co. New York, 1972

References

1. M.D. Raisinghania, Advanced Differential Equations, S. Chand and Company Ltd, New Delhi, 2001.
2. G. Evans, J. Blackledge, P. Yardley, Analytic Methods for Partial Differential Equations, Springer International Edition, 2011.

Sem. IV **Hours/Week: 4**

16PMA4203A **Credits: 4**

AUTOMATA THEORY

Learning Assurance

- To make the students understand the nuances of Automata and Grammar.
- To make them understand the applications of these techniques in computer.
- To study context free grammar
- To learn finite automata and lexical analysis
- To understand basic parsing techniques.

Unit I: Finite Automata and Regular expressions

Definitions and examples - Deterministic and Nondeterministic finite Automata - Finite Automata with $\in$ – moves. (Book 1, Chapter 2: Section 2.1-2.4)

Unit II: Context free grammar

Regular expressions and their relationship with automation - Grammar - Ambiguous and unambiguous grammars - Derivation trees - Chomsky Normal form. (Book 1, Chapter 2, Section 2.5, Chapter 4, Sections 4.1-4.3, 4.5, 4.6)

Unit III: Pushdown Automaton

Pushdown Automaton - Definition and examples - Relation with Context free languages. (Book 1, Chapter 5: Section 5.2, 5.3)

Unit IV: Finite Automata and lexical analysis

Role of a lexical analyzer - Minimizing the number of states of a DFA - Implementation of a lexical analyzer. (Book 2, Chapter 3: Section 3.1-3.8)

Unit V: Basic parsing techniques

Parsers - Bottom up Parsers - Shift reduce - operator precedence - Top down Parsers - Recursive descent - Predictive parsers. (Book 2, Chapter 5: Section 5.1-5.5)

Textbooks

1. John E. Hopcroft and Jeffrey D. Ullman, Introduction to Automata theory, Languages and Computations, Narosa Publishing House, Chennai, 2000.
2. A.V. Aho and Jeffrey D. Ullman, Principles of Compiler Design, Narosa Publishing House, Chennai, 2002.

References

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall, 1997.
2. A.V. Aho, Monica S. Lam, R. Sethi, J.D. Ullman, Compilers: Principles, Techniques, and Tools, Second Edition, Addison-Wesley, 2007.

Sem. IV **Hours/Week: 4**
16PMA4203B **Credits: 4**

FUZZY ANALYSIS

Learning Assurance

- To make the students understand the nuances of Fuzzy Analysis.
- To make them understand the applications of these techniques in computer.

Unit I

Crisp sets and fuzzy sets - basic concept of fuzzy set - fuzzy logic - operations on fuzzy sets - general discussion fuzzy complements.

BOOK 1: chapter 1- 1.4, 1.6 & chapter 2-2.1 & 2.2.

Unit II

Fuzzy union - fuzzy intersection - combinations operations.

BOOK 1: chapter 2 - 2.3, 2.4, 2.5.

Unit III

Fuzzy relations and fuzzy graphs - fuzzy relation on sets and fuzzy sets - composition of fuzzy relations - properties of the min-max composition - fuzzy graphs - special fuzzy relations.

BOOK 2: chapter 6 - 6.1, 6.1.1, 6.1.2, 6.2, 6.3.

Unit IV

Fuzzy measures - general discussion - belief and plausibility measures - probability measures - possibility and necessity measures.

BOOK 1: chapter 4 - 4.1, 4.2, 4.3, 4.4.

Unit V

Fuzzy decision making - individual decision making - fuzzy ranking methods - fuzzy linear programming.

BOOK 3: chapter 4 - 4.1, 4.2, 4.3, and 4.4.

Textbooks

1. George J.Klir, Tina.AFolger, Fuzzy sets, uncertainty and information, Prentice Hall of India Pvt Ltd, New Delhi, 2008.
2. H.J. Zimmermann, Fuzzy set theory and its applications, Second Edition, Springer New Delhi, 2006.
3. George J. Klir and Bo Yuan, Fuzzy sets and fuzzy logic theory and applications, Prentice-Hall of India private limited, New Delhi, 1995.

References

1. Timothy J. Ross, Fuzzy logic with Engineering Applications, McGraw-Hill, Inc. New Delhi, 2000.

Sem. IV **Hours/Week: 0**
16PMA4116 **Credits: 2**

COMPREHENSIVE EXAMINATION

Sem. IV **Hours/Week: 8**
16PMA4117 **Credits: 4**

PROJECT DISSERTATION
&
VIVA VOCE

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