ST. JOSEPH'S COLLEGE (AUTONOMOUS)
IRINJALAKUDA

SYLLABUS
M. Sc MATHEMATICS PROGRAMME
CHOICE BASED CREDIT SEMESTER SYSTEM (CBCSS)
(Total Credits – 80)

EFFECTIVE FROM 2018 ADMISSIONS ONWARDS

CONTENTS

1. Major Changes
2. Semester wise plan and Electives
3. Detailed Syllabi
4. Guideline for Project
5. Guideline to conduct the Viva Voce
6. Evaluation and Grading
7. Question Paper Pattern for the End Semester Examination
8. Rules for conducting viva voce of project

Major Changes from the Previous Syllabus:

1. In the syllabus certain changes like

   (i) Text Book Of Algebra I & II changed To Fraleigh, J.B, A First Course In Abstract Algebra. (5th Edn.) Narosa (1999)

   (ii) Text book for Real Analysis II is changed to Royden,H.L, Real Anaylsis(4th Edn.) Macmillan Publishing company.

   (iii) From III Module of Operation Research Integer programming and Flow and potential removed and attached to elective paper Advanced Operation research

   (iv) In Second semester, industry related applied mathematics project using Mathematical software is introduced which is considered for internal mark evaluation

Semester I

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
MT1C01	**Algebra- I**	**4**	**5**	**core**
MT1C02	**Linear Algebra**	**4**	**5**	**core**
MT1C03	**Real Analysis-I**	**4**	**5**	**core**
MT1C04	**Number Theory**	**4**	**5**	**core**
MT1C05	**Discrete Mathematics**	**4**	**5**	**core**
MT1V06	**Viva Voce**	**2**		

Semester II

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
MT2C07	**Algebra- II**	**4**	**5**	**core**
MT2C08	**Real Analysis-II**	**4**	**5**	**core**
MT2C09	**Topology**	**4**	**5**	**core**
MT2C10	**ODE and Calculus of Variations**	**4**	**5**	**core**
MT2C11	**Operations Research**	**4**	**5**	**core**

Semester III

Course Code	Title of the Course	No. of Credits	Work Load Hrs./ week	Core/ Elective
MT3C12	**Multivariable Calculus and Geometry**	**4**	**5**	**core**
MT3C13	**Complex Analysis**	**4**	**5**	**core**
MT3C14	**Functional Analysis**	**4**	**5**	**core**
MT3C15	**PDE and Integral Equations**	**4**	**5**	**core**
MT4C17	**Project**		**5**	**core**
MT3V16	**Viva Voce**	**2**		

Semester IV

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
	Elective 1	**4**	**5**	**elective**
	Elective 2	**4**	**5**	**elective**
	Elective 3	**4**	**5**	**elective**
	Elective 4	**4**	**5**	**elective**
MT4C17	**Project**	**4**	**5**	

CREDITS

Accumulated minimum credit required for successful completion of course shall be 80.

LIST OF ELECTIVES

Four electives to be chosen with one each from the given group.

GROUP - I	
MT4E01	COMMUTATIVE ALGEBRA
MT4E02	ALGEBRAIC NUMBER THEORY
MT4E03	CRYPTOGRAPHY
MT4E04	REPRESENTATION THEORY
GROUP - II	
MT4E05	MEASURE AND INTEGRATION
MT4E06	ADVANCED COMPLEX ANALYSIS
MT4E07	ADVANCED FUNCTIONAL ANALYSIS
MT4E08	PROBABILITY THEORY
GROUP - III	
MT4E09	FLUID DYNAMICS
MT4E10	ADVANCED OPERATIONS RESEARCH
MT4E11	GRAPH THEORY
MT4E12	COMPUTER ORIENTED NUMERICAL ANALYSIS
GROUP - IV	
MT4E13	ALGEBRAIC TOPOLOGY
MT4E14	DIFFERENTIAL GEOMETRY
MT4E15	WAVELET THEORY

DETAILED SYLLABI
SEMESTER - I

MT1C01 ALGEBRA - I

No. of Credits: 4

No. Of hours of Lectures/week: 5

Text: FRALEIGH, J.B, A FIRST COURSE IN ABSTRACT ALGEBRA.(7th edn.) Narosa (1999)

Module - I

Plane Isometries, Direct products & finitely generated Abelian Groups, Factor Groups, Factor-Group

Computations and Simple Groups, Group action on a set, Applications of G-set to counting. [Sections

12, 11, 14, 15, 16, 17]

Module - II

Isomorphism theorems, Series of groups, (Omit Butterfly Lemma and proof of the Schreier

Theorem), Sylow theorems, Applications of the Sylow theory, Free Groups (Omit Another look at

free abelian groups).

[Sections 34, 35, 36, 37, 39]

Module- III

Group Presentations, Rings of polynomials, Factorization of polynomials over a field, Non Commutative examples, Homomorphism and factor rings.

[40, 22, 23, 24, 26]

REFERENCES

1. I.N. Herstein, Topics in Algebra, Wiley Eastern (Reprint)
2. N.H. McCoy and R.Thomas, Algebra, Allyn & Bacon Inc. (1977).
3. J. Rotman, The theory of groups, Allyn & Bacon Inc. (1973)
4. Hall,Marshall, The theory of groups, Chelsea Pub. Co. NY. (1976)
5. Clark, Allan, Elements of Abstract Algebra, Dover Publications (1984)
6. L.W. Shapiro, Introduction to Abstract Algebra, McGraw Hill Book Co. NY (1975) 7. N.Jacobson, Basic Algebra, vol. I, Hindustan Publishing Corporation, Reprint (1991)
8. T.W. Hungerford, Algebra, Springer Verlag GTM 73 (1987) 4th Printing.
9. D.M. Burton, A First Course in Rings and Ideals, Addison Wesley 1970
10. Mac Lane & Brikhoff, Algebra, Macmillian
11. JosephA.Gallian, Contemporary Abstract Algebra (4thEdn), Narosa 1999

MT1C02 LINEAR ALGEBRA

No of Credits : 4

No. of hours of Lectures/week : 5

Text: HOFFMAN K and KUNZE R., LINEAR ALGEBRA, (2nd Edn.), Prentice- Hall of India, 1991. **Module - I**

Vector Spaces & Linear Transformations

[Chapter 2 Sections 2.1 - 2.4; Chapter 3 Sections 3.1 to 3.3 from the text]

Module - II

Linear Transformations (continued) and Elementary Canonical Forms

[Chapter 3 Sections 3.4 - 3.7; Chapter 6 Sections 6.1 to 6.4 from the text]

Module- III

Elementary Canonical Forms (continued), Inner Product Spaces

[Chapter 6. Sections 6.6 & 6.7; Chapter 8 Sections 8.1 & 8.2 from the text]

REFERENCES

1. P.R. Halmos, Finite Dimensional Vector spaces, Narosa Pub House, New Delhi (1980)
2. S. Lang, Linear Algebra, Addison Wesley Pub.Co.
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd Reprint
4. S. Mac Lane and G. Bikhrkhoff, Algebra Macmillan Pub Co NY
5. G.D. Mostow and J.H. Sampson , Linear Algebra, McGraw-Hill Book Co NY (1969)
6. T.W. Hungerford, Algebra, Springer Verlag GTM No 73 (1974)
7. S. Kumaresan, Linear Algebra-A Geometric Approach, Prentice Hall of India (2000)
8. J. B. Fraleigh& R.H. Beauregard, Linear Algebra, Addison Wesley

MT1C03 REAL ANALYSIS – I

No. of Credits : 4
No.of hours of Lectures / week : 5
TEXT: RUDIN, W., PRINCIPLES OF MATHEMATICAL ANALYSIS, (3rd Edn.) Mc. Graw-

Hill, 1986.

Module - I

Basic Topololgy – Finite, Countable and Uncountable sets Metric Spaces, Compact Sets, Perfect Sets, Connected Sets. Continuity - Limits of function, Continuous functions, Continuity and compactness, continuity and connectedness, Discontinuities, Monotonic functions, Infinite limits and Limits at Infinity.
[Chapter 2 & Chapter 4]

Module – II

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. The Riemann – Stieltjes Integral, - Definition and Existence of the integral, properties of the integral, Integration and Differentiation.
[Chapters 5 & Chapter 6 up to and including 6.22]

Module – III

The Riemann – Stieltjes Integral (Continued) - Integration of Vector vector-valued Functions, Rectifiable curves. Sequences and Series of Functions - Discussion of Main problem, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform convergence and Differentiation. Equicontinuous Families of Functions, The Stone – Weierstrass Theorem.
[Chapters 6 (from 6.23 to 6.27) & Chapter 7 (upto and including 7.27 only)]

REFERENCES

1. a) R.G. Bartle : Element of Real Analysis, Wiley International Edn (Second Edn) (1976)
   b) R.G. Bartle and D.R. Sherbert : Introduction to Real Analysis, John Wiley Bros (1982)
2. L.M. Graves : The theory of functions of a real variable, Tata McGraw-Hill Book Co (1978)
3. M.H. Protter & C.B. Moray : A first course in Real Analysis, Springer Verlag UTM (1977)
4. S.C. Saxena and SM Shah : Introduction to Real Variable Theory, Intext Educational Publishers San Francisco (1972).
5. I.K.Rana : An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. Hewitt and Stromberg K : Real and Abstract Analysis, Springer Verlag GTM 25 (1975) Reprint
7. S.R. Ghorpade & B.V. Limaye : A course in Calculus and Real Analysis, Springer 2006.
8. Terence Tao : Analysis I &II, Hindustan Book agency.

MT1C04 NUMBER THEORY

No. of Credits 4
No.of hours of Lectures / week : 5
TEXT :1. APOSTOL, T.M.,: INTRODUCTION TO ANALYTIC NUMBER THEORY, Narosa
Publishing House, New Delhi, 1990.
2. KOBLITZ , NEAL:A COURSE IN NUMBER THEROY AND CRYPTOGRAPHY, SpringerVerlag, NewYork, 1987.

Module – I

Arithmetical functions and Dirichlet multiplication; Averages of arithmetical functions [Chapter 2: sections 2.1 to 2.14, 2.18, 2.19; Chapter 3: sections 3.1 to 3.4, 3.9 to 3.12 of Text 1]

Module - II

Some elementary theorems on the distribution of prime numbers [Chapter 4: Sections 4.1 to 4.10 of Text 1]

Module - III

Quadratic residues and quadratic reciprocity law [Chapter 9: sections 9.1 to 9.8 of Text 1]
Cryptography, Public key [Chapters 3 ; Chapter 4 sections 1and 2 of Text 2.]

REFERENCES

[1] W. W Adams & : Introduction to Number Theory L. J. Goldstein Printice Hall Inc (1976)

[2] Tom M. Apostol : Introduction to Analytic Number Theory Springer Inter-national Edn.(4th Reprint) Narosa Pub House,Delhi, (1993)

[3] A.N. Stewart & D.O.Tall : Algebraic Number Theory (2nd Edn.), Chapman & Hall, (1985)

[4] P. Samuel : Theory of Algebraic Numbers Hermann Paris Houghton Mifflin (1975)

[5] W.J. Le Veque : Topics in Number Theory ,vols I & II Addison Wesley Pub.Co. (1961)

[6] A Hurwitz & N.Kritiko : Lectures on Number Theory Springer Verlag ,Universitext (1986)

[7] H. Davenport : The higher arithmetic Cambridge Univ.Press, Sixth Edn. (1992)

[8] KH Rosen : Elementary Number Theory and its applications Addison Wesley , 3rd Edn., (1993)

[9] G.H. Hardy & E M Wright : Introduction to the theory of numbers Oxford Internl Edn (1985) [10] D.P. Parent : Exercises in Number Theroy Springer Vertlag, (Problem Books in Math) 1984 [11] Don Redmond : Number Theory Monographs & Texts in Maths No:220 Marcel Dekker (1994).

[12] Thomas Koshy : Elementary Number Theory with Applications Harcourt / Academic Press 2002

[13] Douglas R Stinson : Cryptography- Theory and Practice (2nd edn.) Chapman & Hall / CRC (214. Simon Sing : The Code Book The Fourth Estate London (1999)

[14] Song Y. Yan : Number Theroy for Computing (2nd Edition) Springer Verlag 2002

[15] Oystein Ore : Number Theory and its History Mc Graw Hill Book Company 1948

[16] Paulo Ribenboim : The little book of Big Primes Springer-Verlag (NewYork 1991)

[17] Albrecht Beautelspacher : Cryptology Mathematical Association of America (Incorporated),1994

MT1C05 DISCRETE MATHEMATICS

No. of Credits 4
No.of hours of Lectures / week : 5

TEXTS:

1. **K.D.JOSHI**, FOUNDATIONS OF DISCRETE MATHEMATICS, NewAge International (P) Ltd. New Delhi 1989
2. **R. BALAKRISHNAN & K. RANGANATHAN** , *A TEXT BOOK OF GRAPH THEORY*, Springer verlag.
3. **PETER LINZ**, AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA. (Second Edition) Narosa Publishing House, New Delhi, 1997.

Module - I

Order Relations, Lattices; Boolean Algebra – Definition and Properties, Boolean Functions. [TEXT 1 - Chapter 3 (section.3 (3.1-3.11), chapter 4 (sections 1& 2)]

Module - II

Basic concepts, Subgraphs, Degree of vertices, Paths and connectedness, Automorphism of a simple graph, Operations on graphs, Vertex cuts and Edge cuts, Connectivity and Edge connectivity, TreesDefinition, Characterization and Simple properties, Eulerian graphs, Planar and Non planar graphs, Euler formula and its consequences, K_5 and $K_{3,3}$ are non planar graphs, Dual of a plane graph.
[TEXT 2 – Chapter 1 Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, Chapter 3 Sections 3.1, 3.2, Chapter 4 Section 4.1(upto and including 4.1.10), Chapter 6 Section 6.1(upto and including 6.1.2), Chapter 8 Sections 8.1(upto and including 8.1.7), 8.2(upto and including 8.2.7), 8.3, 8.4.]

Module - III

Automata and Formal Languages: Introduction to the theory of Computation, Finite Automata. [TEXT 3 - Chapter 1 (sections 1.2 & 1.3); Chapter 2 (sections 2.1, 2.2 & 2.3)]

REFERENCES:

[1]. **J.A. Bondy and U.S.R.Murty** : *Graph Theory with applications*. Macmillan

[2]. **F. Harary** : *Graph Theory*, Narosa publishers

[3]. **John Clark and Derek Allan Holton** : *A First look at Graph Theory*, Prentice Hall

[4]. **K.R. Parthasarathy** : *Basic Graph Theory*, Tata-Mc Graw Hill

[5]. **Douglas B**. **West**, Intoduction To Graph Theory (Second Edition) Pearson Education [6].

C.L. Liu : *Elements of Discrete Mathematics* (2nd Edn.) Mc Graw Hill Book Company, 1985. [7].

K.H. Rosen : *Discrete Mathematics and its Applications* (5th Edition) MC Graw Hill 2003.

MT1V06 Viva Voce Examination

Viva voce examination based on the papers
(i) Algebra- I (ii) Linear Algebra (iii) Real Analysis (iv) Number Theory (v) Discrete Mathematics

of a duration of minimum 5 minutes for each subject.

SEMESTER - II

MT2C07 ALGEBRA – II

No. of Credits: 4
No.of hours of lectures/week: 5
Text: FRALEIGH, J.B: A FIRST COURSE IN ABSTRACT ALGEBRA, (5 Edn.)
Narosa (1999)

Module - I Prime and Maximal Ideals, Introduction to Extension Fields, Algebraic Extensions

(Omit Proof of the Existence of an Algebraic Closure), Geometric Constructions. [27, 29, 31, 32]

Module - II

Finite Fields, Automorphisms of Fields, The Isomorphism Extension Theorem, Splitting Fields, Separable Extensions.
[33, 48, 49, 50, 51]

Module - III Galois Theory, Illustration of Galois Theory, Cyclotomic Extensions, Insolvability of the Quintic. [53, 54, 55, 56]

REFERENCES

1. N.H. McCoy and R.Thomas, Algebra, Allyn & Bacon Inc. (1977). 2.
J. Rotman, The Theory of Groups Allyn & Bacon, Inc.1973
3. Hall, Marshall, The Theory of Groups, Chelsea Pub.Co. NY 1976
4. Clark, Allan, Elements of Abstract Algebra, Dover Publications (1984)
5. L.W. Shapiro, Introduction to Abstract Algebra, McGraw Hill Book Co. NY (1975)
6. C. Musili, Introduction to Rings and Modules, Narosa Publishing House, New Delhi1922
7. N. Jacobson, Basic Algebra , Vol. I., Hindustan Publishing Corporation, Reprint (1991)
8. P.B. Bhattacharya and S.K. Jain, First Course in Rings, Fields and Vector Spaces, Wiley Eastern Ltd., New Delhi (1976)
9. T.W. Hungerford, Algebra, Springer Verlag GTM 73 (1987) 4th Printing
10. I.N.Herstein, Topics in Algebra. New York, Blaisdell. 1964
11. F Lorenz, Algebra: Volume I: Fields and Galois Theory, Univesitext, Springer
12. P. Morandi, Fields and Galois Theory, Graduate Text in Mathematics, Springer

MT2C08 REAL ANALYSIS – II

No. of Credits : 4
No.of hours of Lectures / week : 5

TEXTS: 1. **ROYDEN,H.L**, REAL ANAYLSIS(4rd Edn.) Macmillan Publishing company.

UNIT – I

Lebesgue measure (Chapter 2 sections 2.1 to 2.6) Lebesgue measurable functions (Chapter 3(omit Egoroff's theorem Lusin's Theorem)) Lebesgue Integration(Chapter 4 sections 4.1 to 4.3)

UNIT – II

Lebesgue Integration(Chapter 4 sections 4.4 to 4.6) Lebesgue Integration further topics (Chapter 5 sections 5.2, 5. 3) Differentiation and Integration (Chapter 6 sections 6.1 to 6.5)

Unit- III

General measure spaces: Their properties and construction (Chapter 17 sections 17.1 to17. 4) Integration over General measure spaces (Cpapter 1`8 sections 18.1 to 18.4)

REFERENCES

2. L.M. Graves : The Theory of Functions of a Real Variable Tata McGraw-Hill Book Co (1978)
3. M.H. Protter & C.B. Moray : A First course in Real Analysis Springer Verlag UTM (1977)
4. S.C. Saxena and SM Shah : Introduction to Real Variable Theory Intext Educational Publishers San Francisco (1972)
5. I.K.Rana : An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997, 2nd Edn.
6. E.Hewitt and K. Stromberg : Real and Abstract Analysis Springer Verlag GTM 25 (1975) Reprint
7. P. R. Halmos : Measure Theory, Graduate Texts in Mathematics, Springer
8. R. G. Bartle : The Elements of Integration and Lebesgue Measure, Wiley (1995)
9. K.B. Athreya & S. Lahiri : Measure Theory, TRIM 36, Hindustan Book Agency

MT2C09 TOPOLOGY

No. of Credits : 4
No.of hours of Lectures / week : 5
TEXT: JOSHI, K.D., INTRODUCTION TO GENERAL TOPOLOGY, (Revised Edition) Wiley
Eastern Ltd., New Delhi, 1984

Module - I

A Quick Revision of Chapter 1,2 and 3. Topological Spaces, Basic Concepts
[Chapter 4 and Chapter 5 Sections 1, Section 2 (excluding 2.11 and 2.12) and Section 3 only]

Module - II

Making Functions Continuous, Quotient Spaces, Spaces with Special Properties [Chapter 5 Section 4 and Chapter 6]

Module - III

Separation Axioms: Hierarchy of Separation Axioms, Compactness and Separation Axioms, The Urysohn Characterization of Normality, Tietze Characterisation of Normality. [Chapter 7: Sections 1 to 3 and Section 4 (up to and including 4.6)]

REFERENCES

1. J .Dugundji : Topology, Prentice Hall of India (1975)
2. S.Willard : General Topology, Addison Wesley Pub Co., Reading Mass (1976)
3. G.F. Simmons : Introduction to Topology and Modern Analysis, McGraw-Hill International Student Edn. (1963)
4. M. Gemignani : Elementary Topology, Addison Wesley Pub Co Reading Mass (1971)
5. M.G. Murdeshwar : General Topology (2nd Edn), Wiley Eastern Ltd (1990)
6. M.A. Armstrong : Basic Topology, Springer Verlag, New York 1983
7. J. R. Munkres : Topology- a First Course, PHI
8. Fred H. Croom : Principles of Topology, Cengage Learning Asia

MT2C10 ODE AND CALCULUS OF VARIATIONS

No. of Credits : 4.
No.of hours of Lectures / week : 5

TEXT: SIMMONS, G.F, DIFFERENTIAL EQUATIONS WITH APPLICATIONS AND HISTORICAL NOTES, TMH Edition, New Delhi, 1974.

Module – I

Power Series Solutions and Special functions; Some Special Functions of Mathematical Physics.
[Chapter 5: Sections 26, 27, 28, 29, 30, 31 ; Chapter 6: Sections 32, 33]

Module – II

Some special functions of Mathematical Physics (continued), Systems of First Order Equations; Non linear Equations
[Chapter 6 : Sections 34, 35 : Chapter 7 :Sections 37, 38, Chapter 8 : Sections 40, 41, 42, 43, 44]

Module – III

Oscillation Theory of Boundary Value Problems, The Existence and Uniqueness of Solutions, The Calculus of Variations.
[Chapter 4 : Sections 22, 23 & Appendix A. (Omit Section 24) ; Chapter 11 : Sections 55, 56,57: Chapter 9 : Sections 47, 48, 49]

REFERENCES

1. G. Birkhoff & G.C. Rota : Ordinary Differential Equations, Edn. Wiley & Sons 3rd Edn (1978)
2. E.A. Coddington : An Introduction to Ordinary Differential Eqution Printice Hall of India, New Delhi (1974)
3. P. Hartman : Ordinary Differential Equations, John Wiley & Sons (1964)
4. L.S. Pontriyagin : A course in ordinary Differential Equations, Hindustan Pub. Corporation,Delhi (1967)
5. Courant R and Hilbert D : Methods of Mathematical Physics , vol I, Wiley Eastern Reprint (1975)
6. W.E. Boyce & R.C. Deprima : Elementary Differential Equations and boundary value problems John Wiley & Sons NY 2nd Edn (1969)
7. A. Chakrabarti : Elements of ordinary Differential Equations and special functions, Wiley Eastern Ltd New Delhi (1990)
8. Ian Sneddon : Elements of Partial Differential Equations, McGraw-Hill International Edn., (1957)

MT2C11 OPERATIONS RESEARCH

No. of Credits: 4

No. of Lectures/Week: 5

TEXT : K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS(3rd. Edn.), New Age International(P) Ltd. Publishers.

(Pre requisites : A basic course in calculus and Linear Algebra)

Module – I
Convex Functions; Linear Programming [Chapter 2 : Sections 11 to 12 ;
Chapter 3 : Sections 1 to 15, 17 from the text]
Module – II
Linear Programming (contd.); Transportation Problem [Chapter 3 : Sections 18 to 20, 22; Chapter 4 Sections 1 to 11, 13 from the text]
Module – III
Sensitivity Analysis [Chapter 7 Sections 1 to 10 from the text]
Theory of Games [Chapter 12 : all Sections]

REFERENCES

[1] G. Hadley., Linear Programming, Addison-Wesley Pub Co Reading, Mass, 1975.

[2] G. Hadley., Non-linear and Dynamic Programming, Wiley Eastern Pub Co.Reading, Mass, 1964.

[3] S.S.Rao., Optimization - Theory and applications(2nd Edn.), Wiley Eastern(P) Ltd., New Delhi.

[4] Russel L Ackoff; MauriceW.Sasioni., Fundamentals of Operations Research, Wiley Eastern Ltd. New Delhi, 1991.

[5] Charles S. Beightler; D.T.Philiphs; D.J. Wilde., Foundations of optimization(2nd Edn.), Prentice Hall of India, Delhi, 1979.

[6] Hamdy A.Taha, Operations Research: An Introduction(4th Edn.), Macmillan Pub Co. Delhi, 1989.

SEMESTER – III

MT3C12 MULTIVARIABLE CALCULUS AND GEOMETRY

No. of Credits: 4

No. of Lectures/Week: 5

Texts: 1 **RUDIN W, PRINCIPLES OF MATHEMATICAL ANALYSIS, (3rd Edn.) Mc. Graw-Hill, 1986.**

2. ANDREW PRESSLEY, ELEMENTARY DIFFERENTIAL GEOMETRY, (2nd Edn) Springer-Verlag 2010.

Module - I

Functions of Several Variables – Linear Transformations, Differentiation, The Contraction Principle, The Inverse Function Theorem, the Implicit Function Theorem. [Chapter 9 – Sections 1-29, 33-37 from Text – 1]

Module - II

What is a curve? Arc-length, Reparametrization, Closed curves 1.5 Level curves versus parametrized curves. Curvature, Plane curves, Space curves
What is a surface, Smooth surfaces, Smooth maps, Tangents and derivatives, Normals and orientability.

[Chapter 1 – Sections 1- 5, Chapter 2 – Sections 1 – 3, Chapter 4 – Sections 1 – 5 from Text - 2]

Module - III

Applications of the inverse function theorem, Lengths of curves on surfaces, The second fundamental form, The Gauss and Weingarten maps, Normal and geodesic curvatures. Gaussian and mean curvatures, Principal curvatures of a surface. [Chapter 5 – Section 6, Chapter 6 – Sections 1, Chapter 7 – Sections 1 – 3, Chapter 8 – Sections 1 – 2 from Text - 2]

REFERENCES

1. J.R. Munkres, Analysis on Manifolds, Westview Press, 1997 2.

Michael Spivak, Calculus on Manifolds, Westview Press, 1971.

3. C.C. Pugh, Real Mathematical Analysis, Springer, 2010.

4. M. Spivak, A Comprehensive Introduction to Differential Geometry, Vol. 1, Publish or Perish, Boston, 1970.

5. W Klingenberg , A course in Differential Geometry 6. M.P. do Carmo, Differential Geometry of Curves and Surfaces

MT3C13 COMPLEX ANALYSIS

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT : LARS V. AHLFORS : Complex Analysis, 3rd edn. Mc Graw Hill (1979)

Module - I

Conformality, Linear Transformations, Fundamental Theorems, Cauchy's Integral Formula.

(**Chap. 3,** Sections : 2.1,2.2, 2.3, 3.1, 3.2 & 3.3 **Chap. 4,** Sections : 1.1 to 2.3) **Module**

- II

Local Properties of Analytical Functions, The General Form of Cauchy's Theorem, The Calculus of Residues, Harmonic Functions. (**Chap. 4,** Sections : 3.1 to 6.4)

Module - III

Power Series Expansions, Simply Periodic Functions, Doubly Periodic Functions, The Weierstrass Theory. (**Chap. 5,** Sections : 1.1 to 1.3 **Chap. 7,** Sections : 1.1 to 3.3)

REFERENCES :

1. Cartan, H. : Elementary Theory of Analytic Functions of one or Several Variables, Addison - Wesley Pub. Co. (1973)

2. Conway, J.B. : Functions of One Complex Variable, Narosa Pub. Co., New Delhi. (1973)

3. Moore T.O. &Hadlock E.H. : Complex Analysis, Series in Pure Mathematics - Vol. 9. World Scientific . (1991)

4. Pennisi, L. : Elements of Complex Variables, Holf, Rinehart & Winston, 2nd Edn. . (1976)

5. Rudin, W. : Real and Complex Analysis, 3rd Edn. McGraw - Hill International . Edn. (1987)

6. Silverman, H. : Compex Variables, Houghton Mifflin Co. Boston (1975)

7. Remmert, R. : Theory of Complex Functions, UTM, Springer- Verlag, NY, (1991)

MT3C14 FUNCTIONAL ANALYSIS

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT : LIMAYE B.V, FUNCTIONAL ANALYSIS, (2nd Edn.) New Age International Ltd, Publishers, New Delhi, Bangalore (1996)

Module - I

Metric spaces and Continuous Functions (section 3, 3.1 to 3.4, 3.11 to 3.13(without proof)), Lp spaces , Fourier series and Integrals (section 4.5 to4.7, 4.8 to 4.11(without proof)), Normed spaces (section 5) Continuity of linear maps (section 6).

Module – II

Hahn-Banach Theorems (section 7, omit Banach limits) Banach spaces (section 8) Uniform Boundedness Principle (section 9, omit Quadrature Formulae and Matrix Transformations and Summability Methods).

Module - III

Closed Graph and Open Mapping Theorems (section 10), Bounded Inverse Theorem(section 11.1), Inner product spaces, Orthonormal sets (Sections 21 and 22).

REFERENCES :

1. R. Bhatia, Notes on Functional Analysis TRIM series, Hindustan Book Agency
2. Kesavan S, Functional Analysis, TRIM series, Hindustan Book Agency
3. S David Promislow, A First Course in Functional Analysis, Wiley Interscience, John wiley & Sons, INC., (2008)
4. Sunder V.S, Functional Analysis, TRIM series, Hindustan Book Agency
5. George Bachman & Lawrence Narici, Functional Analysis , Academic Press, NY (1970) 6. Kolmogorov and Fomin S.V, Elements of the Theory of Functions and Functional Analysis. English Translation, Graylock Press, Rochaster NY (1972)
7. W. Dunford and J. Schwartz, Linear Operators Part 1, General Theory, John Wiley & Sons (1958)
8. E.Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons 1978)
9. F. Riesz and B. Nagy, Functional Analysis, Frederick Unger NY (1955)
10. J.B.Conway, Functional Analysis, Narosa Pub House New Delhi (1978)
11. Walter Rudin, Functional Analysis, TMH edition (1978)
12. Walter Rudin, Introduction to Real and Complex Analysis, TMH edition (1975)
13. J.Dieudonne, Foundations of Modern Analysis, Academic Press (1969)
14. Yuli Eidelman,Vitali Milman and Antonis Tsolomitis, Functional analysis An Introduction, Graduate Studies in Mathematics, Vol. 66 American Mathematical Society 2004.

MT3C15 PDE AND INTEGRAL EQUATIONS

No. of Credits : 4
No.of hours of Lectures / week : 5
TEXTS : 1. AMARNATH, M., : PARTIAL DIFFERENTIAL EQUATIONS, Narosa , New Delhi (1997)
2. HILDEBRAND, F.B.: METHODS OF APPLIED MATHEMATICS, (2nd Edn.) Prentice-Hall of India, New Delhi, 1972.

Module – I

First Order PDE .
[Sections 1.1 – 1.11. from the Text 1], Omit the Proof of Theorem 1.11.1

Module – II

Second Order PDE
[Sections 2.1 – 2.5. from the Text 1]

Module – III

Integral Equations.
[Sections 3.1 – 3.3, 3.6 – 3.11 from the Text 2]

REFERENCES

1. G. Birkhoff & G.C. Rota : Ordinary Differential Equations, Edn. Wiley & Sons 3rd Edn (1978)
2. E.A. Coddington : An Introduction to Ordinary Differential Equations, Printice Hall of India, New Delhi (1974)
3. P. Hartman : Ordinary Differential Equations, John Wiley & Sons (1964)
4. L.S. Pontriyagin : A Course in Ordinary Differential Equations, Hindustan Pub. Corporation, (1967)
5. F. John : Partial Differential Equations, Narosa Pub. House New Delhi (1986)
6. Phoolan Prasad & : Partial Differential Equations, Renuka Ravindran Wiley Eastern Ltd New Delhi (1985)
7. R. Courant and D.Hilbert : Methods of Mathematical Physics , Vol I, Wiley Eastern Reprint (1975)
8. W.E. Boyce & R.C. Deprima : Elementary Differential Equations, and Boundary Value Problems John Wiley & Sons, NY, 9th Edition
9. A. Chakrabarti : Elements of Ordinary Differential, Equations and Special Functions, Wiley Eastern Ltd New Delhi (1990)
10. Ian Sneddon : Elements of Partial Differential Equations, McGraw-Hill International Edn., (1957

ELECTIVES

MT4E01 COMMUTATIVE ALGEBRA

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : ATIYAH,M.F & MACDONALD, I.G, INTRODUCTION TO COMMUTATIVE ALGEBRA, Addison Wesley, N.Y, (1969).

Module – I

Rings and Ideals, Modules
[Chapters I and II from the text]

Module – II

Rings and Modules of Fractions, Primary Decomposition
[Chapters III & IV from the text]

Module – III

Integral Dependence and Valuation, Chain conditions, Noetherian rings, Artinian rings [Chapters V, VI, VII & VIII from the text]

REFERENCES

1. N. Bourbaki : Commutative Algebra, Paris - Hermann, 1961
2. D. Burton : A First Course in Rings and Ideals, Addison - Wesley , 1970.
3. N.S. Gopalakrishnan : Commutative Algebra, Oxonian Press, 1984.
4. T.W. Hungerford : Algebra, Springer - Verlag, 1974
5. D.G. Northcott : Ideal Theory, Cambridge University Press, 1953
6. O. Zariski & P. Samuel : Commutative Algebra, Vols. I & II, Van Nostrand, Princeton, 1960

MT4E02 ALGEBRAIC NUMBER THEORY

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : I. N. STEWART & D.O. TALL, ALGEBRAIC NUMBER THEORY, (2nd Edn.), Chapman & Hall, (1987)

Module – I

Symmetric polynomials, Modules, Free abelian groups, Algebraic Numbers, Conjugates and Discriminants, Algebraic Integers, Integral Bases, Norms and Traces, Rings of Integers, Quadratic Fields, Cyclotomic Fields.
[Chapter1, Sections 1.4 to 1.6; Chapter 2, Sections 2.1 to 2.6; Chapter 3, Sections 3.1 and 3.2 from the text]

Module – II

Historical background, Trivial Factorizations, Factorization into Irreducibles, Examples of Nonunique Factorization into Irreducibles, Prime Factorization, Euclidean Domains, Eucidean Quadratic fields
Ideals – Historical background, Prime Factorization of Ideals, The norm of an ideal [Chapter 4, Sections 4.1 to 4.7, Chapter 5, Sections 5.1 to 5.3.]

Module – III

Lattices, The Quotient Torus, Minkowski theorem, The Space Lst, The Class-Group An Existence Theorem, Finiteness of the Class-Group, Factorization of a Rational Prime, Fermat's Last Theorem – Some history, Elementary Considerations, Kummer's Lemma, Kummer's Theorem.
[Chapter 6, Chapter 7, Section 7.1 Chapter 8, Chapter 9, Sections 9.1 to 9.3, Chapter 10. Section 10.1, Chapter 11: 11.1 to 11.4.]

REFERENCES

1. P. Samuel : Theory of Algebraic Numbers, Herman Paris Houghton Mifflin, NY, (1975)
2. S. Lang : Algebraic Number Theory, Addison Wesley Pub Co., Reading, Mass, (1970)
3. D. Marcus : Number Fields, Universitext, Springer Verlag, NY, (1976)
4. T.I.FR. Pamphlet No: 4 : Algebraic Number Theory (Bombay, 1966)
5. Harvey Cohn : Advanced Number Theory, Dover Publications Inc., NY, (1980)
6. Andre Weil : Basic Number Theory, (3rd Edn.), Springer Verlag, NY, (1974)
7. G.H. Hardy and E.M. Wright : An Introduction to the Theory of Numbers, Oxford University Press.
8. Z.I. Borevich & I.R.Shafarevich : Number Theory, Academic Press, NY 1966.
9. Esmonde & Ram Murthy : Problems in Algebraic Number Theory, Springer Verlag 2000.

MT4E03 CRYPTOGRAPHY

No. of Credits : 4

Number of hours of Lectures/week : 5

Text: **Douglas R. Stinson, *Cryptography Theory and Practice*, Chapman & Hall, 2nd Edition.**

Module - I

Classical Cryptography**:** – Some Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Ciphers. Cryptanalysis of the Affine, Substitution, Vigenere, Hill and LFSR Stream Cipher.

Module - II

Shannon's Theory:- Elementary Probability Theory, Perfect Secrecy, Entropy, Huffman Encodings, Properties of Entropy, Spurious Keys and Unicity Distance, Product Cryptosystem.

Module - III

Block Ciphers**:** –Substitution Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis , Data Encryption Standard (DES), Advanced Encryption Standard (AES).

Cryptographic Hash Functions**:** Hash Functions and Data integrity, Security of Hash Functions, iterated hash functions- MD5, SHA 1, Message Authentication Codes, Unconditionally Secure MAC s.

[Chapter 1 : Section 1.1(1.1.1 to 1.1.7), Section 1.2 (1.2.1 to 1.2.5) ; Chapter 2 : Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 ; Chapter 3 : Sections 3.1, 3.2, 3.3(3.3.1 to 3.3.3), Sect.3.4, Sect. 3.5(3.5.1,3.5.2), Sect.3.6(3.6.1, 3.6.2); Chapter 4 : Sections 4.1, 4.2(4.2.1 to 4.2.3), Section 4.3 (4.3.1, 4.3.2), Section 4.4(4.4.1, 4.4.2), Section 4.5 (4.5.1, 4.5.2)]

REFERENCES:

1. **Jeffrey Hoffstein, Jill Pipher, Joseph H. Silverman**, An Introduction to Mathematical Cryptography, Springer International Edition.
2. **H. Deffs & H. Knebl** , *Introduction to Cryptography*, Springer – Verlag, 2002.
3. **Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone**, *Handbook of Applied Cryptography*, CRC Press, 1996.
4. **William Stallings**, *Cryptography and Network Security Principles and Practice*, Third Edition, Prentice-hall India, 2003.

MT4E04 REPRESENTATION THEORY

No. of credits: 4

Number of hours of Lectures/week : 5

Text Book: Walter Ledermann, Introduction to Group Characters(Second Edition)

Module - I

Introduction, G- modules, Characters, Reducibility, Permutation Representa- tions, Complete reducibility, Schur's lemma, The commutant(endomorphism) algebra. (Sections: 1.1 to 1.8)

Module - II

Orthogonality relations, the group algebra, the character table, finite abelian groups, the lifting process, linear characters. (section: 2.1 to 2.6)

Module - III

Induced representations, reciprocity law, the alternating group A5, Normal sub- groups, Transitive groups, the symmetric group, induced characters of S n. (Sections: 3.1 to 3.4 & 4.1 to 4.3)

REFERENCES

[1] C. W. Kurtis and I. Reiner, Representation Theory of Finite Groups and Associative Algebras, John Wiley & Sons, New York(1962)

[2] Faulton, The Reprsentation Theory of Finite Groups, Lecture Notes in Mathematics, No. 682, Springer 1978.

[3] C. Musli, Reprsentations of Finite Groups, Hindustan Book Agency, New Delhi (1993).

[4] I. Schur, Theory of Group Characters, Academic Press, London (1977).

[5] J.P. Serre, Linear Reprsentation of Finite Groups, Graduate Text in Mathematics, Vol 42, Springer (1977).

MT4E05 MEASURE AND INTEGRATION

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT : WALTER RUDIN : Real and Complex Analysis ,

3rd Edition, Mc Graw Hill International Edn. New Delhi (1987)

Module – I

The concept of measurability, Simple functions, Elementary properties of measures, Arithmetic in [0,infinity], Integration of Positive Functions, Integration of Complex Functions, The Role Played by Sets of Measure zero, Topological Preliminaries, The Riesz Representation Theorem.

(**Chap. 1,** Sections : 1.2 to 1.41 **Chap. 2,** Sections : 2.3 to 2.14)

Module – II

Regularity Properties of Borel Measures, Lebesgue Measure, Continuity Properties of Measurable Functions. Total Variation, Absolute Continuity, Consequences of Radon - Nikodym Theorem.

(**Chap. 2,** Sections : 2.15 to 2.25 **Chap. 6**, Sections : 6.1 to 6.14)

Module – III

Bounded Linear Functionals on L^P, The Riesz Representation Theorem, Measurability on Cartesian Products, Product Measures, The Fubini Theorem, Completion of Product Measures. (**Chap. 6,** Sections : 6.15 to 6.19 **,** **Chap. 8,** Sections : 8.1 to 8.11)

REFERENCES :

1. P.R. Halmos : Measure Theory, Narosa Pub. House New Delhi (1981) Second Reprint
2. H.L. Roydon : Real Analysis, Macmillan International Edition (1988) Third Edition
3. E.Hewitt & K. Stromberg : Real and Abstract Analysis, Narosa Pub. House New Delhi (1978)
4. A.E.Taylor. : General Theory of Functions and Integration, Blaidsell Publishing Co NY (1965)
5. G.De Barra : Measure Theory and Integration, Wiley Eastern Ltd. Bangalore (1981)

MT4E06 ADVANCED COMPLEX ANALYSIS

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT - 1 : LIANG – SHIN HAHN BERNARD EPSTEIN : Classical Complex Analysis ,

Jones And Bartlett Publishers (1996)

TEXT - 2 : JOHN B. CONWAY, Functions of One Complex Variable, 2nd Edn., Springer . International Edn. (1973)

Module - I

The Mittag - Leffler Theorem, A Theorem of Weierstrass, Extensions of Theorems of Mittag -Leffler and Weierstrass, Infinite Products, Blaschke Product,The Factorisation of Entire Functions, The Jensen formula. (**Chap. 7,** Sections : 7.1 to 7.7 from *Text 1.*)

Module - II

Entire Functions of Finite Order, Runge Approximation Theorem, The Power Series Method, Natural Boundaries, Multiple Valued Functions. (**Chap. 7,** Sections : 7.8 ,7.9 & **Chap. 8,** Sections 8.1 to 8.3 from *Text 1.*)

Module - III

The Schwarz Symmetry Principle, The Monodromy Theorem, The Space of Continuous Functions, Space of Analytic Functions, Space of Meromorphic Functions, The Riemann Mapping Theorem. (**Chap. 8,** Sections : 8.5, 8.6 from *Text 1.* & **Chap. 7,** Sections : 7.1 to 7.4 from *Text 2.*)

REFERENCES :

1. Cartan H, Elementary Theory of Analytic Functions of one or Several Variables, Addison-Wesley Pub. Co. (1973)
2. Conway J.B, Functions of One Complex Variable, Narosa Pub. Co, New Delhi (1973)
3. Moore T.O. & Hadlock E.H, Complex Analysis, Series in Pure Mathematics - Vol. 9. World Scientific, (1991)
4. Pennisi L, Elements of Complex Variables, Holf, Rinehart & Winston, 2nd Edn. (1976)
5. Rudin W, Real and Complex Analysis, 3rd Edn. Mc Graw - Hill International Edn. (1987)
6. Silverman H, Compex Variables, Houghton Mifflin Co. Boston (1975)
7. Remmert R, Theory of Complex Functions, UTM, Springer- verlag, NY, (1991)

MT4E07 ADVANCED FUNCTIONAL ANALYSIS

No. of Credits : 4
Number of hours of Lectures/week : 5
TEXT : LIMAYE , B.V, FUNCTIONAL ANALYSIS, (2nd Edn.) New Age International Ltd, Publishers, New Delhi, Bangalore (1996)

Module - I

Duals and Transposes (section 13, upto and including 13.8), Duals of L_p [a,b] and C[a,b] (section 14) weak and weak* convergence (section 15, omit 15,5 and 15.6)Reflexivity (section 16, Omit 16.3 and the proof of 16.6),

Module - II

Definition of Compact Linear Map, spectrum of a compact operator(section 18) Riesz

Representation Theorems (section 24,omit24.1).

Module - III

Bounded Operators and Adjoints (section 25), Normal, Unitary and Self Adjoint Operators (section 26, omit Fourier-Plancherel Transform), Spectrum and Numerical Range (section 27), Compact self Adjoint Operators (section 28 , omit 28.7 and 28.8(b)).

References

1.R. Bhatia, Notes on Functional Analysis TRIM series, Hindustan Book Agency
2.KesavanS, Functional Analysis TRIM series, Hindustan Book Agency
3. S David Promislow, A First Course in Functional Analysis, John wiley & Sons, INC., (2008)
4. Sunder V.S, Functional Analysis TRIM Series, Hindustan Book Agency
5.GeorgeBachman&LawrenceNarici, Functional Analysis Academic Press, NY (1970)
6.Kolmogorov andFomin S.V, Elements of the Theory of Functions and Functional Analysis. English Translation, Graylock, Press Rochaster NY (1972)
7.W.DunfordandJ.Schwartz, LinearOperatorsPart1,GeneralTheory John Wiley & Sons (1958)
8.E.Kreyszig, Introductory Functional Analysis with Applications John Wiley & Sons (1978)
9.F. Riesz and B. Nagy, Functional Analysis Frederick Unger NY (1955)
10. J.B.Conway, Functional Analysi Narosa Pub House New Delhi (1978)
11. Walter Rudin, Functional Analysis TMH edition (1978)
12. Walter Rudin, Introduction to Real and Complex Analysis TMH edition (1975)
13. J.Dieudonne, Foundations of Modern Analysis Academic Press (1969)
14.YuliEidelman,Vitali Milman and Antonis Tsolomitis, Functional analysis An Introduction, Graduate Studies in Mathematics Vol. 66 American Mathematical Society 2004.

MT4E08 PROBABILITY THEORY

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : An Introduction to Probability Theory and Statistics (Second Edition), By Vijay K. Rohatgi and A.K. MD. Ehsanes Saleh, John Wiley Sons Inc. New York.

Module – I

1. Random Variables and Their Probability Distributions Random Variables. Probability Distribution of a random Variable. Discrete and Continuous Random Variables. Functions of a random Variable. Chapter 2 of Text. (Sections 2.1- 2.5)
2. Moments and Generating Functions. Moments of a distribution Function. Generating Functions. Some Moment Inequalities.
Chapter 3 of Text. (Sections 3.1- 3.4)

Module - II

3. Multiple Random Variables. Multiple random Variables. Independent Random Variables. Functions of several Random variables. Covariance, Correlation and Moments. Conditional Expectations Order statistics and their Distributions. Chapter 4 of Text. (Sections 4.1- 4.7)

Module - III

4. Limit Theorems. Modes of Convergence. Weak law of Large Numbers. Strong Law of large Numbers. Limiting Moment Generating Functions. Central Limit Theorem. Chapter 6 of Text. (Sections 6.1- 6.6)

REFERENCES

1. B.R. Bhat MODERN PROBABILITY THEORY (Second Edn.) Wiley Eastern Limited, Delhi (1988)
2. K.L. Chung Elementary Probability Theory with Stochastic Processes Narosa Pub House, New Delhi (1980)
3. W.E.Feller An Introduction to Probability Theory and its Applications Vols I & II- John Wiley & Sons, (1968) and (1971)
4. Rukmangadachari. E. Probability and Statistics, Pearson (2012)
5. Robert V Hogg, Allen Craig & Joseph W McKean Introduction to Mathematical Statistics (Sixth Edn.), Pearson 2005.

MT4E09 FLUID DYNAMICS

No. of Credits : 4
No. of hours of Lectures/week : 5
TEXT : L.M. MILNE-THOMSON, THEORETICAL HYDRODYNAMICS, (Fifth Edition)
Mac Millan Press, London, 1979.

Module – I

EQUATIONS OF MOTION : Differentiation w.r.t. the time, The equation of continuity Boundary condition (Kinematical and Physical), Rate of change of linear momentum, The equation of motion of an invicid fluid, Conservative forces, Steady motion, The energy equation,
Rate of change of circulation, Vortex motion, Permanence of vorticity, Pressure equation, Connectivity, Acyclic and cyclic irrotational motion, Kinetic energy of liquid, Kelvin's minimum energy theorem.
TWO-DIMENSIONAL MOTION : Motion in two-dimensions, Intrinsic expression for the vorticity; The rate of change of vorticity; Intrinsic equations of steady motion; Stream function; Velocity derived from the stream-function; Rankine's method; The stream function of a uniform stream; Vector expression for velocity and vorticity; Equation satisfied by stream function; The pressure equation; Stagnation points; The velocity potential of a liquid; The equation satisfied by the velocity potential.
[Chapter III: Sections 3.10, 3.20, 3.30, 3.31, 3.40, 3.41, 3.43, 3.45, 3.50, 3.51, 3.52, 3.53, 3.60, 3.70, 3.71, 3.72, 3.73. Chapter IV : All Sections.]

Module - II

STREAMING MOTIONS : Complex potential; The complex velocity stagnation points, The speed, The equations of the streamlines, The circle theorem, Streaming motion past a circular cylinder; The dividing streamline, The pressure distribution on the cylinder, Cavitation, Rigid boundaries and the circle theorem, The Joukowski transformation, Theorem of Blasius. AEROFOILS: Circulation about a circular cylinder, The circulation between concentric cylinders, Streaming and circulation for a circular cylinder, The aerofoil, Further investigations of the Joukowski transformation Geometrical construction for the transformation, The theorem of Kutta and Joukowski.
[Chaper VI : Sections 6.0, 6.01, 6.02, 6.03, 6.05, 6.21, 6.22, 6.23, 6.24, 6.25, 6.30, 6.41. Chapter VII: Sections 7.10, 7.11, 7.12, 7.20, 7.30, 7.31, 7.45.]

Module - III

SOURCES AND SINKS: Two dimensional sources, The complex potential for a simple source, Combination of sources and streams, Source and sink of equal strengths Doublet, Source and equal sink in a stream, The method of images, Effect on a wall of a source parallel to the wall, General method for images in a plane, Image of a doublet in a plane, Sources in conformal transformation Source in an angle between two walls, Source outside a circular cylinder, The force exerted on a circular cylinder by a source.
STKOKES' STREAM FUNCTION: Axisymmetrical motions Stokes' stream function, Simple source, Uniform stream, Source in a uniform stream, Finite line source, Airship forms, Source and equal sink - Doublet; Rankin's solids.
[Chapter VIII. Sections 8.10, 8.12, 8.20, 8.22, 8.23, 8.30, 8.40, 8.41, 8.42, 8.43, 8.50, 8.51, 8.60, 8.61, 8.62. Chapter XVI. Sections 16.0, 16.1, 16.20, 16.22, 16.23, 16.24, 16.25, 16.26, 16.27]

REFERENCES

1. Von Mises and K.O. Friedrichs : Fluid Dynamics, Springer International Edition. Reprint, (1988) 2. James EA John : Introduction to Fluid Mechanics (2nd Edn.), Prentice Hall of India ,Delhi,(1983).
3. Chorlten : Text Book of Fluid Dynamics, CBS Publishers, Delhi 1985
4. A. R. Patterson : A First Course in Fluid Dynamics, Cambridge University Press 1987.

MT4E10 ADVANCED OPERATIONS RESEARCH

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS(3rd.Edn.), New Age International(P) Ltd. Publishers.

(Pre requisites : A basic course in calculus and Linear Algebra)

Module – I

Kuhn Tucker theory and Nonlinear programming [Chapter 8 : Sections 1 to 7]

Module – II

Geometric Programming [Chapter 9 : Sections 1 to 6]

Module – III

Dynamic Programming [Chapter 10 : Sections 1 to 10]

REFERENCES

[1] G. Hadley., Linear Programming, Addison-Wesley Pub Co Reading, Mass, 1975.

[2] G. Hadley., Non-linear and Dynamic Programming, Wiley Eastern Pub Co.Reading, Mass, 1964.

[3] S.S.Rao., Optimization - Theory and applications(2nd Edn.), Wiley Eastern(P) Ltd., New Delhi.

[4] Russel L Ackoff; MauriceW.Sasioni., Fundamentals of Operations Research, Wiley Eastern Ltd. New Delhi, 1991.

[5] Charles S. Beightler; D.T.Philiphs; D.J. Wilde., Foundations of optimization(2nd Edn.), Prentice Hall of India, Delhi, 1979.

[6] Hamdy A.Taha, Operations Research: An Introduction(4th Edn.), Macmillan Pub Co. Delhi, 1989.

MT4E10 ADVANCED OPERATIONS RESEARCH

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS(3rd.Edn.), New Age International(P) Ltd. Publishers.

(Pre requisites : A basic course in calculus and Linear Algebra)

Module – I

Flow and Potential in Networks; [Chapter 5 : Sections 1 to 4, 6 ,7)
Integer Programming; [Chapter 6 : Sections 1 to 9)

Module – II
Kuhn Tucker theory and Nonlinear programming [Chapter 8 : Sections 1 to 6]
Geometric Programming [Chapter 9 : Sections 1 to 6 (omit section 5)]

Module – III

Dynamic Programming [Chapter 10 : Sections 1 to 10]
Direct Search and Gradient Method [Chapter 11 (section 1 to 14)]

REFERENCES

[1] G. Hadley., Linear Programming, Addison-Wesley Pub Co Reading, Mass, 1975.

[2] G. Hadley., Non-linear and Dynamic Programming, Wiley Eastern Pub Co.Reading, Mass, 1964.

[3] S.S.Rao., Optimization - Theory and applications(2nd Edn.), Wiley Eastern(P) Ltd., New Delhi.

[4] Russel L Ackoff; MauriceW.Sasioni., Fundamentals of Operations Research, Wiley Eastern Ltd. New Delhi, 1991.

[5] Charles S. Beightler; D.T.Philiphs; D.J. Wilde., Foundations of optimization(2nd Edn.), Prentice Hall of India, Delhi, 1979.

[6] Hamdy A.Taha, Operations Research: An Introduction(4th Edn.), Macmillan Pub Co. Delhi, 1989.

MT4E11 GRAPH THEORY

No. of credits: 4

Number of hours of Lectures/week : 5

TEXT:

J.A. Bondy and U.S.R.Murty : *Graph Theory with applications*. Macmillan

Module – I

Basic concepts of Graph. Trees, Cut edges and Bonds, Cut vertices, Cayley's Formula, The Connector Problem, Connectivity, Blocks, Construction of Reliable Communication Networks, Euler Tours, Hamilton Cycles, The Chineese Postman Problem, The Travelling Salesman Problem.

Module – II

Matchings, Matchings and Coverings in Bipartite Graphs, Perfect Matchings, The Personnel Assignment Problem, Edge Chromatic Number, Vizing's Theorem, The Timetabling Problem, Independent Sets, Ramsey's Theorem,

Module – III

Vertex Colouring-Chromatic Number, Brooks' Theorem, Chromatic Polynomial, Girth and Chromatic Number, A Storage Problem, Plane and Planar Graphs, Dual Graphs, Euler's Formula, Bridges, Kuratowski's Theorem, The Five-Colour Theorem, Directed Graphs, Directed Paths, Directed Cycles.

[Chapter 2 Sections 2.1(Definitions & Statements only), 2.2, 2.3, 2.4, 2.5; Chapter 3 Sections 3.1, 3.2, 3.3; Chapter 4 Sections 4.1(Definitions & Statements only), 4.2, 4.3, 4.4; Chapter 5 Sections 5.1, 5.2, 5.3, 5.4; Chapter 6 Sections 6.1,6.2,6.3; Chapter 7 Sections 7.1,7.2; Chapter 8 Sections 8.1, 8.2, 8.4, 8.5, 8.6; Chapter 9 Sections (9.1,9.2,9.3 Definitions & Statements only), 9.4, 9.5, 9.6; Chapter 10 Sections 10.1, 10.2, 10.3.

REFERENCES:

[1]. **F. Harary** : *Graph Theory*, Narosa publishers, Reprint 2013.

[2]. **Geir Agnarsson, Raymond Greenlaw:** Graph Theory Modelling, Applications and Algorithms, Pearson Printice Hall, 2007.

[3]. **John Clark and Derek Allan Holton** : *A First look at Graph Theory*, World Scientific (Singapore) in 1991 and Allied Publishers (India) in 1995

[4]. **R. Balakrishnan & K. Ranganathan** : *A Text Book of Graph Theory*, Springer Verlag, 2nd edition 2012.

MT4E12 COMPUTER ORIENTED NUMERICAL ANALYSIS

No. of Credits : 4
No. of hours of Lectures/week : 5

Programming Language: Python

Texts:

1. **A Byte of Python, Swaroop C H**
2. **Numerical Methods, E Balagurusamy, Tata McGraw-Hill Publishing Company Limited, New Delhi.**

THEORY PART

Module – I

(Text Book 1, Text Book 2)

A quick review of preliminaries of computers, numerical computing, programming languages, Algorithms, flow charts, computer codes based on chapter 1, 2 and 3 of text book
2

Approximations and errors in computing: Significant Digits, Numerical Errors, Absolute and relative errors, convergence of iterative processes and error estimation. (Sections 4.2, 4.4, 4,
7, 4.11 and 4.12 of text book 2)

A quick review of chapters 1, 2 and 3 of Text Book 1

Chapter 4: The Basics: Literal Constants, Numbers, Strings, Variables, Identifier, Data types

Chapter 5: Operators, Operator Precedence, Expressions

Chapter 6: Control flow: If, while, for, break, continue statements

Chapter 7: Functions: Defining a function, function parameters, local variables, default arguments, keywords, return statement, Doc-strings

Chapter 8: Modules: using system modules, import statements, creating modules Chapter 9: Data Structures: Lists, tuples, sequences.

Chapter 10: Writing a python script

Chapter 12: Files: Input and output using file and pickle module

Chapter 13: Exceptions: Errors, Try-except statement, raising exceptions, try-finally statement

Module – II

(Text Book 2)

Chapter 6: Roots of Nonlinear Equations: Evaluation of Polynomials, Bisection method, Newton-Raphson Method, Complex roots by Bairstow method. (Sections 6.5, 6.6, 6.8 and 6.15) Chapter 7: Direct Solution of Linear Equations: Solution by elimination, Gauss Elimination method, Gauss Elimination with Pivoting, Triangular Factorisation method (Dolitle Algorithm). (Sections 7.3, 7.4, 7.5 and 7.7)

Chapter 8: Iterative Solution of Linear Equations: Jacobi Iteration method, Gauss-Seidel method. (Sections 8.2 and 8.3)

Module – III

(Text Book 3)

Chapter 9: Curve Fitting-Interpolation: Lagrange Interpolation Polynomial, Newton Interpolation Polynomial, Divided Difference Table, Interpolation with Equidistant points.(Sections 9.4, 9.5, 9.6 and 9.7)

Chapter 11: Numerical Differentiation: Differentiating Continuous functions, Differentiating Tabulated functions. (Sections 11.2 and 11.3)
Chapter 12: Numerical Integration: Trapezoidal Rule, Simpson's 1/3 rule. (Sections 12.3 and 12.4)
Chapter 13: Numerical Solution of Ordinary Differential Equations: Euler's Method, Rung-Kutta method (Order 4) (Sections 13.3 and 13.6).
Chapter 14: Eigenvalue problems: Polynomial Method, Power method. (Sections 14.5 and 14.6)

PRACTICAL PART

The following programs in Python have to be done on a computer and a record of algorithm,
Printout of the program and printout of solution as shown by the computer for each program should be maintained. These should be bound together and submitted to the examiners at the time of practical examination.

Sample Programs (Recommended)

GCD of two numbers
To Check an integer prime
Evaluation of Totient Function
Writing of Fibonacci sequence
Listing of prime numbers
Average and maximum of a set of numbers

Programs (Compulsory)

Part A

Lagrange Interpolation
Newton's Interpolation Bisection Method
Newton-Raphson Method
Numerical Differentiation of continuous function
Numerical Differentiation of tabulated function
Trapezoidal rule of Integration
Simpson's rule of Integration

Part B

Euler's method
Runge – Kutta method of order 4
Gauss elimination with pivoting
Bairstow Method of finding complex root
Runge – Kutta method of order 4
Gauss – Seidal iteration Eigen value
evaluation
Triangular Factorisation

REFERENCES

SD Conte and Carl De Boor : Elementary Numerical Analysis (An algorithmic approach) – 3rd edition, McGraw-Hill, New Delhi
K. Sankara Rao : Numerical Methods for Scientists and Engineers – Prentice Hall of India, New Delhi.
Carl E Froberg : Introduction to Numerical Analysis, Addison Wesley Pub Co, 2nd Edition
Knuth D.E. : The Art of Computer Programming: Fundamental Algorithms(Volume I), Addison Wesley, Narosa Publication, New Delhi.
Python Programming, wikibooks contributors
Programming Python, Mark Lutz,
Python 3 Object Oriented Programming, Dusty Philips, PACKT Open source Publishing
Python Programming Fundamentals, Kent D Lee, Springer
Learning to Program Using Python, Cody Jackson, Kindle Edition
Online reading http://pythonbooks.revolunet.com/

MT4E13 ALGEBRAIC TOPOLOGY

No. of Credits : 4

Number of hours of Lectures/week : 5

TEXT : FRED H. CROOM., BASIC CONCEPTS OF ALGEBRAIC TOPOLOGY, UTM, Springer Verlag ,NY, 1978.

(Pre requisites: Fundamentals of group theory and Topology)

Module – I

Geometric Complexes and Polyhedra: Introduction. Examples, Geometric Complexes and Polyhedra ;Orientation of geometric complexes. Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups, Examples of homology groups; The structure of homology groups; [Chap- ter 1 Sections 1.1 to 1.4; Chapter 2 Sections 2.1 to 2.3 from the text]

Module – II

Simplicial Homology Groups (Contd.): The Euler Poincare's Theorem; Pseu- domanifolds and the homology groups of Sn . Simplicial Approximation: Intro- duction ; Simplicial approximation ; Induced homomorphisms on the Homology groups; The Brouwer fixed point theorem and related results [Chapter 2 Sec- tions 2.4,2.5; Chapter 3 Sections 3.1 to 3.4 from the text]

Module – III

The Fundamental Group : Introduction; Homotopic Paths and the Funda- mental Group; The Covering Homotopy Property for S1; Examples of Funda- mental Groups. [Chapter 4 Sections 4.1 to 4.4 from the text]

REFERENCES

[1] Eilenberg S; Steenrod N., Foundations of Algebraic Topology, Princeton Univ. Press, 1952.

[2] S.T. Hu., Homology Theory, Holden-Day, 1965.

[3] 3. MasseyW.S., Algebraic Topology : An Introduction, Springer Verlag NY, 1977.

[4] 4. C.T.C. Wall., A Geometric Introduction to Topology, Addison-Wesley Pub. Co. Reading Mass, 1972.

MT4E14 DIFFERENTIAL GEOMETRY

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT: J.A.THORPE : ELEMENTARY TOPICS IN DIFFERENTIAL GEOMETRY
Springer – Verlag, New York.

Module – I

Graphs and Level Set, Vector fields, The Tangent Space, Surfaces, Vector Fields on Surfaces, Orientation. The Gauss Map. [Chapters : 1,2,3,4,5,6 from the text.]

Module – II

Geodesics, Parallel Transport, The Weingarten Map, Curvature of Plane Curves, Arc Length and Line Integrals. [Chapters : 7,8,9,10,11 from the text].

Module – III

Curvature of Surfaces, Parametrized Surfaces, Local Equivalence of Surfaces and Parametrized Surfaces. [Chapters 12,14,15 from the text]

REFERENCES

1. W.L. Burke : Applied Differential Geometry, Cambridge University Press (1985)
2. M. de Carmo : Differential Geometry of Curves and Surfaces, Prentice Hall Inc Englewood Cliffs NJ (1976)
3. V. Grilleman and A. Pollack : Differential Topology, Prentice Hall Inc Englewood Cliffs NJ (1974)
4. B. O'Neil : Elementary Differential Geometry, Academic Press NY (1966)
5. M. Spivak : A Comprehensive Introduction to Differential, Geometry, (Volumes 1 to 5), Publish or Perish, Boston (1970, 75)
6. R. Millmen and G. Parker : Elements of Differential Geometry, Prentice Hall Inc Englewood Cliffs NJ (1977)
7 I. Singer and J.A. Thorpe : Lecture Notes on Elementary Topology and Geometry, UTM, Springer Verlag, NY (1967)

MT4E15 WAVELET THEORY

No. of credits: 4

Number of hours of Lectures/week : 5

TEXT :Michael. W. Frazier, "An Introduction to Wavelets through Linear Algebra", Springer, Newyork, 1999.

Module - I

The discrete Fourier transforms :Basic Properties of Discrete Fourier Transforms , Translation invariant Linear Transforms ,The Fast Fourier Transforms.

Construction of wavelets on Z_N - The First Stage , Construction of Wavelets on Z_N – The Iteration Step.

Module - II

Wavelets on Z**:** l^2 (Z), Complete orthonormal sets in Hilbert spaces , $L^2(-\pi,\pi)$ and Fourier series ,The Fourier Transform and convolution on l^2 (Z) , First stage Wavelets on Z , Implementation and Examples.

Module - III

Wavelets on R : L^2 (R) and approximate identities , The Fourier transform on R , Multiresolution analysis , Construction of MRA .

References:

1. ***C.K. Chui , An introduction to wavelets, Academic Press,1992***

2. Jaideva. C. Goswami, Andrew K Chan, "Fundamentals of Wavelets Theory Algorithms and Applications", John Wiley and Sons, Newyork. , 1999.

3. Yves Nievergelt, "Wavelets made easy", Birkhauser, Boston,1999.

4. G. Bachman, L.Narici and E. Beckenstein , "Fourier and wavelet analysis", Springer, 2006

MT1V06 & MT3V16 VIVA VOCE EXAMINATIONS

Viva Voce in the FIRST and THIRD semesters are to be conducted in the presence of **two external examiners**. These viva voce must be based on the papers in the respective semesters. In the viva voce all the papers in that semester must be covered and each paper must have a minimum of 5 minutes duration. Total weightage of each viva voce is 18.

PROJECT

The Project in this Programme is to be done in the III & IV Semesters with a total credit of 4 including Project Viva. The work load per week of the Project is 5 hours each in III & IV Semesters. The Project Report (Dissertation) should be self contained. It should contain an introduction, necessary background and a reference list in addition to the main content. The main content may be of length not less than 30 pages in the A4 format with one and half line spacing.

Project Viva is to be conducted by a board consisting of one external and one internal (preferably the supervisor of the project) examiners and equal weightage must be given to the dissertation and the presentation of the student and half of that may be given to the viva. There must be a 20 minute presentation by the student followed by 10 minutes viva.

INTERNAL PROJECT

In Second semester, industry related applied mathematics project using Mathematical software is introduced which is considered for internal mark evaluation.

EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts.

(a) Internal Evaluation – 25% Weightage

(b) External Evaluation – 75% Weightage

Both Internal and External evaluation shall be carried out using direct grading system as per the general guidelines. Internal evaluation must consist of (i) 2 tests (ii) 1 assignment or seminar (iii) attendance.

Rules for the Conduct of Viva Voce of Project

1. Evaluation of candidates is to be done by both the Internal and External Examiners.
2. The Grade Sheet is to be consolidated and must be signed by both the Internal and External Examiners.

QUESTION PAPER PATTERN FOR THE WRITTEN EXAMINATIONS OF ALL COURSES

For each course there will be an external examination of duration 3 hours. The valuation will be done by Direct Grading System. Each question paper will consists of 14 short answer questions, each of weightage 1, 10 paragraph type questions each of weightage 2 and 4 essay type questions, each of weightage 4. All short answer questions are to be answered while 7 paragraph type questions and 2 essay type questions are to be answered with a total weightage of 36. The questions are to be evenly distributed over the entire syllabus.
