FACULTY OF SCIENCES

SYLLABUS

FOR

M.Sc. MATHEMATICS
(Credit Based Evaluation & Grading System)
(Semester: I - IV)

Examinations: 2019-20

GURUNANAKDEVUNIVERSITY
AMRITSAR

(ii) Subject to change in the syllabi at any time.
Please visit the University website time to time.

M.Sc. Mathematics (Semester System)
(Credit Based Evaluation & Grading System)

Note : All Theory Papers having Mid Semester Marks : 20 & End Semester Marks : 80. Total Marks will be 100.

Programme Code: MTB

Master of Science in Mathematics

Total minimum credits required for M. Sc. Mathematics are 96.

*Out of 96 credits, student will choose minimum 8 credits interdisciplinary courses from other departments by choosing at least three credits course in each of the third and fourth semester.

Programme Code: MTB

Total minimum credits required for M. Sc. Mathematics are 96.

SEMESTER – I

Course No.	**C/E/I**	**Course Title**	**L**	**T**	**P**	**Total Credits**
Core Courses						
MTL 401	**C**	Real Analysis-I	**4**	**0**	**0**	**4**
MTL 402	**C**	Algebra-I	**4**	**0**	**0**	**4**
MTL 403	**C**	Linear Algebra	**4**	**0**	**0**	**4**
MTL 404	**C**	Number Theory	**4**	**0**	**0**	**4**
MTL 405	**C**	Complex Analysis	**4**	**0**	**0**	**4**
MTL 406	**C**	Differential Equations	**4**	**0**	**0**	**4**
Total Credit			**24**	**0**	**0**	**24**

SEMESTER – II

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses						
MTL 451	**C**	Real Analysis-II	**4**	**0**	**0**	**4**
MTL 452	**C**	Algebra-II	**4**	**0**	**0**	**4**
MTL 453	**C**	Probability Theory	**4**	**0**	**0**	**4**
MTL 454	**C**	Calculus of Several Variables	**4**	**0**	**0**	**4**
MTL 455	**C**	Differential Geometry	**4**	**0**	**0**	**4**
MTL 456	**C**	Mathematical Methods	**4**	**0**	**0**	**4**
Total Credit			**24**	**0**	**0**	**24**

***Note : PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper). Students can opt. this paper in any semester except the 1st Semester. This ID Paper is one of the total ID Papers of this course.**

M.Sc. Mathematics (Semester System)
(Credit Based Evaluation & Grading System)

SEMESTER-III

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses						
MTL 501	C	Measure Theory	4	0	0	4
MTL 502	C	Functional Analysis-I	4	0	0	4
MTL 503	C	Statistical Inference	3	0	1	4
Elective/Optional Courses (Choose any two courses)						
MTL 531	E	Operations Research-I	4	0	0	4
MTL 532	E	Discrete Mathematics-I	4	0	0	4
MTL 533	E	Fluid Dynamics	4	0	0	4
MTL 534	E	Advanced Numerical Analysis	4	0	0	4
MTL 535	E	Stochastic Process	4	0	0	4
MTL 537	E	Calculus of Several Variables	4	0	0	4
MTL 538	E	Commutative Algebra	4	0	0	4
MTL 539	E	Theory of Wavelets	4	0	0	4
MTL 541	E	Fourier Analysis	4	0	0	4
MTL-542	E	Topics in Linear Algebra	4	0	0	4
		***Interdisciplinary Courses**				**4**
Total Credits						

SEMESTER–IV

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses						
MTL 551	C	Topology	4	0	0	4
MTL 552	C	Functional Analysis-II	4	0	0	4
MTL 553	C	Field Extensions and Galois Theory	4	0	0	4
Elective/Optional Courses (Choose any two courses)						
MTL 581	E	Topological Vector Spaces	4	0	0	4
MTL 582	E	Computer Programming with C	3	0	1	4
MTL 583	E	Operations Research-II	4	0	0	4
MTL 584	E	Discrete Mathematics-II	4	0	0	4
MTL 586	E	Banach Algebra and Operator Theory	4	0	0	4
MTL 588	E	Financial Derivatives	4	0	0	4
MTL 589	E	Theories of Integration	4	0	0	4
MTL 590	E	Algebraic Topology	4	0	0	4
MTL 591	E	Theory of Sample Survey	4	0	0	4
MTL 592	E	Special Functions	4	0	0	4
MTL 593	E	Representation Theory of Finite Groups	4	0	0	4
MTL-594	E	Analytic Number Theory	4	0	0	4
Interdisciplinary Courses						**4**
Total Credits						

M.Sc. Mathematics (Semester-I)
(Credit Based Evaluation & Grading System)

MTL 401
REAL ANALYSIS-I

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Countable and uncountable sets. Metric spaces: Definition and examples, open sets, closed sets, compact sets, elementary properties of compact sets.

Section-B
Compactness of k- cells, Compact subsets of Euclidean space Rk . Heine Borel theorem, Perfect sets, The Cantor set, Separated sets, connected sets in a metric space, connected subsets of real line.

Section-C
Functions of Bounded Variation, Sequences in Metric Spaces: Convergent sequences (in Metric Spaces), subsequences, Cauchy sequences, Complete metric spaces, Cantor's Intersection Theorem, Baire's theorem, Banach contraction principle.

Section-D
Continuity: Limits of functions (in metric spaces) Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform Continuity.

Books Recommended:

1. Walter Rudin	: Principles of Mathematical Analysis (3rd Edition) McGraw-Hill Ltd., Ch.2, Ch.3.
2. Simmons, G.F.	: Introduction to Topology and Modern Analysis, McGraw-Hill Ltd. (App.1)
3. Shanti Narayan & P.K. Mittal	: A Course of Mathematical Analysis.
4. S.C. Malik & Savita Arora	: Mathematical Analysis, Wiley Eastern Ltd

M.Sc. Mathematics (Semester-I)
(Credit Based Evaluation & Grading System)

MTL 402
ALGEBRA-I

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Groups, Subgroups, Equivalence relations and partitions, generators and relations, Homomorphisms, Cosets, Normal subgroups, Simple groups, Quotient groups, Group actions, Lagrange's theorem, Conjugate elements, the Class equation, Isomorphism theorems, Cyclic Groups, Cauchy's theorem

Section-B
Composition series, the Jordan Holder theorem, Groups of automorphisms, Inner automorphisms, Symmetric groups, Alternating groups, Sylow's theorems, p-groups.

Section-C
Nilpotent groups, Simplicity of An $n \geq 5$, Cayley's theorem, the imbedding theorem, Commutator subgroup, Characteristic subgroup, Solvable groups, Sequences of subgroups.

Section-D
Direct product and semi direct product of groups, Fundamental theorem of finitely generated Abelian groups, Free groups, groups of symmetries, Groups of small order.

BOOKS RECOMMENDED:

1. Artin,. M	: Algebra, Prentice-Hall, 1991
2. Dummit, D.S.	: Abstract-Algebra, John-Wiley & Sons, Students Edition-1999 & Foote
3. Surjit Singh, and Zameerudin, Q	: Modern Algebra.
4 . J. Gallian.	: Contemporary Abstract Algebra

M.Sc. Mathematics (Semester-I)
(Credit Based Evaluation & Grading System)

MTL-403
LINEAR ALGEBRA

L-T-P: 4-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Vector spaces, Subspaces, Quotient Spaces, Basis and Dimension Theorems, Sum of subspaces, Direct sum decompositions, Linear transformations, The Algebra of linear transformations.

Section-B

Matrices associated with linear transformations, effect of change of ordered bases on the matrix of linear transformation, Elementary matrix operations and Elementary matrices, Row rank, Column rank and their equality, system of linear equations

Section-C

Eigen values and Eigen vectors of linear operators, Characteristic and minimal polynomials, companion matrix, subspaces invariant under linear operators, triangulation, Diagonalization, Linear Functionals, Dual Spaces and dual basis, the double dual

Section-D

Inner Product Spaces, The Gram-Schmidt Orthogonalization, Orthogonal Complements, The Adjoint of a linear operator on an inner product space, Normal and Self-Adjoint Operators, Unitary and Normal Operators, Spectral Theorem

Recommended Books:

1. Hoffman, K. and Kunze, R. : Linear Algebra, Second Edition, Prentice Hall, 1971.
2. Axler, S.: Linear Algebra Done Right, Second Edition, Springer-Verlag, 1997.
3. Friedberg, S.H., Insel, A.J, Spence, L.E. : Linear Algebra, Fourth Edition, Prentice Hall, 2003.
4. Lang, S.: Linear Algebra, Third Edition, Springer-Verlag, 1987.
5. Sahai, Vivek and Bist, Vikas: Linear Algebra, Narosa Publishing House, 2008

M.Sc. Mathematics (Semester-I)
(Credit Based Evaluation & Grading System)

MTL-404
NUMBER THEORY

L-T-P: 4-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

The sum of non-negative divisors of an integer, Number of divisors of an integer, Multiplicative functions, The Mobius function, Mobius Inversion formula, The greatest integer function, Euler's Phi-function and its properties.

Section-B

The order of an integer modulo n, primitive roots for primes, Composite Numbers having primitive roots, theory of indices and its applications to solving congruences.

Section-C

Quadratic residues modulo a prime, Euler's criterion, The Legendre symbol and its properties, Gauss Lemma, Quadratic reciprocity law, Jacobi's symbol and its properties, Phythagoren triplets, Insolvability of the Diophantine Equations: $x^4 + y^4 = z^4, x^4 - y^4 = z^2$ in positive integers.

Section-D

Representation of an integer as a sum of two squares and sum of four squares, Finite and Infinite continued fractions, convergents of a continued fraction and their properties, Pell's equation.

Recommended Books:

1. David M. Burton: Elementary Number Theory, Mc Graw Hill 2002.
2. Hardy and wright: The Theory of Numbers.

M.Sc. Mathematics (Semester-I)
(Credit Based Evaluation & Grading System)

MTL 405
COMPLEX ANALYSIS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Functions of complex variables, limit, continuity and differentiability, Analytic functions, Conjugate function, Harmonic function. Cauchy Riemann equations (Cartesian and Polar form). Construction of analytic functions.

Section-B
Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form. Cauchy's inequality. Poisson's integral formula, Morera's theorem. Liouville's theorem. Power Series and its circle of convergence.

Section-C
Taylor's theorem, Laurent's theorem. Zeros and Singularities of an analytic function, Residue at a pole and at infinity, Cauchy's Resiude theorem, Integration round unit circle, Evaluation of integrals of the type $\int_{-\square}^{\square} f(x)dx$

Section-D
Jordan's lemma, Fundamental theorem of algebra, Argument principle, Rouche's theorem, Conformal transformations, Bilinear transformations, critical points, fixed points, cross ratio, Problems on cross ratio and bilinear transformation.

BOOKS RECOMMENDED:

1. Copson, E.T.: Theory of functions of complex variables.
2. Ahlfors, D. V.: Complex analysis.
3. Titchmarsh, E.C. Theory of functions of a complex variable.
4. Conway, J.B. Functions of one complex variable

M.Sc. Mathematics (Semester-I)
(Credit Based Evaluation & Grading System)

MTL 406
DIFFERENTIAL EQUATIONS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Existence and uniqueness theorem for solution of the equation $\frac{dx}{dy} = f(x, y)$, the method of successive approximation, general properties of solution of linear differential equation of order n, adjoint and self-adjoint equations. Total differential equations. Simultaneous differential equations.

Section-B

Sturm Liouville's boundary value problems. Sturm comparison and Separation theorems. First order PDE's., Integral surface through a given curve. Surface orthogonal to given system of surfaces.

Section-C

Non linear PDE's of first order, Charpit's method and Jacobi's method, PDE's of the 2nd order. Linear PDE's with constant coefficients. Second order PDE's with variable coefficients and their classification.

Section-D

Non-linear PDE's of second order, Monge's Method. Solution of linear hyperbolic equation, Solution of Laplace, wave and diffusion equations by method of separation of variables.

BOOKS RECOMMENDED:

1. Piaggio: Differential equations.
2. Ross, S.L.: Differential equations.
3. Sneddon, I.N.: Elements of partial differential equations.

M.Sc. Mathematics (Semester-II)
(Credit Based Evaluation & Grading System)

MTL 451
REAL ANALYSIS-II

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

The Riemann Stieltje's Integral: Definition and existence of Riemann Stieltje's integral, Properties of integral. Integration and Differentiation. Fundamental Theorem of Calculus, Ist and 2nd Mean Value Theorems of Riemann Stieltje's integral.

Section-B

Integration of vector valued functions, Sequence and Series of functions: Uniform Convergence, Uniform Convergence and continuity, Uniform Convergence and Integration, Uniform Convergence and Differentiation

Section-C

Equicontinuous families of functions, Arzela's Theorem, Weierstrass Approximation theorem. The Stone-Weierstrass theorem.

Section-D

Power series : Radius of convergence, properties, Abel's Theorem, Taylor's Theorem Fourier series :Convergence, Riemann Lebesgue Lemma, Bessel's inequality, Parseval's Equality.

BOOK RECOMMENDED:

1. Walter Rudin : Principles of Mathematical Analysis (3rd edition) McGraw Hill Ltd.Ch. 6, Ch.7, Ch. 8, Ch. 9 (9.1-9.8).
2. S.C. Malik & Savita Arora. : Mathematical Analysis, Wiley Eastern Ltd.
3. Shanti Narayan & P.K. Mittal : A Course of Mathematical Analysis.
4. Apostol, T.M. : Mathematical Analysis 2nd Edition (7.18 Th. 7.30 & 7.31)

M.Sc. Mathematics (Semester-II)
(Credit Based Evaluation & Grading System)

MTL-452
ALGEBRA-II

L-T-P: 4-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Rings, Subrings, Ideal, Factor Rings, Homomorphisms, Integral domains, Maximal and Prime Ideals, The field of quotients of an integral domain, Chinese Remainder Theorem, Simple Rings, Ideals of Matrix rings.

Section-B
Principal Ideal domains, Euclidean rings, The ring of Gaussian Integers, Unique factorization domains, Gauss Lemma, Polynomial rings, Division algorithm, factorization in polynomial rings over unique factorization domains.

Section-C
Modules, submodules, free modules, quotient modules, Homomorphism theorems, direct sums, finitely generated modules, Simple modules, cyclic modules, differences between modules over rings and vector spaces.

Section-D
Modules over PID's, structure theorem of modules over PID's, Torsion modules, Torsion free modules, Artinian and Noetherian Modules, Artinian And Noetherian rings, modules of finite length.

Recommended Books:
1. Fraleigh, J.B, : A finite course in Abstract Algebra 7th edition, Narosa Publishing House, New Delhi.
2. Singh, S. and Zameeruddin, Q.: Modern Algebra, Vikas Publishing House, New Delhi.
3. Dummit, D.S. and Foote, R.M.: Abstract Algebra, John-Wiley & Sons, Student Edition-1999.
4. Bhattacharya, P.B., Jain, S.K., Nagpal, S.R.: Basic Abstract Algebra, Cambridge University Press, 1997.
5. Musili, C.: Rings and Modules, Narosa Publishing House, New Delhi, 1994.

M.Sc. Mathematics (Semester-II)
(Credit Based Evaluation & Grading System)

MTL 453
PROBABILITY THEORY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Bayes theorem. Random variable, probability mass function, probability density function, cumulative distribution function, Distribution of functions of random variable.

Section-B

Two and higher dimensional random variables, joint distribution, marginal and conditional distributions, bivariate and multivariate transformation of random variables Stochastic independence. Mathematical expectations, moments, moment generating function, characteristic function, Chebyshev's and Cauchy Schwartz Inequality.

Section-C

Discrete Distribution: Uniform, Binomial, Poisson, Geometric, Hyper geometric, Multinomial. Continuous Distributions: Uniform, Exponential, Normal distributions, Gamma distribution, Beta distribution.

Section-D

Chi-square distribution, t-distribution, F-distribution, sampling distribution of mean and variance of sample from normal distribution. Convergence in probability and convergence in distribution, central limit theorem (Laplace theorem Linder berg, Levy's Theorem).

Books Recommended:
1. Hogg, R.V., Mckean, J.W. and Craig, A.T. : Introduction to Mathematical Statistics.
2. Rohtagi, V. K. and Ehsanes Saleh, A. K. Md. An Introduction to Probability and Statistics
3. Casella, G. and Berger, R. L. : Statistical Inference

M.Sc. Mathematics (Semester-II)
(Credit Based Evaluation & Grading System)

MTL 454 : CALCULUS OF SEVERAL VARIABLES

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Functions, Continuity, and Differentiability on Euclidean Space R^n: Vector space structure of R^n over R, norm and inner product, linear transformations, dual spaces; topology of R^n, limit points, continuity, compactness, connectedness, vector valued functions ($f: R^n \rightarrow R^m$), oscillation of functions and continuity; Frechet derivatives, results on chain rule, differentiability, partial derivatives and continuity of Frechet derivatives; the inverse function theorem, implicit function theorem.

Section-B

Integration On R^n**:** Partition of a closed rectangle, lower and upper sums, Integral of a function ($f: R^n \rightarrow R$) on a closed rectangle, measure zero and content zero, integrable functions, characteristic function, Fubini's theorem; real-analytic functions, partitions of unity, change of variable;

Section-C

Differential Forms On R^n**:** Multilinear functions over a finite dimensional vector space V, $k$tensors, tensor product, alternating k-tensors, wedge product, vector spaces of k-tensors over R, determinant, orientation and volume element; tangent spaces in R^n, vector fields, differential forms, linear maps between vector spaces of alternating k-tensors, closed differential forms, exact differential forms, Poincare lemma.

Section-D

Integration On Chains In R^n**:** Singular n-cubes and singular n-chains in R^n, results on boundary of a chain, definitions of integral of a function ($f: R^n \rightarrow R$) over a singular n-cube and n-chain, Stokes' theorem on chains.

BOOKS RECOMMENDED:

1. M. Spivak, Calculus on Manifolds, Addison Wesley, 1965.
2. S. Lang, Introduction to Differentiable Manifolds, Springer, 2002.
3. S. Axler, K.A. Ribet, An Introduction to Manifolds, Springer, 2008.

M.Sc. Mathematics (Semester-II)
(Credit Based Evaluation & Grading System)

MTL 455
DIFFERENTIAL GEOMETRY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Curves in $\mathbf{R^3}$, a simple arc, curves and their parametric representation, arc length, Contact of curves, tangent line, osculating plane, curvature, principal normal, binormal, Normal Plane, rectifying plane.

Section-B

Curvature and torsion, Serret-Frenet Formule, Helics, Evolute and Involute of a parametric curve, Osculating circle and osculating sphere, spherical curves.

Section-C

Einstein’s Summation Convention, Transformation of coordinates, tensor’s law for transformation, Contravariant, covariant and mixed Tensors, addition, outer product, contraction, inner product and quotient law of tensors, Metric Tensor and Riemannian metric, christoffel symbols, Covariants differentiation of tensors.

Section-D

Surfaces in $\mathbf{R^3}$, Implicit and Explicit forms for the equation of the surface, two fundamental forms of a surface, Family of surfaces, Edge of regression, Envelops, Ruled surface, Developable and skew surfaces, Gauss and Weingarten formulae.

Recommended Books:-

1. A. Pressley: Elementary Differential Geometry, Springer, 2005.
2. T.J.Willmore: Introduction to Differential Geometry
3. Martin M. Lipschutz: Differential Geometry
4. U.C. De; A.A. Shaikh & J. Sengupta: Tensor Calculus
5. M.R. Spiegel: Vector Analysis
6. D. Somasundaram: Differential Geometry – A First course, Narosa Publishing House

M.Sc. Mathematics (Semester-II)
(Credit Based Evaluation & Grading System)

MTL 456
MATHEMATICAL METHODS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Laplace Transform: Definition, existence, and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace transform solution of linear differential equations and simultaneous linear differential equations with constant coefficients.

Section-B
Fourier Transform: Definition, existence, and basic properties, Convolution theorem, Fourier transform of derivatives and Integrals, Fourier sine and cosine transform, Inverse Fourier transform, solution of linear ordinary differential equations and partial differential equations.

Section-C
Volterra Equations **:** Integral equations and algebraic system of linear equations. Volterra equation L_2 Kernels and functions. Volterra equations of first & second kind. Volterra integral equations and linear differential equations.

Section-D
Fredholm equations, solutions by the method of successive approximations. Neumann's series, Fredholm's equations with Pincherte-Goursat Kernel's.

Books Recommended:
1. Tricomi, F.G. : Integral Equation (Ch. I and II)
2. Kanwal R, P : Linear Integral Equations
3. Pinckus, A. and Zafrany, S.: Fourier Series and Integral Transforms

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

MTL 501
MEASURE THEORY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section - A

Lebesgue Outer Measure, Measurable Sets and their properties, Non Measurable Sets, Outer and Inner Approximation of the Lebesgue Measurable Sets, Borel Sigma Algebra and The Lebesgue Sigma Algebra, Countable Additivity, Continuity and the Borel-Cantelli Lemma.

Section-B

The motivation behind Measurable Functions, various Characterizations and Properties of Measurable functions: Sum, Product and Composition, Sequential Pointwise Limits and Simple Approximations to Measurable Functions. Littlewood's three Principles.

Section-C

Lebesgue Integral: Lebesgue Integral of a simple function and bounded measurable function over a set of finite measure. Comparison of Riemann and Lebesgue Integral. Bounded Convergence Theorem, Integral of a non-negative measurable function, Fatou's Lemma, Monotone convergence Theorem.

Section-D

General Lebesgue Integral, Lebesgue Dominated Convergence Theorem, Countable Additivity and Continuity of Integration, Vitali Covers and Differentiability of Monotone Functions, Functions of Bounded Variation, Jordan's Theorem, Absolutely Continuous Functions, Absolute Continuity and the Lebesgue Integral.

Books Recommended:

1. Royden, H.L. and Fitzpatrick: Real Analysis (Fourth Edition), Pearsoon Education Inc. New Jersey, U.S.A.(2010).
2. R. A. Gordon, The integrals of Lebesgue, Denjoy, Perron and Henstock, Amer. Math. Soc. Province, RI, (1994).
3. Barra, G De. : Introduction to Measure Theory, Van Nostrand and Reinhold Company.
4. Jain, P.K. and Gupta, V.P.: Lebesgue Measure and Integration.

MTL 502
FUNCTIONAL ANALYSIS – I

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Normed linear spaces, Banach spaces, subspaces, quotient spaces. Continuous linear Transformations.

Section-B
Equivalent norms.Finite dimensional normed linear spaces and compactness, Riesz Lemma, The conjugate space N*.

Section-C
The Hahn-Banach theorem and its consequences. The natural imbedding of N into N**, reflexivity of normed spaces.

Open mapping theorem, projections on a Banach space, closed graph theorem, uniform boundedness principle.

Section-D
Conjugate operators. L_p-spaces: Holder's and Minkowski's Inequalities, completeness of L_p-spaces.

BOOKS RECOMMENDED:
1. G.F. Simmons: Introduction to Topology and Modern Analysis,
   Ch. 9, Ch.10 (Sections 52-55), Mc.Graw-Hill International Book Company, 1963.
2. Royden, H. L.: Real Analysis, Ch 6 (Sections 6.1 -6.3), Macmillan Co. 1988.
3. Erwin Kreyszig: Introduction to Functional Analysis with Applications, John Wiley & Sons, 1978.
4. Balmohan V. Limaye: Functional Analysis, New Age International Limited.
5. P.K.Jain and : Functional Analysis, New Age International (P) Ltd, Publishers, 2010.
   O.P Ahuja.
6. K. Chanrashekhra Rao: Functional Analysis, Narosa, 2002
7. D. Somasundram: A First Course in Functional Analysis, Narosa, 2006.

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

MTL 503
STATISTICAL INFERENCE

L T P
3 0 1

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Point Estimation: Sufficient statistics, Neyman factorization theorem, minimal sufficient statistics, ancillary statistics, complete statistics, Basu's theorem, unbiasedness, consistency, efficiency.

Section-B

Minimum variance unbiased estimators, Rao Blackwell Theorem, Lehmann-Scheffe theorem. Cramer-Rao lower bound. Efficiency of an estimator. Methods of estimation: maximum likelihood estimator, properties of MLE(without proof) method of moments.

Section-C

Bayes estimator, Concepts of testing of hypotheses, critical region, test function, two types of errors, power function, level of significance, p-value, Neyman-Pearson theory, M.P. test,

Section-D

UMP test, Likelihood ratio property, Karlin Rubin theorem, onfidence intervals, confidence level, construction of confidence interval using pivots. Shortest expected length confidence intervals. Likelihood tests (excluding properties of Likelihood Ratio Tests). Tests based on t, chi square and F distributions. Large sample tests.

Books Recommended:
1. Hogg, R.V., Mckean, J.W. and Craig, A.T. : Introduction to Mathematical Statistics.
2. Rohtagi, V. K. and Ehsanes Saleh, A. K. Md. An Introduction to Probability and Statistics
3. Casella, G. and Berger, R. L. : Statistical Inference

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 531
OPERATIONS RESEARCH-I

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Mathematical formulation of linear programming problem, properties of a solution to the linear programming problem, generating extreme point solution, simplex computational procedure, development of minimum feasible solution, the artificial basis techniques, a first feasible solution using slack variables.

Section-B

Two phase and Big-M method with artificial variables , General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, Duality theorems, complementary slackness theorem, duality and simplex method, economic interpretation of primal-dual problems.

Section-C

The General transportation problem, transportation table,
duality in transportation problem, loops in transportation tables, linear programming formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm (MODI method), time minimization transportation problem.

Section-D

Assignment Problems: Mathematical formulation of assignment problem, the assignment method, typical assignment problem, the traveling salesman problem. Game Theory: Two-person zero sum games, maximin-minimax principle, games without saddle points (Mixed strategies), graphical solution of $2 \times n$ and $m \times 2$ games, dominance property, arithmetic method of $n \times n$ games, general solution of $m \times n$ rectangular games.

BOOKS RECOMMENDED:

1. Gass, S. L.: Linear Programming
2. Hadley, G.: Mathematical Programming
3. Kambo, N. S.: Mathematical Programming
4. Kanti Swarup, Gupta, P.K. & Man Mohan: Operations Research
5. R.Panneerselvam: Operations Research
6. Taha, H.A.: Operations Research

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 532
DISCRETE MATHEMATICS-I

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Mathematical Logic: Properties and logical operations, Truth function, Logical connections, logically equivalent statements, tautology and contradiction, algebra of proposition, arguments, duality law, Quantifiers, inference rules for quantified statements, predicates calculus, interference theory of predicate logic, valid formula involving quantifiers.

Section-B

Boolean Algebra: Boolean Algebra and its properties, Principle of duality in Boolean Algebra, Algebra of Classes, Isomorphism, Partial Order, Boolean switching circuits, Equivalence of two circuits, simplification of circuit, Boolean polynomial, Boolean expression & function, Fundamental forms of a Boolean function. Disjunctive normal form, Complement function of a Boolean function.

Section-C

Lattices: Partial ordered sets, Hasse diagrams, isomorphism, External elements of practically ordered set, lattices, lattices as algebraic system, sub-lattices, direct product and homomorphism.

Section-D

Graph Theory: Simple Graphs, Incidence and degree, regular graph, isolated vertex, pendent vertex, Null graph, Diagraph, isomorphism's, Euleriam graph, planner and dual graph, planner graph representations, Thickness and crossing numbers, adjancy matrix, incideme metrix, cycle matrix.

BOOKS RECOMMENDED:

1. Trambley, J.P. and Manohar,R: Discrete Mathematical Structures with Applications to Computer Science.
2. Liu C.L.: Elements of Discrete Mathematics.
3. Alan Doerr and Kenneth Levasseur: Applied Discrete Structures for Computer Science

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 533
FLUID DYNAMICS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Inviscid Flows: Introduction to fluid flows, equation of continuity, Euler's equation of motion, Bernoulli's equation, steady motion under conservative body forces, potential theorems.

Section-B

Viscous Flows: Newtonian fluids, convective momentum transport, shell momentum balances and boundary conditions, use of shell momentum balance to solve laminar flow problems: flow of a falling film, flow through a circular tube (Hagen-Poiseuille flow), flow through an annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

Section-C

The Navier-Stokes Equation: The Navier-Stokes equation, use of the Navier-Stokes equation in solving the following flow problems: Steady flow in a long circular cylinder, falling film with variable viscosity, The Taylor-Couette flow, Plane Couette flow; Shape of the surface of a rotating liquid, Flow near a slowly rotating sphere.

Section-D

Steady viscous flow in tubes of uniform cross sections, viscous flow past a fixed sphere, Dimensional analysis of fluid motion, Prandtl boundary layer, Time dependent flows of Newtonian fluids.

Reference Books:

1. F. Charlton, Textbook of Fluid Dynamics 1st Edition. (Scope in **Ch.2-5, 8**)
2. R. B. Bird, W. E. Stewart, E. Lightfoot, Transport Phenomena, 2nd Edition. **(Scope in Ch. 1-4**)
3. L. D. Landau and E. M. Lifshitz, Fluid Mechanics, 3rd Edition. (Scope in **Ch. I-II**)

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 534
ADVANCED NUMERICAL ANALYSIS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Finite difference approximation to partial derivatives, parabolic equations: Transformation to non-dimensional forms, an explicit method, Crank Nicolson Implicit method, solution of implicit equations by Gauss Elimination, derivative boundary conditions, local truncation error, Consistency, Convergence and stability.

Section-B
Iterative methods for elliptic equations, Jacobi’s method, Gauss-Siedel method, S.O.R. method, Residual method. Hyperbolic equations: Implicit difference methods for wave equation, Stability Analysis, Lax, Wendroff explicit method on rectangular mesh for 1st order equations, second order quasi-linear Hyperbolic equations,

Section-C
Least squares curve fitting for st. line and non linear curves, Orthogonal polynomials, Gram Schmidt Orthogonalization process.

Section-D
Finite element methods: Rayleigh Ritz Method, Collocation and Galerkin’s Method, Finite element methods for ODE’s., finite element methods for one dimensional and two dimensional problems, Introduction to F. E. M. for partial differential equations.

Books Recommended:
1. G. D. Smith: Numerical Solution of Partial Differential Equations.
2. S.S. Sastry : Introductory Methods of Numerical Analysis.
3. J. N. Reddy: An Introduction to Finite Element Methods.

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 535
STOCHASTIC PROCESS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Introduction to stochastic processes, classification of stochastic processes according to state space and time domain. Countable state Markov Chains, Chapman-Kolmogorov equations, calculations of n-step transition probability and its limit.

Section-B
Stationary distribution, classification of states. Random walk model, gambler's ruin problem. Discrete state space continuous time Markov Chains: Kolmogorov-Feller differential equations.

Section-C
Poisson process, Simple birth process, Simple death process. Recurrent events, recurrence time distribution,

Section-D
Necessary and sufficient condition for persistent and transient events and their illustrations, delayed recurrent event. Discrete branching process, mean and variance of the n-th generation, probability of extinction.

BOOKS RECOMMENDED:

1. Feller, W.: Introduction to Probability Theory and its Applications, Vol. 1.
2. Hoel, P.G., Port, S.C. and Stone, C.J.: Introduction to Stochastic Processes.
3. Karlin, S. and Taylor, H.M.: A First Course in Stochastic Processes, Vol. 1.
4. Medhi, J.: Stochastic Processes.
5. Bailey, N.T.J.: The Elements of Stochastic Processes.
6. Adke, S.R. and Manjunath, S.M.: An Introduction to Finite Markov Processes.

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 537
CALCULUS OF SEVERAL VARIABLES

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Functions, Continuity, and Differentiability on Euclidean Space R^n: Vector space structure of R^n over R, norm and inner product, linear transformations, dual spaces; topology of R^n, limit points, continuity, compactness, connectedness, vector valued functions ($f: R^n \to R^m$), oscillation of functions and continuity; Frechet derivatives, results on chain rule, differentiability, partial derivatives and continuity of Frechet derivatives; the inverse function theorem, implicit function theorem.

Section-B

Integration On R^n**:** Partition of a closed rectangle, lower and upper sums, Integral of a function ($f: R^n \to R$) on a closed rectangle, measure zero and content zero, integrable functions, characteristic function, Fubini's theorem; real-analytic functions, partitions of unity, change of variable;

Section-C

Differential Forms On R^n**:** Multilinear functions over a finite dimensional vector space V, $k$tensors, tensor product, alternating k-tensors, wedge product, vector spaces of k-tensors over R, determinant, orientation and volume element; tangent spaces in R^n, vector fields, differential forms, linear maps between vector spaces of alternating k-tensors, closed differential forms, exact differential forms, Poincare lemma.

Section-D

Integration On Chains In R^n**:** Singular n-cubes and singular n-chains in R^n, results on boundary of a chain, definitions of integral of a function ($f: R^n \to R$) over a singular n-cube and n-chain, Stokes' theorem on chains.

BOOKS RECOMMENDED:

1. M. Spivak, Calculus on Manifolds, Addison Wesley, 1965.
2. S. Lang, Introduction to Differentiable Manifolds, Springer, 2002.
3. S. Axler, K.A. Ribet, An Introduction to Manifolds, Springer, 2008.

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 538
COMMUTATIVE ALGEBRA

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Prime ideals and maximal ideals in commutative rings, Nilradical, Jacobson radical, Operations on ideals, Extension and contraction of ideals, Nakayama lemma, Exact sequences of modules,

Section-B

Injective modules, Projective modules, Tensor product of modules, restriction and extension of scalars, Exactness properties of the tensor product, flat modules.

Section-C

Rings and Modules of fractions, Localization, Local properties, extended and Contracted ideals in rings of fractions, Primary decomposition, Integral dependence, integrally closed domains, Zariski topology, The Nullstellensatz.

Section-D

The going up theorem, The going down theorem, valuation rings, rings with chain conditions, discrete valuation rings, Dedekind domains, fractional ideals.

BOOKS RECOMMENDED:

1. Atiyah, M.F. and Macdonald, I.G.: Introduction to Commutative Algebra
2. Matsumura, H.: Commutative Ring Theory
3. Reid, M: Undergraduate Commutative Algebra
4. Jacobson, N: Basic Algebra-II, Dover Publications, Inc.
5. Gopalakrishnan, N.S.: Commutative Algebra

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 539
THEORY OF WAVELETS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Orthonormal systems and basic properties, Trigonometric system, Walsh orthonormal system, Haar system.

Section-B
Generalization of Orthonormal system (Frames and Riesz basis) and their examples. Introduction to wavelets: Definition and examples of continuous and discrete wavelet transforms.

Section-C
Multi-resolution analysis, Properties of translation, dilation and rotation operators, Wavelet and scaling series.

Section-D
Wavelets and signal analysis, Denoising, Representation of signals by frames.

BOOKS RECOMMENDED:
1. D.F. Walnut, An Introduction to Wavelet Analysis, Birkhauser, Boston, Basel 2000.
2. F. Schipp, W.R. Wade and P.Simon, Walsh Series: An Introduction to Dyadic Harmonic Analysis, Adam Hilger, Bristol, New York 1990.
3. O. Christensen, An Introduction to Frames and Reisz Bases, Birkhauser, Basel 2008.
4. K.P. Soman & K.I. Ramachandran. Insight into Wavelets: From Theory to Prachce, Prentice Hall of India, 2008.

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 541
FOURIER ANALYSIS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Trigonometric Series, Basic Properties of Fourier Series, Riemann-Lebesgue Lemma, The Dirichlet and Fourier Kernels, Continuous and Discrete Fourier Kernels.

Section-B
Lebesgue's pointwise convergence theorem.Finite Fourier Transforms, Convolutions, the exponential form of the Lebesgue's theorem.

Section-C
Pointwise and Uniform, Convergence of Fourier Series. Cesaro and Abel Summability. Fejer's Kernel, Fejer's theorem, a continuous function with divergent Fourier series, termwise integration, termwise differentiation,

Section-D
The Fourier Transforms and Residues, inversions of the trigonometric and exponential forms, Fourier Transformations of derivatives and integrals.

BOOKS RECOMMENDED:
1. R. Strichartz, A Guide to Distributions and Fourier Transforms, CRC Press.
2. E.M. Stein and R. Shakarchi, Fourier Analysis: An Introduction, Princeton University Press, Princeton 2003.
3. G. Bachman, L. Narici, E. Beckenstein; Fourier and Wavelet Analysis, Universitext, Springer-Verlag, New York, 2000. x+505 pp. ISBN: 0-387-98899-8

M.Sc. Mathematics (Semester-III)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL-542
TOPICS IN LINEAR ALGEBRA

L-T-P: 4-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Generalized eigen vectors of a linear operator, direct sum decomposition of a finite dimensional vector space V over an algebraically closed field into generalized eigen spaces of a linear operator on V, Jordan chains, Jordan basis, Nilpotent operators on finite dimensional vector spaces, Existence and uniqueness of Jordan form for nilpotent operators on finite dimensional vector space over any field, existence and uniqueness of Jordan form for any operator on finite dimensional vector spaces over the field of complex numbers, Jordan form for linear operators on finite dimensional vector space over reals,

Section-B
Semi-simple operators, cyclic spaces, cyclic decompositions, existence and uniqueness of rational canonical form for any linear operator on a finite dimensional vector space over any field. Bilinear forms, matrix representation of a bilinear form w.r.t an ordered basis, vector space of all bilinear forms on a vector space, symmetric bilinear forms, functional and bilinear forms, radicals of a bilinear form, degenerate and non-degenerate bilinear forms, diagonalizable bilinear forms, quadratic forms, rank and signature of bilinear forms, Sylvestor's law of interia,

Section-C
positive definite, positive semi-definite , negative definite and negative semi-definite matrices and various characterizations for positive definiteness/negative definiteness of a matrix, Principle axis transformation of quadratic forms, classification of quadrics in three dimensional Euclidean space, Hermitian forms, The second derivative test for maxima and minima of functions of several variables using quadratic forms, Multilinear products, The tensor algebra, The exterior algebra.

Section-D
Determinant as n-linear function, its properties, characterizations and uniqueness of determinant function, determinant as n-dimensional volume of the parallelepiped, Some applications of linear algebra: finite symmetry groups in three dimensions, applications of linear algebra in solving differential equations, sum of squares and Hurwitz's theorem, linear codes, linear codes defined by generating matrices, The ISBN , Hamming codes, Hadamard codes, Perfect linear codes.
(20 Lectures)

Suggested Readings:

1) Linear Algebra by Charles W. Curtis.

2) Fundamentals of Linear Algebra by James B. Carrell.

3) Linear Algebra by Kenneth Hoffman and Ray Kunze.

4) Linear Algebra by Vivek Sahai and Vikas Bist.

5) Linear Algebra by Friedberg, Insel and Spence.

MTL 551
TOPOLOGY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Topological spaces, Continuous functions, Homeomorphisms, Countability axioms Product spaces, Quotient spaces, Topological groups.

Section-B
Connectedness, Intermediate value theorem and uniform limit theorem, Local connectedness,

Section-C
Compactness, Finite intersection property (F.I.P.), Cantor's intersection theorem, Uniform continuity, Bolzano-Weierastrass Property, Local compactness. Metrizable topological spaces, The Tychonoff Theorem.

Section-D
Separation axioms, Hausdorff spaces, Regular Spaces, Normal spaces, Urysohn's Lemma, Completely regular spaces, , Urysohn's Metrization Theorem, The Tietze extension theorem, Completely normal spaces,

BOOKS RECOMMENDED:
1. J. R. Munkres : Topology, Prentice Hall of India, 2007 (Indian reprint)
2. J. L. Kelley : General Topology, 2008 (Indian reprint).
3. K. Janich, Topology, Springer-Verlag, 2004.

MTL 552
FUNCTIONAL ANALYSIS – II

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets,

Section-B
The conjugate space H*. Strong and weak convergence in finite and infinite dimensional normed linear spaces. Weak convergences in Hilbert spaces, weakly compact set in Hilbert spaces.

Section-C
The adjoint of an operator, self adjoint operators, positive operators, normal operators, Unitary operators. Projections on a Hilbert space,

Section-D
Spectral Theorem for normal operators, Compact linear operators on normed spaces, properties of Compact linear operators.

BOOKS RECOMMENDED:
1. Simmons, G.F.: Introduction to Topology and Modern Analysis Ch. X (Sections 56-59), Ch. XI (Sections 61-62), Mc Graw- Hill (1963) International Book Company.
2. Erwin Kreyszig: Introduction to Functional Analysis with Applications, John Wiley & Sons (1978).
3. Limaye, Balmohan V.: Functional Analysis, New Age International Limited, 1996.
4. Jain, P.K. & Ahuja, O.P.: Functional Analysis, New Age International (P) Ltd. Publishers, 2010.
5. Chandrasekhra Rao, K.: Functional Analysis, Narosa, 2002.
6 Somasundram, D.: A First Course in Functional Analysis, Narosa, 2006.

MTL 553
FIELD EXTENSIONS AND GALOIS THEORY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Fields, Characteristic of a field, prime fields, finite field extensions, degree of a field extension, Algebraic extensions, splitting fields: Existence & Uniqueness.

Section-B
Algebraic closure, Algebraically closed fields. Finite fields, Existence of GF(p_n), Construction of finite fields. Separable and purely inseparable extensions, Perfect fields,

Section-C
Simple extensions, Primitive elements, Lagrange's theorem on primitive elements, Normal extensions, Roots of unity. Galois extensions, The fundamental theorem of Galois theory,

Section-D
Cyclotomic extensions, Abelian extensions, cyclic extensions, Frobenius mapping, Galois groups of finite fields, Quintic equations and solvability by radicals, Constructive polygons.

Recommended Texts:
1. Fraleigh, J.B. A first course in Abstract Algebra, Narosa Publishing House, New Delhi.
2. Dummit, D.S. and Foote, R.M.Abstract Algebra, John-Wiely and Sons, Students Edition-1999.
3. Bhattacharya, P.B., Jain, S.K. and Nagpal, S.R.Basic Abstract Algebra, Cambridge University Press, 1997.
4. Singh,S. and Zameeruddin,Q. Modren Algebra, Vikas Publishing House, New Delhi.
5. Hungerford, T.W.Algebra, Springer 1974
6. Bastida, J.R.Field Extensions and Galois Theory, Encyclopedia of Mathematics and Its Applications, Volume 22, Addison-Wesley Publishing Company.

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 581
TOPOLOGICAL VECTOR SPACES

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Definition and examples of topological vector spaces. Convex, balanced and absorbing sets and their properties. Minkowski's functional.

Section-B

Subspace, product space and quotient space of a topological vector space.

Section-C

Locally convex topological vector spaces. Normable and metrizable topological vector spaces.

Section-D

Complete topological vector spaces and Frechet space. Linear transformations and linear functional and their continuity.

BOOKS RECOMMENDED :

1. Walter Rudin : Functional Analysis, TMH Edition, 1974.
2. Schaefer, H.H.: Topological Vector Spaces, Springer, N.Y., 1971.

(Elective Paper)
MTL 582
COMPUTER PROGRAMMING WITH C

L T P
3 0 1

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Basic Structure of C-Program, Constants, variables, Data types, Assignments, console I/O statements, Arithmetical, Relational and logical operators, Control statements: if, switch.

Section-B

While, do while, for, continue, goto and break. Function definition and declaration, Arguments, return values and their types, Recursion. One and two-dimensional arrays, Initialization, Accessing array elements, Functions with arrays.

Section-C

Address and pointer variables, declaration and initialization, pointers and arrays, pointers and functions.

Section-D

Structure initialization, structure processing, nested structure, Array of structures, structure and functions. Union. Defining and opening a file, closing a file, Input/Output operations on files.

Practical: Based on implementation of Numerical and Statistical Techniques Using C Language.
Solution to non linear equations, a system of linear equations; Numerical integration, Solution to ordinary differential equations. Measures of central tendency, Correlation and Regression.

BOOKS RECOMMENDED:

1. Byron S. Gottrfried: Programming with C (Schaum’s outline series).
2. Stan Kelly-Bootle: Mastering Turbo C.
3. Brain Kernighan & Dennis Ritchi: The C Programming Language.
4. Yashavant Kanetkar: Let us C.
5. E Balagurusamy: Programming in ANSI C.
6. R.S. Salaria: Application Programming in C.

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 583
OPERATIONS RESEARCH-II

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Queueing Theory: Introduction, Queueing System, elements of queueing system, distributions of arrivals, inter arrivals, departure service times and waiting times. Classification of queueing models, Queueing Models**:** (M/M/1): (∞/FIFO), (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process, (M/M/C): (∞/FIFO), (M/M/C) (N/FIFO).

Section-B

Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, Significance of Inventory control, economic order quantity (EOQ), Deterministic inventory problems with out shortage and with shortages, EOQ problems with price breaks, Multi item deterministic problems.

Section-C

Replacement Problems: Replacement of equipment/Asset that deteriorates gradually, replacement of equipment that fails suddenly, Mortality Theorem, recruitment and promotion problem, equipment renewal problem.

Section-D

Simulation: Need of simulation, methodology of simulation. Simulation models, event- type simulation, generation of random numbers, Monte Carlo simulation. Simulation of inventory problems, queuing system, maintenance problems and job sequencing

BOOKS RECOMMENDED:

1. R.Panneerselvam: Operations Research
2. Taha, H.A.: Operations Research
3. Chaddrasekhara, Rao & Shanti Lata Mishra: Operations Research
4. Kanti Swarup, Gupta, P.K. & Man Mohan: Operations Research
5. Mustafi, C.K.: Operations Research

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 584
DISCRETE MATHEMATICS-II

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Graph Theory: Tree, rooted tree, binary tree, spanning trees, minimal spanning tree, kruskal's algorithm, Chromatic number, four-column problem, Chrometric Polynomials

Section-B

Directed Graphs: Directed paths, directed cycles, acyclic graph, network flow, Max flow, min0cut theorem, K-flow.

Section-C

Recurrence relation & Generating functions: Order & Degree of recurrence relation, telescopic form, recursion theorem, solution of linear recurrence relation, Homogenous solution, closed form expression, Generating function, solution of recurrence relation using generating function.

Section-D

Combinatorics: Principle of Mathematics Induction, the basic of counting, inclusion and exclusion principle, pigeonhole principles, Polya's counting theorem.

BOOKS RECOMMENDED:

1. Trambley, J.P. and Manohar,R: Discrete Mathematical Structures with Applications to Computer Science.
2. Liu C.L.: Elements of Discrete Mathematics.
3. Alan Doerr and Kenneth Levasseur: Applied Discrete Structures for Computer Science
4. Narsingh Deo: Graph Theory with Applications to Engineering and Computer Sciences

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 586
BANACH ALGEBRA AND OPERATOR THEORY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Banach Algebras: Definitions and simple examples. Regular and singular elements. Topological divisors of zero, Spectrum of an element of a Banach Algebra, formula for spectral radius.

Section-B

Compact and Bounded Operators: Spectral properties of compact linear operators, spectral properties of bounded linear operators, operator equations involving compact linear operators.

Section-C

Spectral radius of a bounded linear operator. Spectral properties of bounded self adjoint linear operators on a complex Hilbert space. Positive operators.

Section-D

Monotone sequence theorem for bounded self adjoint operators on a complex Hilbert space. Square roots of a positive operator. Projection operators, Properties of projection operators.

BOOKS RECOMMENDED:

1. Simmons, G.F.: Introduction to Topology and Modern Analysis
(Section 6.4-6.8), Mc Graw- Hill (1963) International Book
Company.
2. Kreyszig, E. Introductory Functional Analysis with Applications,
(Sections 8.1-8.5, 9.1-9.6) John Wiley & Sons,
New York, 1978.

(Elective Paper)
MTL 588
FINANCIAL DERIVATIVES

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Products and Markets: Time Value of money, Periodic and Continuous compounding Commodities, equities Currencies, Indices, Fixed income securities, Derivatives: Basic Concepts, Pay-off diagrams, Risk and Return.

Section-B

One step Binomial model. Random behaviour of assets, Time scales, Wiener Process. Forwards contracts and future contracts. Options, call and Put options, Put-call parity, Bounds on Option Prices, European and American calls.

Section-C

Elementary Stochastic Calculus: Motivation and examples, Brownian Motion, Mean Square limit. Ito's Lemma, Some Pertinent examples, **Black Scholes Model:** Arbiterage.

Section-D

The derivation of Black Schole, Partial differential equation, Reduction of Black Scholes equation to diffusion equation, Numerical solutions of Black Scholes equation.

Recommended Books:
1. M. Capinski and T. Zastawniak: Mathematics for Finance: An Introduction to Financial Engineering, Springer
2. P.Wilmott: The Theory and Practice of Financial Engineering, John Willey and Sons, London, 1998.
3. P.Wilmott, Sam Howison and Jeff Dewynne: The Mathematics of Financial Derivatives, Cambridge University Press, 1995.

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 589
THEORIES OF INTEGRATION

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

The need to extend the Lebesgue integral, The Darboux integral, necessary and sufficient conditions for Darboux integrability, the equivalence of the Riemann and Darboux integrals, tagged divisions and their use in elementary real analysis, Cousin's lemma, the Henstock-Kurzweil and McShane integrals.

Section-B

Saks-Henstock Lemma, the fundamental theorems of Calculus for the gauge integrals and its consequences. The Squeeze theorem, regulated functions and their integrability, Convergence theorems for the gauge integrals, the Hake's Theorem, The McShane integral Vs Lebesgue integral.

Section-C

Extensions of Absolute Continuity and Bounded variation, the relationship between the function classes ACG*, ACG\delta, BVG* and BVG\delta, the Denjoy and Perron integrals.

Section-D

Locally and globally small Riemann sums and their equivalence, The class of Henstock-Kurzweil integrable functions, advantages of the Henstock-Kurzweil integral over Riemann, Lebesgue, Denjoy, Perron and McShane integrals.

BOOKS RECOMMENDED:

1. R. A. Gordon, The Integrals of Lebesgue, Denjoy, Perron and Henstock, Amer. Math. Soc. Province, RI, (1994).
2. R.G. Bartle, A Modern Theory of Integration, Graduate Studies in Mathematics, 32. Amer. Math. Soc., Province, RI (2001).
3. D. S. Kurtz; C. W. Schwatz, Theories of Integration, the Integrals of Riemann, Lebesgue, Henstock-Kurzweil and McShane, Series in Real Analysis 9, World Scientific Publishing Co., Inc., NJ, (2004).
4. P. Y. Lee; R. Vyborny, Integral: An Easy Approach after Kurzweil and Henstock, Aus. Math. Soc. Lecture Series 14. Cambridge University Press, Cambridge, (2000).

(Elective Paper)
MTL 590
ALGEBRAIC TOPOLOGY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
N-manifolds, orientable vs nonorientable manifolds, Compact-connected 2-manifolds, Classification theorem for compact surfaces, Triangulations of compact surfaces, The Euler characteristic of a surface, Fundamental group of a space, Fundamental group of Circle and product spaces, The Brouwer fixed point theorem in dimension 2, Homotopy type and Homotopy Equivalence of Spaces.

Section-B
Weak products of abelian groups, free abelian groups, free products of groups, free groups.

Section-C
The Seifert Von Kampen theorem and its applications, Structure of the fundamental group of a Compact surface.

Section-D
Covering Spaces: Lifting of paths to covering spaces, The funcdamental group of a covering space, Homomorphism and automorphisms of covering spaces, Regular covering spaces and Quotient spaces, The Borsuk-Ulam theorem for 2-sphere, The existence theorem for covering spaces.

BOOKS RECOMMENDED:
1. W.S. Massey. A Basic Course in Algebraic Topology, Springer
(Indian reprint) 2007. (**Ch. 1-5)**
2. J.R. Munkres. Topology, Prentice Hall of India (India reprint) 2007.

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 591
THEORY OF SAMPLE SURVEY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Concepts of population, population unit, sample, sample size, parameter, statistics estimator, biased and unbiased estimator, mean square error, standard error. Census and Sample surveys, Sampling and Non sampling errors, Concepts of Probability and non-probability sampling, ampling scheme and sampling strategy, Introduction of Simple Random Sampling (Use of Lottery Method, Random numbers and Pseudo random numbers)

Section-B
Simple Random sampling (with or without replacement); Estimation of population Mean and Total, Expectation and Variance of these Estimators, unbiased estimators of the variance of these Estimators

Section-C
Estimation of Population proportion and Variance of these estimators, estimation of sample size based on desired accuracy, Confidence interval for population Mean and Proportion Concepts of Stratified population and stratified sample, estimation of population mean and Total based on stratified sample.

Section-D
Expectation and variance of estimator of population mean and total assuming SRSWOR within strata. Unbiased estimator of the variances of these estimators. Proportional Allocation, Optimum allocation (Neyman allocation) with and without varying costs, Comparison of simple random sampling and stratified random sampling with proportional and optimum allocations.

BOOKS RECOMMENDED:

1. Sukhatme P.V., Sukkhatme P.V., Sukhatme S. & Ashok C. (1997): Sampling Theory of Surveys and Applications-Piyush Publications.
2. Des Raj and P.Chandok (1998): Sample Survey Theory. Narosa Publishing House.
3. Wiliam G. Cochran (1977): Sampling Techniques, 3rd Edition-John Wiely & Sons.
4. Parimal Mukhopadhyay (1988): Theory and Methods of Survey Sampling-Prentice Hall of India Pvt. Ltd.
5. Murthy M.N. (1977): Sampling Theory of Methods-Statistical Publishing Society, Culcutta.

(Elective Paper)
MTL 592
SPECIAL FUNCTIONS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Bessel's functions of first and second kind, Recurrence relations, Generating functions, Trigonometric expansions, Asymptotic expansion, Neumann Expansion theory.

Section-B
Legendre's functions, Laplace integral for the Legendre Polynomials, Generating functions, Recurrence relations, Orthogonality, solution of Legendre's equations.

Section-C
Hermite Polynomials, Recurrence relations, Rodrigue formula. Hypergeometric function, solution of hypergeometric equation, Kummer function and it's asymptotic expansion.

Section-D
Barnes Contour Integral, Integral representation, Gauss Theorem, Kummer's theorem, Vandermonde's theorem.

BOOKS RECOMMENDED:
1. Luke, Y.P.: The Special Functions and Their Approximation
2. Rainville, F.D.: Special Functions
3. Titchmarh, E.C.: The Theory of Functions.

(Elective Paper)
MTL 593
REPRESENTATION THEORY OF FINITE GROUPS

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A
Semisimple modules, semisimple rings, Wedderburn Artin theorem, Maschke's theorem, Tensor products of modules and algebras.

Section-B
Examples of Decomposition of Group algebras, Simple Modules over K[G], Representations of Groups, K(G)-modules, K[G]-submodules and reducibility.

Section-C
Schur's lemma, Characters of representations, Orthogonality relations, The number of irreducible characters. Integrity of complex characters.

Section-D
Buruside's paqb-Theorem, Tensor product of representations, Induced representations, Restriction and Induction, Frobenius reciprocity theorems.

BOOKS RECOMMENDED:
1. T.Y.Lam, A First Course in Non-commutative Rings, Graduate Texts in Mathematics; 131, Springer Verlag 1991.
2. C.Musili, Representation of Finite Groups, Hindustan Book Agency, 1993.
3. Gordon James and Martin Liebeck, Representation and Characters of Groups, Cambridge University Press, 1993.

M.Sc. Mathematics (Semester-IV)
(Credit Based Evaluation & Grading System)

(Elective Paper)
MTL 594
ANALYTIC NUMBER THEORY

L T P
4 0 0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Arithmetic Functions: Infinitude of primes, Euler zeta function, Arithmetic functions, The Mobius function, Euler totient, the Dirichlet product, Dirichlet inverses, Group structure on arithmetic functions, Multiple Dirichlet products, Group of arithemtic functions as a Q-vector space and its direct sum decomposition.

Section-B

The Mangoldt function, multiplicative functions and Dirichlet multiplication, Completely multiplicative functions. **The Bell Series**: Generalized convolution, Bell series of arithmetic functions and Dirichlet multiplication, Derivatives of arithmetic functions.

Section-C

Averages of Arithmetic Functions: The Big-O notation, Euler's summation formula, the Riemann zeta function, Asymptotic formulas for zeta functions, average order of some standard arithmetic functions, partial sums of Dirichlet product.

Section-D

The Riemann Zeta Function: The Hurwitz zeta function and its contour integral representation, the Hurwitz formula for $\zeta(s,a)$, the Riemann zeta function $\zeta(s)$ and its functional equation, Evaluation of $\zeta(-n,a)$, $\zeta(2)$, $\zeta(2k)$, Bernoulli numbers, Bernoulli polynomials and their properties, Power sums via Bernoulli numbers.

BOOKS RECOMMENDED:-

1. T. M. Apostol. *An introduction to analytic number theory*. Indian reprint, Springer (1976). (Scope in Chapters 1-3, 12)
2. G. A. Jones and J. M. Jones. *Elementary number theory*. 6th Indian reprint, Springer (2011). (Scope in Chapter 5-6, 8-9)
3. B. Berndt. *Ramanujan's Notebooks: Part I*. Springer, (1985