Swami Ramanand Teerth Marathwada University,

Vishnupuri, Nanded. (Maharashtra), India.

M.A. /M. Sc. (Mathematics) Syllabus Semester-III (For Campus School)

Swami Ramanand Teerth Marathwada University, Nanded.
SCHOOL OF MATHEMATICAL SCIENCES

M.Sc. (Mathematics)-II year (CGPA)

SEMESTER-III	
Paper No.	**Name of the paper**
MTU-301	Algebra II (Field Theory and Galois Theory) Theory)
MTU-302	Functional Analysis
Any three papers from MTU-303 to MTU- 310 **which will be taught in the School**	
MTU-303	Graph Theory
MTU-304	Operations Research
MTU-305	Advanced Number Theory
MTU-306	Lattice Theory
MTU-307	Coding Theory
MTU-308	Riemannian Geometry
MTU-309	Theory of Linear Operators
MTU-310	Wave Propagation
MTU-311 (Compulsory to all the students)	**Lab Course -III** MATLAB and Programmes using MATLAB : Optimization Problems, ODE and PDE, Mathematical Models

MTU-301: <u>Algebra II</u>

(Field Theory and Galois Theory)

(Maximum Number of Periods: 60)

UNIT 1: Algebraic Extension of fields: Irreducible polynomials and Eisenstein criterion (as a pre-requisite), adjunction of roots, algebraic extensions, algebraically closed fields.

UNIT 2: Normal and Separable extensions: Splitting fields, Normal extensions, multiple roots, finite fields, separable extensions.

UNIT 3: Galois Theory: Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of algebra.

UNIT 4: Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials, cyclic extensions, polynomials solvable by radicals, symmetric functions, ruler and compass constructions.

Text Book:

P. B. Bhattacharyya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (2e),
Cambridge University Press, Indian Edition.

Scope: Chapter no: 15, 16, 17 and 18.

Reference Books:

1. M. Artin, Algebra, Prentice-Hall of India Pvt. Ltd.
2. T. A. Hungerford, Algebra, Graduate Texts in Mathematics, Vol. 73, Springer-Verlag, 1980 (Indian Reprint 2004).

3. S. Lang, Algebra, 3rd Edition, Addison-Wesley, 1999

4. I. S. Luthar, I. B. S. Passi, Algebra, Vol. 1, Groups, Narosa Publishing House.

5. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.

MTU-302: Functional Analysis

(Maximum Number of Periods: 60)

Unit I : Banach Spaces:

Definition and some Examples, continuous linear transformations, The Hahn-Banach Theorem, The Natural embedding of N in N**. The open Mapping Theorem, The conjugate of an operator.

Unit II : Hilbert Spaces:

The definition and some simple properties, orthogonal complements, orthonormal sets, The conjugate space H*, The adjoint of an operator, self adjoint operators, Normal and Unitary Operators, projections.

Unit III : Finite Dimensional Spectral Theory:

Introduction, Matrices, Determinants and spectrum of an operator, The spectral Theorem.

Text Book : "Introduction to Topology and Modern Analysis" By G.F. Simmons McGraw-Hill Book Company, International student Edition, New York.

Scope : Articles 46 to 62

Reference books (1) B.V. Limaye, "Functional Analysis", Wiley Eastern Ltd.

(2) G. Bachman and L. Narici "Functional Analysis"

(3) Kreyszig , Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978Academic Press 1966.

(4) J. B. Conway, A course in functional analysis, Springer-Verlag, New York 1990.

(5) Foundations Of Functional Analysis , by S.Ponnusamy, Narosa Publishing House.

MTU-303: Graph Theory

(Maximum Number of Periods: 60)

Unit 1: Introduction to Graphs
 graphs, subgraphs, paths ,cycles, matrix representation of a graph, fusion

Unit 2: Trees and connectivity
definition and properties, bridges, spanning trees, cut vertices and connectivity

Unit 3: Euler tour and Hamiltonian cycles
 Euler tour, Euler Graph, the Chinese postman problem, Hamiltonian graphs, Travelling salesman Problem

Unit 4: Planar Graphs
planar graphs, Euler's formula, Kuratowski's theorem, Non-Hamiltonian plane graphs, the dual of a plane graph

Unit 5: Directed graphs and Networks
 definitions   and   properties,Tournaments,Traffic   flow,   The   Ford   and   Fulkerson Algorithm,Seperating sets.

Textbook:
A First Look at Graph Theory: John Clark and Derek Allan Holton Allied Publishers Ltd.
Chapters:-1, 2, 3,5,7,8

Reference Books:-
1) Graph Theory With Applications to Engineering and Computer Science:
    Narsing Deo ,Prentice Hall of India.

2) Graph Theory : F. Harare, Addison Wesley.

3) Introduction to Graph Theory: Douglas B. West, Prentice- Hall, New Delhi
    (1999)

4) Basic Graph Theory : K. R. Parthasarthy, Tata Mc Graw- Hill Pub Comp
    Limited Delhi.

MTU-304: Operations Research
(Maximum Number of Periods: 60)

Unit 1 (Pre-requisites):
 Operations research & its scope, Necessity of operations research in industry
 Introductions to Linear programming problems, General linear programming problems ,
Mathematical Formulation of L.P.P., Basic solution, Important theorems, solution of linear
programming problem, Graphical method for solution , convex set , some important theorems,
Revised simplex method, dual simplex method.

Unit 2: Theory of Simplex methods:
 Introduction, slack and surplus variables, some definitions and notations , Fundamental
theorems of linear programming, BSF from F.S., Improved B.S.F. Unbounded solution,
optimality of solutions, computational procedure of simplex method for the solution of a
maximization L.P.P., artificial variable technique., duality and sensitivity analysis.

Unit 3:
 Transportation and assignment Problems.

Unit 4: Game Theory:
 Introduction, competitive game, finite and infinite game, two person zero sum game,
rectangular game , solution of game, saddle point, solution of a rectangular game with saddle
point.

Unit 5;
 PERT-CPM, product planning control with PERT-CPM.

Text Books:
 1. Dr. R. K. Gupta "Linear Programming",Krishna Prakashan Mandir.
 2. F.S.Hillier and G.J.Liebermann, Introduction to Operations Research
 (6th Ed.) Mc Graw Hill International Edition, Industrial Engineering
 Series, 1995.
 3. Kantiswaroop, P.K.Gupta and Manmohan, Operations Research,
 Sultan Chand & Sons, New Delhi.

Reference Books: 1) G.Hadley, Linear Programming, Narosa publishing House, 1995.
 2) G.Hadley, Nonlinear and Dynamic Programming, Addison-Wesley,
 Reading Mass.
 3) H.A.Taha, Operations Research - An Introduction, Macmillan
 Publishing Company, Inc, New York.
 4) S.S.Rao, Optimization Theory and Applications, Wiley Eastern Ltd.,
 New Delhi.
 5) Prem Kumar Gupta and D.S.Hira, Operations Research - An
 Introduction. Chand & company Ltd, New Delhi.
 6) N.S.Kambo, Mathematical Programming Techniques. Affiliated
 East-West Press Pvt.Ltd, New Delhi, Madras.

Paper-XXI-Advanced Number Theory (MTU-305)

Unit 1:

Arithmetical functions: The Mobius function $\mu(n)$, Euler's phi function $\phi(n)$, von Mangoldt function $\Lambda(n)$, Liouville's function $\lambda(n)$, convolutions of arithmetical functions, averages of arithmetical functions, Euler Summation formula, derivative of arithmetical functions.

Unit 2:

Prime numbers, distribution of prime numbers, Chebyechevs functions $\theta(x), \psi(x)$, the prime counting function $\pi(x)$, the prime number theorem.

Unit 3:

Dirichlet Series and Euler Product, multiplication of Dirichlet series, its analytic properties, Dirichlet series with non-negative coefficients, mean value formulas for Dirichlet series.

Unit 4:

Riemann Zeta function $\zeta(s)$, analytical properties of $\zeta(s)$, study of the zeros of $\zeta(s)$, Riemann Hypothesis (RH) and some consequences of RH.

Syllabus:-

Unit 1: Apostol chapter 2 (2.1 to 2.14, 2.18), Chapter 3 (3.1 to 3.7)
Unit 2: Apostol Chapter 4 and Ingham's book
Unit 3: Apostol chapter 11
Unit 4: Titchmarsh and Ingham's book

Textbooks:-
1)Tom M.Apostol: "Introduction to Analytic Number Theory",Springer
                          International Student Edition.

2)E.C.Titchmarsh:"The Theory of Riemann Zeta Function"(second edition),revised
                          by D.R.Heath-Brown,Clarendon Press.Oxford
3)A.E.Ingham :"The Distribution of Prime Numbers",Cambridge University Press

References:-
1)H.M.Edward: "Riemann Zeta Function",Academic Press
2)G.H.Hardy and E.M.Wright, D.R.Heath-Brown, J.H.Silverman:"An Introduction
      to the Theory of Numbers"

3)A.J.Hildebrand:"Introduction to Analytic Number Theory"
4)Paul T.Bateman,Harold G. Diamond:"Analytic Number Theory:An Introductory
  Course",World Scientific

MTU-307: CODING THEORY

(Maximum number of periods: 60)

UNIT I: **Error detection, correction and decoding**: Communication channels, Maximum likelihood decoding, Hamming distance, Nearest neighbor / minimum distance decoding, Distance of a code.

UNIT II: **Linear codes**: Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes, Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome decoding.

UNIT III: **Cyclic codes**: Definitions, Generator polynomials, Generator and parity check matrices, Decoding of cyclic codes, Burst-error-correcting codes.

UNIT IV: **Some special cyclic codes**: BCH codes, Definitions, Parameters of BCH codes, Decoding of BCH codes.

Textbook: 1) San Ling and Chaoping Xing, "Coding Theory- A First Course", Cambridge University Press, 1st Edition
.

Scope: Chapters 2, 4, 6 and 8.

Reference Books:

1. Applied Abstract Algebra - Lid and Pilz 2nd Edition
2. Introduction to finite fields and their applications ,R. Lidl, H. Neiderreiter. Cambridge University   Press.
3. Fundamentals of error correcting codes, W.C.Haffman and Vera Pless. Cambridge University Press.(First Edition.)

MTU-308: <u>RIEMANNIAN GEOMETRY</u>
(Maximum number of periods: 60)

Unit-I :
Riemannian metric, metric tensor , Christoffel symbol,christoffel symbol of first kind, second kind, properties of christoffel symbols. Computations of Christoffel's symbols for static and non-static spherically symmetric and R-W space-times ,transformation of christoffel symbols, derivatives of tensor, absolute derivative. Covariant derivatives, divergence, gradient, laplacian.

Unit-II :
Parallel Vector Fields : Parallel vector field of constant magnitude, parallel displacement of covariant vector field, parallelism of a vector field of variable magnitude Geodesic :Differential equations of a geodesic, special co-ordinate system : Local cartesians, Riemannian co-ordinates, Normal co-ordinates, Geodesic normal co-ordinates.

Unit-III :
Curvature Tensor : Covariant curvature tensor of Riemann tensor , curvature tensor in Riemannian co-ordinates, properties of curvature tensors, on a cyclic property , number of independent companents of R

Unit-IV :
Ricci tensor, curvature invariant, Einstein tensor, Computations of Einstein's tensor for static and non-static spherically symmetric and R-W space times, the Bianchi identity . Geodesic deviation : Equations of Geodesic deviation.

Unit-V :
Riemannian curvature, space of constant curvature, flat space, cartesian tensor .

Reference Books :
(1) T. M. Karade, G .S. Khadekar and Maya S.Bendre, Lectures on General Relativity Sonu Nilu Publication.
(2) T .J.Willmore .An Introduction in Differential Geometry
(3) J. L. Synge,Tensor Calculus – Schild.(4) C.E. Weatherburn, An introduction to Riemannian geometry and tensor calculus, Cambridge university press, (1963
(5) L.P. Eisenhard, Riemannian geometry, University press Princeton (1926)
(6) J.A. Schouten, Ricci Calculus, Springer Verlag, Berlin (7) T.Y. Thomas, Concepts from tensor analysis and differential geometry, Academic press, New York
(8) W. Boothby, Introduction to differentiable manifold and Riemannian geometry, Academic press, 1975
(9) S. Kobayashi and K. Nomizu, Foundations of differential geometry,Vol. I and II Wiley Interscience publisher 1963 (Vol.I), 1969 (Vol. I)

MTU-309: Theory of Linear Operators

(Maximum Number of Periods: 60)

Unit I:

Spectral theory in normed linear spaces, resolvent set and spectrum, spectral properties of bounded linear operators. Properties of resolvent and spectrum. Spectral maping theorem for polynomials. Spectral radius of a bounded linear operator on a complex banach space. Elementary theory banach algebra.

Unit II:

General properties of compact linear operators. Spectral properties of compact linear operators on nomed spaces. Behaviors of compact linear operators with respect to solvability of operator equations. Fredholm type theorems. Fredholm alternative theorm. Fredholm alternative for integral equations.

Unit III:

Spectral properties of bounded self-adjoint linear operators on a complex Hibert space. Positive operators. Monotone Sequences theorem for bounded self-adjoint operators on a complex Hilbert space, Square roots of a positive operator.

Reference Books : 1. E. Kreyszig, Introductory functional analysis with applications, Johan-Wiley & Sons, New York, 1978.

2. P.R. Halmos, Introduction to Hilbert space and the theory of spectral multiplicity, 2nd Edn. Chelsea Pub., Co., N.Y. 1957.

3. N. Dunford and J.T. Schwartz, Linear operators-3 parts, Interscience Wiley, New York, 1958-71.

4. G. Bachman & Narici, Functional analysis, Aca-demic Press, New York, 1966.

5. Akniezer, N.I. and I.M. Glazman, Theory of linear operators in Hilbert space, Frederick Ungar Pub. Co. NY, Vol. 1 (1961), Vol. 2(1963).

6. P.R. Halmos, A Hilbert space problem book, D.Van Nostrand Co. Inc, 1967.

MTU-310: Wave Propagation

(Maximum Number of Periods: 60)

Unit I:

Introduction, SHM, damped harmonic oscillations, viscous damping, damped forced oscillations, wave equation in one, two & three dimensions, harmonic waves, spherical waves, super postion of waves & stationary waves, solution of equation of wave motion of stationary types (1)

Unit II:

Transverses waves on tightly stretched elastic string, derivation of the wave equation, normal vibration of finite continous sting with fixed ends, Fourier series solution for problem involving different intial conditions, vibration of a string with damping, expressions for kinetic & potential energy of a vibrating string, reflection of a waves at discontinuity of string. (1)

Unit III:

Transverse vibration of thin membrance, normal modes of vibrations of flexible rectangular drum head with fixed edges, normal vibration of a rectangular flexible drum head with fixed edges having given initial displacements & released from rest.

Text Books : 1. Gosh P.K., "The mathematics of waves and vibrations,"
Mc Millan Company of India Limited.

2. Ceulson C.A., "Waves. A mathematical account of the common types of wave motion: Oliver and Boyed."