Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-I)
Paper-MHM- 101

REAL ANALYSIS -1

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1.Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2.Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3.Question paper should cover atleast 40% article work from the recommended books.
4.Every question should be of length at most three pages.

Unit-I

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

Unit-II

Compactness of k- cells, Compact subsets of Euclidean space R^k. Heine Borel theorem, Perfect sets, The Cantor set, Separated sets, connected sets in a metric space, connected subsets of real line, Components, Functions of Bounded Variation.

Unit-III

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. **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: A Course of Mathematical Analysis.
4. S.C. Malik & Savita Arora: Mathematical Analysis, Wiley Eastern Ltd

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-I)
Paper-MHM- 102

ALGEBRA -1

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consist six questions and students are required to attempt total of ten questions selecting atleast three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

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.

Unit-II

Composition series, the Jordan Holder theorem, Groups of automorphisms, Inner automorphisms, Symmetric groups, Alternating groups, Sylow's theorems, p-groups, Nilpotent groups, Simplicity of A_n;$n \geq 5$, Cayley's theorem, the imbedding theorem, Commutator subgroup, Characteristic Subgroup, Solvable groups, Sequences of subgroups.

Unit-III

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. Herstein, I.N.: Topics in Algebra, 2nd edition, Wiley I
3. Dummit, D.S.: Abstract-Algebra, John-Wiley & Sons, Students Edition-1999
   & Foote
4. Fraleigh, J. B.: An Introduction to Abstract Algebra.
5. Bhattacharya,: Basic Abstract Algebra, Cambridge & Nagpaul, S.R. University Press, 1997
P.B.,Jain, S.K.
6. Surjit Singh. Modern Algebra.
7. J. Gallian. Contemporary Abstract Algebra

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-I)
Paper-MHM- 103

LINEAR ALGEBRA

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting al least three questions from each section. Each question will carry eight marks.
3. Questions paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-1

Vector spaces, subspaces, basis and dimension theorems, direct sum decomposition, the algebra of linear transformations, matrices with linear transformations, change of ordered bases, elementary matrices ,row rank, column rank and their equality , proof of consistency of system of linear equations.

Unit-II

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, Inner Product Spaces, The Gram-Schmidt Orthogonalization, orthogonal complements.

Unit-III

The Adjoint of a Linear operator on an inner product space, Normal and Self-Adjoint Operators, Unitary and Normal Operators, Spectral Theorem, Bilinear and Quadratic forms, Generalized Eigen Vectors, Rational and Jordan Canonical forms.

Recommended Texts:

1. Hoffman, K. and Kunze, R. : Linear Algebra, Second Edition, Prentice Hall.
2. Axler, S. : Linear Algebra Done Right, Second Edition, Springer-Verlag.
3. Friedberg, S.H., Insel,A.J.,. : Lawrence, Linear Algebra, Second Edition Prentice Hall, Spence, L.E 1989
4. Lang,S. : Linear Algebra, Springer-Verlag, 2000.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-I)
Paper-MHM- 104

NUMBER THEORY

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consist six questions and students are required to attempt total of ten question selecting atleast three questions from each section. Each question will carry eight marks.
3. Questions paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-1

Number theoretic functions and Multiplicative functions, The Mobius Inversion formula, Euler's Phi-function and its properties, Euler's theorem, Fermat's Theorem, Lagrange's Theorem, Primitive roots, m indices and their applications.

Unit-II

Euler's criterion, The Legendre symbol and its properties, Gauss Lemma, Quadratic reciprocity law, Jacobi's symbol and its Properties, Pythagoreon triples, the famous "Last Theorem"

Unit-III

Representation of an integer as a sum of two squares and sum of four squares, finite and infinite simple continued fractions, Convergents, The fundamental solution of Pell's Equations, Applications to Pell's equations.

BOOKS RECOMMENDED:

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

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-I)
Paper-MHM -105

Complex ANALYSIS

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten question selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

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

Unit-II

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, Taylor's theorem, Laurent's theorem. Fundamental theorem of Algebra and Rouche's theorem.

Unit-III

Zeros, Singularities, Residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma. Integration round Unit circle. Evaluation of integrals. 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

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-I)
Paper-MHM- 106

DIFFERENTIAL EQUATIONS

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten question selecting atleast three questions from each section. Each question will carry eight marks.
3. Questions paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Existence and uniqueness theorem for solution of the equation $\frac{dy}{dx} = f(x, y)$, 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. Sturm Liouville's boundary value problems. Sturm comparison and Separation theorems.

Unit-II

First order PDE's., Integral surface through a given curve. Surface orthogonal to given system of surfaces. Non linear PDE's of first order, Cauchy's characteristics. Charpit's method and Jacobi's method.

Unit-III

PDE's of the 2^{nd} order. Linear PDE's with constant coefficients. Second order PDE's with variable coefficients and their classification. 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.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-II)
Paper-MHM- 201

Real analysis -II

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting atleast three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit I

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 2^{nd} Mean Value Theorems of Riemann Stieltje's integral. Integration of vector valued functions, Rectifiable curves.

Unit II

Sequence and Series of functions: Uniform Convergence, Uniform Convergence and continuity, Uniform Convergence and Integration, Uniform Convergence and Differentiation, .Equicontinuous families of functions, Arzela's Theorem, Weierstrass Approximation theorem. The Stone-Weierstrass theorem.

Unit III

Power series : Radius of convergence, properties, Abel's Theorem, Taylor's Theorem
Fourier series :Convergence, Riemann Lebesgue Lemma, Bessel's inequality, Parseval's Equality. Gamma function. Linear Transformations (in IR^n).

BOOK RECOMMENDED:

1. Walter Rudin : : Principles of Mathematical Analysis (3^{rd} edition) MMc Graw 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 : A Course of Mathematical Analysis.
4. Apostol, T.M. : Mathematical Analysis 2^{nd} Edition (7.18 Th. 7.30 & 7.31)

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-II)
Paper-MHM- 202

ALGEBRA -II

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1.Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2.Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3.Question paper should cover atleast 40% article work from the recommended books.
4.Every question should be of length at most three pages.

Unit I

Rings, Subrings, Ideals, 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.

Unit-II

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, Rings with chain conditions.

Unit-III

Modules, Submodules, free modules, quotient modules, Homomorphism theorems, Direct sums, Finitely generated modules, Simple modules, Cyclic modules, Differences between modules and vector spaces, Structure theorem for finitely generated modules over principal ideal domains, submodules of a finitely generated free module over a P.I.D., Artinian and Noetherian modules.

BOOKS RECOMMENDED:

1. Fraleigh, J. B.: A first 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. & Foote, R.M. : Abstract-Algebra, John-Wiley & Sons, Students 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.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-II)
Paper-MHM- 203

PROBABILITY THEORY

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

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

Unit-II

Two and higher dimensional random variables and their functions, joint distribution, marginal and conditional distributions, Stochastic independence. Mathematical expectations, moments, moment generating function, probability generating function, Chebyshev's, Markov, Jenson inequalities, Stochastic convergence, central limit theorem (Laplace theorem Linderberg, Levy's Theorem).

Unit-III

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

Books Recommended:

1. Hogg, R.V., Mckean, J.W. and Craig, A.T. : Introduction to Mathematical Statistics.
2. Mukhopadhyay, P : Mathematical Statistics.
3. Casella, G. and Berger, R. L. : Statistical Inference

Khalsa College Amritsar

(An Autonomous College)

Syllabus for

M.Sc. Mathematics (Semester-II)

Paper-MHM- 204

CLASSICAL MECHANICS AND CALCULUS OF VARIATIONS

Time :3hrs **M:M-80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectivel
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Principle of virtual work, D'Alembert's Principle, Constrains and their types, Generalized co-ordinates and velocities, virtual work, generalized forces, Lagrange's equations for a holonomic dynamical system, conservative system, holonomic dynamical system for impulsive forces and their applications, kinetic energy as a quadratic function of velocities, theory of small oscillations.

Unit-II

Functional, variation of functional and its properties, fundamental lemma of calculus of variation, Euler's equations, necessary and sufficient conditions for extremum, The Brachistochrone problem, Functionals dependent on higher order derivatives and several dependent variables, Variational problems with moving boundaries, Transversality conditions, Orthogonality conditions, problems with moving boundary in implicit form.

Unit-III

Sturm-Liouville's theorem on extremals, one sided variations, Hamilton's principle, Hamilton's canonical equation of motion, The principle of least action, Langrange's equations from Hamilton's principle. Variational Methods (Direct Methods, Euler's finite difference method, The Ritz method, Kantorovich Method), for Boundary value problems in ODE's & PDE's, Isoperimetric Problems.

Books Recommended:

1. Chorlton, F.: Text Book of Dynamics.
2. Elsgolts, L: Differential Equations and the Calculus of Variations.
3. Gelfand,I.M. and Fomin, S.V.: Calculus of Variations.

Khalsa College Amritsar

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Syllabus for
M.Sc. Mathematics (Semester-II)
Paper-MHM-205
DIFFERENTIAL GEOMETRY

Time:3hrs

M:M-80

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit – I

Curves in R^3**:** Parametric curves, Curvature and torsion, Serret-Frenet Formulas, Helices, Evolute and involute of a parametric curve, Spherical curves.

Unit-II

Tensor Analysis: Einstein's summation convention, Transformation laws for vectors, Addition, multiplication, contraction and quotient law of tensors, Differentiation of Cartesians tensors, metric tensor, contra-variant, covariant and mixed tensors, Christoffel symbols, Covariant differentiation w. r. t. metric tensor.

Unit-III

Surfaces in R^3**:** Simple sheet of a surface, Envelopes, Developable surfaces, The Two Fundamental forms of a surface, The Gaussian curvature, Formulas of Gauss and Codazzi, Geodesic curvature and geodesic torsion, Geodesics, Parallel transport along a closed contour, The Gauss-Bonnet theorem, Euler-Poincaré characteristic, integral curvature.

Reference Books:

1. L. P. Eisenhart, Riemannian Geometry, Princeton University Press, 1949. (**Scope in Ch. 1 for tensor analysis**)
2. A. Goetz, Introduction to Differential Geometry, Addison-Wesley, 1970.
3. A. Pressley, Elementary Differential Geometry, Springer, 2005.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. Mathematics (Semester-II)
Paper-MHM- 206

MATHEMATICAL METHODS

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consist six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

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

Unit-II

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

Unit-III

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. 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. Mikhlin : Integral Equations
4. Pinckus, A. and Zafrany, S.: Fourier Series and Integral Transforms

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons.)Mathematics (Semester-III)
Paper-MHM- 301

MEASURE THEORY

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions se lecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Limitations of the Riemann integral, the 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, the Cantor Set and the Cantor function.

Unit-II

The motivation behind Measurable Functions, various Characterizations and Properties of Measurable functions: Sums, Products and Compositions Sequential Pointwise Limits and Simple Approximations to Measurable Functions. Littleword's three principales.

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.

Unit-III

General Lebesgue Integral, Lebesgue's 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, The Fundamental Theorems of Calculus for the Lebesgue Integral.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons.) Mathematics (Semester-III)
Paper-MHM- 302

FUNCTIONAL ANALYSIS -1

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Normed linear spaces, Banach spaces, subspaces, quotient spaces. Continuous linear transformations, equivalent norms.

Unit-II

Finite dimensional normed linear spaces and compactness, Riesz Lemma, The conjugate space N*. The Hahn-Banach theorem and its consequences. The natural imbedding of N into N**, reflexivity of normed spaces.

Unit-III

Open mapping theorem, projections on a Banach space, closed graph theorem, uniform boundedness principle, 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 46-51), 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 : Intro. to Functional Analysis with Applications John Wiley & Sons, 1978.

4. Balmohan V. Limaye: Functional Analysis, New Age International Limited.

1. P.K.Jain and O.P Ahuja : Functional Analysis, New Age International (P) Ltd Publishers, 2010
2. K. Chanrashekhra Rao : Functional Analysis, Narosa, 2002
3. D. Somasundram: A First Course in Functional Analysis, Narosa, 2006

Khalsa College Amritsar

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Syllabus for
M.Sc. (Hons.) Mathematics (Semester-III)
Paper-MHM-303

STATISTICAL INFERENCE

Time: 3Hrs **M.M:56**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consist six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit –I

Point estimation: Criteria of estimation, unbiasedness, consistency, efficiency, sufficiency, Neyman factorization theorem .Minimum variance unbiased estimators, Rao Blackwell theorem, completeness, Lehmann-Scheffe theorem, necessary and sufficient conditions for MVUE, Cramer-Rao lower bound. Efficiency of an estimator.
Methods of estimation: maximum likelihood method and method of moments.

Unit –II

Tests of hypothesis, critical region, test functions, two types of errors, power function, level, Neyman-Pearson theory, M.P.test, UMP test, Likelihood test, (excluding properties of Likelihood Ratio Tests).

Unit-III

Chi square, t and F distributions and their applications in testing of hypothesis. Sampling distribution of mean and variance of sample from normal distribution. Large sample tests.

BOOKS RECOMMENDED:

1. Hogg, R, V., Mckean,,J.W.and Craig,A.T: Introduction to mathematical statistics
2. Casella,G.and Berger : statistical inference.
3. Mukhopadhyay,P : Mathematical statistics

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons.) Mathematics (Semester-III)
Paper-MHM- 304

OPERATIONS RESEARCH-I

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1.Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2.Each section will consists six questions and students are required to attempt total of ten questions selecting atleast three questions from each section. Each question will carry eight marks.
3.Question paper should cover atleast 40% article work from the recommended books.
4.Every question should be of length at most three pages.

Unit-I

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, two phase and Big-M method with artificial variables.

Unit-II

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. 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.

Unit-III

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

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons.) Mathematics (Semester-III)
Paper-MHM- 305

DISCRETE MATHEMATICS-1

Time:3hrs **M:M-80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Mathematical Logic: Introduction to Binary relations, equivalence relations and partitions, partial order relations, Hasse diagram. Inclusion and exclusion principle, Pigeonhole principle. Basic logical operations, conditional and biconditional statements, tautologies, contradiction, quantifiers, prepositional calculus.

Unit-II

Grammar and Languages: Phrase structure grammars, derivation sentential forms, language generated by grammar, regular, context free and context sensitive grammar and languages, finite state machines.

Unit-III

Recurrence Relations and Generating Functions: Polynomial expressions, telescopic form, recurrence relations , closed form expression, generating function, solution of recurrence relation using generating function.

BOOKS RECOMMENDED:

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

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons) Mathematics (Semester-IV)
Paper-MHM- 401

TOPOLOGY

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Topological spaces, Continuous functions, Homeomorphisms, Product spaces, Quotient spaces, Topological groups.

Unit-II

Connectedness, Intermediate value theorem and uniform limit theorem, Local connectedness, Compactness, Finite intersection property (F.I.P.), Cantor's intersection theorem, Uniform continuity, Bolzano-Weierastrass Property, Local compactness.

Unit-III

Countability and separation axioms, Hausdorff spaces, Regular Spaces, Normal spaces, Urysohn's Lemma, Completely regular spaces, Metrizable topological spaces, Urysohn's Metrization Theorem, The Tietze extension theorem, Completely normal spaces, The Tychonoff Theorem.

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.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons) Mathematics (Semester-IV)
Paper-MHM- 402

FUNCTIONAL ANALYSIS -II

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit -1

Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets, the conjugate space H*.

Unit-II

Strong and weak convergence in finite and infinite dimensional normed linear spaces. Weak convergences in Hilbert spaces, weakly compact set in Hilbert spaces, The adjoint of an operator, self adjoint operators, positive operators, normal operators, Unitary operators.

Unit-III

Projections on a Hilbert space, 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. 10 (Sections 52-59), Ch. 11, 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.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons) Mathematics (Semester-IV)
Paper-MHM- 403

FIELD EXTENSIONS AND GALOIS THEORY

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1.Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2.Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3.Question paper should cover atleast 40% article work from the recommended books.
4.Every question should be of length at most three pages

Unit-1

Field , characteristic of field,prime fields,finite field extensions,degree of field extension ,algebraic extensions,splitting fields:Existence and Uniqueness,Algebraic closure,Algebraically closed fields.

Unit –II

Finite field,Existence of GF(p^n),Construction of finite fields,Separable and purely inseparable extensions,perfect fields,simple extentions,primitive elements,Lagranges theorem on primitive elements ,normal extentions, roots of unity.

Unit-III

Galois extensions,the fundamental theorem of Galois theory,Cyclotomic extentions,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.Modern Algebra, Vikas Publishing House,New Delhi.
5. Hungerford, T.W.Algebra,Springer 1974.
6. Bastida, J.R.Field Extension and Galois Theory, Encyclopedia of Mathematics and Its Applications, Volume 22, Addison-Wesley Publishing Company.

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons) Mathematics (Semester-IV)
Paper-MHM-404

OPERATION RESEARCH -II

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting atleast three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

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).

Unit-II

Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, Significance of Inventory control, economic order quantity (EOQ), Deterministic inventory problems without shortage and with shortages, EOQ problems with price breaks, Multi item deterministic problems.

Unit-III

Replacement Problems: Replacement of equipment/Asset that deteriorates gradually, replacement of equipment that fails suddenly, Mortality Theorem, recruitment and promotion problem, equipment renewal problem. Simulation: Need of simulation, methodology of simulation. Simulation models, event- type simulation, generation of random numbers, Monte Carlo simulation.

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

Khalsa College Amritsar

(An Autonomous College)

Syllabus for
M.Sc. (Hons) Mathematics (Semester-IV)
Paper-MHM- 405

DISCRETE MATHEMATICS -II

Time: 3Hrs **M.M:80**

Instructions for paper setters/examiners:

1. Question paper will consist of three sections A, B and C based on unit I, II and III respectively.
2. Each section will consists six questions and students are required to attempt total of ten questions selecting at least three questions from each section. Each question will carry eight marks.
3. Question paper should cover atleast 40% article work from the recommended books.
4. Every question should be of length at most three pages.

Unit-I

Lattices and Boolean Algebra: Lattices as partially ordered sets, properties, lattices as algebraic systems, sublattices, direct products, Homomorphism, some special lattices (complete, complemented, distributive lattices). Boolean algebra as lattices, Boolean identities, sub-algebra, Boolean forms and their equivalence, sum of product, product of some canonical forms.

Unit-II

Graph Theory: Definition, undirected graphs, paths, circuits, cycles, subgraphs, induced subgraphs, degree of vertex, connectivity, planner graph, complete, bipartile complete graph, matrix representation of graph, adjacency and incidence matrix for graph, Euler's theorem on the existence of Eulerian paths and circuits,

Unit-III

Trees and Colouring of the Graph: Rooted tree, search tree, tree traversals, spanning trees, minimal spanning trees, Kruskal's algorithm. Chromatic number, four-colour problem, chromatic polynomials.

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