# Khalsa College Amritsar

(An Autonomous College)


## Faculty of Mathematical Sciences

Syllabus for

## M.Sc. (Mathematics)

## Semester I-VI

Session 2018-19

# Khalsa College Amritsar

**(An Autonomous College)**
**Syllabus for**
**M.Sc.-Mathematics (Semester-I)**
**Session 2018-19**
**Paper-MHM- 101**

## REAL ANALYSIS –I

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### 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 ($3^{rd}$ Edition) McGraw-Hill Ltd., Ch.2, Ch.3.
2. Simmons, G.F.: Introduction to Topology and Modern Analysis, McGraw-Hill Ltd.
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)**
**Session 2018-19**
**Paper-MHM- 102**

## ALGEBRA - I

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### 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. I.N. Herstein,: 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. P.B. Bhattacharya, S.K.Jain & S.R. Nagpaul : Basic Abstract Algebra, Cambridge University Press , 1997
6. Surjit Singh & Quazizamerrudin. Modern Algebra, Vikas Pub. House .
7. Nagpaul, S.R. University Press, 1997

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-I)**
**Session 2018-19**
**Paper-MHM- 103**

## LINEAR ALGEBRA

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

**Unit-1**

Vector spaces, subspaces, Basis and Dimension Theorems, Direct sum decomposition, The Algebra of linear transformations, Matrices associated with linear transformations, change of ordered bases, Elementary matrix operations and 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.

**Unit-III**

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.

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**Recommended Book:**


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.
5. Surjit Singh : Linear Algebra, Vikas Publishing House.

# Khalsa College Amritsar

**(An Autonomous College)**

## Syllabus for
## M.Sc.-Mathematics (Semester-I)
## Session 2018-19
## Paper-MHM- 104

## NUMBER THEORY

**Time: 3Hrs** **Max.Marks:100**

**Theory Marks:75**

**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### Unit-1

Number theoretic functions $\tau$ and $\sigma$, 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 triplets, the Fermat "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. G.H.Hardy and E.M.Wright : An Introduction to the Theory of Numbers, Oxford Univ. Press.

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-I)**
**Session 2018-19**
**Paper: MHM- 105**

## COMPLEX ANALYSIS

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### 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 transformations.

**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)**
**Session 2018-19**
**Paper-MHM- 106**

## DIFFERENTIAL EQUATIONS

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### 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, H.T.H. : Differential equations.
2. Ross, S.L. : Differential equations.
3. Sneddon, I : Elements of partial differential equation

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-II)**
**Session 2018-19**
**Paper-MHM- 201**

## REAL ANALYSIS -II

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### 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 $R^n$).

**BOOK RECOMMENDED:**

1.Walter Rudin: Principles of Mathematical Analysis ($3^{rd}$ edition) Mc 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, S.Chand & Co.
4. Apostol, T.M. : Mathematical Analysis $2^{nd}$ Edition Theorem (7.18, 7.30 & 7.31)

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-II)**
**Session 2018-19**
**Paper-MHM- 202**

## ALGEBRA -II

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### 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 $7^{th}$ 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)**
**Session 2018-19**
**Paper-MHM- 203**

## PROBABILITY THEORY

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**
**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.
6. Use of Scientific and Non-programmable calculator is allowed.

### 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 and Cauchy Schwartz Inequality, Convergence in probability and convergence in distribution, 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, t distribution, F distribution, Chi-square distribution, sampling distribution of mean and variance of sample from 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)**

**Session 2018-19**

**Paper-MHM- 204**

## CLASSICAL MECHANICS AND CALCULUS OF VARIATIONS

**Time: 3Hrs** **Max.Marks:100**

**Theory Marks:75**

**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### Unit-I

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.

### Unit-III

Sturm-Liouville's theorem on extremals, one sided variations, Hamilton's principle, 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

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-II)**
**Session 2018-19**
**Paper-MHM- 205**

## DIFFERENTIAL GEOMETRY

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:75**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### Unit – I

**Curves in $R^3$:** A simple arc, curves and their parametric representation, arc length and natural parameter, Contact of curves, tangent, principal normal, binormal, osculating plane, curvature and torsion, Serret-Frenet Formule, Helics, 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 of tensors.

### Unit-III

**Surfaces in $R^3$:** Implicit and Explicit forms for the equation of the surface, the two fundamental forms of a surface, Family of surfaces, Edge of regression, Envelops, Ruled surface, Developable and skew surfaces, Gauss and Weingarten formulae, Introduction to Geodesics, Geodesics differential equation.

**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)**

**Session 2018-19**

**Paper-MHM- 206**

## MATHEMATICAL METHODS

**Time: 3Hrs** **Max.Marks:100**

**Theory Marks:75**

**Internal Assessment:25**

**Instructions for paper setters/examiners:**

1. Question paper will consist of four sections namely section A which will be from entire syllabus (equally distributed from each unit), section B from unit I, section C from unit II and section D from unit III.
2. The Section–A will consist of five compulsory questions each of one mark.
3. Each section B, C, D will consist of six questions and students are required to attempt a total of ten questions selecting at least three questions from each section. Each question will carry seven marks.
4. Question paper should cover at least 40% article work from the recommended books.
5. Teaching time for this paper will be eight periods per week.

### Unit-I

**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, Complex Inversion formula.

### Unit-II

**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.

### Unit-III

**Volterra Equations**: Integral equations and algebraic system of linear equations. Kernels and $L_2$ -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. S.G. Mikhlin : Integral Equations
4. Pinckus, A. and Zafrany, S.: Fourier Series and Integral Transforms

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**

**M.Sc.-Mathematics (Semester-III)**

**Session 2018-19**

**Paper-MHM- 301**

## MEASURE THEORY

**Time: 3Hrs** **Max.Marks:100**

**Theory Marks:80**

**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### Unit-I

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.

### 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. Littlewood's three principles. 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 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 P.M. Fitzpatrik; Real Analysis (Fourth Edition), Pearson 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. ,Gupta, V.P. and Pankaj Jain : Lebesgue Measure and Integration, New Age International Publishers.

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-III)**
**Session 2018-19**
**Paper-MHM- 302**

## FUNCTIONAL ANALYSIS-I

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**
1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### 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. & P.M. Fitzpatrik : 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 O.P Ahuja : Functional Analysis, New Age International (P) Ltd Publishers, 2010

6. K. Chanrashekhra Rao : Functional Analysis, Narosa, 2002

7. D. Somasundram: A First Course in Functional Analysis, Narosa, 2006

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-III)**
**Session 2018-19**
**Paper-MHM- 303**

## STATISTICAL INFERENCE

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:56**
**Internal Assessment:20**
**Practical Marks:24**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of five questions and students are required to attempt total of eight questions selecting atleast two questions from each section. Each question will carry seven marks.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.
4. Use of Scientific and Non-programmable calculator is allowed.

**Unit-I**

Point Estimation: Sufficient statistics, Neyman factorization theorem, minimal sufficient statistics, ancillary statistics, complete statistics, Basu's theorem, unbiasedness, consistency, efficiency, Minimum variance unbiased estimators, Rao Blackwell Theorem, Lehmann-Scheffe theorem.

**Unit II**

Cramer-Rao lower bound. Efficiency of an estimator. Methods of estimation: maximum likelihood estimator, properties of MLE(without proof) method of moments, Bayes estimator, Concepts of testing of hypotheses, critical region, test function, two types of errors, power function, level of significance, p-value.

**Unit-III**

Neyman-Pearson theory, M.P. test, UMP test, Likelihood ratio property, Karlin Rubin theorem, 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. Casella,G.and Berger, R.L. Statistical Inference.
3. Mukhopadhyay,P : Mathematical Statistics

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-III)**
**Session 2018-19**
**Paper-MHM- 304**

## OPERATIONS RESEARCH-I

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**
1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### 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

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-III)**
**Session 2018-19**
**Paper-MHM- 305**

## DISCRETE MATHEMATICS-I

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### 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.

### 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 Leasseur: Applied Discrete Structures for Computer Science

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**

**M.Sc.-Mathematics (Semester-III)**

**Session 2018-19**

**Paper-MHM- 306**

## INTRODUCTION TO COMPUTER AND INFORMATION TECHNOLOGY

**Time: 3Hrs** **Max.Marks:100**

**Theory Marks:60**

**Internal Assessment Theory Marks:15**

**Practical Marks:20**

**Practical Internal Assessment Marks:05**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections namely section A from unit I, section B from unit II and section C from unit III. 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.3. Teaching time for this paper would be six periods per week.4. Each question will carry 6 marks.

**UNIT-I**

**Introduction to Computers and its Applications:** Computer definition and its characteristics , Block diagram of a computer, Evolution of Computers, Classification of Computers : Based on Generation, Based on Size (Micro, Mini, Mainframe, Super, Notebook, Personal Computer, Workstation) ,Based on Data Processing Techniques (Analog, Digital and Hybrid Computers) Batch oriented/on line/real-time applications Applications of Computer.

**UNIT-II**

**Interacting with the Computer:**

**Input Devices:** Keyboard, Mouse, pens, Touch screens, Bar Code reader, Joystick, Source data automation, (MICR, OMR, OCR), Screen assisted data entry: portable / handheld terminals for data collection, vision input systems.**Output Devices:** Monitor, Printers (Line, Character, Page), plotters, voice response units.**Data Storage Devices and Media:** Primary storage (Storage addresses and capacity, types of memory ), Secondary storage, Magnetic storage devices and Optical storage devices.

**UNIT-III**

**MS–Word 2010**: Overview, creating, saving, opening, importing, exporting and inserting files, formatting pages, paragraphs and sections, indents and outdents , creating lists and numbering. Headings, styles, fonts and font size editing, positioning and viewing texts, Finding and replacing text, inserting page breaks, page numbers, book marks, symbols and dates. Using tabs and tables, header, footer and printing, mail merge, macros.

**MS-Excel2010:**Worksheet overview.Entering information.Worksheet creation.Opening and saving workbook.Formatting number and texts. Protecting cells.Producing Charges and printing operationsgraphs.

**BOOKS RECOMMENDED:**

1. Computer Fundamentals – P.K. Sinha.
2. Introduction to Computers – N. Subramanian.
3. Introduction to Computers – Peter Norton Mcgraw Hill.
4. MS–Office _ BPB Publications

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-IV)**
**Session 2018-19**
**Paper-MHM- 401**

## TOPOLOGY

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### Unit-I

Topological spaces, Continuous functions, Homeomorphisms, definition of Product spaces and quotient spaces.

### 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.-Mathematics (Semester-IV)**

**Session 2018-19**

**Paper-MHM- 402**

**FUNCTIONAL ANALYSIS-II**

**Time: 3Hrs** **Max.Marks:100**

**Theory Marks:80**

**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

**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. Simmon G.F.: Introduction to topology and Modern Analysis Ch.X (sections 52-59) 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.

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-IV)**
**Session 2018-19**
**Paper-MHM- 403**

## FIELD EXTENTIONS AND GALOIS THEORY

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

**Unit-1**

Fields, characteristic of a 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 fields, Existence of $GF(p^n)$, Construction of finite fields, Separable and purely inseparable extensions, Perfect fields, Simple extentions, Primitive elements, Lagrange's 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.

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-IV)**
**Session 2018-19**
**Paper-MHM- 404**

## OPERATIONS RESEARCH-II

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### 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 Methods & Practice.

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-IV)**
**Session 2018-19**
**Paper-MHM- 405**

## DISCRETE MATHEMATICS-II

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:80**
**Internal Assessment:20**

**Instructions for paper setters/examiners:**

1. Question paper will consist of three sections. Section A from unit I, Section B from unit II and Section C from unit III. Each section will consist of 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.
2. Question paper should cover at least 40% article work from the recommended books.
3. Teaching time for this paper will be eight periods per week.

### 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

# Khalsa College Amritsar

**(An Autonomous College)**

**Syllabus for**
**M.Sc.-Mathematics (Semester-IV)**
**Session 2018-19**

**Paper-MHM- 406**
**PROGRAMMING IN C**

**Time: 3Hrs** **Max.Marks:100**
**Theory Marks:60**
**Internal assessment Marks:15**
**Practical Marks:20**
**Practical internal Assessment marks:05**

**Instructions for paper setters/examiners:**
1. Question paper will consist of three sections namely section A from unit I, section B from unit II and section C from unit III.
2. Each section will consist six questions and students are required to attempt total of ten questions selecting atleast three questions from each section.
3. Each question will carry six marks.

**UNIT-I**

**Logic Development Tools:** Data Representation, Flow Charts, Problem Analysis,Decision Trees/Tables, Pseudo Codes and Algorithms,**Fundamentals:** Character Set, Identifiers and Key Words, Data Types, Constants,Variables, Expressions, Statements, Symbolic Constants.

**Operators and Expressions:** Arithmetic Operators, Unary Operators, Relational and logic Operators, Assignment and Conditional Operators, Library functions.

**Data Input and Output**: Preliminaries, getch ,getche , getchar , gets, puts, scanf, printf functions.

**Control Statements:** Preliminaries, If statement, If–else statement, nested-if statement, else-if ladder statement, While, Do–While and For statements, Nested loops, Switch, Break, Continue statements.

**UNIT-II**

**Functions:** Brief overview, defining, accessing function, passing arguments to a function, specifying argument data types, function prototypes, recursion.**Arrays:** Defining and processing an array, passing array to a function, multi–dimensional arrays.**Strings**: String declaration, string functions and string manipulation.**Pointers**: Fundamentals, pointer declaration, operations on pointers, pointer and one dimension arrays ,passing pointers to a functions, pointers & multi–dimensional arrays.

**UNIT-III**

**Storage classes**: Automatic, external and static variables.

**Structures & Unions**: Defining and processing a structure, user defined data types, structures and pointers, passing structures to functions, self-referential structure, unions.

**Data Files**: Opening, closing, creating and processing of data files.

**BOOKS RECOMMENDED:** 1. Programming in C: Schaum Outlines Series.
2. C Programming: Stephen G. Kochan.
3. Let Us C: Yashwant Kanitkar