SEMESTER 1

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/Audit Course
MTH1C01	Algebra- I	4	5	core
MTH1C02	Linear Algebra	4	5	core
MTH1C03	Real Analysis I	4	5	core
MTH1C04	Discrete Mathematics	4	5	core
MTH1C05	Number Theory	4	5	core
MTH1A01	Ability Enhancement Course[a]	4	0	Audit Course

SEMESTER 2

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
MTH2C06	Algebra- II	4	5	core
MTH2C07	Real Analysis II	4	5	core
MTH2C08	Topology	4	5	core
MTH2C09	ODE & calculus of variations	4	5	core
MTH2C10	Operations Research	4	5	core
	Professional Competency Course[a]	4	0	Audit Course

SEMESTER 3

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/Elective
MTH 3C11	Multivariable Calculus & Geometry	4	5	core
MTH3C12	Complex Analysis	4	5	core
MTH3C13	Functional Analysis	4	5	core
MTH3C14	PDE & Integral Equations	4	5	core
	Elective I*	3	5	Elec.

SEMESTER 4

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/Elective
MTH4C15	Advanced Functional Analysis	4	5	Core
	Elective II**	3	5	Elec.
	Elective III**	3	5	Elec.
	Elective IV**	3	5	Elec.
MTH4P01	Project	4	5	Core
MTH4 V01	Viva Voce	4		Core

[a] Evaluation of these courses will be as per the latest PG regulations.

* This Elective is to be selected from list of elective courses in third semester

Detailed Syllabi

Semester 1

MTH1C01: ALGEBRA - I

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

TEXT : JOHN B. FRALEIGH, A FIRST COURSE IN ABSTRACT ALGEBRA(7^{th} Edn.), Pearson Education Inc., 2003.

Module 1

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 2

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 3

Group Presentations, Rings of polynomials, Factorization of polynomials over a field, Non Commutative examples, Homomorphism and factor rings[sections 40, 22, 23, 24, 26].

References

[1] **N. Bourbaki**: Elements of Mathematics: Algebra I, Springer; 1998.

[2] **Dummit and Foote**: Abstract algebra(3rd edn.); Wiley India; 2011.

[3] **P.A. Grillet**: Abstract algebra(2nd edn.); Springer; 2007

[4] **I.N. Herstein**: Topics in Algebra(2nd Edn); John Wiley & Sons, 2006.

[5] **T.W. Hungerford**: Algebra; Springer Verlag GTM 73(4th Printing); 1987.

[6] **N. Jacobson**: Basic Algebra-Vol. I; Hindustan Publishing Corporation(India), Delhi; 1991.

[7] **T.Y. Lam**: Exercises in classical ring theory(2nd edn); Springer; 2003.

[8] **C. Lanski**: Concepts in Abstract Algebra; American Mathematical Society; 2010.

[9] **N.H. Mc Coy**: Introduction to modern algebra, Literary Licensing, LLC; 2012.

[10] **S. M. Ross**: Topics in Finite and Discrete Mathematics; Cambridge; 2000.

[11] **J. Rotman**: An Introduction to the Theory of Groups(4th edn.); Springer, 1999.

Semester 1

MTH1C02: LINEAR ALGEBRA

No. of Credits: 4

No. Of hours of Lectures/week: 5

TEXT : HOFFMAN K. and KUNZE R., LINEAR ALGEBRA(2^{nd} Edn.), Prentice-Hall of India, 1991.

Module 1

Vector Spaces & Linear Transformations [Chapter 2 Sections 2.1 - 2.4; Chapter 3, Sections 3.1 to 3.3 from the text]

Module 2

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 3

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] **A. K. Hazra**: Matrix: Algebra, Calculus and generalised inverse- Part I; Cambridge International Science Publishing; 2007.

[3] **I. N. Herstein**: Topics in Algebra; Wiley Eastern Ltd Reprint; 1991.

[4] **S. Kumaresan**: Linear Algebra-A Geometric Approach; Prentice Hall of India; 2000.

[5] **S. Lang**: Linear Algebra; Addison Wesley Pub.Co.Reading, Mass; 1972.

[6] **S. Maclane and G. Bikhrkhoff**: Algebra; Macmillan Pub Co NY; 1967.

[7] **N. H. McCoy and R. Thomas**: Algebra; Allyn Bacon Inc NY; 1977.

[8] **R. R. Stoll and E.T.Wong**: Linear Algebra; Academic Press International Edn; 1968.

[9] **G. Strang**: linear algebra and its applications(4th edn.); Cengage Learning; 2006.

Semester 1

MTH1C03: REAL ANALYSIS I

No. of Credits: 4

No. Of hours of Lectures/week: 5

TEXT : RUDIN W., PRINCIPLES OF MATHEMATICAL ANALYSIS(3^{rd} Edn.), Mc. Graw-Hill, 1986.

Module 1

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 2

Differentiation The derivative of a real function, Mean Value theorems, The continuity of Derivatives, L Hospitals Rule, Derivatives of Higher Order, Taylors Theorem, Differentiation of Vector valued functions. The Riemann Stieltjes Integral, - Definition and Existence of the integral, properties of the integral, Integration and Differentiation[Chapter 5 & Chapter 6 up to and including 6.22].

Module 3

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] **H. Amann and J. Escher**: Analysis-I; Birkhuser; 2006.

[2] **T. M. Apostol**: Mathematical Analysis(2nd Edn.); Narosa; 2002.

[3] **R. G. Bartle**: Elements of Real Analysis(2nd Edn.); Wiley International Edn.; 1976.

[4] **R. G. Bartle and D.R. Sherbert**: Introduction to Real Analysis; John Wiley Bros; 1982.

[5] **J. V. Deshpande**: Mathematical Analysis and Applications- an Introduction; Alpha Science International; 2004.

[6] **V. Ganapathy Iyer**: Mathematical analysis; Tata McGrawHill; 2003.

[7] **R. A. Gordon**: Real Analysis- a first course(2nd Edn.); Pearson; 2009.

[8] **F. James**: Fundamentals of Real analysis; CRC Press; 1991.

[9] **A. N. Kolmogorov and S. V. Fomin**: Introductory Real Analysis; Dover Publications Inc; 1998.

[10] **S. Lang**: Under Graduate Analysis(2nd Edn.);Springer-Verlag; 1997.

[11] **M. H. Protter and C. B. Moray**: A first course in Real Analysis; Springer Verlag UTM; 1977.

[12] **C. C. Pugh**: Real Mathematical Analysis, Springer; 2010.

[13] **K. A. Ross**: Elementary Analysis- The Theory of Calculus(2nd edn.); Springer; 2013.

[14] **A. H. Smith and Jr. W.A. Albrecht**: Fundamental concepts of analysis; Prentice Hall of India; 1966

[15] **V. A. Zorich**: Mathematical Analysis-I; Springer; 2008.

Semester 1

MTH1C04: DISCRETE MATHEMATICS

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT 1: R. BALAKRISHNAN and K. RANGANATHAN, A TEXT BOOK OF GRAPH THEORY, Springer-Verlag New York, Inc., 2000.

TEXT 2: K. D JOSHI, FOUNDATIONS OF DISCRETE MATHEMATICS, New Age International(P) Limited, New Delhi, 1989.

TEXT 3: PETER LINZ, AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA (2^{nd} Edn.), Narosa Publishing House, New Delhi, 1997.

Module 1

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

Module 2

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, Trees-Definition, 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 1 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 3

Automata and Formal Languages: Introduction to the theory of Computation: Three basic concepts, some applications, Finite Automata: Deterministic finite accepters, Non deterministic accepters, Equivalence of deterministic and nondeterministic finite accepters . [TEXT 3 - Chapter 1 (sections 1.2 & 1.3); Chapter 2 (sections 2.1, 2.2 & 2.3)]

References

[1] **J. C. Abbot**: Sets, lattices and Boolean Algebras; Allyn and Bacon, Boston; 1969.

[2] **J. A. Bondy, U.S.R. Murty**: Graph Theory; Springer; 2000.

[3] **S. M. Cioaba and M.R. Murty**: A First Course in Graph Theory and Combinatorics; Hindustan Book Agency; 2009.

[4] **J. A. Clalrk**: A first look at Graph Theory; World Scientific; 1991.

[5] **Colman and Busby**: Discrete Mathematical Structures; Prentice Hall of India; 1985.

[6] **C. J. Dale**: An Introduction to Data base systems(3rd Edn.); Addison Wesley Pub Co., Reading Mass; 1981.

[7] **R. Diestel**: Graph Theory(4th Edn.); Springer-Verlag; 2010

[8] **S. R. Givant and P. Halmos**: Introduction to boolean algebras; Springer; 2009.

[9] **R. P. Grimaldi**: Discrete and Combinatorial Mathematics- an applied introduction(5th edn.); Pearson; 2007.

[10] **J. L. Gross**: Graph theory and its applications(2nd edn.); Chapman & Hall/CRC; 2005.

[11] **F. Harary**: Graph Theory; Narosa Pub. House, New Delhi; 1992.

[12] **D. J. Hunter**: Essentials of Discrete Mathematics(3rd edn.); Jones and Bartlett Publishers; 2015.

[13] **A. V. Kelarev**: Graph Algebras and Automata; CRC Press; 2003

[14] **D. E. Knuth**: The art of Computer programming -Vols. I to III; Addison Wesley Pub Co., Reading Mass; 1973.

[15] **C. L. Liu** : Elements of Discrete Mathematics(2nd Edn.); Mc Graw Hill International Edns. Singapore; 1985.

[16] **L. Lovsz, J. Pelikn and K. Vesztergombi**: Discrete Mathematics: Elementary and beyond; Springer; 2003.

[17] **J. G. Michaels and K.H. Rosen**: Applications of Discrete Mathematics; McGraw-Hill International Edn. (Mathematics & Statistics Series); 1992.

[18] **Narasing Deo**: Graph Theory with applications to Engineering and Computer Science; Prentice Hall of India; 1987.

[19] **W. T. Tutte**: Graph Theory; Cambridge University Press; 2001

[20] **D. B. West**: Introduction to graph theory; Prentice Hall; 2000.

[21] **R. J. Wilson** : Introduction to Graph Theory; Longman Scientific and Technical Essex(co-published with John Wiley and sons NY); 1985.

Semester 1

MTH1CO5: 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.

TEXT 2: KOBLITZ NEAL A., COURSE IN NUMBER THEROY AND CRYPTOGRAPHY, SpringerVerlag, NewYork, 1987.

Module 1

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 2

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

Module 3

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 1 and 2 of Text 2.]

References

[1] **A. Beautelspacher**: Cryptology; Mathematical Association of America (Incorporated); 1994

[2] **H. Davenport**: The higher arithmetic(6th Edn.); Cambridge Univ.Press; 1992

[3] **G. H. Hardy and E.M. Wright**: Introduction to the theory of numbers; Oxford International Edn; 1985

[4] **A. Hurwitz & N. Kritiko**: Lectures on Number Theory; Springer Verlag ,Universitext; 1986

[5] **T. Koshy**: Elementary Number Theory with Applications; Harcourt / Academic Press; 2002

[6] **D. Redmond**: Number Theory; Monographs & Texts in Mathematics No: 220; Marcel Dekker Inc.; 1994

[7] **P. Ribenboim**: The little book of Big Primes; Springer-Verlag, New York; 1991

[8] **K.H. Rosen**: Elementary Number Theory and its applications(3rd Edn.); Addison Wesley Pub Co.; 1993

[9] **W. Stallings**: Cryptography and Network Security-Principles and Practices; PHI; 2004

[10] **D.R. Stinson**: Cryptography- Theory and Practice(2nd Edn.); Chapman & Hall / CRC (214. Simon Sing : The Code Book The Fourth Estate London); 1999

[11] **J. Stopple**: A Primer of Analytic Number Theory-From Pythagorus to Riemann; Cambridge Univ Press; 2003

[12] **S.Y. Yan**: Number Theroy for Computing(2nd Edn.); Springer-Verlag; 2002

SEMESTER 2

MTH2C06: ALGEBRA II

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT: John B. Fraleigh: A FIRST COURSE IN ABSTRACT ALGEBRA(7^{th} Edn.), Pearson Education Inc., 2003.

Module 1

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 2

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

Module 3

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

References

[1] **N. Bourbaki**: Elements of Mathematics: Algebra I, Springer; 1998

[2] **Dummit and Foote**: Abstract algebra(3rd edn.); Wiley India; 2011

[3] **M.H. Fenrick**: Introduction to the Galois correspondence(2nd edn.); Birkhuser; 1998

[4] **P.A. Grillet**: Abstract algebra(2nd edn.); Springer; 2007

[5] **I.N. Herstein**: Topics in Algebra(2nd Edn); John Wiley & Sons, 2006.

[6] **T.W. Hungerford**: Algebra; Springer Verlag GTM 73(4th Printing); 1987

[7] **C. Lanski**: Concepts in Abstract Algebra; American Mathematical Society; 2010

[8] **R. Lidl and G. Pilz** Appli:ed abstract algebra(2nd edn.); Springer; 1998

[9] **N.H. Mc Coy**: Introduction to modern algebra, Literary Licensing, LLC; 2012

[10] **J. Rotman**: An Introduction to the Theory of Groups(4th edn.); Springer; 1999

[11] **I. Stewart**: Galois theory(3rd edn.); Chapman & Hall/CRC; 2003

SEMESTER 2

MTH2CO7: REAL ANALYSIS II

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT : H. L.Royden ,P. M. FitzpatrickH.L. REAL ANAYLSIS (4th Edn.), Prentice Hall of India, 2000.

Module 1

The Real Numbers:Sets, Sequences and Functions
Chapter 1 : Sigma Algebra , Borel sets Section 1.4 : Proposition13
Lebesgue Measure Chapter 2 : Sections 2.1, 2.2 ,2.3 ,2.4 ,2.5 ,2.6,2.7 upto preposition19.
Lebesgue Measurable Functions Chapter 3 : Sections 3.1, 3.2 , 3.3

Module 2

Lebesgue Integration Chapter 4 : Sections 4.1, 4.2, 4.3, 4.4, 4.5 , 4.6
Lebesgue Integration: Further Topics Chapter 5 : Sections: 5.1, 5.2 ,5.3

Module 3

Differentiation and Integration Chapter 6 : Sections 6.1, 6.2, 6.3 6.4, 6.5,6.6 The L^pspaces : Completeness and Approximation Chapter 7 : Sections 7.1 ,7.2 ,7.3

References

[1] **K B. Athreya and S N Lahiri:**,Measure theory,Hindustan Book Agency,New Delhi,(2006).

[2] **R G Bartle:**, The Elements of Integration and Lebsgue Mesure , Wiley(1995).

[3] **S K Berberian:** ,measure theory and Integration,The Mc Millan Company,New York,(1965).

[4] **L M Graves:** ,The Theory of Functions of Real Variable Tata McGraw-Hill Book Co(1978)

[5] **P R Halmos:** , Measure Theory, GTM ,Springer Verlag

[6] W Rudin:, Real and Complex Analysis,Tata McGraw Hill,New Delhi,2006

[7] **I K Rana:**,An Introduction to Measure and Integration,Narosa Publishing Company,New York.

[8] **Terence Tao:** ,An Introduction to Measure Theory,Graduate Studies in Mathematics,Vol 126 AMS

SEMESTER 2

MTH2C08: TOPOLOGY

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT : JOSHI, K.D., INTRODUCTION TO GENERAL TOPOLOGY (Revised Edn.), New Age International(P) Ltd., New Delhi, 1983.

Module 1

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 2

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

Module 3

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] **M.A. Armstrong**: Basic Topology; Springer- Verlag New York; 1983

[2] **J. Dugundji**: Topology; Prentice Hall of India; 1975

[3] **M. Gemignani**: Elementary Topology; Addison Wesley Pub Co Reading Mass; 1971

[4] **M.G. Murdeshwar**: General Topology(2nd Edn.); Wiley Eastern Ltd; 1990

[5] **G.F. Simmons**: Introduction to Topology and Modern Analysis; McGraw-Hill International Student Edn.; 1963

[6] **S. Willard**: General Topology; Addison Wesley Pub Co., Reading Mass; 1976

SEMESTER 2

MTH2C09: 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, New Delhi, 1974.

Module 1

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 2

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 3

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 and G.C. Rota**: Ordinary Differential Equations(3rd Edn.); Edn. Wiley & Sons; 1978

[2] **W.E. Boyce and R.C. Diprima**: Elementary Differential Equations and boundary value problems(2nd Edn.); John Wiley & Sons, NY; 1969

[3] **A. Chakrabarti**: Elements of ordinary Differential Equations and special functions; Wiley Eastern Ltd., New Delhi; 1990

[4] **E.A. Coddington**: An Introduction to Ordinary Differential Equtions; Printice Hall of India, New Delhi; 1974

[5] **R.Courant and D. Hilbert**: Methods of Mathematical Physics- vol I; Wiley Eastern Reprint; 1975

[6] **P. Hartman**: Ordinary Differential Equations; John Wiley & Sons; 1964

[7] L.S. Pontriyagin : A course in ordinary Differential Equations Hindustan Pub. Corporation, Delhi; 1967

[8] **I. Sneddon**: Elements of Partial Differential Equations; McGraw-Hill International Edn.; 1957

SEMESTER 2

MTH2C10: 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., 1996.

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

Module 1

Convex Functions; Linear Programming [Chapter 2 : Sections 11 to 12 ; Chapter 3 : Sections 1 to 15, 17 from the text]

Module 2

Linear Programming (contd.); Transportation Problem [Chapter 3 : Sections 18 to 20, 22; Chapter 4 Sections 1 to 11, 13 from the text]

Module 3

Integer Programming; Sensitivity Analysis [Chapter 6 : Sections 1 to 9; Chapter 7 Sections 1 to 10 from the text] Flow and Potential in Networks; Theory of Games [Chapter 5 : Sections 1 to 4, 6 7; Chapter 12 : all Sections]

References

[1] **R.L. Ackoff and M.W. Sasioni**: Fundamentals of Operations Research; Wiley Eastern Ltd. New Delhi; 1991

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

[3] **G. Hadley**: Linear Programming; Addison-Wesley Pub Co Reading, Mass; 1975

[4] **G. Hadley**: Non-linear and Dynamic Programming; Wiley Eastern Pub Co. Reading, Mass; 1964

[5] **H.S. Kasana and K.D. Kumar**: Introductory Operations Research-Theory and Applications; Springer-Verlag; 2003

[6] **R. Panneerselvam**: Operations Research; PHI, New Delhi(Fifth printing); 2004

[7] **A. Ravindran, D.T. Philips and J.J. Solberg**: Operations Research-Principles and Practices(2nd Edn.); John Wiley & Sons; 2000

[8] **G. Strang**: Linear Algebra and Its Applications(4th Edn.); Cengage Learning; 2006

[9] **Hamdy A. Taha**: Operations Research- An Introduction(4th Edn.); Macmillan Pub Co. Delhi; 1989

SEMESTER 2 (PCC)

MTH2A02: TECHNICAL WRITING WITH LaTeX (PCC)

No. of Credits: 4

1. Installation of the software LaTeX
2. Understanding LaTeX compilation
3. Basic Syntex, Writing equations, Matrix, Tables
4. Page Layout : Titles, Abstract, Chapters, Sections, Equation references, citation.
5. List making environments
6. Table of contents, Generating new commands
7. Figure handling, numbering, List of figures, List of tables, Generating bibliography and index
8. Beamer presentation
9. Pstricks: drawing simple pictures, Function plotting, drawing pictures with nodes
10. Tikz:drawing simple pictures, Function plotting, drawing pictures with nodes

References

[1] **L. Lamport**: A Document Preparation System, User's Guide and Reference Manual, Addison-Wesley, New York, second edition, 1994.

[2] **M.R.C. van Dongen**:LaTeX and Friends, Springer-Verlag Berlin Heidelberg 2012.

[3] **Stefan Kottwitz**: LaTeX Cookbook, Packt Publishing 2015.

[4] **David F. Griffths and Desmond J. Higham**: Learning LaTeX (second edition), Siam 2016.

[5] **George Gratzer**: Practical LaTeX, Springer 2015.

[6] **W. Snow**: TeX for the Beginner. Addison-Wesley, Reading, 1992

[7] **D. E. Knuth**:The TeX Book. Addison-Wesley, Reading, second edition, 1986

[8] **M. Goossens, F. Mittelbach, and A. Samarin** :The LaTeXCompanion. Addison-Wesley, Reading, MA, second edition, 2000.

[9] **M. Goossens and S. Rahtz**:TheLaTeXWeb Companion: Integrating TEX, HTML, and XML. Addison-Wesley Series on Tools and Techniques for Computer Typesetting. Addison-Wesley, Reading, MA, 1999.

[10] **M. Goossens, S. Rahtz, and F. Mittelbach**: The LaTeXGraphics Companion: Illustrating Documents with TeX and PostScript. Addison-Wesley Series on Tools and Techniques for Computer Typesetting. Addison-Wesley, New York, 1997

SEMESTER 3

MTH3C11: MULTIVARIABLE CALCULUS AND GEOMETRY

No. of Credits: 4

No. of hours of Lectures/week: 5

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

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

Module 1

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 2

What is a curve? Arc-length, Reparametrization, Closed curves, 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 3

Level surfaces, Ruled surfaces and surfaces of revolution, Applications of the inverse function theorem, Lengths of curves on surfaces, Equiareal maps and a theorem of Archimedes, The second fundamental form, The Gauss and Weingarten maps, Normal and geodesic curvatures. Gaussian and mean curvatures, Principal curvatures of a surface. [Chapter 5 Sections 1 , 3 & 6, Chapter 6 Sections 1 and 4(up to and including 6.4.3) Chapter 7 Sections 1 – 3, Chapter 8 Sections 1 – 2 from Text - 2]

References

[1] **M. P. do Carmo**: Differential Geometry of Curves and Surfaces;

[2] **W. Klingenberg**: A course in Differential Geometry;

[3] **J. R. Munkres**: Analysis on Manifolds; Westview Press; 1997

[4] **C. C. Pugh**: Real Mathematical Analysis, Springer; 2010

[5] **M. Spivak:** A Comprehensive Introduction to Differential Geometry-Vol. I; Publish or Perish, Boston; 1970

[6] **M. Spivak**: Calculus on Manifolds; Westview Press; 1971

[7] **V.A. Zorich**: Mathematical Analysis-I; Springer; 2008

SEMESTER 3

MTH3C12: COMPLEX ANALYSIS

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT : JOHN B. CONWAY, FUNCTIONS OF ONE COMPLEX VARIABLE(2nd Edn.); Springer International Student Edition; 1992

Module 1

The extended plane and its spherical representation, Power series, Analytic functions, Analytic functions as mappings, Mobius transformations, Riemann-Stieltijes integrals [Chapt. I Section 6;,Chapt. III Sections 1, 2 and 3; Chapter IV Section 1]

Module 2

Power series representation of analytic functions, Zeros of an analytic function,The index of a closed curve, Cauchy's Theorem and Integral Formula, The homotopic version of Cauchys Theorem and simple connectivity, Counting zeros; theOpen Mapping Theorem and Goursats Theorem.

Module 3

The classification of singularities, Residues, The Argument Principle and The Maximum Principle, Schwarz's Lemma, Convex functions and Hadamards three circles theorem [Chapt. V: Sections 1, 2, 3; Chapter VI Sections 1, 2, 3]

References

[1] **H. Cartan**: Elementary Theory of analytic functions of one or several variables; Addison - Wesley Pub. Co.; 1973

[2] **T.W. Gamelin**: Complex Analysis; Springer-Verlag, NY Inc.; 2001

[3] **T.O. Moore and E.H. Hadlock**: Complex Analysis, Series in Pure Mathematics-Vol. 9; World Scientific; 1991

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

[5] **R. Remmert**: Theory of Complex Functions; UTM , Springer-Verlag, NY; 1991

[6] **W. Rudin**: Real and Complex Analysis(3rd Edn.); Mc Graw - Hill International Editions; 1987

[7] **H. Sliverman**: Complex Variables; Houghton Mifflin Co. Boston; 1975

SEMESTER 3

MTH3C13: FUNCTIONAL ANALYSIS

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT : YULI EIDELMAN, VITALI MILMAN & ANTONIS TSOLOMITIS; FUNCTIONAL ANALYSIS AN INTRODUCTION; AMS, Providence, Rhode Island, 2004

Module 1

Linear Spaces; normed spaces;first examples: Linear spaces, Normed spaces;first exaples, Holder's inequality, Minkowski's ineaquality, Topological and geometric notions, Quotient normed space, Completeness;completion. [Chapter 1 Sections 1.1- 1.5]

Module 2

Hilbert spaces: Basic notions; first examples, Cauchy- Schwartz ineaquality and Hilbertian norm,Bessels ineaquality,Completesystems, Gram-Schmidt orthogonalization procedure, orthogonal bases, Parseval' identity; Projection; orthgonal decompositions; Separable case, The distance from a point to a convex set, Orthogonal decomposition; linear functionals; Linear functionals in a general linear space,Bounded linear functionals, Bounded linear functionals in a Hilbert space, An example of a non separable Hilbert space. [Chapter 2; Sections 2.1-2.3(omit Proposition 2.1. 15)]

Module 3

The dual space; The Hahn Banach Theorem and its first consequences, corollories of the Hahn Banach theorem, Examples of dual spaces. Bounded linear Operators; Completeness of the space of bounded linear operators, Examples of linear operators, Compact operators, Compact sets, The space of compact boperators, Dual operators ,Operators of finite rank, Compactness of the integral operators in L2, Convergence in the space of bounded operators, Invertible operators[Chapter3; Sections 3.1 , 3.2; Chapter4; Sections 4.1- 4.7]

References

[1] **B. V. Limaye**: Functional Analysis, New Age International Ltd, New Delhi, 1996.

[2] **G. Bachman and L. Narici**: Functional Analysis; Academic Press, NY; 1970

[3] **J. B. Conway**: Functional Analysis; Narosa Pub House, New Delhi; 1978

[4] **J. Dieudonne**: Foundations of Modern analysis; Academic Press; 1969

[5] **W. Dunford and J. Schwartz**: Linear Operators - Part 1: General Theory; John Wiley & Sons; 1958

[6] **Kolmogorov and S.V. Fomin**: Elements of the Theory of Functions and Functional Analysis (English translation); Graylock Press, Rochaster NY; 1972

[7] **E. Kreyszig**: Introductory Functional Analysis with applications; John Wiley & Sons; 1978

[8] **F. Riesz and B. Nagy**: Functional analysis; Frederick Unger NY; 1955

[9] **W. Rudin**: Functional Analysis; TMH edition; 1978

[10] **W. Rudin**: Real and Complex Analysis(3rd Edn.); McGraw-Hill; 1987

SEMESTER 3

MTH3C14: PDE and Integral Equations

No. of Credits: 4

No. of hours of Lectures/week: 5

TEXT 1: AN INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS, YEHUDA PINCHOVER AND JACOB RUBINSTEIN, Cambridge University Press

TEXT 2: HILDEBRAND, F.B., METHODS OF APPLIED MATHEMATICS (2nd Edn.), Prentice-Hall of India, New Delhi, 1972.

Module 1

First-order equations: Introduction, Quasilinear equations, The method of characteristics, Examples of the characteristics method, The existence and uniqueness theorem, The Lagrange method, Conservation laws and shock waves, The eikonal equation, General nonlinear equations

Second-order linear equations in two indenpendent variables: Introduction, Classification, Canonical form of hyperbolic equations, Canonical form of parabolic equations, Canonical form of elliptic equations

The one-dimensional wave equation: Introduction, Canonical form and general solution, The Cauchy problem and d'Alemberts formula, Domain of dependence and region of influence, The Cauchy problem for the nonhomogeneous wave equation [Chapter 2, 3 and 4 from Text 1]

Module 2

The method of separation of variables: Introduction, Heat equation: homogeneous boundary condition, Separation of variables for the wave equation, Separation of variables for nonhomogeneous equations, The energy method and uniqueness, Further applications of the heat equation

Elliptic equations: Introduction, Basic properties of elliptic problems, The maximum principle, Applications of the maximum principle, Greens identities, The maximum principle for the heat equation, Separation of variables for elliptic problems, Poissons formula [Chapter 5 and 7 from Text 1]

Module 3

Integral Equations: Introduction, Relations between differential and integral equations, The Green's functions, Fredholom equations with separable kernels, Illustrative examples, Hilbert- Schmidt Theory, Iterative methods for solving Equations of the second kind. The Newmann Series, Fredholm Theory [Sections 3.1 3.3, 3.6 3.11 from the Text 2]

References

[1] **Amaranath T.**:Partial Differential Equations, Narosa, New Delhi, 1997.

[2] **A. Chakrabarti**: Elements of ordinary Differential Equations and special functions; Wiley Eastern Ltd, New Delhi; 1990

[3] **E.A. Coddington**: An Introduction to Ordinary Differential Equtions Printice Hall of India ,New Delhi; 1974

[4] **R. Courant and D.Hilbert**: Methods of Mathematical Physics-Vol I; Wiley Eastern Reprint; 1975

[5] **P. Hartman**: Ordinary Differential Equations; John Wiley & Sons; 1964

[6] **F. John**: Partial Differential Equations; Narosa Pub House New Delhi; 1986

[7] **Phoolan Prasad Renuka Ravindran**: Partial Differential Equations; Wiley Eastern Ltd, New Delhi; 1985

[8] **L.S. Pontriyagin**: A course in ordinary Differential Equations; Hindustan Pub. Corporation, Delhi; 1967

[9] **I. Sneddon**: Elements of Partial Differential Equations; McGraw-Hill International Edn.; 1957

SEMESTER 3(Elective)

MTH3E02: CRYPTOGRAPHY

No. of Credits: 3

No. of hours of Lectures/week : 5

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

Module 1

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 2

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

Module 3

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.

SEMESTER 4

MTH4C15 ADVANCED FUNCTIONAL ANALYSIS

No. of Credits: 4

No. of hours of Lectures/week: 5

Text YULI EIDELMAN, VITALI MILMAN & ANTONIS TSOLOMITIS; FUNCTIONAL ANALYSIS AN INTRODUCTION; AMS, Providence, Rhode Island, 2004.

Module 1

Spectrum, Fredholm Theory of Compact operators; Classification of spectrum, Fredholm Theory of Compact operators. Slf adjoint operators; General properties, Self adjoint compact operators, spectral theory, Minimax principle, Applications to integral operators. [Chapter5; Sections 5.1, 5.2; Chapter6; Sections 6.1, 6.2]

Module 2

Order in the space of self-adjoint operators, properties of the ordering; Projection operators; properties of projection in linear spaces, Orthoprojectios. Functions of Operators spectral decomposition; Spectral decomposition, The main inequality, Construction of the spectral integral, Hilbert Theorem[Chapter6; Sections6.3- 6.4, Chapter7, sections 7.1 , 7.2 upto and including statement of Theorem 7.2.1]

Module 3

The fundamental theorems and the basic methods; Auxiliary results, The Banach open mapping Theorem, The closed graph Theorem, The Banach- Steinhaus theorem, Bases in Banach spaces, Linear functionals;the Hahn Banach theorem, Separation of Convex sets. Banach Algebras; Preliminaries, Gelfand's theorem on maximal ideals[Chapter9 Sections9.1- 9.7; Chapter10, Sections10.1, 10.2]

References

[1] **B. V. Limaye**: Functional Analysis, New Age International Ltd, New Delhi, 1996.

[2] **R. Bhatia:** Notes on Functional Analysis TRIM series, Hindustan Book Agency

[3] **Kesavan S:** Functional Analysis TRIM series, Hindustan Book Agency

[4] **S David Promislow:** A First Course in Functional Analysis, John wiley & Sons, INC., (2008)

[5] **Sunder V.S:** Functional Analysis TRIM Series, Hindustan Book Agency

[6] **George Bachman &LawrenceNarici:** Functional Analysis Academic Press, NY (1970)

[7] **Kolmogorov and Fomin S.V:** Elements of the Theory of Functions and Functional Analysis. English Translation, Graylock, Press Rochaster NY (1972)

[8] **W.DunfordandJ.Schwartz:** Linear Operators Part1,GeneralTheory John Wiley & Sons (1958)

[9] **E.Kreyszig:** Introductory Functional Analysis with Applications John Wiley & Sons (1978)

[10] **F. Riesz and B. Nagy:** Functional Analysis Frederick Unger NY (1955)

[11] **J.B.Conway:** Functional Analysi Narosa Pub House New Delhi (1978)

[12] **Walter Rudin:** Functional Analysis TMH edition (1978)

[13] **Walter Rudin:** Introduction to Real and Complex Analysis TMH edition (1975)

[14] **J.Dieudonne:** Foundations of Modern Analysis Academic Press (1969)

[15] **YuliEidelman,Vitali Milman and Antonis Tsolomitis:** Functional analysis An Introduction, Graduate Studies in Mathematics Vol. 66 American Mathematical Society 2004.

SEMESTER 4 (Elective)

MTH4E08: COMMUTATIVE ALGEBRA

No. of Credits: 3

No. of hours of Lectures/week: 5

TEXT : ATIYAH M.F., MACKONALD I. G., INTRODUCTION TO COMMUTATIVE ALGEBRA, Addison Wesley, NY, 1969.

Module 1

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

Module 2

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

Module 3

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 Idials; Addison - Wesley; 1970

[3] **N. S. Gopalakrishnan**: Commutative Algebra; Oxonian Press; 1984

[4] **T.W. Hungerford**: Algebra; Springer Verlag GTM 73(4th Printing); 1987

[5] **D. G. Northcott**: Ideal Theory; Cambridge University Press; 1953

[6] **O. Zariski, P. Samuel**: Commutative Algebra- Vols. I & II; Van Nostrand, Princeton; 1960

SEMESTER 4 (Elective)

MTH4E09: DIFFERENTIAL GEOMETRY

No. of Credits: 3

No. of hours of Lectures/week : 5

TEXT : J.A.THORPE : ELEMENTARY TOPICS IN DIFFERENTIAL GEOMETRY

Module 1

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 2

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 3

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)

SEMESTER 4 (Elective)

MTH4E11: GRAPH THEORY

No. of Credits: 3

No. of hours of Lectures/week : 5

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

Module 1

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

Module 2

Matchings, Matchings and Coverings in Bipartite Graphs, Perfect Matchings, The Personnel Assignment Problem, Edge Chromatic Number, Vizings Theorem, The Timetabling Problem, Independent Sets, Ramseys Theorem

Module 3

Vertex Colouring-Chromatic Number, Brooks Theorem, Chromatic Polynomial, Girth and Chromatic Number, A Storage Problem, Plane and Planar Graphs, Dual Graphs, Eulers Formula, Bridges, Kuratowskis 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.