5 -Years Integrated M.Sc. (Honours) Mathematics

NEW SCHEME
Scheme of Examination of
Semester-I
(w.e.f. 2012-2013)

Paper Code	Title of the paper	Teaching Hours	Max. Marks			
			Theory	Internal Assessment	Practicals	Total Marks
12MHM 111	Algebra	4 Hours/ week	60	15	-	75
12MHM 112	Calculus	4 Hours/ week	60	15	-	75
12MHM 113	Solid Geometry	4 Hours/ week	60	15	-	75
12MHM 114	Discrete Mathematics-I	4 Hours/ week	60	15	-	75
12MHM 115	Descriptive Statistics	4 Hours/ week	60	15	-	75
12MHM 116	Computer Fundamentals and MS- OFFICE	4 Hours/ week	60	15	-	75
12MHM 117	Practical/ Computational work based on Paper 12MHM 115	4 Hours/ week	-		25	25
12MHM 118	Practical/ Computational work based on Paper 12MHM 116	4 Hours/ week	-		25	25
12MHM 119	English - I	4 Hours/ week	60	15	-	75
Total marks of Semester-I						575

Note : The other conditions will remain the same as per relevant Ordinance and rules and regulations of the University.

(w.e.f. 2018-19)
Algebra: 12MHM 111

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Apply the elementary operations on the matrices.

CO2 Compute the eigen values, eigen function, characteristic equation and minimal polynomial of a given matrix.

CO3 Obtain the solution of the systems of linear equations using the concept of rank of matrices.

CO4 Explain the concept of bilinear and quadratic forms with reference to the matrices and linear transformations.

CO5 Use the Descarte's rule of sign to find the nature of roots.

Section – I

Symmetric, Skew-symmetric, Hermitian and skew Hermitian matrices. Elementary Operations on matrices. Rank of a matrices. Inverse of a matrix. Linear dependence and independence of rows and columns of matrices. Row rank and column rank of a matrix. Eigenvalues, eigenvectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley Hamilton theorem and its use in finding the inverse of a matrix.

Section – II

Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations. Unitary and Orthogonal Matrices, Bilinear and Quadratic forms.

Section – III

Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots. Common roots and multiple roots. Transformation of equations.

Section – IV

Nature of the roots of an equation Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions.

Note: The question paper will consist of **five** sections. Each of the first four sections(**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended :

1. H.S. Hall and S.R. Knight, Higher Algebra, H.M. Publications 1994.
2. Shanti Narayan, A Text Books of Matrices.
3. Chandrika Prasad, Text Book on Algebra and Theory of Equations. Pothishala Private Ltd., Allahabad.

(w.e.f. 2018-19)
Calculus
Code: 12MHM 112

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Understand the method of successive differentiation and Taylor series expansions.
CO2 Be familiar with concepts of asymptotes, curvature and singular points.
CO3 Apply the concepts of calculus for tracing and rectification of the curves in cartesian, parametric and polar coordinates.
CO4 Understand reduction formulae and be familiar with the method of finding volumes and surfaces of solids of revolution.

Section – I

Definition of the limit of a function. Basic properties of limits, Continuous functions and classification of discontinuities. Differentiability. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions.

Section – II

Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates. Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves. Newton's method. Radius of curvature for pedal curves. Tangential polar equations. Centre of curvature. Circle of curvature. Chord of curvature, evolutes. Tests for concavity and convexity. Points of inflexion. Multiple points. Cusps, nodes & conjugate points. Type of cusps.

Section – III

Tracing of curves in Cartesian, parametric and polar co-ordinates. Reduction formulae. Rectification, intrinsic equations of curve.

Section – IV

Quadrature (area) Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution. Theorems of Pappu's and Guilden.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended :

1. Differential and Integral Calculus, Shanti Narayan.
2. Murray R. Spiegel, Theory and Problems of Advanced Calculus. Schaun's Outline series. Schaum Publishing Co., New York.
3. N. Piskunov, Differential and integral Calculus. Peace Publishers, Moscow.
4. Gorakh Prasad, Differential Calculus. Pothishasla Pvt. Ltd., Allahabad.
5. Gorakh Prasad, Integral Calculus. Pothishala Pvt. Ltd., Allahabad.

(w.e.f. 2018-19)
Solid Geometry
Code: 12MHM 113

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Derive system of conics, confocal conics and polar equation of a conic.

CO2 Determine the tangent and normal at any point, chord of contact and poles of line for a conic.

CO3 Understand the concept of sphere, cone and cylinder.

CO4 Obtain the equations of tangent plane, director sphere, normal to the conicoids and enveloping.

CO5 Describe circular section, plane sections of conicoids, generating lines, confocal conicoid and reductions of second degree equations.

Section – I

General equation of second degree. Tracing of conics. Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic. System of conics. Confocal conics. Polar equation of a conic, tangent and normal to the conic.

Section – II

Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Co-axal system of spheres

Cones. Right circular cone, enveloping cone and reciprocal cone.

Cylinder: Right circular cylinder and enveloping cylinder.

Section – III

Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid.

Section – IV

Paraboloids: Circular section, Plane sections of conicoids.

Generating lines. Confocal conicoid. Reduction of second degree equations.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. R.J.T. Bill, Elementary Treatise on Coordinary Geometry of Three Dimensions, MacMillan India Ltd. 1994.

2. P.K. Jain and Khalil Ahmad : A Textbook of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd. 1999.

(w.e.f. 2018-19)

Discrete Mathematics-I

Code: 12MHM 114

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Learn basic concepts of set theory, arithmetic, logic, proof techniques, binary relations.

CO2 Obtain mathematical proofs of the results and to differentiate between valid and unreliable arguments.

CO3 Present both technical and non-technical information in various forms such as written, oral, electronic and graphic.

CO4 Make effective use of appropriate technology to locate and use data and to evaluate its quality.

CO5 Apply diverse counting strategies to solve varied problems involving strings, combinations, distributions and partitions.

Section – I

Sets, principle of inclusion and exclusion, relations, equivalence relations and partition, denumerable sets, partial order relations, Mathematical Induction, Pigeon Hole Principle and its applications.

Section – II

Propositions, logical operations, logical equivalence, conditional propositions, Tautologies and contradictions. Quantifier, Predicates and Validity.

Section – III

Permutations and combinations, probability, basic theory of Graphs and Rings.

Section -IV

Discrete numeric functions, Generating functions, recurrence relations with constant coefficients. Homogeneous solution, particular relations, total rotation, Solution of recurrence relation by the method of generating functions.

Note: The question paper will consist of **five** sections. Each of the first four sections(**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended :

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.

5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors, Delhi, 2004.

(w.e.f. 2018-19)
Descriptive Statistics
Code: 12MHM 115

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Know Statistics as a subject, its origin and development stages.
CO2 Understand types of data and apply methods of collection like how to construct a questionnaire and collect data for the problem under study (in hand).
CO3 Compute and interpret measures of central tendancy and spread of data.
CO4 Construct and analyze graphical displays to summarize data and solve problems of finding association for qualitative data.
CO5 Calculate and interpret the correlation coefficient between variables.

Section – I

Introduction of Statistics, Basic knowledge of various types of data, Collection, classification and tabulation of data. Presentation of data: histograms, frequency polygon, frequency curve and ogives. Stem- and- Leaf and Box plots.

Section – II

Measures of Central Tendency and Location: Mean, median, mode, geometric mean, harmonic mean, partition values.

Measures of Dispersion:Absolute and relative measures of range, quartile deviation, mean deviation, standard deviation (σ), coefficient of variation.

Section – III

Moments, Skewness and Kurtosis: Moments about mean and about any point and derivation of their relationships, effect of change of origin and scale on moments, Sheppard's correction for moments (without derivation), Charlier's checks, Concepts of Skewness and Kurtosis.

Section – IV

Theory of Attributes: Symbolic notation, dichotomy of data, class frequencies, order of class frequencies, consistency of data, independence and association of attributes, Yule's coefficient of association and coefficient of colligation.

Correlation for Bivariate Data: Concept and types of correlation, Scatter diagram, Karl Pearson Coefficient (r) of correlation and rank correlation coefficient.

Note: The question paper will consist of **five** sections. Each of the first four sections(**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Suggested

1. A.M. Goon, M.K. Gupta, and B. Das Gupta: Fundamentals of Statistics, Vol-I.

2. S. Bernstein and R. Bernstein, Elements of Statistics, Schaum's outline series, McGraw-Hill.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.

(w.e.f. 2018-19)
Computer Fundamentals and MS-OFFICE
Code: 12MHM 116

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Design various text documents using MS Word such as lecture notes, applications, posters etc.

CO2 Apply and demonstrate various designs and animations using MS Power Point presentations.

CO3 Create tables, analyse data, design spreadsheets and implement various formulas in MS Excel.

CO4 Install and upgrade various softwares, hardware and peripherals in a desktop system.

Section-I

Fundamentals of Computer: Model of a digital computer, Functioning of a digital computer, Historical evolution of computers, classification of computers, Human being vs computer, Input / Output devices, Storage devices, Memory and mass storage devices, characteristics of memory systems, types of memory, RAM, ROM, concepts of Virtual and Cache memory, Types of software, Application and system software and its functions, time sharing, multiprocessing, Applications of Computer.

Section-II

Introduction to Windows: Types of windows, windows as an operating system, windows explorer, using clipboard, using paintbrush, control panel, installing a printer.
MS Power Point: Introduction, Power point slide creation, Slide-show, Adding graphics, Formatting Customizing and Printing.

Section-III

MS-Word: Introduction to MS-Word, Standard Toolbar, Word Wrap, Text formatting, Indents, Tabs, Formatting paragraphs, Applying Effects to text, Applying animation to text.

Section-IV

MS Excel: Introduction to MS Excel, Working with Toolbars, Formatting, Formulas, Data management, Graphs and Charts, Macros and other additional functions.

Note: The question paper will consist of **five** sections. Each of the first four sections(**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. Donald Sanders, Computers Today, McGraw-Hill Publishers.
2. Davis, Introduction to Computers, McGraw-Hill Publishers.

3. V. Rajaraman, Fundamental of Computers, Prentice-Hall India Ltd., New Delhi.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 117
(Based on paper 12MHM 115)

Practical/Computational work based on Paper 12MHM 115

Max. Marks : 25

Time: 3 Hours

Course Outcomes

Students would be able to:

CO1 Construct a questionnaire and collect data for the problem in hand.

CO2 Compute and interpret measures of central tendency and spread of data.

CO3 Analyse data through the use of various diagrams and graphs including bar diagrams, histograms, box plots, stem-and-leaf displays and other common visualizations.

CO4 Solve problems on association/correlation for given qualitative/quantitative data along with interpretation.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 118
(Based on paper12MHM 116)

Practical/Computational work based on Paper 12MHM 116

Max. Marks : 25

Time:3 Hours

Course Outcomes

Students would be able to:

CO1 Identify and explain the usage of computers and their importance to the society.
CO2 Identify different parts of the computer and their usage.
CO3 Create, format, save and process different MS Office documents.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

(w.e.f. 2018-19)
English - I
Code: 12MHM 119

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Learn about the production of correct speech sounds with the use of Phonetic Symbols.

CO2 Know about the place and manner of speech mechanism.

CO3 Learn about the uses of different Parts of Speech like Noun, Pronoun, Verb, Adjective, Types of Sentences and Common Errors to acquire proficiency in the use of English language.

Part-A Poetry

The following poems from **The Chronicles of Time edited by Asha Kadyan (Oxford University Press)**

a) "Let Me Not to the Marriage of True Minds" by William Shakespeare
b) "Death Be not Proud" by John Donne
c) "On His Blindness" by John Milton
d) "Shadwell" by John Dryden
e) "Know then Thyself" by Alexander Pope
f) "The Little Black Boy" By William Blake
g) "Three Years She Grew in Sun and Shower" by William Wordsworth

Part-B Phonetics and Grammar

i) **Phonetics**: Introduction to the Sound system of English: Phonetics Symbols, Organs of Speech, Transcription of Words (Oxford Advance Learners' Dictionary by Hornby to be followed).

ii) **Grammar:** Parts of Speech, Types of Sentences, Common Errors, Technical Writing (application writing, business letter).

Instruction for the paper-setter and the students

Q. No.1 Explanation with reference to the context. The students will be required to attempt two passages out of the given four from the book of poems. **(6x2=12)**

Q. No. 2 Two questions (with internal choice) will be asked based on theme, central idea, message and narrative technique of the poem. **(6x2=12)**

Q. No. 3 The question will be based on the Sound System of English language having internal choice. **(12)**

Q. No. 4 The question will be based on grammar. There will be internal choice with 12 sentences out of 20 to be attempted.

(12)

Q. No. 5 The question will be based on technical writing. There will be internal choice.

(12)

Total=60

Suggested Reading:

High School Grammar by Wren and Martin.

Remedial English Grammar for Foreign Students by F.T. Wood.

Essentials of Communication by D.G. Sexena, Kuntal Tamang (Top Quark)

NEW SCHEME

Scheme of Examination of

5- Years Integrated M.Sc. (Honours) Mathematics, Semester-II

(w.e.f. 2013-2014)

Paper Code	Title of the paper	Teaching Hours	Max. Marks			
			Theory	Internal Assessment	Practicals	Total Marks
12MHM 121	Number Theory and Trigonometry	4 Hours/ week	60	15	-	75
12MHM 122	Ordinary Differential Equations	4 Hours/ week	60	15	-	75
12MHM 123	Vector Calculus	4 Hours/ week	60	15	-	75
12MHM 124	Discrete Mathematics-II	4 Hours/ week	60	15	-	75
12MHM 125	Regression Analysis and Probability	4 Hours/ week	60	15	-	75
12MHM 126	Programming in Visual Basic	4 Hours/ week	60	15	-	75
12MHM 127	Practical / Computational work based on Paper12MHM125	4 Hours/ week	-		25	25
12MHM 128	Practical / Computational work based on Paper 12MHM126	4 Hours/ week	-		25	25
12MHM 129	English-II	4 Hours/ week	60	15	-	75
Total Marks of Semester-II						575

Note: The other conditions will remain the same as per relevant Ordinance and rules and regulations of the University.

(w.e.f. 2018-19)
Number Theory and Trigonometry
Code: 12MHM 121

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Understand the concepts of congruences, residue classes and least residues.

CO2 Learn the operations of addition, subtraction, multiplication and calculation of powers of integers with respect to modulo m.

CO3 Determine multiplicative inverses with respect to modulo m and use these to solve linear congruences.

CO4 Work with the trigonometric form of complex numbers including De-Moivre's formula.

CO5 Be familiar with the Euler form $r \cdot e^{i\theta}$ of complex numbers.

Section – I

Divisibility, G.C.D.(greatest common divisors), L.C.M.(least common multiple) Primes, Fundamental Theorem of Arithemetic. Linear Congruences, Fermat's theorem. Wilson's theorem and its converse. Linear Diophanatine equations in two variables

Section – II

Complete residue system and reduced residue system modulo m. Euler's ø function Euler's generalization of Fermat's theorem. Chinese Remainder Theorem. Quadratic residues. Legendre symbols. Lemma of Gauss; Gauss reciprocity law. Greatest integer function [x]. The number of divisors and the sum of divisors of a natural number n (The functions d(n) and σ(n)). Moebius function and Moebius inversion formula.

Section - III

De Moivre's Theorem and its Applications. Expansion of trigonometrical functions. Direct circular and hyperbolic functions and their properties.

Section – IV

Inverse circular and hyperbolic functions and their properties. Logarithm of a complex quantity. Gregory's series. Summation of Trigonometry series.

Note: The question paper will consist of **five** sections. Each of the first four sections(**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended :

1. S.L. Loney, Plane Trigonometry Part – II, Macmillan and Company, London.
2. R.S. Verma and K.S. Sukla, Text Book on Trigonometry, Pothishala Pvt. Ltd. Allahabad.

3. Ivan Ninen and H.S. Zuckerman, An Introduction to the Theory of Numbers.

(w.e.f. 2018-19)

Ordinary Differential Equations

Code: 12MHM 122

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to :

CO1 Be familiar with formation of differential equations and to solve exact differential equations by finding integrating factors.

CO2 Find solution of Lagrange's equations, Clairauts equations and other standard equations of first order but not of first degree.

CO3 Learn the concept of auxiliary equation, particular integral for linear differential equations with constant co-efficients and their solution.

CO4 Understand linear differential equations of second order and their solution by different methods.

CO5 Get familiar with solution of ordinary simultaneous differential equations and total differential equations.

Section – I

Geometrical meaning of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for x,y,p Lagrange's equations, Clairaut's equations. Equation reducible to Clairaut's form. Singular solutions.

Section – II

Orthogonal trajectories: in Cartesian coordinates and polar coordinates. Self orthogonal family of curves.. Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous

Section – III

Linear differential equations of second order: Reduction to normal form. Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations. Reduction of order of a differential equation. Method of variations of parameters. Method of undetermined coefficients.

Section – IV

Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators x (d/dx) or t (d/dt) etc. Simultaneous equation of the form $dx/P = dy/Q = dz/R$. Total differential equations. Condition for $Pdx + Qdy + Rdz = 0$ to be exact. General method of solving $Pdx + Qdy + Rdz = 0$ by taking one variable constant. Method of auxiliary equations.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended :

1. D.A. Murray, Introductory Course in Differential Equations. Orient Longaman (India) . 1967
2. A.R.Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd., London
3. E.A. Codington, Introduction to Differential Equations.
4. S.L.Ross, Differential Equations, John Wiley & Sons
5. B.Rai & D.P. Chaudhary, Ordinary Differential Equations, Narosa Publishing House Pvt. Ltd.

(w.e.f. 2018-19)
Vector Calculus
Code: 12MHM 123

Time : 3 Hours **Max. Marks : 60**

CourseOutcomes

Students would be able to:

CO1 Find the derivative along a curve and directional derivatives.

CO2 Calculate and interpret gradient, divergence, curl and their related vector identities.

CO3 Be familiar with line, surface and volume integrals.

CO4 Use theorems of Gauss, Green and Stokes to compute integrals.

Section – I

Scalar and vector product of three vectors, product of four vectors. Reciprocal vectors. Vector differentiation. Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives

Section – II

Gradient of a scalar point function, geometrical interpretation of grad Φ , character of gradient as a point function. Divergence and curl of vector point function, characters of Div $\vec{f}$ and Curl $\vec{f}$ as point function, examples. Gradient, divergence and curl of sums and product and their related vector identities. Laplacian operator.

Section – III

Orthogonal curvilinear coordinates Conditions for orthogonality fundamental triad of mutually orthogonal unit vectors. Gradient, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinates, Cylindrical co-ordinates and Spherical co-ordinates.

Section – IV

Vector integration; Line integral, Surface integral, Volume integral.
Theorems of Gauss, Green & Stokes and problems based on these theorems.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. Murrary R. Spiegal, Theory and Problems of Advanced Calculus, Schaum Publishing Company, New York.
2. Murrary R. Spiegal, Vector Analysis, Schaum Publisghing Company, New York.
3. N. Saran and S.N. Nigam, Introduction to Vector Analysis, Pothishala Pvt. Ltd., Allahabad.

4. Shanti Narayna, A Text Book of Vector Calculus. S. Chand & Co., New Delhi.

(w.e.f. 2018-19)
Discrete Mathematics-II
Code: 12MHM 124

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Learn about properties of graphs such as distinctive circuits or trees.
CO2 Produce and interpret graphs of various types of basic functions.
CO3 Solve equations and inequalities algebraically and graphically including model for applied problems.
CO4 Use the boolean algebra in different fields of science and engineering.

Section -I

Lattices and their properties, lattice as algebraic system, Bounded, Complement and distributive lattices.

Section -II

Boolean algebra, definition and examples, properties, duality, distributive and complmented Calculus. Design and implementation of digital networks, switching circuits, Karnaugh map.

Section -III

Graph, definition, exemplary types of graphs, paths and circuits. Eulearian and Hermitian circuits. Seven bridges machine, shortest path traveling salesman problems. Planar graph. Matrix of graph.

Section -IV

Directed Graphs, Trees, Isomorphism of Trees, Representation of Algebraic Expressions by Binary Trees, Spanning Tree of a Graph, Shortest Path Problem, Minimal spanning Trees, Cut Sets, Tree Searching..

Note: The question paper will consist of **five** sections. Each of the first four sections**(I-IV)** will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.
5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors, Delhi, 2004.

(w.e.f. 2018-19)
Regression Analysis and Probability
Code: 12MHM 125

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Define explanatory variable as the independent variable (predictor), and the response variable as the dependent variable (outcome) for a given practical situation and solve simple problems.

CO2 Explain what probability is and how to express it numerically as a ratio, a decimal and a percentage.

CO3 Determine the probability of different experimental results.

CO4 Distinguish marginal and conditional probabilities.

CO5 Apply properties of expectation to various probabilistic problems.

Section -I

Linear Regression: Concept of regression, principle of least squares and fitting of straight line, derivation of two lines of regression, properties of regression coefficients, standard error of estimate obtained from regression line, correlation coefficient between observed and estimated values.Angle between two lines of regression. Difference between correlation and regression.

Curvilinear Regression: Fitting of second degree parabola, power curve of the type $Y=ax^b$, exponential curves of the types $Y=ab^x$ and $Y=ae^{bx}$.

Section –II

Concepts in Probability: Random experiment, trial, sample point, sample space, operation of events, exhaustive, equally likely and independent events, Definitions of probability—classical, relative frequency, statistical and axiomatic approach, Addition and multiplication laws of probability, Boole's inequality.

Section -III

Bayes' theorem and its applications.

Random Variable and Probability Functions:Definition and properties of random variables, discrete and continuous random variable, probability mass and density functions, distribution function.

Section –IV

Concepts of bivariate random variable: joint, marginal and conditional distributions.

Mathematical Expectation: Definition and its properties –moments, measures of location, dispersion, skewness and kurtosis.

Note: The question paper will consist of **five** sections. Each of the first four sections**(I-IV)** will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Suggested:

1. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the theory of Statistics, McGraw Hill, 1974.
2. Baisnab and M. Jas, Element of Probability and Statistics, Tata McGraw Hill.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.
4 P.L.Meyer, Introductory Probability and Statistical Applications, Addison-Wesley Publishing Company, 1970.

(w.e.f. 2018-19)
Programming in Visual Basic
Code: 12MHM 126

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Differentiate between sequential and event driven programming.
CO2 Get familiar with the concepts of objects, methods, and events pertaining to the programming.
CO3 Create attractive program interfaces using different controls on forms and applying different events.
CO4 Develop programs employing simple animations.
CO5 Understand database programming and reporting.

Section - I

Visual Basic: Introduction, Analyzing, Data types, Variables, Constants, Controls and Properties.
Control Structures: Conditional Statements, Loop Statements, Exit statement, Stop statement Arrays

Section - II

Text Boxes, Command Buttons, Labels, Additional Controls – List Box, ComboBox, Difference between ListBox and Combo Box, Option Buttons, Check Boxes, Frames, Scroll Bars, Timer Control
Control Arrays, Procedures and Functions, SDI and MDI Applications

Section - III

Menus: Menu Editor, Menu controls, Submenus, Popup Menus
Common Dialog Controls: Color Dialog Box, Font Dialog Box, Open and Save as Dialog Box, Print Dialog Box, Help Dialog Box.
Database Programming: Data Access Object, Data Binding, Data Control and Data Bound Controls, Database Object, Recordset Object, Field Object.

Section - IV

Crystal Reports:Introduction to Reports, Crystal Reports, Creating and Using a Report in VB
Library Functions: Conversion functions, String functions, Numeric functions, Date and Time Functions.

Note: The question paper will consist of **five** sections. Each of the first four sections ***(I-IV)***will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended

1. Reselman& Other, Using Visual Basic 6, Prentice Hall of India.
2. Donald &Oancea, Visual Basic 6 from Scratch, Prentice- Hall of India.
3. Noel Jerke, Visual Basic 6, Tata Mc-Graw Hill
4. Days Maver, Teach Yourself More VB in 21 days, Techmedia.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 127
(Based on paper 12MHM 125)

Practical/Computational work based on Paper 12MHM 125

Max. Marks : 25

Time: 3 Hours

Course Outcomes

Students would be able to:

CO1 Identify relationships between variables and carry out regression analysis for the given data to predict outcomes.

CO2 Construct simple linear regression model and obtain two lines of regression for the given bivariate data.

CO3 Find probability using classical/statistical/geometrical definition of probability for the data collected for different situations.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 128
(Based on paper 12MHM 126)

Practical/Computational work based on Paper 12MHM 126

Max. Marks : 25

Time:3 Hours

Course Outcomes

Students would be able to:

CO1 Analyse program requirements in Visual Basics
CO2 Design/develop programs with different GUI interfaces
CO3 Coding different programs and develop interfaces of data entry and form design using Visual Basic

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

(w.e.f. 2018-19)
English - II
Code: 12MHM 129

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Learn about the different features of grammar like Synonyms, Antonyms, Prefix-Suffix and One Word Substitution.
CO2 Write Theme-based Paragraphs effectively.
CO3 Understand Technical Writing of Applications and Business Letters through E-mail writing.
CO4 Write a review of good English Novels, Movies and T.V. Programmes of their liking.
CO5 Write an eye-witnessed Report on specific situation.

Part-A Short Stories

The following Stories from **The Pointed Vision: An Anthology of Short Stories** By Usha Bande and Krishan Gopal (Oxford University Press, New Delhi) :

1. 'The Bet' by Anton Chekhov
2. 'Gift of Magi' by O Henry
3. 'The Postmaster' by Rabindranath Tagore
4. 'Three Questions' by Leo Tolstoy.
5. 'The Dying Detective' by Arthur Conana Coyle.
6. 'Under the Banyan Tree' by R.K. Narayan.

Part-B (i) Grammar and Writing Skills

a) Synonyms and Antonyms
b) Prefix-Suffix
c) Homophones and Homonyms
d) One word substitution

(ii) a) Developing writing skills through theme based paragraphs.
b) Technical writing: E-mail writing, Reporting, Resume Writing, Re-viewing. T.V. Programmes

Instruction to the Paper-Setter and the Students

Q. No. 1 Explanation with reference to the context. The student will be required to

attempt two passages (with internal choice) from the book of Stories.
(6x2=12)

Q. No. 2 Two essay type questions (with internal choice) will be asked from the book of stories.
(6x2=12)

Q. No.3 This question will be based on grammar. Students will be required to attempt 12 sentences out of the given 20.
(12)

Q. No. 4.& 5 Question No. 4 & 5 will be based on writing skills and technical writing.
(12x2=24)

Total=60

Suggested Reading:

High School Grammar by Wren and Martin.
Remedial English Grammar for Foreign Students by F.T. Wood.
Essentials of Communication by D.G. Sexena, Kuntal Tamang (Top Quark)

NEW SCHEME

Scheme of Examination of
5-Years Integrated M.Sc. (Honours) Mathematics, Semester-III
(w.e.f. 2013-2014)

Paper Code	Title of the paper	Teaching Hours	Max. Marks			Total Marks
			Theory	Internal Assessment	Practicals	
12MHM 231	Advanced Calculus	4 Hours/ week	60	15	-	75
12MHM 232	Partial Differential Equations	4 Hours/ week	60	15	-	75
12MHM 233	Statics	4 Hours/ week	60	15	-	75
12MHM 234	Differential Geometry	4 Hours/ week	60	15	-	75
12MHM 235	Probability Distributions	4 Hours/ week	60	15	-	75
12MHM 236	Database Management and Oracle	4 Hours/ week	60	15	-	75
12MHM 237	Practical/ Computational work (based on Papers 12MHM 235)	4 Hours/ week	-		25	25
12MHM 238	Practical/ Computational work (based on Papers 12MHM 236)	4 Hours/ week	-		25	25
Total Marks of Semester-III						500

Note : The conditions with regard to the above scheme will be as per the relevant ordinance and rules and regulations of the University.

(w.e.f. 2018-19)
Advanced Calculus
Code: 12MHM 231

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Understand the concepts of continuity, uniform continuity and their related theorems.

CO2 Describe the concepts of limit, continuity and differentiability of real valued function of two variables.

CO3 Explain maxima, minima and saddle pointes of two variables and Lagrange's method of multipliers.

CO4 Determine the tangent, principle normal, locus of curvature, Bertrand curves, tangent plains and apply them to different problems.

Section – I

Continuity, Sequential Continuity, properties of continuous functions, Uniform continuity, chain rule of differentiability. Mean value theorems; Rolle's Theorem and Lagrange's mean value theorem and their geometrical interpretations. Taylor's Theorem with various forms of remainders, Darboux intermediate value theorem for derivatives, Indeterminate forms.

Section – II

Limit and continuity of real valued functions of two variables. Partial differentiation. Total Differentials; Composite functions & implicit functions. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables.

Section – III

Differentiability of real valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Maxima, Minima and saddle points of two variables. Lagrange's method of multipliers.

Section – IV

Curves: Tangents, Principal normals, Binormals, Serret-Frenet formulae. Locus of the centre of curvature, Spherical curvature, Locus of centre of Spherical curvature, Involutes, evolutes, Bertrand Curves. Surfaces: Tangent planes, one parameter family of surfaces, Envelopes.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. C.E. Weatherburn , Differential Geometry of three dimensions, Radhe Publishing House, Calcutta
2. Gabriel Klaumber, Mathematical analysis, Marcel Dekkar, Inc., New York, 1975
3. R.R. Goldberg , Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi, 1970
4. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd., Allahabad
5. S.C. Malik , Mathematical Analysis, Wiley Eastern Ltd., Allahabad.
6. Shanti Narayan, A Course in Mathemtical Analysis, S.Chand and company, New Delhi
7. Murray, R. Spiegel, Theory and Problems of Advanced Calculus, Schaum Publishing co., New York

(w.e.f. 2018-19)
Partial Differential Equations
Code: 12MHM 232

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Solve Lagrange's linear equations using Charpit's general method and Jacobi's method.
CO2 Classify partial differential equations and transform them into cononical forms.
CO3 Solve partial differential equations of second order by Monge's method.
CO4 Understand the characteristic equations and characteristic curves of second order partial differential equations.
CO5 Solve Laplace equation, wave equations and diffusion equation.

Section – I

Partial differential equations: Formation, order and degree, Linear and Non-Linear Partial differential equations of the first order: Complete solution, singular solution, General solution, Solution of Lagrange's linear equations, Charpit's general method of solution. Compatible systems of first order equations, Jacobi's method.

Section – II

Linear partial differential equations of second and higher orders, Linear and non-linear homogenious and non-homogenious equations with constant co-efficients, Partial differential eqution with variable co-efficients reducible to equations with constant coefficients, their complimentary functions and particular Integrals, Equations reducible to linear equations with constant co-efficients.

Section – III

Classification of linear partial differential equations of second order, Hyperbolic, parabolic and elliptic types, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions, Solution of linear hyperbolic equations, Monge's method for partial differential equations of second order.

Section – IV

Cauchy's problem for second order partial differential equations, Characteristic equations and characteristic curves of second order partial differential equation, Method of separation of variables: Solution of Laplace's equation, Wave equation (one and two dimensions), Diffusion (Heat) equation (one and two dimension) in Cartesian Co-ordinate system.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. D.A.Murray, Introductory Course on Differential Equations, Orient Longman, (India), 1967
2. Erwin Kreyszing, Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
3. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd.
4. Ian N.Sneddon, Elements of Partial Differential Equations, McGraw Hill Book Company, 1988
5. Frank Ayres, Theory and Problems of Differential Equations, McGraw Hill Book Company, 1972
6. J.N. Sharma and Kehar Singh, Partial Differential Equations

(w.e.f. 2018-19)
Statics
Code: 12MHM 233

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Understand the composition and resolution of forces and familiar with the concepts of moments and couples.

CO2 Apply the conditions of equilibrium to solve problems on friction, center of gravity and virtual work.

CO3 Understand and solve the problems based on stable and unstable equilibrium.

CO4 Be familiar with the theory of forces in three dimensions and wrenches.

Section – I

Composition and resolution of forces. Parallel forces. Moments and Couples.

Section – II

Analytical conditions of equilibrium of coplanar forces. Friction. Centre of Gravity.

Section – III

Virtual work. Forces in three dimensions. Poinsots central axis.

Section – IV

Wrenches. Null lines and planes. Stable and unstable equilibrium.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. S.L. Loney, Statics, Macmillan Company, London
2. R.S. Verma, A Text Book on Statics, Pothishala Pvt. Ltd., Allahabad

(w.e.f. 2018-19)
Differential Geometry
Code: 12MHM 234

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Describe the basic features of curves and parametric families of surfaces in Euclidean space.

CO2 Be familiar with the concepts of envelope, edge of regression and developable surfaces.

CO3 Acquire knowledge of the normal curvature of a surface and its connection with the first and second fundamental forms.

CO4 Understand the concepts of surface of revolution, asymptotic lines, curvature and torsion, isometric parameters and minimal curves.

CO5 Have knowledge of geodesics on a surface, their characterization, torsion of geodesic, Bonnet theorem and its implication for a geodesic triangle.

Section – I

One Parameter family of Surfaces : Envelope, Characteristics , Edge of regression , Developable surfaces.

Developables Associated with a Curve :Osculating developable, Polar developable, Rectifying developable.

Section – II

Two- parameter Family of Surfaces:Envelope, Characteristics points,

Curvilinear coordinates, First order magnitudes, Directions on a surface, The normal, Second order magnitudes, Derivatives of **n**.

Section III

Curves on a Surface:Principal directions and curvatures, First and second curvatures, Euler's theorems, Dupin's indicatrix, The surfaces $z = f(x,y)$, Surface of revolution. Conjugate directions, Conjugate systems. Asymptotic lines, Curvature and torsion, Isometric parameters, Null lines, minimal curves.

Section IV

Geodesics and Geodesic Parallels:Geodesics: Geodesic property, Equation of Geodesics, Surface of revolution, Torsion of Geodesic.

Curves in Relation to Geodesics: Bonnet's theorem, Joachimsthal's theorems, Vector curvature, Geodesic curvature κ_g, Other formulae for κ_g, Bonnet's formula.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question

from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. A.K. Singh and P.K. Mittal , A Textbook of Differential Geometry, Har-Anand Publications.
2. C.E. Weatherburn, Differential Geometry of Three Dimensions, Radhe Publishing House.
3. Erwin Kreyszig, Differential Geometry.

(w.e.f. 2018-19)
Probability Distributions
Code: 12MHM 235

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Explain moment generating and cumulant generating functions and apply them.

CO2 Understand Tchebychev's inequality, convergence in probability and laws of large numbers.

CO3 Apply Bernoulli, binomial, Poisson, geometric and hyper-geometric distributions to real life problems.

CO4 Define and use Uniform, gamma, beta (first and second kinds) and exponential distributions to solve problems.

CO5 Demonstrate normal probability distribution, its properties and applications.

Section – I

Generating Functions: Moment generating function and cumulant generating function along with their properties and uses.

Tchebychev's inequality, Convergence in probability, Weak and strong laws of large numbers (Statements only).

Section – II

Bernoulli, binomial, Poisson, geometric and hyper-geometric distributions with their properties.

Section – III

Uniform, gamma, beta (first and second kinds) and exponential distributions with their properties.

Section – IV

Normal distribution with its properties. Central Limit Theorem (Statement only) and its applications.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Suggested:

1. Baisnab and M. Jas, Element of Probability and Statistics, Tata McGraw Hill.

2. P.L.Meyer, Introductory Probability and Statistical Applications, Addison-Wesley Publishing Company, 1970.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.

(w.e.f. 2018-19)
Database Management System and Oracle
Code: 12MHM 236

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Describe basic concepts of database system.
CO2 Design a data model and schemas in RDBMS.
CO3 Apply RDBMS to the industry applications.
CO4 Learn to use Structured Query Language.
CO5 Analyze functional dependencies to design a robust database.
CO6 Implement transactions, concurrency control, database recovery and query optimization.

Section - I

Terminologies of database, Drawbacks of conventional file systems, Data administrator (Role and functions), Characteristics of databases, Data redundancy, Data integrity, Data independence. DBMS and its functions. Advantages and disadvantages of database.

Section - II

Three levels of the architecture: External level, Conceptual level and Internal level, Mappings and Schemas, Client/Server architecture, Distributed processing.

Section - III

Data model, Relational data model, Hierarchical data model, Network data model.
Relational model, Basic structure, Terminology.
Normalization, First Normal Form, Second Normal Form, Third Normal Form, BCNF, Relational algebra and Relational Calculus

Section - IV

PL/SQL Blocks, Data types, PL/SQL functions, Cursors, Error handling inPL/SQL, Package functions, Package procedures.
Database Triggers: Use & type of database Triggers, DatabaseTriggers Vs. Declarative Integrity Constraints, Creatinga Trigger, BEFORE vs AFTER Trigger Combinations, Dropping a Trigger.

Note: The question paper will consist of **five** sections. Each of the first four sections (***I-IV***) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended

1. C.J. Date, Sixth Ed., An Introduction to Database System, Addison-Wesley Publishing Co.
2. Ullman, D.Jeffery, Principles of Database System, Computer Science Press.
3. James Martin, Principles of Database Management System, Prentice Hall of India Pvt. Ltd.
4. Desai, C.Bipin, Introduction to Data base Systems, Galgotia Publ.
5. R.P. Whittington, Data Base Systems Engineering, Clavendon Press.
6. D.M.Kroenke, Database Processing : Fundamental Design, Implementation, 2nd Edn. Galgotia Publ. Pvt. Ltd.
7. Wiederhold, Database Design, McGraw Hill Book Comp.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 237
(Based on paper 12MHM 235)

Practical/Computational work based on Paper 12MHM 235

Time:3 Hours **Max. Marks : 25**

Course Outcomes

Students would be able to:

CO1 Fit binomial distribution to the given data when the probability of success is known/ unknown.

CO2 Find expected frequencies by fitting Poisson to the given data.

CO3 Fit the geometric distributions to real data.

CO4 Compute mean and variance of the given data and fit the normal distribution.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 238
(Based on paper 12MHM 236)

Practical/Computational work based on Paper 12MHM 236

Time:3 Hours **Max. Marks : 25**

Course Outcomes

Students would be able to:

CO1 Ability to design and implement a database schema for different problem.

CO2 Apply the normalization techniques for development applications and day to day problems.

CO3 Ability to formulate queries using SQL DML/DDL/DCL commands.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

NEW SCHEME

Scheme of Examination of

5-Years Integrated M.Sc. (Honours) Mathematics Semester-IV

(w.e.f. 2013-2014)

Paper Code	Title of the paper	Teaching Hours	Max. Marks			Total Marks
			Theory	Internal Assesment	Practicals	
12MHM 241	Sequences and Series	4 Hours/ week	60	15	-	75
12MHM 242	Special Functions and Integral transforms	4 Hours/ week	60	15	-	75
12MHM 243	Programming in C and Numerical Methods	4 Hours/ week	45	-	30	75
12MHM 244	Hydrostatics	4 Hours/ week	60	15	-	75
12MHM 245	Elementary Inference	4 Hours/ week	60	15	-	75
12MHM 246	Data Structures using C	4 Hours/ week	60	15	-	75
12MHM 247	Practical/ Computational Work (Based on paper 12MHM 245)	4 Hours/ week	-		25	25
12MHM 248	Practical/ Computational Work (Based on paper 12MHM 246)	4 Hours/ week	-		25	25
Total Marks of Semester-IV						500

Note : The conditions with regard to the above scheme will be as per the relevant ordinance and rules and regulations of the University.

(w.e.f. 2018-19)
Sequences and Series
Code: 12MHM 241

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Explain the concept of sequences and their types.
CO2 Identify the convergence of sequences and series of positive terms.
CO3 Apply various important convergence tests to the given series.
CO4 Understand the difference between conditional and absolute convergence of a lternating series.

Section – I

Boundedness of the set of real numbers; least upper bound, greatest lower bound of a set, neighborhoods, interior points, isolated points, limit points, open sets, closed set, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weiestrass theorem, Open covers, Compact sets and Heine-Borel Theorem.

Section – II

Sequence: Real Sequences and their convergence, Theorem on limits of sequence, Bounded and monotonic sequences, Cauchy's sequence, Cauchy general principle of convergence, Subsequences, Subsequential limits.

Infinite series: Convergence and divergence of Infinite Series, Comparison Tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series.

Section – III

Infinite series: D-Alembert's ratio test, Raabe's test, Logarithmic test, de Morgan and Bertrand's test, Cauchy's Nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test.

Section – IV

Alternating series, Leibnitz's test, absolute and conditional convergence, Arbitrary series: abel's lemma, Abel's test, Dirichlet's test, Insertion and removal of parenthesis, re-arrangement of terms in a series, Dirichlet's theorem, Riemann's Re-arrangement theorem, Pringsheim's theorem (statement only), Multiplication of series, Cauchy product of series, (definitions and examples only) Convergence and absolute convergence of infinite products.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. R.R. Goldberg , Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi, 1970
2. S.C. Malik, Mathematical Analysis, Wiley Eastern Ltd., Allahabad.
3. Shanti Narayan, A Course in Mathematical Analysis, S.Chand and Company, New Delhi
4. Murray, R. Spiegel, Theory and Problems of Advanced Calculus, Schaum Publishing Co., New York
5. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
6. Earl D. Rainville, Infinite Series, The Macmillan Co., New York

(w.e.f. 2018-19)
Special Functions and Integral Transforms
Code: 12MHM 242

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Be familiar with Bessel's functions, Hermite's polynomial, Legendre's polynomial and their properties.
CO2 Solve Bessel's, Legendre's and Hermite's equations.
CO3 Find the Laplace transform, inverse laplace transform of various functions.
CO4 Apply Laplace transform to solve ordinary differential equations.
CO5 Determine the Fourier transform of various functions and solve the partial differential equations using them.

Section – I

Series solution of differential equations – Power series method, Definitions of Beta and Gamma functions. Bessel equation and its solution: Bessel functions and their properties-Convergence, recurrence, Relations and generating functions, Orthogonality of Bessel functions.

Section – II

Legendre and Hermite differentials equations and their solutions: Legendre and Hermite functions and their properties-Recurrence Relations and generating functions. Orhogonality of Legendre and Hermite polynomials. Rodrigues' Formula for Legendre & Hermite Polynomials, Laplace Integral Representation of Legendre polynomial.

Section – III

Laplace Transforms – Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting theorems, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Convolution theorem, Inverse Laplace transforms, convolution theorem, Inverse Laplace transforms of derivatives and integrals, solution of ordinary differential equations using Laplace transform.

Section – IV

Fourier transforms: Linearity property, Shifting, Modulation, Convolution Theorem, Fourier Transform of Derivatives, Relations between Fourier transform and Laplace transform, Parseval's identity for Fourier transforms, solution of differential Equations using Fourier Transforms.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. Erwin Kreyszing, Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
2. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd.
3. I.N. Sneddon, Special Functions on mathematics, Physics & Chemistry.
4. W.W. Bell, Special Functions for Scientists and Engineers.
5. I.N. Sneddon, The use of integral transform, McGraw Hill, 1972
6. Murray R. Spiegel, Laplace transform, Schaum's Series

(w.e.f. 2018-19)
Programming in C and Numerical Methods
Code: 12MHM 243

Course Outcomes
Students would be able to:
CO1 Develop C programs and execute them.
CO2 Write the C code for a given algorithm.
CO3 Learn conditional statements, logical statements and their programs along with array implementation.
CO4 Apply numerical methods using C language.

Part-A (Theory)
Time: 3 Hours **Max. Marks: 45**

Section – I
Programmer's model of a computer, Algorithms, Flow charts, Data types, Operators and expressions, Input / Output functions.

Section – II
Decisions control structure: Decision statements, Logical and conditional statements, Implementation of Loops, Switch Statement & Case control structures. Functions, Preprocessors and Arrays.

Section – III
Strings: Character Data Type, Standard String handling Functions, Arithmetic Operations on Characters. Structures: Definition, using Structures, use of Structures in Arrays and Arrays in Structures. Pointers: Pointers Data type, Pointers and Arrays, Pointers and Functions.
Solution of Algebraic and Transcendental equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson's method. Newton's iterative method for finding pth root of a number, Order of convergence of above methods.

Section – IV
Simultaneous linear algebraic equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method). Crout's method, Cholesky Decomposition method. Iterative method, Jacobi's method, Gauss-Seidal's method, Relaxation method.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question

from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. B.W. Kernighan and D.M. Ritchie, The C Programming Language, 2nd Edition
2. V. Rajaraman, Programming in C, Prentice Hall of India, 1994
3. Byron S. Gottfried, Theory and Problems of Programming with C, Tata McGraw-Hill Publishing Co. Ltd., 1998
4. Babu Ram, Numerical Methods, Pearson Publication.
5. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
6. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999
7. E. Balagurusamy, Programming in ANSI C, Tata McGraw-Hill Publishing Co. Ltd.

Part-B (Practical)

Time: 3 Hours **Max. Marks: 30**

There will be a separate practical paper consisting of simple programs in Cand the implementation of Numerical Methods, studied in the paper 12MHM 243 (Part-A).

(w.e.f. 2018-19)
Hydrostatics
Code: 12MHM 244

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Establish a fundamental familiarity with the basic hydrostatics concepts and their applications.

CO2 Calculate the magnitude and location of hydrostatic pressure forces on plane submerged surfaces and curved surfaces.

CO3 Determine the response of any floating structure to changes in its geometry and weight distribution.

CO4 Explain principles of buoyancy and floatation and to calculate the buoyant forces on floating bodies.

CO5 Analyze the pressure variation in a static fluid and to understand the concepts of absolute pressure, gage pressure and the standard atmosphere.

Section – I

Pressure equation. Condition of equilibrium. Lines of force. Homogeneous and heterogeneous fluids. Elastic fluids. Surface of equal pressure. Fluid at rest under action of gravity. Rotating fluids.

Section – II

Fluid pressure on plane surfaces. Centre of pressure. Resultant pressure on curved surfaces. Equilibrium of floating bodies. Curves of buoyancy. Surface of buoyancy.

Section – III

Stability of equilibrium of floating bodies. Metacentre. Work done in producing a displacement. Vessels containing liquid.

Section – IV

Gas laws. Mixture of gases. Internal energy. Adiabatic expansion. Work done in compressing a gas. Isothermal atmosphere. Connective equilibrium.

Note: The question paper will consist of **five** sections. Each of the first four sections(**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended

1. S.L. Loney, An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Cambridge University Press, 1956.
2. A.S. Ramsey, Dynamics, Part I, Cambridge University Press, 1973.
3. W.H. Basant and A.S. Ramsey, A Treatise on Hydromechanics, Part I Hydrostatics, ELBS and G. Bell and Sons Ltd., London.

(w.e.f. 2018-19)
Elementary Inference
Code: 12MHM 245

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Understand the concepts of point estimation and interval estimation.
CO2 Identify good estimators using criterion of good estimators and obtain them using method of maximum likelihood.
CO3 Explain and use Neyman-Pearson lemma.
CO4 Carry out tests of significance and obtain confidence intervals for single proportion and difference of two proportions, single mean, difference of two means for large samples.
CO5 Learn about the Fisher's Z transformation, chi-square, Students't and Snedcor F-statistics and their important applications.

Section – I

Parameter and statistic, sampling distribution and standard error of estimate. Point and interval estimation, Unbiasedness, Efficiency, Consistency and Sufficiency.

Section – II

Method of maximum likelihood estimation.
Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Types of errors, Neyman- Pearson Lemma.

Section – III

Testing and interval estimation of a single mean, single proportion, difference between two means and two proportions. Fisher's Z-transformation.

Section – IV

Definition of Chi-square statistic, Chi-square tests for goodness of fit and independence of attributes.
Definition of Student's 't' and Snedcor's F-statistics. Testing for the mean and variance of univariate normal distributions, Testing of equality of means and variances of two univariate normal distributions. Related confidence intervals. Analysis of variance(ANOVA) for one-way and two-way classified data.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question

from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Suggested:

1. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the theory of Statistics, McGraw Hill, 1974.
2. A.M. Goon, M.K. Gupta, and B. Das Gupta, Fundamentals of Statistics, Vol-II.
3. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.

(w.e.f. 2018-19)
Data Structures Using C
Code: 12MHM 246

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Write and analyze algorithms using the concepts of data structures.
CO2 Apply searching and sorting techniques.
CO3 Describe stack, queue, linked list and their uses in the programs.
CO4 Develop programs using trees and graphs for different applications.

Section – I

Data structure and its essence, Data structure types.
Linear and list structures: Arrays, stacks, queues and lists; Sequential and linked structures; Simple lists, circular lists, doubly linked lists.
Inverted lists, threaded lists, Operations on all these structures and applications.

Section – II

Arrays, Multidimensional arrays, sequential allocation, address calculations, sparse arrays. Tree structures: Trees, binary trees and binary search trees. Implementing binary trees, Tree traversal algorithms, threaded trees, trees in search algorithms, AVL Trees.

Section – III

Graph data structure and their applications. Graph traversals, shortest paths, spanning trees and related algorithms.
Family of B-Trees: B-tree, B*-Trees, B+ Trees.

Section – IV

Sorting: Internal and External sorting. Various sorting algorithms, Time and Space complexity of algorithms.
Searching techniques and Merging algorithms. Applications of sorting and searching in computer science.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Suggested Readings:

1. Lipschutz, Data Structures (Schaum's Outline Series), Tata McGraw-Hill.

2.Adam Drozdek, Data Structures and Algorithms in C++, Vikas Pub. House (Thompson), New Delhi.
3. Amit Gupta, Data Structures Through C, Galgotia Booksource Pvt. Ltd., New Delhi.
4. S. Sofat, Data Structures With C and C++, Khanna Book Pub. Co.(P) Ltd, N. Delhi.
5. R.G Dromey, How to Solve it by Computer ?, Prentice Hall India.
6. Loomis, Data Structure and File Management, Prentice-Hall India Ltd.
7. Tannenbaum, Data Structure Using C, Tata McGraw-Hill.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 247
(Based on paper 12MHM 245)

Practical/Computational work based on paper 12MHM 245

Time:3 Hours

Max. Marks : 25

Course Outcomes

Students would be able to:

CO1 Carry out tests of significance for single proportion, difference of two proportions, single mean and difference of two means for the given data in case of large samples.

CO2 Find confidence intervals in case of large samples.

CO3 Compute Fisher's Z transformation, Chi-square, Students' t and Snedcor F-statistics and apply these statistics for various tests of significance.

CO4 Perform one-way and two-way analysis of variance to the given data.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 248
(Based on paper 12MHM 246)

Practical/Computational work based on paper 12MHM 246

Max. Marks : 25

Time:3 Hours

Course Outcomes

Students would be able to:

CO1 Design and analyse programming problem statements.

CO2 Choose appropriate data structures and algorithms for solving day to day problems.

CO3 Comprehend and select algorithm design approaches in a problem specific manner.

CO4 Thorough Computational Practice.

i) Written Practical/ Lab work : 20 Marks
ii)Viva-voce and practical record : 05 Marks

Note: The examiner is requested to set **3(Three)** experiments. The candidate is required to attempt **2(Two)** of the allotted experiments.

NEW SCHEME

Scheme of Examination of

5-Years Integrated M.Sc. (Honours) Mathematics Semester-V

(w.e.f. 2014-2015)

Paper Code	Title of the paper	Teaching Hours	Max. Marks			
			Theory	Internal Assessment	Practicals	Total Marks
12MHM 351	Real Analysis	4 Hours/ week	60	15	-	75
12MHM 352	Groups and Rings	4 Hours/ week	60	15	-	75
12MHM 353	Dynamics	4 Hours/ week	60	15	-	75
12MHM 354	Integral Equations	4 Hours/ week	60	15	-	75
12MHM 355	Methods of Applied Mathematics	4 Hours/ week	60	15	-	75
12MHM 356	Operations Research-I	4 Hours/ week	60	15	-	75
12MHM 357	Practical/ Computational work to be performed on computers using EXCEL/SPSS)	4 Hours/ week	-		50	50
Total Marks in Semester-V						500

Note : The conditions with regard to the above scheme will be as per the relevant ordinance and rules and regulations of the University.

(w.e.f. 2018-19)
Real Analysis
Code: 12MHM 351

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Explain the fundamental concepts of real analysis and Reimann integrability on the universal set of functions.
CO2 Understand the geometric interpretation of metric space.
CO3 Construct and interpret various proper and improper integrals.
CO4 Operate with real numbers, real functions, use of characteristics of study of metric spaces in the related fields such as geometry and complex analysis etc.

Section – I

Riemann integral, Integrabililty of continuous and monotonic functions, The Fundamental theorem of integral calculus. Mean value theorems of integral calculus.

Section – II

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter.

Section – III

Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle

Section – IV

Continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness , components, continuity in relation with connectedness.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. P.K. Jain and Khalil Ahmad, Metric Spaces, 2nd Ed., Narosa, 2004
2. Babu Ram, Metric Spaces, Vinayaka Publication
3. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
4. R.R. Goldberg, Real analysis, Oxford & IBH publishing Co., New Delhi, 1970
5. D. Somasundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997
6. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., New Delhi
7. E.T. Copson, Metric Spaces, Cambridge University Press, 1968.
8. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

(w.e.f. 2018-19)
Groups and Rings
Code: 12MHM 352

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Demonstrate understanding of the idea of a group, subgroup, cyclic groups, normal groups and quotient groups.

CO2 Understand and apply the concepts of homomorphism, isomorphism, automorphisms and inner automorphisms of a group.

CO3 Describe rings, subrings, Euclidean rings, polynomial rings and the Eisenstien's criterion of irreducibility.

Section – I

Definition of a group with example and simple properties of groups, Subgroups and Subgroup criteria, Generation of groups, cyclic groups, Cosets, Left and right cosets, Index of a sub-group Coset decomposition, Largrage's theorem and its consequences, Normal subgroups, Quotient groups.

Section – II

Homoomorphisms, isomophisms, automorphisms and inner automorphisms of a group. Automorphisms of cyclic groups, Permutations groups. Even and odd permutations. Alternating groups, Cayley's theorem, Center of a group and derived group of a group.

Section – III

Introduction to rings, subrings, integral domains and fields, Characteristics of a ring. Ring homomorphisms, ideals (principle, prime and Maximal) and Quotient rings, Field of quotients of an integral domain.

Section – IV

Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion, Polynomial rings over commutative rings, Unique factorization domain, R unique factorization domain implies so is $R[X_1, X_2, \ldots\ldots X_n]$

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2nd edition).
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.

(w.e.f. 2018-19)

Dynamics

Code: 12MHM 353

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Solve the problems based on simple harmonic motion and elastic strings.

CO2 Apply Newton's laws of motion and describe motion of a particle on smooth and rough plane curves.

CO3 Describe the motion of a projectile, Kepler's laws of motion and motion of a particle in three dimensions.

Section – I

Velocity and acceleration along radial, transverse, tangential and normal directions. Relative velocity and acceleration. Simple harmonic motion. Elastic strings.

Section – II

Mass, Momentum and Force. Newton's laws of motion. Work, Power and Energy. Definitions of Conservative forces and Impulsive forces.

Section – III

Motion on smooth and rough plane curves. Projectile motion of a particle in a plane. Vector angular velocity.

Section – IV

General motion of a rigid body. Central Orbits, Kepler laws of motion. Motion of a particle in three dimensions. Acceleration in terms of different co-ordinate systems.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. S.L. Loney, An Elementary Treatise on the Dynamics of a Particle and a Rigid Bodies, Cambridge University Press, 1956
2. F. Chorlton, Dynamics, CBS Publishers, New Delhi
3. A.S. Ramsey, Dynamics Part-1&2, CBS Publisher & Distributors.

(w.e.f. 2018-19)
Integral Equations
Code: 12MHM 354

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Student would be able to:

CO1 Understand the methods to reduce Initial value problems associated with linear differential equations to various integral equations.

CO2 Categorise and solve different integral equations using various techniques.

CO3 Describe importance of Green's function method for solving boundary value problems associated with non-homogeneous ordinary and partial differential equations, especially the Sturm-Liouville boundary value problems.

Section I

Linear integral equations, Some basic identities, Initial-value problems reduced to Volterra integral equations, Method of successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equation. Resolvent kernel as a series in λ, Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind.

Section II

Boundary value problems reduced to Fredholm integral equations, method of successive approximations to solve Fredholm equation of second kind, Iterated kernels and Neumann series for Fredholm equations, Resolvent kernel as a sum of series, Fredholm resolvent kernel as a ratio of two series. Fredholm equations with degenerate kernel, approximation of a kernel by a degenerate kernel, Fredholm Alternative.

Section III

Green's function. Use of method of variation of parameters to construction the Green's function for a nonhomogeneous linear second degree BVP, Basic four properties of the Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Method of series representation of the Green's function in terms of the solutions of the associated homogeneous BVP. Reduction of a BVP to a Fredholm integral equation with kernel as Green's function.

Section IV

Homogeneous Fredholm equations with symmetric kernels, Solution of Fredholm equations of the second kind with symmetric kernel, Method of Fredholm Resolvent Kernel, Method of Iterated Kernels, Fredholm Equations of the First Kind with Symmetric Kernels.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. A.J. Jerri, Introduction to Integral Equations with Applications.
2. A.D. Polyanin and A.V. Manzhirov, Handbook of Integral Equations, CRC Press.
3. J. Kondo, Integral Equations, Oxford Applied mathematics and Computing Science Series.

(w.e.f. 2018-19)
Methods of Applied Mathematics
Code: 12MHM 355

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Solve boundary value problems related to Laplace, heat and wave equations by method of separation of variables.

CO2 Find the solution of the wave, diffusion and Laplace equations using Fourier series.

CO3 Use Parallel Axes Theorem to obtain moment of inertia.

CO4 Apply Hankel transformation to solve BVP and IVP.

Section - I

Solution of 3D Laplace, wave and heat equations in spherical polar co-ordinates and cylindrical polar co-ordinates by the method of separation of variables. Fourier series solution of the wave equation, transformation of boundary value problems.

Section - II

Fourier series solution of the heat equation, steady-state temperature in plates, The heat and wave equations in unbounded domains, Fourier transform solution of boundary value problems. The heat equation in an infinite cylinder and in a solid sphere.

Section - III

Hankel transform of elementary functions. Operational properties of the Hankel transform. Applications of Hankel transforms to PDE.

Definition and basic properties of finite Fourier sine and cosine transforms, its applications to the solutions of BVP's and IVP's.

Section - IV

Moments and products of inertia, Angular momentum of a rigid body, principal axes and principal moment of inertia of a rigid body, kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid and equimomental systems, coplanar mass distributions, general motion of a rigid body.

Note: The question paper will consist of **five** sections. Each of the first four sections**(I-IV)** will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended :

1. A.J. Jerri, Introduction to Integral Equations with Applications.
2. Lokenath Debnath, Integral Transforms and their Applications, CRC Press, Inc., 1995.
3. Peter V. O'Neil, Advanced Engineering Mathematics, 4th Edition, An International Thomson Publishing Company.
4. I.N. Sneddon, Elements of Partial Differential Equations, Prentice Hall, McGraw Hill.
5. I.N. Sneddon, Special Functions of Mathematical Physics and Chemistry.
6. F. Chorlton, Dynamics, CBS publishers and Distributors.

(w.e.f. 2018-19)
Operations Research-I
Code: 12MHM 356

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Explain operations research, its scope and utility.
CO2 Know about operations research models, its methodology and classification.
CO3 Formulate and solve LPP's using Graphical & Simplex methods and understand the concept of duality in linear programming.
CO4 Classify and handle different types of transportations problems and assignment problems.
CO5 Learn to solve game problems using graphical, algebraic and linear programming methods.

Section- I

Definition, scope, methodology and applications of OR. Types of OR models.
Concept of optimization, Linear Programming: Introduction, Formulation of a Linear Programming Problem (LPP), Requirements for an LPP, Advantages and limitations of LP. Graphical solution: Multiple, unbounded and infeasible solutions.

Section-II

Principle of simplex method: standard form, basic solution, basic feasible solution.
Computational Aspect of Simplex Method: Cases of unique feasible solution, no feasible solution, multiple solution and unbounded solution and degeneracy. Two Phase and Big-M methods.

Section-III

Duality in LPP, primal-dual relationship.
Transportation Problem: Methods for finding basic feasible solution of a transportation problem, Modified distribution method for finding the optimum solution, Unbalanced and degenerate transportation problems, transhipment problem, maximization in a transportation problem.

Section-IV

Assignment Problem: Solution by Hungarian method, Unbalanced assignment problem, maximization in an assignment problem, Crew assignment and Travelling salesman problem.

Game Theory: Two person zero sum game, Game with saddle points, the rule of dominance; Algebraic, graphical and linear programming methods for solving mixed strategy games.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended

1. J.K. Sharma, Mathematical Model in Operations Research, Tata McGraw Hill.
2. H.A. Taha, Operations Research – An Introduction.
3. Kanti Swarup, P.K. Gupta, and Manmohan, Operations Research.
4. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
5. S.I. Gass, Linear Programming (3rd Edition), McGraw Hill, New York, 1985.
6. S.D. Sharma, Operations Research.
7. N.S. Kambo, Mathematical Programming.
8. G. Hadley, Linear Programming, Narosa Publishing House, 1987.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 357

Practical/Computational work to be performed on computers using EXCEL/SPSS

Time:3 Hours **Max. Marks : 50**

Course Outcomes

Students would be able to:

CO1 Carry out mathematical formulations of the given real problems as LPPs.

CO2 Solve LPP's using Graphical /Simplex methods for the given problem using EXCEL.

CO3 Solve different types of transportation problems, assignment problems, crew assignment problems, travelling salesman problems, game problems for the given data using EXCEL/SPSS.

i) Written Practical/ Lab work : 40 Marks
ii)Viva-voce and practical record : 10 Marks

Note: The examiner is requested to set **4** experiments. The candidate is required to attempt **2** of the allotted experiments.

This paper covers the practical/computational work to be performed on computer using EXCEL/SPSS.

NEW SCHEME

Scheme of Examination of

5-Years Integrated M.Sc. (Honours) Mathematics Semester-VI

(w.e.f. 2014-2015)

Paper Code	Title of the paper	Teaching Hours	Max. Marks			
			Theory	Internal Assessment	Practicals	Total Marks
12MHM 361	Real and Complex Analysis	4 Hours/ week	60	15	-	75
12MHM 362	Linear Algebra	4 Hours/ week	60	15	-	75
12MHM 363	Numerical Analysis	4 Hours/ week	45	-	30	75
12MHM 364	Elementary Topology	4 Hours/ week	60	15	-	75
12MHM 365	Fluid Dynamics	4 Hours/ week	60	15	-	75
12MHM 366	Operations Research-II	4 Hours/ week	60	15	-	75
12MHM 367	Practical/ Computational work to be performed on computers using MATLAB/TORA)	4 Hours/ week	-		50	50
Total Marks in Semester-VI						500

Note : The conditions with regard to the above scheme will be as per the relevant ordinance and rules and regulations of the University.

(w.e.f. 2018-19)
Real and Complex Analysis
Code: 12MHM 361

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Understand how real numbers provide a complete ordered field and to explain the fundamental concepts of real analysis.

CO2 Describe various properties of complex numbers and their geometric interpretation.

CO3 Construct and interpret various power series of real functions.

CO4 Interpret complex numbers as an extension of the real numbers and explain the fundamental concepts of complex analysis.

Section – I

Jacobians, Beta and Gama functions, Double and Triple integrals, Dirichlets integrals, change of order of integration in double integrals.

Section – II

Fourier's series: Fourier expansion of piecewise monotonic functions, Properties of Fourier Co-efficients, Dirichlet's conditions, Parseval's identity for Fourier series, Fourier series for even and odd functions, Half range series, Change of Intervals.

Section – III

Extended Complex Plane, Stereographic projection of complex numbers, continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations. Harmonic functions.

Section – IV

Mappings by elementary functions: Translation, rotation, Magnification and Inversion. Conformal Mappings, Mobius transformations. Fixed pints, Cross ratio, Inverse Points and critical mappings.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
2. R.R. Goldberg, Real analysis, Oxford & IBH publishing Co., New Delhi, 1970
3. D. Somasundaram and B. Choudhary, A First Course in Mathematical, Analysis, Narosa Publishing House, New Delhi, 1997
4. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co., New Delhi
5. R.V. Churchill and J.W. Brown, Complex Variables and Applications, 5^{th} Edition, McGraw-Hill, New York, 1990
6. Shanti Narayan, Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.

(w.e.f. 2018-19)
Linear Algebra
Code: 12MHM 362

Time : 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Get familiar with vector spaces, subspaces and existence theorem for basis of a finitely generated vector space.

CO2 Describe the concepts of homomorphism, isomorphism and dual spaces.

CO3 Learn singular and non-singular linear transformations, eigen values and eigen vectors of linear transformations.

CO4 Have knowledge of inner product spaces, orthogonal vectors, orthogonal sets and Gram Schmidt orthogonalization process.

Section – I

Vector spaces, subspaces, Sum and Direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space. Finitely generated vector space, Existence theorem for basis of a finitely generated vactor space, Finite dimensional vector spaces, Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension.

Section – II

Homomorphism and isomorphism of vector spaces, Linear transformations and linear forms on vactor spaces, Vactor space of all the linear transformations Dual Spaces, Bidual spaces, annihilator of subspaces of finite dimentional vactor spaces, Null Space, Range space of a linear transformation, Rank and Nullity Theorem,

Section – III

Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations, Matrix of a linear Transformation, Change of basis, Eigen values and Eigen vectors of linear transformations.

Section – IV

Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthogonal complements, Orthogonal sets and Basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt, Orthogonalization process, Adjoint of a linear transformation and its properties, Unitary linear transformations.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. I.N. Herstein,: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2^{nd} edition).
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.

(w.e.f. 2018-19)
Numerical Analysis
Code: 12MHM 363

Time : 3 Hours **Max. Marks : 45**

Course Outcomes

Students would be able to:

CO1 Learn about interpolation with equal and unequal intervals.
CO2 Apply forward, backward, central and divided difference formulae for interpolation.
CO3 Apply standard probability distributions to the concerned problems.
CO4 Understand the method of numerical differentiation and various methods for finding solution of eigen value problems.
CO5 Know how to solve integration and ordinary differential equation using numerical data.

Part-A (Theory)

Section – I

Finite Differences operators and their relations. Finding the missing terms and effect of error in a difference tabular values, Interpolation with equal intervals: Newton's forward and Newton's backward interpolation formulae. Interpolation with unequal intervals: Newton's divided difference, Lagrange's Interpolation formulae, Hermite Formula.

Section – II

Central Differences: Gauss forward and Gauss's backward interpolation formulae, Sterling, Bessel Formula.

Probability distribution of random variables, Binomial distribution, Poisson's distribution, Normal distribution: Mean, Variance and Fitting.

Section – III

Numerical Differentiation: Derivative of a function using interpolation formulae as studied in Sections –I & II.

Eigen Value Problems: Power method, Jacobi's method, Given's method, House-Holder's method, QR method, Lanczos method.

Section – IV

Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one- third and three-eighth rule, Chebychev formula, Gauss Quadrature formula.

Numerical solution of ordinary differential equations: Single step methods-Picard's method. Taylor's series method, Euler's method, Runge-Kutta Methods. Multiple step methods; Predictor-corrector method, Modified Euler's method, Milne-Simpson's method.

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. Babu Ram, Numerical Methods: Pearson Publication.
2. R.S. Gupta, Elements of Numerical Analysis, Macmillan's India 2010.
3. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
4. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999
5. C. E. Froberg, Introduction to Numerical Analysis (2nd Edition).
6. Melvin J. Maaron, Numerical Analysis-A Practical Approach, Macmillan Publishing Co., Inc., New York
7. R.Y. Rubnistein, Simulation and the Monte Carlo Methods, John Wiley, 1981

Part-B (Practical)

Time: 3 Hours **Max. Marks: 30**

There will be a separate practical paper consisting of implementation of numerical methods in C Programming Language, studied in the theory paper 12MHM 363(Part-A).

(w.e.f. 2018-19)
Elementary Topology
Code: 12MHM 364

Time : 3 hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Get familiar with the concepts of topological space and continuous functions.
CO2 Generate new topologies from a given set with bases.
CO3 Describe the concept of homeomorphism and topological invariants.
CO4 Establish connectedness and compactness of topological spaces and proofs of related theorems.
CO5 Have in-depth knowledge of separation axioms and their properties.

Section-1

Definition and examples of topological spaces. Comparison of topologies on a set, Intersection and union of topologies on a set. Neighbourhoods, Interior point and interior of a set , Closed set as a complement of an open set , Adherent point and limit point of a set, Closure of a set, Derived set, Properties of Closure operator, Boundary of a set , Dense subsets, Interior, Exterior and boundary operators. Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator.

Section-II

Relative(Induced) topology, Base and subbase for a topology, Base for Neighbourhood system. Continuous functions, Open and closed functions , Homeomorphism. Connectedness and its characterization, Connected subsets and their properties, Continuity and connectedness, Components, Locally connected spaces.

Section-III

Compact spaces and subsets, Compactness in terms of finite intersection property,Continuity and compact sets, Basic properties of compactness, Closedness of compactsubset and a continuous map from a compact space into a Hausdorff and its consequence. Sequentially and countably compact sets, Local compactness and one point compatification.

Section-IV

First countable, second countable and separable spaces, hereditary and topological

property, Countability of a collection of disjoint open sets in separable and second countable spaces, Lindelof theorem. T_0, T_1, T_2 (Hausdorff) separation axioms,their characterization and basic properties.

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended :

1. C.W.Patty, Foundation of Topology, Jones & Bertlett, 2009.
2. Fred H. Croom, Principles of Topology, Cengage Learning, 2009.
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill
4. Book Company, 1963.
5. J. L. Kelly, General Topology, Springer Verlag, New York, 2000.
6. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
7. K. Chandrasekhara Rao, Topology, Narosa Publishing House Delhi,2009.
8. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, 2006.

(w.e.f. 2018-19)
Fluid Dynamics
Code: 12MHM 365

Time : 3 hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Be familiar with continuum model of fluid flow and classify fluid/flows based on physical properties of a fluid/flow along with Eularian and Lagrangian descriptions of fluid motion.

CO2 Derive and solve equation of continuity, equations of motion, vorticity equation, equation of moving boundary surface, pressure equation and equation of impulsive action for a moving inviscid fluid.

CO3 Calculate velocity fields and forces on bodies for simple steady and unsteady flow including those derived from potentials.

CO4 Understand the concepts of velocity potential, stream function and complex potential, and their use in solving two-dimensional flow problems applying complex-variable techniques.

CO5 Represent mathematically the potentials of source, sink and doublets in two-dimensions as well as three-dimensions, and study their images in impermeable surfaces.

Section - I

Kinematics - Eulerian and Lagrangian methods. Stream lines, path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vortex lines. Equation of continuity. Boundary surfaces.

Section - II

Acceleration at a point of a fluid. Components of acceleration in cylindrical and spherical polar co-ordiantes, Pressure at a point of a moving fluid. Euler's and Lagrange's equations of motion. Bernoulli's equation. Impulsive motion. Stream function.

Section - III

Acyclic and cyclic irrotation motions. Kinetic energy of irrotational flow. Kelvin's minimum energy theorem. Axially symmetric flows. Liquid streaming past a fixed sphere. Motion of a sphere through a liquid at rest at infinity. Equation of motion of a sphere. Three-dimensional sources, sinks, doublets and their images. Stoke's stream function.

Section - IV

Irrotational motion in two-dimensions. Complex velocity potential. Milne-Thomson circle theorem. Two-dimensional sources, sinks, doublets and their images. Blasius theorem. Two- dimensional irrotation motion produced by motion of circular and co-axial cylinders in an infinite mass of liquid.

Note: The question paper will consist of **five** sections. Each of the first four sections**(I-IV)** will contain two questions and the students shall be asked to attempt **one** question from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
2. M.E. O'Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.
3. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
4. W.H. Besant and A.S. Ramsay, A Treatise on Hydromechanics Part I and II, CBS Publishers, New Delhi.
5. Bansi Lal, Theoretical Fluid Dynamics, Skylark Pub., New Delhi.

(w.e.f. 2018-19)
Operations Research-II
Code: 12MHM 366

Time : 3 hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Explain inventory control and inventory models for specific situations in an organization.

CO2 Understand queuing system and various characteristics of single server/multi servers queuing models with limited and unlimited capacity.

CO3 Define, classify and handle different types of sequencing problems.

CO4 Distinguish between PERT and CPM.

CO5 Learn the various important concepts used in network analysis and project scheduling.

Section- I

Inventory Control: introduction of inventory, factors affecting inventory, Inventory models, Deterministic models: Economic order quantity model when shortages are allowed/not allowed, price discounts model, multi-item inventory models.

Section-II

Queuing Theory : Basic characteristics of queuing system, Birth-death equations, Steady state solution of Markovian queuing models with single and multiple servers with infinite capacity (M/M/1 and M/M/c), and with limited capacity (M/M/1/K and M/M/c/K).

Section-III

Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

Replacement problems: Replacement of items whose running cost increases with time, Replacement policies for the items that fail completely - Individual and the group replacement policies.

Section-IV

PERT and CPM: Introduction of PERT and CPM, Earliest and latest times, Determination of critical path and various types of floats, Probablistic and cost considerations in project scheduling

Note: The question paper will consist of **five** sections. Each of the first four sections (**I-IV**) will contain two questions and the students shall be asked to attempt **one** question

from each section. **Section-V** will contain **six** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Books Recommended:

1. J.K. Sharma, Mathematical Model in Operations Research, Tata McGraw Hill.
2. H.A. Taha, Operations Research – An Introduction.
3. Kanti Swarup, Gupta, P.K. and Manmohan. Operations Research.
4. P.K. Gupta and D.S Hira, Operations Research, S. Chand & Co.
5. S.D. Sharma, Introduction to Operations Research.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 367

Practical/Computational work to be performed on computers using MATLAB/TORA

Time: 3 Hours

Max. Marks : 50

Course Outcomes

Students would be able to:

CO1 Solve problems related to inventory control models for various situations using MATLAB/TORA software.

CO2 Compute various characteristics of single/multi server(s) queuing models with limited and unlimited capacity using MATLAB.

CO3 Solve different types of sequencing and replacement problems for varying situations using MATLAB/TORA software.

CO4 Solve network and project scheduling problems using PERT and CPM techniques.

i) Written Practical/ Lab work : 40 Marks
ii)Viva-voce and practical record : 10 Marks

Note: The examiner is requested to set **4** experiments. The candidate is required to attempt **2** of the allotted experiments.

This paper covers the practical/Computational work to be performed on computer using MATLAB/TORA.

Scheme of Examination of
5 – Year Integrated M.Sc. (Honours) Mathematics, Semester- VII
(w.e.f. Session 2012-13)

Paper Code	Title of the Paper	Theory Marks	Internal-Assessment Marks	Practical	Total Marks
12MHM 411	Advanced Abstract Algebra	80	20	-	100
12MHM 412	Measure and Integration Theory	80	20	-	100
12MHM 413	Complex Analysis	80	20	-	100
12MHM 414	Differential Equations and Calculus of Variations	80	20	-	100
12MHM 415	Opt(i) : Mathematical Modeling	80	20	-	100
	Opt(ii) : Object Oriented Programming with C++	60	-	40	100
				Total Marks	500

(w.e.f. 2018-19)
12MHM 411 : Advanced Abstract Algebra

Time: 3 Hours **Max. Marks: 80**

Course Outcomes
Students would be able to:

CO1 Assess properties of 'solvable and nilpotent groups', 'Noetherian and Artinian modules' and rings.

CO2 Describe various canonical types of groups (including cyclic and permutation groups) and rings (including polynomial and modular rings).

CO3 Know how to apply central, normal and subnormal series; Noetherian and Artinian rings.

Unit - I (2 Questions)

Groups : Normal and subnormal series, Solvable series, Derived series, Solvable groups, Solvability of S_n – the symmetric group of degree $n \geq 2$. Composition series, Zassenhaus lemma, Jordan-Holder theorem.

Unit - II (2 Questions)

Nilpotent group: Central series, Nilpotent groups and their properties, Equivalent conditions for a finite group to be nilpotent, Upper and lower central series, Sylow-p sub groups, Sylow theorems with simple applications. Description of group of order p^2 and pq, where p and q are distinct primes(In general survey of groups upto order 15).

Unit - III (2 Questions)

Field theory, Extension of fields, algebraic and transcendental extensions. Splitting fields, Separable and inseparable extensions, Algebraically closed fields, Perfect fields.

Unit - IV (2 Questions)

Finite fields, Automorphism of extensions, Fixed fields, Galois extensions, Normal extensions and their properties, Fundamental theorem of Galois theory, Insolvability of the general polynomial of degree $n \geq 5$ by radicals.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
3. P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
4. N. Jacobson, Basic Algebra, Vol. I & II, W.H Freeman, 1980 (also published by Hindustan Publishing Company).
5. S. Lang, Algebra, 3rd Editioin, Addison-Wesley, 1993.
6. I.S. Luther and I.B.S.Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. I – 1996, Vol. II –1990).
7. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
8. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.

(w.e.f. 2018-19)

12MHM 412 : Measure and Integration Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Learn about the shortcomings of Riemann integral and benefits of Lebesgue integral.

CO2 Understand the fundamental concepts of measure, Lebesgue measure and measurable functions.

CO3 Learn about the differentiation of monotonic function, indefinite integral, use of the fundamental theorem of calculus.

Unit - I (2 Questions)

Set functions, Intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of a set of real numbers, Algebra of measurable sets, Borel set, Equivalent formulation of measurable sets in terms of open, Closed, F_σ and G_δ sets, Non measurable sets.

Unit - II (2 Questions)

Measurable functions and their equivalent formulations. Properties of measurable functions. Approximation of a measurable function by a sequence of simple functions, Measurable functions as nearly continuous functions, Egoroff's theorem, Lusin's theorem, Convergence in measure and F. Riesz theorem. Almost uniform convergence.

Unit - III (2 Questions)

Shortcomings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties. Lebesgue integral as a generalization of Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions, Integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.

Unit - IV (2 Questions)

Riemann-Stieltjes integral, its existence and properties, Integration and differentiation, The fundamental theorem of calculus, Integration of vector-valued functions, Rectifiable curves.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to**

ten short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Boks Recommended :

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International Student Edition.
2. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
3. P. K. Jain and V. P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986.
4. G.De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition.

(w.e.f. 2018-19)

12MHM 413 : Complex Analysis

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand complex numbers as an extension of the real numbers, their properties and geometrical interpretations.

CO2 Represent the sum function of a power series as an analytic function.

CO3 Demonstrate the ideas of complex differentiation and integration for solving related problems and establishing theoretical results.

CO4 Understand concept of residues, evaluate contour integrals and solve polynomial equations.

CO5 Describe various types of singularities and their role in study of complex functions.

Unit - I (2 Questions)

Path in a region, Contour, Simply and multiply connected regions, Complex integration. Cauchy theorem. Cauchy's integral formula. Poisson's integral formula. Higher order derivatives. Complex integral as a function of its upper limit, Morera's theorem. Cauchy's inequality. Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem.

Unit - II (2 Questions)

Zeros of an analytic function, Laurent's series. Isolated singularities. Cassorati-Weierstrass theorem, Limit point of zeros and poles.

Maximum modulus principle, Minimum modulus principle. Schwarz lemma. Meromorphic functions. The argument principle. Rouche's theorem, Inverse function theorem.

Unit - III(2 Questions)

Calculus of residues. Cauchy's residue theorem. Evaluation of integrals.

Analytic Continuation. Natural Boundary. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. Schwarz Reflection principle.

Unit - IV (2 Questions)

Integral Functions. Factorization of an integral function. Weierstrass' factorisation theorem. Factorization of sine function. Gamma function and its properties. Stirling formula. Integral version of gamma function. Riemann Zeta function. Riemann's functional equation. . Runge's theorem. Mittag-Leffler's theorem.

Note : The question paper will consist of five units. Each of the first four units will contain two questions from unit I , II , III , IV respectively and the students shall be asked to attempt one question from each unit. Unit five will contain eight to ten short answer

type questions without any internal choice covering the entire syllabus and shall be compulsory.

Books Recommended :

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
6. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.
7. S. Lang, Complex Analysis, Addison Wesley, 1977.
8. Mark J. Ablowitz and A.S. Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
9. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
10. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company.
11. Rajendra Kumar Sharma, Sudesh Kumari Shah and Asha Gauri Shankar, Comlex Numbers, Anthem Press, 2011.

(w.e.f. 2018-19)

12MHM 414 : Differential Equations and Calculus of Variations

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand the system of differential equations and their solution using matrix method.

CO2 Familiarize with Strum-Liouville boundary-value problem and adjoint equations.

CO3 Describe characteristics of critical points-node, spiral, centre and saddle points.

CO4 Get familiar with calculus of variations and its applications.

CO5 Solve simple initial and boundary value problems by using several-variable calculus.

Unit - I (2 Questions)

Systems of first order differential equations, linear systems, Matrix method for homogeneous linear systems with constants coefficients , eigenvalues and eigen vectors ,fundamental set ,fundamental matrix , Wronskian of a system, matrix exponentials , non-homogeneous linear systems, nth –order homogeneous linear differential equation reduced to a homogeneous linear system of first –order equations.

Unit - II (2 Questions)

Adjoint equations , Lagrange identity, Green's formula ,self-adjoint equations of the second order, Sturm-Liouville boundary – value problems, eigenvalues and eigen functions of SLBVP, orthogonally of eigenfunctions,

Existence and Uniqueness of solution of dy/dx=f(x,y), Lipschitz condition.

Unit - III (2 Questions)

Nonlinear systems, plane autonomous systems ,phase plane and its phenomena, types of critical points ,paths of linear systems, paths of non linear systems, stability for linear systems. Almost linear systems, Liapunov function, stability by Liapunov's method. Ecological model-prey and predator equations.

Unit - IV (2 Questions)

Some typical problems of the calculus of variations, Euler 's differential equation for an extremal , functionals depending on two unknown functions, isoperimetric problems, Lagrange multipliers ,integral side conditions, variational problems for double integrals. (Relevant topics from Simmons Book)

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. S.L. Ross-Differential equations, Jonhs Wiley&Sons,1984
2. G.F. Simmons-Differentials equations with Applications and Historicals notes, McGraw- hill,1991
3. C.H. Edwards and D.E. Penney- Differentials equations and boundary value problems, 2004, Pearson education.
4. W.E. Boyce and R.C. Diprima-Elementary differential equations and boundary value problems, John and sons,2003.
5. Gelfand, J.M. and Fomin, S.V., Calculus of Variations, Prentice Hall, New Jersy, 1963.
6. Weinstock , Calculus of Variations, McGraw Hall.

(w.e.f. 2018-19)

12MHM 415(Opt(i)) : Mathematical Modelling

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand the core principles of mathematical modeling.
CO2 Apply precise and logical reasoning to problem solving.
CO3 Frame quantitative problems and model them mathematically.
CO4 Understand the concept of Microbial, its growth and formation.
CO5 Formulate mathematically the observable real life problems.

Unit -I (2 Questions)

Introduction and the technique of mathematical modelling, classification and characteristics of mathematical models.Mathematical modeling through algebra, finding the radius of the earth, motion of planets, motions of satellites.

Linear and Non-linear growth and decay models, population growth models. Effects of Immigration and Emigration on Population size, decrease of temperature, diffusion, change of price of a commodity, Logistic law of population growth. A simple Compartment model.

Unit – II (2 Questions)

Mathematical Modelling of Epidemics, a simple epidemics model, a susceptible – infected -susceptible (SIS) Model, SIS model with constant number of carriers, simple epidemic model with carriers, model with removal, model with removal and immigration.

Mathematical Modelling in Economics, Domar Macro model, Domar first debt model, Domar's second debt model, Samuelson's investment model, stability of market equilibrium.

Unit -III (2 Questions)

Mathematical Modelling in Medicine, Arms Race and Battles: A model for diabetes mellitus, Richardson's model for arms race, Lamechester's combat model.

Microbial population models, microbial growth in a chemostat, stability of steady states for chemostat, growth of microbial populations, product formation due to microbial action.

Unit – IV (2 Questions)

Stochastic models of population growth, need for stochastic models, linear birth-death-immigration-emigration processes, linear birth-death process, linear birth-death-immigration process, linear birth-death-emigration process, non-linear birth-death process.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to**

ten short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. J.N. Kapur, Mathematical Modeling, New Age International Limited.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press (P) Ltd.
3. Mathematical Models in the Social, Management and Life Sciences, D.N. Burghes and A.D. Wood, John Wiley & Sons.
4. Mathematical Modeling, J.G. Andrews & R.R Mclone, Butterworths (Pub.) Inc.

(w.e.f. 2018-19)

12MHM 415(Opt(ii)) : Object Oriented Programming with C++

Time: 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Apply C++ features to design and implement a program.

CO2 Develop solutions to problems demonstrating usage of data abstraction, encapsulation and inheritance.

CO3 Program using C++ features such as operators overloading, polymorphism, streams, exception handling etc.

CO4 Implement practical applications and analyze issues related to object-oriented techniques in the C++ programming language.

Section – I(2 Questions)

Basic concepts of Object-Oriented Programming (OOP). Advantages and applications of OOP. Difference between OOP and Procedure oriented programming, Abstraction, Overview of OOP principles, Encapsulation, Inheritance and Polymorphism.Object-oriented languages. Introduction to C++. Structure of a C++ program. Creating the source files. Compiling and linking.

Section – II(2 Questions)

C++ Programming: Data types, Declaration of variables, Expressions, Operators, Operator Precedence, Evaluation of expressions, Type conversions, Arrays, Pointers, Strings, Structures, References. Flow control statement- if, switch, while, for, do, break, continue, goto statements.

Functions-Scope of variables, Passing arguments to and returning values from functions, Default arguments, inline functions, Recursive functions, Function overloading.

Section – III(2 Questions)

Classes and Objects: Class definition, Class structure, Class objects, Class scope, this pointer, Friends to a class, Static class membersUsing Arrays within a class, Arrays of objects, Object as a function arguments, Friendly functions. Constructors and destructors.

Polymorphism: Function overloading, Operator overloading, use of This pointer, Virtual functions.

Inheritance: Defining a class hierarchy, Different forms of inheritance, Defining the Base and Derived classes

Section - IV(2 Questions)

Streams, Stream classes, Unformatted Input/Output operations, Formatted console Input/Output operations, Managing output with manipulators.Virtual destructors.

String streams, Overloading <<&>> operators,Formatted I/O.

Exception Handling: Benefits of exception handling, Throwing an exception, The try block, Catching an exception, Exception objects, Exception specifications, Rethrowing an exception, Catching all exceptions.

Note : The question paper of each course will consist of **five** Sections. Each of the sections**I to IV** will contain **two** questions and the students shall be asked to attempt **one** question from each. **Section-V**shall be **compulsory** and will contain **eight** short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:

1. I.S. Robert Lafore, Waite Group Object Oriented Programming using C++, Galgotia Pub.
2. E. Balagrusamy, Object Oriented Programming with C++, 2nd Edition, Tata Mc Graw Hill Pub. Co.
3. Byron, S. Gottfried, Object Oriented Programming using C++, Schaum Outline Series, Tata Mc Graw Hill Pub. Co.
4. J.N. Barakaki, Object Oriented Programming using C++, Prentic Hall of India, 1996

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 415

Practical based on **Object Oriented Programming with C++**

Time:3 Hours **Max. Marks : 40**

i) Written Practical/ Lab work : 30 Marks
ii)Viva-voce and practical record : 10 Marks

Note: The examiner is requested to set **4** experiments. The candidate is required to attempt **2** of the allotted experiments.

This paper covers the practical work based on Object Oriented Programming with C++

Scheme of Examination of
5 – Year Integrated M.Sc.(Honours) Mathematics, Semester- VIII
(w.e.f. Session 2012-13)

Paper Code	Title of the Paper	Theory Marks	Internal-Assessment Marks	Practical	Total Marks
12MHM 421	Mathematical Analysis	80	20	-	100
12MHM 422	Rings and Modules	80	20	-	100
12MHM 423	General Topology	80	20	-	100
12MHM 424	Classical Mechanics	80	20	-	100
12MHM 425	Opt(i) : Mathematics for Finance and Insurance	80	20	-	100
	Opt(i) : Sampling Techniques and Design of Experiments	60	-	40	100
Total Marks of Semester - II					500
Total Marks of Semester - I					500
Grand Total					1000

(w.e.f. 2018-19)

12MHM421 : Mathematical Analysis

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Have understanding of the concepts of convergence of sequences and series of functions.

CO2 Acquire knowledge of concepts of functions of several variables.

CO3 To have knowledge of stationary and extreme values of implicit and explicit functions respectively.

CO4 Know about bounded variations, monotonicity of functions and absolutely continuous functions and their properties.

Unit - I (2 Questions)

Rearrangements of terms of a series, Riemann's theorem. Sequence and series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weirstrass's M test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation, Weierstrass approximation theorem.

Unit - II (2 Questions)

Power series, its uniform convergence and uniqueness theorem, Abel's theorem, Tauber's theorem.

Functions of several variables, Linear Transformations, Euclidean space R^n, Open balls and open sets in R^n, Derivatives in an open subset of R^n, Chain Rule, Partial derivatives, Continuously Differentiable Mapping, Young's and Schwarz's theorems.

Unit - III (2 Questions)

Taylor's theorem. Higher order differentials, Explicit and implicit functions. Implicit function theorem, Inverse function theorem. Change of variables, Extreme values of explicit functions, Stationary values of implicit functions. Lagrange's multipliers method. Jacobian and its properties, Differential forms, Stoke's Theorem.

Unit - IV (2 Questions)

Vitali's covering lemma, Differentiation of monotonic functions, Function of bounded variation and its representation as difference of monotonic functions, Differentiation of indefinite integral, Fundamental theorem of calculus, Absolutely continuous functions and their properties.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall

be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi.
2. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
3. G. De Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
4. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.
5. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition.

(w.e.f. 2018-19)

12MHM422 : Rings and Modules

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand the concept of modules and applications of finitely generated modules over principal ideal domain to finitely generated abelian groups.

CO2 Learn about the Nil and Nilpotent ideals in Noetherian and Artinian ring.

CO3 Study about the Nilpotent transformation, index of nilpotency, invariants of Nilpotent transformations.

CO4 Have knowledge of the Jordan blocks and Jordan forms.

Unit - I (2 Questions)

Cyclic modules, Simple and semi-simple modules, Schur's lemma, Free modules, Fundamental structure theorem of finitely generated modules over principal ideal domain and its applications to finitely generated abelian groups.

Unit - II (2 Questions)

Neotherian and Artinian modules and rings with simple properties and examples, Nil and Nilpotent ideals in Neotherian and Artinian rings, Hilbert Basis theorem.

Unit - III (2 Questions)

$Hom_R(R,R)$, Opposite rings, Wedderburn – Artin theorem, Maschk's theorem, Equivalent statement for left Artinian rings having non-zero nilpotent ideals, Uniform modules, Primary modules and Neother- Lasker theorem.

Unit - IV (2 Questions)

Canonical forms : Similarity of linear transformations, Invariant subspaces, Reduction to triangular form, Nilpotent transformations, Index of nilpotency, Invariants of nilpotent transformations, The primary decomposition theorem, Rational canonical forms, Jordan blocks and Jordan forms.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
3. M. Artin, Algebra, Prentice-Hall of India, 1991.

4. P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
5. I.S. Luther and I.B.S.Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. I – 1996, Vol. II –1990).
6. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
7. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt., New Dlehi, 2000.
8. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
9. T.Y Lam, Lectures on Modules and Rings, GTM Vol. 189, Springer-Verlag, 1999.

(w.e.f. 2018-19)

12MHM423 : General Topology

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Have knowledge of the separation axioms.

CO2 Understand the concept of product topological spaces and their properties.

CO3 Be familiar with Tychonoff embedding theorem and Urysohn's metrization theorem.

CO4 Know about methods of generating nets and filters and their relations.

CO5 Describe paracompact spaces and their characterizations.

Section-1

Regular, Normal, T_3 and T_4 separation axioms, their characterization and basic properties, Urysohn's lemma and Tietze extension theorem, Regularity and normality of a compact Hausdorff space, Complete regularity, Complete normality, $T_{3\frac{1}{2}}$ and T_5 spaces, their characterization and basic properties.

Section-II

Product topological spaces, Projection mappings, Tychonoff product topology in terms of standard subbases and its characterization, Seperation axiom and product spaces, Connectedness, Locally connectedness and compactness of product spaces, Product space as first axiom space, Tychonoff product theorem.

Embedding and metrization : Embedding lemma and Tychonoff embedding theorem, Metrizable spaces, Urysohn's metrization theorem

Section-III

Nets : Nets in topological spaces, Convergence of nets, Hausdorffness and nets, Subnet and cluster points, Compactness and nets, Filters : Definition and examples, Collection of all filters on a set as a poset, Finer filter, Methods of generating filters and finer filters, ultra filter and its characterizations,Ultra filter principle, Image of filter under a function, Limit point and limit of a filter, Continuity in terms of convergence of filters, Hausdorffness and filters. Canonical way of converting nets to filters and vice versa, Stone-Cech compactification(statement only).

Section-IV

Covering of a space, Local finiteness, Paracompact spaces, Paracompactness as regular space,Michaell theorem on characterization of paracompactness in regular spaces, Paracompactness as normal space, A. H. Stone theorem, Nagata- Smirnov Metrization theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd.
3. J. L. Kelly, General Topology, Springer Verlag, New York, 1991.
4. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
5. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.
6. K.Chandrasekhara Rao, Toplogy, Narosa Publishing House Delhi, 2009.
7. Fred H. Croom, Principles of Topology, Cengage Learning, 2009.

(w.e.f. 2018-19)

12MHM424 : Classical Mechanics

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Be familiar with constraints and their classification.

CO2 Understand ideal constraints, derive general equation of dynamics and Lagrange equations for potential forces.

CO3 Describe Donkin's theorem, Hamilton principle, Whittaker equations and the principle of least action.

CO4 Find the equation of motion for various dynamical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.

CO5 Get familiar with canonical transformations, conditions of canonicity of a transformation in terms of Lagrange and Poisson brackets.

Unit –I(2 Question)

Degrees of freedom and generalized coordinates, Free and constrained systems, constraints and their classification, holonomic and non-holonomic systems, virtual displacement and virtual work, statement of principle of virtual work (PVW), Mathematical expression for the principle of virtual work, possible velocity and possible acceleration, D' Alembert's principle,

Lagrangian Formulation : Ideal constraints**,** general equation of dynamics for ideal constraints, Lagrange's equations of the first kind, generalized potential.

Unit –II(2 Question)

Independent coordinates and generalized forces, Lagrange's equations of the second kind, generalized velocities and accelerations. Uniqueness of solution, variation of total energy for conservative fields.

Lagrange's variable and Lagrangian function $L(t, q_i, \dot{q}_i)$, Lagrange's equations for potential forces, generalized momenta p_i , Hamiltonian variable and Hamiltonian function $H(t, q_i, p_i)$, Donkin's theorem, ignorable coordinates.

Unit -III(2 Question)

Hamilton's equations of motion, Derivation of Hamilton canonical equations using Lagrange's equations, Routh variables and Routh function R, Routh's equations, Poisson Brackets and their simple properties, Poisson's identity, Jacobi – Poisson theorem.

Hamilton action and Hamilton's principle, Derivation of Hamilton's equations from Hamilton principle, Poincare – Carton integral invariant, Whittaker's equations, Jacobi's equations, Lagrangian action and the principle of least action.

Unit -IV(2 Question)

Canonical transformation, necessary and sufficient condition for a canonical transformation, univalent Canonical transformation, free canonical transformation, Hamilton-Jacobi equation, Jacobis theorem ,Method of separation of variables in HJ equation, Lagrange brackets, necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical

transformation, conditions of canonicity of a transformation in terms of Poison brackets, invariance of Poisson Brackets under canonical transformation. Jacobi's identity for Poisson's brackets.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. F. Gantmacher — Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
2. P.V. Panat — Classical Mechanics, Narosa Publishing House, New Delhi, 2005.
3. N.C. Rana and P.S. Joag — Classical Mechanics, Tata McGraw- Hill, New Delhi, 1991.
4. Louis N. Hand and Janet D. Finch — Analytical Mechanics, CUP, 1998.
5. K. Sankra Rao — Classical Mechanics, Prentice Hall of India, 2005.
6. M.R. Speigal — Theoretical Mechanics, Schaum Outline Series.
7. C.R. Mondal — Classical Mechanics, Prentice Hall of India Private Limited, New Delhi.

(w.e.f. 2018-19)

12MHM425(Opt(i)) : Mathematics for Finance and Insurance

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Demonstrate knowledge of the terminology related to nature, scope, goals, risks and decisions of financial management.

CO2 Predict various types of returns and risks in investments and take necessary protective measures for minimizing the risk.

CO3 Develop ability to understand, analyse and solve problems in bonds, finance and insurance.

CO4 Build skills for computation of premium of life insurance and claims for general insurance using probability distributions.

Unit-I (2 Questions)

Financial Management – AN overview. Nature and Scope of Financial Management. Goals of Financial Management and main decisions of financial management. Difference between risk, speculation and gambling.

Time value of Money - Interest rate and discount rate. Present value and future value- discrete case as well as continuous compounding case. Annuities and its kinds.

Unit-II (2 Questions)

Meaning of return. Return as Internal Rate of Return (IRR). Numerical Methods like Newton Raphson Method to calculate IRR. Measurement of returns under uncertainty situations. Meaning of risk. Difference between risk and uncertainty. Types of risks. Measurements of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model. Sharpe's Single Index Model- Systematic Risk and Unsystematic Risk.

Unit-III (2 Questions)

Taylor series and Bond Valuation. Calculation of Duration and Convexity of bonds.

Insurance Fundamentals – Insurance defined. Meaning of loss. Chances of loss, peril, hazard, and proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures- feature of a loss that is ideal for insurance.

Unit-IV (2 Questions)

Life Insurance Mathematics – Construction of Morality Tables. Computation of Premium of Life Insurance for a fixed duration and for the whole life. Determination of claims for General Insurance – Using Poisson Distribution and Negative Binomial Distribution –the Polya Case.

Determination of the amount of Claims of General Insurance – Compound Aggregate claim model and its properties, and claims of reinsurance. Calculation of a compound claim density function F, recursive and approximate formulae for F.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Aswath Damodaran, Corporate Finance - Theory and Practice, John Wiley & Sons, Inc.
2. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of Indian Private Limited.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.
4. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englwood Cliffs, New Jersey.
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.
6. Salih N. Neftci, An Introduction to the Mathematics of Financial Derivatives, Academic Press, Inc.
7. Robert J. Elliott and P. Ekkehard Kopp, Mathematics of Financial Markets, Sprigner-Verlag, New York Inc.

(w.e.f. 2018-19)

12MHM425(Opt(ii)) : Sampling Techniques and Design of Experiments

Time: 3 Hours **Max. Marks : 60**

Course Outcomes

Students would be able to:

CO1 Have exposure of various sampling techniques and to develop ability to identify the appropriate sampling technique for a given situation.

CO2 Understand the applicability of sample survey over the complete enumeration and vice-versa.

CO3 Distinguish between simple random sampling, stratified random sampling and systematic sampling and select proper sampling technique for specific situations.

CO4 Describe completely randomised, randomized block and Latin square designs.

CO5 Apply CRD, RBD, LSD, 2^2 and 2^3 factorial designs as per the situation and communicate the findings.

Unit -I (2 Questions)

Concepts of census and sample survey, principal steps involved in a sample survey, sampling and non-sampling errors, bias, precision and accuracy.

Simple random sampling (SRS) with and without replacement. Use of random number tables, estimate of population mean and its variance in case of simple random sampling, simple random sampling of attributes.

Unit – II (2 Questions)

Stratified random sampling, estimate of population mean and its variance in case of stratified sampling; Proportional and optimum allocation; Comparison of stratified random sampling with simple random sampling without stratification. Idea of systematic sampling and its various results (without derivation).

Unit -III (2 Questions)

Terminology in experimental designs: Experiment, treatments, experimental unit, blocks, yield, experimental error, replication, precision, efficiency of a design, uniformity trials; Fundamental principles of experimental design, size and shape of plots and blocks; Layout and analysis of completely Randomised Design and randomised block design; Efficiency of R.B.D. relative to C.R.D.

Unit – IV(2 Questions)

Latin Square Design and its analysis, efficiency of LSD relative to RBD and CRD. Factorial designs – 2^2 and 2^3 designs, illustrations, main effects, interaction effects and analysis of these designs.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books recommended :

1. Chochran, W.G. : Sampling Techniques.
2. Chaudhary, F.S. & Singh, D. : Theory & Analysis of Sample Survey.
3. Goon, A.M., Gupta, M.K. & Das Gupta, B., : Basic Statistics, World Press.
4. Gupta, S.C. & Kapoor, V.K., : Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

(w.e.f. 2018-19)
Practical/ Computational Work
Code: 12MHM 425
Practical based on **Sampling Techniques and Design of Experiments**

Time:3 Hours **Max. Marks : 40**

i) Written Practical/ Lab work : 30 Marks
ii)Viva-voce and practical record : 10 Marks

Note: The examiner is requested to set **4** experiments. The candidate is required to attempt **2** of the allotted experiments.

This paper covers the practical work based on Sampling Techniques and Design of Experiments

Scheme of Examination of
5 – Year Integrated M.Sc.(Honours) Mathematics, Semester-IX
(w.e.f. Session 2013-14)

Paper Code	Title of the Paper	Theory Marks	Internal-Assessment Marks	Practical	Total Marks
12MHM 511	Functional Analysis	80	20	-	100
12MHM 512	Mechanics of Solids	80	20	-	100
12MHM 513	Statistical Methods	80	20	-	100
12MHM 514	One paper out of Group A	80	20	-	100
12MHM 515	One paper out of Group B	80	20	-	100
				Total Marks of Semester - III	500
				Total Marks of Semester - II	500
				Total Marks of Semester - I	500
				Grand Total	1500

Group A	Group B
A_1 : Automata Theory **A_2 :** Fuzzy Set Theory **A_3 :** Analytical Number Theory **A_4 :** Wavelets **A_5 :** Algebraic Topology	**B_1 :** Advanced Fluid Dynamics **B_2 :** Bio-Mechanics **B_3 :** Space Dynamics **B_4 :** Integral Equations and Boundary Value Problem **B_5 :** Difference Equations

(w.e.f. 2018-19)

12MHM511 : Functional Analysis

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Be familiar with the completeness in normed linear spaces.

CO2 Understand the concepts of bounded linear transformation, equivalent formulation of continuity and spaces of bounded linear transformations.

CO3 Describe the solvability of linear equations in Banach Spaces, weak and strong convergence and their equivalence in finite dimensional space.

CO4 Learn the properties of compact operators.

CO5 Understand uniform boundedness principle and its consequences.

Unit -I (2 Questions)

Normed linear spaces, Metric on normed linear spaces, Completion of a normed space, Banach spaces, subspace of a Banach space, Holder's and Minkowski's inequality, Completeness of quotient spaces of normed linear spaces. Completeness of l_p, L^p, R^n, C^n and C[a,b]. Incomplete normed spaces.

Unit -II (2 Questions)

Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces, Hahn-Banach extension theorem (Real and Complex form).

Unit -III (2 Questions)

Riesz Representation theorem for bounded linear functionals on L^p and C[a,b]. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, Open mapping theorem and its application projections, Closed Graph theorem.

Unit -IV (2 Questions)

Equivalent norms, Weak and Strong convergence, their equivalence in finite dimensional spaces. Weak sequential compactness, Solvability of linear equations in Banach spaces.

Compact operator and its relation with continuous operator. Compactness of linear transformation on a finite dimensional space, properties of compact operators, compactness of the limit of the sequence of compact operators, the closed range theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to**

ten short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications.

(w.e.f. 2018-19)

12MHM 512 : Mechanics of solids

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Analyse the basic properties of stress and strain components, their transformations, extreme values and invariants.

CO2 Demonstrate generalized Hooke's law for three dimensional elastic solid which provides the linear relationship between stress components and strain components.

CO3 Be familiar with basic properties of materials such as elastic modulii and Poisson's ratio, which are used to solve problems related to isotropic elasticity.

CO4 Use different types of elastic symmetries to derive the stress-strain relationship for isotropic elastic materials for applications to architecture and engineering.

Unit -I (2 Questions)

Analysis of stress, stress vector ,stress components, Cauchy's formula, equilibrium equations in term of stress components, symmetry of stress matrix, basic lemma of stress analysis, equilibrium equations in cylindrical and spherical coordinates, orthogonal transformation of stress matrix, stress tensor, principal invariants of stress tensor, principal stresses, principal basis, extreme properties of principal stresses, extreme values of shear stresses, Mohr's stresses circles, stresses at the outer surface of the body, plane state of stress, normal and tangential stresses in the plane state of stress, Mohr's circle for plane state of stress, linear state of stress[Chapter 1, sections 1.1-1.6 of Guran's book]

Unit -II (2 Questions)

Measures of deformation, strain tensor, displacement vector, elongations, small deformation, shear angles, extension and shear angle for arbitrary directions, infinitesimal rotations, principal directions of strain tensors, strain tensor in cylindrical and spherical coordinates, compatibility conditions for linear strain tensor, plane state of strain, cubical dilatation.[Chapter 2, sections 2.1 to 2.9 of Guran's book]

Unit -III (2 Questions)

Hooke's law, transformation of the elasticity tensor by rotation of coordinate system, anisotropic, orthotropic and isotropic elastic body, Lames constants, Poisson ratio, modulus of elasticity, influence of temperature on the stress-strain relation, Hooke's law in cylindrical and spherical coordinate systems, Beltrami-Michell compatibility equations, equilibrium equations in term of displacement components, Finite deformations in linear state of stress.

[Chapter 3, sections 3.1 –3.8 of Guran's book]

Unit –IV(2 Questions)

Stress function method for the solution of plane problems, solution of some plane problems, complex variable method for plane problems, strain energy function. [Relevant topic from chapter 6 of Guran's book]

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. T.M. Atanackovic and A. Guran - Theory of Elasticity for Scientists and Engineers, Birkhauser, 2000.
2. D.S.chandrrasekharaiah and Lokenath Debnath - Continuum Mechanics, Academic press, 1994.
3. L.S.Sronath -- Advanced Mechanics of solids, Tata-McGraw-hill Co, New Delhi,2003.
4. G.T.Mase and G.E. Mase- Continuum Mechanics for Engineers, CRC Press, 1999.
5. Allen F. Bower-Applied Mechanics of Solids, CRC Press, NY, 2010.

(w.e.f. 2018-19)

12MHM 513 : Statistical Methods

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Solve problems on transformation of random variables from one set to other.

CO2 Have skill to solve problems related to plane of regression, multiple and partial correlations.

CO3 Carry out Sign test for uni-variate and bi-variate distribution, run test, median test, Mann Whitney-U-test.

CO4 Decide the choice of test to be applied using Likelihood ratio test for various problems for testing mean and variance of a normal population, equality of means and variances of two normal populations.

Unit -I (2 Questions)

Transformation of one, two and n-dimensional random variables, distributions of sum, difference, product and quotient of two random variables.

Bi-variate normal distribution, its moment generating functions, marginal and conditional distributions.

Unit -II (2 Questions)

Multiple correlation and Partial correlation in three variables. Plane of regression, variance of residuals. Partial and multiple correlation coefficients and their properties.

Unit -III (2 Questions)

Definition of order statistics and their distributions, Non-parametric tests, Sign test for uni-variate and bi-variate distribution, run test, median test and Mann Whitney-U-test.

Unit -IV (2 Questions)

Liklihood ratio tests. Tests for mean and variance of a normal population, equality of means and variances of two normal populations.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Suggested:

1. Goon, A.M., Gupta, M.K., and Dasgupta B.: An outline of Statistical Theory, Vol-I &II.
2. Gupta, S.C. and Kapoor, V.K. : Fundamental of Mathematical Statistics.
3. Miller, I. and Miller, M. : Mathematical Statistics with Applications.

4. Mood, A.M. and Graybill, F.A. and Boes, D.C.: Introduction to the theory of Statistics.

(w.e.f. 2018-19)

12MHM514 : A_1 : Automata Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Apply a number of proof techniques to theorems in language design.

CO2 Develop a clear understanding of decidability and undecidability.

CO3 Understand the concepts of deterministic and non-deterministic finite state automata and their equivalence.

CO4 Demonstrate the equivalence between context-free grammars and pushdown automata.

CO5 Appreciate the power of the turing machine, as an abstract automaton, that describes computation, effectively and efficiently.

Unit-I (2 Questions)

Introductory Computability Theory - Finite state machines and their transition table diagrams, equivalence of finite state machines, reduced machines, homomorphism, finite automata acceptors.

Unit -II (2 Questions)

Non-deterministic finite automata and equivalence of its power to that of deterministic finite automata, Moore and Mealy machines.

Unit -III (2 Questions)

Regular Languages,Regular Expressions, Properties and uses of Regular expressions, Finite automata and Regular Expressions.

Unit -IV (2 Questions)

Context free Grammars and Context free Languages, Simplification of Context free Grammar, Pumping Lemma, Kleene's Theorems

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.

2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.

3. Seymour Lipschutz, Finite Mathematics (International edition 1983), McGraw-Hill Book Company, New York.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hilll Book Co.
5. Babu Ram, Discrete Mathematics, Vinayak Publishers and Distributors, Delhi, 2004.
6. Nasir S.F.B. and Srimani P.K., A Textbook on Automata Theory,Cambridge University Press India Pvt. Ltd.

(w.e.f. 2018-19)

12MHM514 : A_2 : Fuzzy Set Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Draw a parallelism between crisp set operations and fuzzy set operations through the use of characteristic and membership functions respectively.

CO2 Learn fuzzy sets using linguistic words and represent these sets by membership functions.

CO3 Define mapping of fuzzy sets by a function and fuzzy-set-related notions; such as α-level sets, convexity, normality, support, etc.

CO4 Know the concepts of fuzzy graph, fuzzy relation, fuzzy morphism and fuzzy numbers.

CO5 Become familiar with the extension principle, its compatibility with the α-level sets and its usefulness in performing fuzzy number arithmetic operations.

Unit-I (2 Questions)

Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T- norms and T- conorms. (Chapter 1of [1])

Unit-II (2 Questions)

Product Set, Definition of Relation, Characteristics of Relation, Representation Methods of Relations, Operations on Relations, Path and Connectivity in Graph, Fundamental Properties, Equivalence Relation, Compatibility Relation, Pre-order Relation, Order Relation, Definition and Examples of Fuzzy Relation, Fuzzy Matrix, Operations on Fuzzy Relation, Composition of Fuzzy Relation, α - cut of Fuzzy Relation, Projection and Cylindrical Extension, Extension by Relation, Extension Principle, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets. (Chapter 2,3 of [1])

Unit-III (2 Questions)

Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, α - cut of Fuzzy Graph, Fuzzy Network, Reflexive Relation, Symmetric Relation, Transitive Relation, Transitive Closure, Fuzzy Equivalence Relation, Fuzzy Compatibility Relation, Fuzzy Pre-order Relation, Fuzzy Order Relation, Fuzzy Ordinal Relation, Dissimilitude Relation, Fuzzy Morphism, Examples of Fuzzy Morphism. (Chapter 4 of [1])

Unit-IV (2 Questions)

Interval, Fuzzy Number, Operation of Interval, Operation of α - cut Interval, Examples of Fuzzy Number Operation,, Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers, Approximation of

Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number.

Function with Fuzzy Constraint, Propagation of Fuzziness by Crisp Function, Fuzzifying Function of Crisp Variable, Maximizing and Minimizing Set, Maximum Value of Crisp Function, Integration and Differentiation of Fuzzy Function. (Chapter 5,6 of [1])

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
3. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

(w.e.f. 2018-19)

12MHM514 : A_3 :Analytical Number Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Know about the classical results related to prime numbers and get familiar with the irrationality of *e* and *Π*.

CO2 Study the algebraic properties of U_n and Q_n.

CO3 Learn about the Waring problems and their applicability.

CO4 Learn the definition, examples and simple properties of arithmetic functions and about perfect numbers.

CO5 Understand the representation of numbers by two or four squares.

Unit-I (2 Questions)

Distribution of primes. Fermat's and Mersenne numbers, Farey series and some results concerning Farey series. Approximation of irrational numbers by rations, Hurwitz's theorem. Irrationality of e and π.(Relevant portions from the Books Recommended at Sr. No. 1 and 4)

Unit-II (2 Questions)

Diophantine equations $ax + by = c$, $x^2+y^2 = z^2$ and $x^4+y^4 = z^4$. The representation of number by two or four squares. Warig's problem, Four square theorem, the numbers g(k) & G(k). Lower bounds for g(k) & G(k). Simultaneous linear and non-linear congruences Chinese Remainder Theorem and its extension. (Relevant portions from the Books Recommended at Sr. No. 1 and 4)

Unit-III (2 Questions)

The arithmetic in Z_n. The group U_n . Legender's Symbol. Gauss Lemma and its applications. Quadratic Law of Reciprocity Jacobi's Symbol. Congruences with prime power modulus, primitive roots and their existence. The group U_p^n (p-odd) and U_2^n. The group of quadratic residues Q_n , quadratic residues for prime power moduli and arbitrary moduli. The algebraic structure of U_n and Q_n . (Scope as in Book at Sr. No. 5)

Unit-IV (2 Questions)

Riemann Zeta Function $\zeta(s)$ and its convergence. Application to prime numbers. $\zeta(s)$ as Euler's product. Evaluation of $\zeta(2)$ and $\zeta(2k)$. Dirichlet series with simple properties. Eulers products and Dirichlet products, Introduction to modular forms. (Scope as in Book at Sr. No.5).

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Hardy, G.H. and Wright, E.M., An Introduction to the Theory of Numbers
2. Burton, D.M., Elementary Number Theory.
3. McCoy, N.H., The Theory of Number by McMillan.
4. Niven, I. And Zuckermann, H.S., An Introduction to the Theory of Numbers.
5. Gareth, A. Jones and J. Mary Jones, Elementary Number Theory, Springer Ed. 1998.

(w.e.f. 2018-19)

12MHM514 : A_4 : Wavelets

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand linear spaces, bases and frames, normed spaces, inner product spaces, Hilbert spaces.

CO2 Explain the concept of trigonometric systems, trigonometric Fourier series, convergence of Fourier series and generalized Fourier series.

CO3 Represent Fourier transforms, convolution, Plancherel formula, sampling theorem and Gibbs phenomenon.

CO4 Describe Gabor transforms, Zak transforms and their properties.

CO5 Understand concept of wavelet transforms and their properties.

Unit -I (2 Questions)

Definition and Examples of Linear Spaces, Bases and Frames, Normed Spaces, The L^p - Spaces, Definition and Examples of Inner Product Spaces, Hilbert Spaces, Orthogonal and Orthonormal Systems.

Unit - II (2 Questions)

Trigonometric Systems, Trigonometric Fourier Series, Convergence of Fourier Series, Generalized Fourier Series.

Fourier Transforms in $L^1(\mathrm{R})$ and $L^2(\mathrm{R})$, Basic Properties of Fourier Transforms, Convolution, Plancherel Formula, Poission Summation Formula, Sampling Theorem and Gibbs Phenomenon.

Unit - III (2 Questions)

Definition and Examples of Gabor Transforms, Basic Properties of Gabor Transforms.

Definition and Examples of Zak Transforms, Basic Properties of Zak Transforms, Balian- Low Theorem.

Unit- IV (2 Questions)

Wavelet Transform, Continuous Wavelet Transforms, Basic Properties of Wavelet Transforms, Discrete Wavelet Transforms, Partial Discrete Wavelet Transforms, Maximal Overlap Discrete Wavelet Transforms.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. K. Ahmad and F. A. Shah, Introduction to Wavelet Analysis with Applications, Anamaya Publishers, 2008.

2. Eugenio Hernandez and Guido Weiss, A first Course on Wavelets, CRC Press, New York, 1996.
3. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.
4. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, 1992.
5. Y. Meyer, Wavelets, Algorithms and Applications (translated by R.D. Rayan, SIAM, 1993).

(w.e.f. 2018-19)

12MHM514 : A_5 : Algebraic Topology

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Be familiar with the fundamental concepts of algebraic topology and their role in modern mathematics and applied contexts.

CO2 Demonstrate accurate and efficient use of algebraic topology techniques.

CO3 Know about concepts of functions to obtain algebraic invariant of topological spaces and mappings.

CO4 Get acquainted with connections between analysis and topology.

CO5 Solve problems involving topological spaces and continuous maps by converting them into problems in algebra.

Unit-I (2 Questions)

Fundamental group function, homotopy of maps between topological spaces, homotopy equivalence, contractible and simple connected spaces, fundamental groups of S^1, and $S^1 \times S^1$ etc.

Unit-II (2 Questions)

Calculation of fundamental group of S^n, $n > 1$ using Van Kampen's theorem, fundamental groups of a topological group. Brouwer's fixed point theorem, fundamental theorem of algebra, vector fields on planer sets. Frobenius theorem for 3 x 3 matrices.

Unit-III (2 Questions)

Covering spaces, unique path lifting theorem, covering homotopy theorems, group of covering transformations, criterian of lifting of maps in terms of fundamental groups, universal covering, its existence, special cases of manifolds and topological groups.

Unit-IV (2 Questions)

Singular homology, reduced homology, Eilenberg Steenrod axioms of homology (no proof for homotopy invariance axiom, excision axiom and exact sequence axiom) and their application, relation between fundamental group and first homology.

Calculation of homology of S^n, Brouwer's fixed point theorem for $f : E^n \rightarrow E^n$, application spheres, vector fields, Mayer-Vietoris sequence (without proof) and its applications.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. James R. Munkres, Topology – A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 1978.

2. Marwin J. Greenberg and J.R. Harper, Algebraic Topology – A First Course, Addison-Wesley Publishing Co., 1981.
3. W.S. Massey, Algebraic Topology – An Introduction, Harcourt, Brace and World Inc. 1967, SV, 1977.

(w.e.f. 2018-19)

12MHM515 : B_1 : Advanced Fluid Dynamics

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand about vortex motion and its permanence, rectilinear vertices, vortex images and specific types of rows of vortices.

CO2 Acquire knowledge of viscosity, relation between shear stress and rates of shear strain for Newtonian fluids, energy dissipation due to viscosity, and laminar and turbulent flows.

CO3 Derive the equations of motion for a viscous fluid flow and solve them for flow of Newtonian fluids in pipes and ducts for laminar flow fields, and their applications in mechanical engineering.

CO4 Get familiar with dimensional analysis and similitude, and understand the common dimensional numbers of fluid dynamics along with their physical and mathematical significance.

CO5 Derive and solve the boundary layer equation in two-dimensions and explain the significance of characteristic boundary layer parameters for simple physical problems.

Unit -I (2 Questions)

Vortex motion. Kelvin's proof of permanence. Motions due to circular and rectilinear vortices. Spiral vortex. Vortex doublet. Image of a vortex. Centroid of vortices. Single and double infinite rows of vortices. Karman vortex street. Applications of conformal mapping to fluid dynamics.

Unit -II (2 Questions)

Stress components in a real fluid. Relation between Cartesian components of stress. Translational motion of fluid element. Rates of strain. Transformation of rates of strains. Relation between stresses and rates of strain. The co-efficient of viscosity and laminar flow.

Navier-Stoke's equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates. Equation of energy. Diffusion of vorticity. Energy dissipation due to viscosity. Equation of state.

Unit -III (2 Questions)

Plane Poiseuille and Couette flows between two parallel plates. Theory of lubrication. Hagen Poiseuille flow. Steady flow between co-axial circular cylinders and concentric rotating cylinders. Flow through tubes of uniform elliptic and equilateral triangular cross-section. Flow in convergent and divergent chennals. Unsteady flow over a flat plate. Steady flow past a fixed sphere.

Unit -IV (2 Questions)

Dynamical similarity. Inspection analysis. Non-dimensional numbers. Dimensional analysis. Buckingham π-theorem and its application. Physical importance of non-dimensional parameters.

Prandtl's boundary layer. Boundary layer equation in two-dimensions. The boundary layer on a flat plate (Blasius solution). Characteristic boundary layer parameters. Karman integral conditions. Karman-Pohlhausen method.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
2. J. L. Bansal, Viscous Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 2000.
3. O'Neill, M.E. and Chorlton, F. , Viscous and Compressible Fluid Dynamics, Ellis Horwood Limited, 1989.
4. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
5. H. Schlichting, Boundary-Layer Theory, McGraw Hill Book Company, New York, 1979.
6. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
7. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

(w.e.f. 2018-19)
12MHM515 : B_2 :Biomechanics

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Use the mathematics of mechanics to quantify the kinematics and kinetics of human movement alongwith describing its qualitative analysis.

CO2 Possess knowledge of steady laminar flow in elastic tubes, pulsatile flow and significance of non-dimensional number affecting the flow.

CO3 Study the problems of external flow around bodies moving in wind and water, in locomotion, flying and swimming.

CO4 Be familiar with internal flows such as blood flow in blood vessels, gas in lungs, urine in kidneys, water and other body fluids in interstitial space between blood vessels and cells.

Unit-I (2 Questions)

Newton's equations of motion. Continuum approach. Segmental movement and vibrations. Generalized Co-ordinates, Lagrange's equations. Normal modes of vibration. Decoupling of equations of motion.Flow around an airfoil. Flow around bluff bodies. Steady state aeroelastic problems. Transient fluid dynamics forces due to unsteady motion. Flutter.

Unit-II (2 Questions)

Kutta-Joukowski theorem. Circulation and vorticity in the wake. Vortex system associated with a finite wing in nonstationary motion. Thin wing in steady flow. Stokeslet and Dipole in a Viscous fluid. Motion of Sphere , Cylinder and Flagella in Viscous Fluid. Resistive-Force Theory of Flagellar Propulsion. Theory of Fish Swimming.

Unit-III (2 Questions)

Blood flow in heart, lungs, arteries, and veins. Field equations and boundary conditions. Pulsatile flow in Arteries. Progressive waves superposed on a steady flow. Reflection and transmission of waves at junctions. Velocity profile of a steady flow in a tube. Steady laminar flow in an elastic tube. Velocity profile of Pulsatile flow. The Reynolds number, Stokes number, and Womersley number. Flow in collapsible tubes.

Unit-IV (2 Questions)

Micro-and macrocirculation Rheological properties of blood. Pulmonary capillary blood flow. Respiratory gas flow. Intraction between convection and diffusion. Dynamics of the ventilation system.

Laws of thermodynamics. Gibbs and Gibbs – Duhem equations. Chemical potential. Entropy in a system with heat and mass transfer.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall

be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended

1. Y.C. Fung, Biomechanics: Motion, Flow, Stress and Growth, Springer-Verlag, New York Inc., 1990.
2. J.D.Humprey and S.L. Delange: An Introduction to Bio-Mechanics- Solids and Fluids, Analysis and Design, Springer, India Pvt Ltd., 2007.
3. Y.C. Fung, Biomechanics: Mechanical Properties of Living Tisues, Springer, India Pvt Ltd., 2008.

(w.e.f. 2018-19)

12MHM515 : B_3 :Space Dynamics

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Have a good understanding of orbiting bodies.

CO2 Solve body problems analytically by using Hamilton Jacobi theory.

CO3 Find stationary solutions and stability of dynamical system.

CO4 Be familiar with perturbations such as perturbing forces, secular and periodic perturbations on body problems.

Unit-I (2 Questions)

Basic Formulae of a spherical triangle - The two-body Problem : The Motion of the Center of Mass. The relative motion. Kepler's equation. Solution by Hamilton Jacobi theory.

Unit-II (2 Questions)

The Determination of Orbits – Laplace's Gauss Methods.

The Three-Body problem – General Three Body Problem. Restricted Three Body Problem.

Unit-III (2 Questions)

Jacobi integral. Curves of Zero velocity. Stationary solutions and their stability.

The n-Body Problem – The motion of the centre of Mass. Classical integrals.

Unit-IV (2 Questions)

Perturbation – Osculating orbit, Perturbing forces, Secular & Periodic perturbations. Lagrange's Planetory Equations in terms of pertaining forces and in terms of a perturbed Hamiltonian.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. J.M. A. Danby, Fundamentals of Celestial Mechanics. The MacMillan Company, 1962.
2. E. Finlay, Freundlich, Celestial Mechanics. The MacMillan Company, 1958.
3. Theodore E. Sterne, An Introduction of Celestial Mechanics, Intersciences Publishers. INC., 1960.
4. Arigelo Miele, Flight Mechanics – Vol . 1 - Theory of Flight Paths, Addison-Wesley Publishing Company Inc., 1962.

(w.e.f. 2018-19)

12MHM515 : B_4 :Integral Equations and Boundary Value Problems

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Be familiar with interior and exterior Dirichlet and Neumann problems.

CO2 Get importance of symmetric kernels and its solution by using Hilbert-Schmidt theorem.

CO3 Derive the Green's function for Laplace equation with free and bounded spaces.

CO4 Understand the concept of Hilbert transforms and its application in solving electrostatic and electrodynamics problems.

Unit -I (2 Questions)

Applications of integral equations to Partial Differential Equations. Integral representation formulas for the solutions of the Laplace and Poisson equations. Newtonian single layer and double layer potentials. Interior and exterior Dirichlet and Neumann problems for Laplace equation. Green's function for Laplace equation in a free space as well as in a space bounded by a grounded vessel. Integral equation formulation of BVPs for Lapalce equation. The Helmholftz equation. (Relevant topics from the chapters 5 and 6 of the book by R.P. Kanwal).

Unit -II (2 Questions)

Symmetric kernels. Complex Hilbert space. Orthonormal system of functions. Riesz-Fischer theorem (statement only). Fundamental properties of eigenvalues and eigenfunctions for symmetric kernels. Expansion in eigenfunctions and bilinear form. A necessary and sufficient condition for a symmetric L_2-kernel to be separable. Hilbert Schmidt theorem. Definite and indefinite kernels. Mercer's theorem (statement only). Solution of integral equations with symmetric kernels by using Hilbert-Schmidt theorem.

Unit -III (2 Questions)

Singular integral equations. The Abel integral equation. Inversion formula for singular integral equation with kernel of the type $[h(s) - h(t)]^{-\alpha}$ with $0 < \alpha < 1$. Cauchy principal value for integrals. Solution of the Cauchy type singular integral equations. The Hilbert kernel. Solution of the Hilbert-type singular integral equations. Integral transform methods, Fourier transform, Laplace transform. Applications to Volterra integral equations with convolution type kernels.

Unit -IV (2 Questions)

Hilbert transforms and their use to solve integral equations. Applications to mixed BVP's. Two-part BVP's, Three-part BVP's, Generalized two-part BVP's. Perturbation method. Its applications to Stokes and Oseen flows, and to Navier-Cauchy equations of elasticity for elastostatic and elastodynamic problems. (Relevant topics from the chapters 9 to 11 of the book by R.P. Kanwal).

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Kanwal, R.P., Linear Integral Equations – Theory and Technique, Academic Press, 1971.
2. Kress, R., Linear Integral Equations, Springer-Verlag, New York, 1989.
3. Jain, D.L. and Kanwal, R.P., Mixed Boundary Value Problems in Mathematical Physics.
4. Smirnov, V.I., Integral Equations and Partial Differential Equations, Addison-Wesley, 1964.
5. Jerri, A.J., Introduction to Integral Equations with Applications, Second Edition, John-Wiley & Sons, 1999.
6. Kanwal, R.P., Linear Integral Equations, (2^{nd} Ed.) Birkhauser, Boston, 1997.

(w.e.f. 2018-19)

12MHM515 : B_5 :Difference Equations

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Be familiar with various types of difference operators, their derivation and solution.

CO2 Apply the concepts of stability on linear and nonlinear systems.

CO3 Get aware of phase plane analysis and chaotic behavior of difference equations.

CO4 Understand the concept of asymptotic methods for linear and nonlinear equations.

CO5 Be familiar with the concepts of Green function.

Unit-I (2 Questions)

Introduction, Difference Calculus – The difference operator, Summation, Generating functions and approximate summation.

Linear Difference Equations - First order equations. General results for linear equations.

Unit-II (2 Questions)

Equations with constant coefficients. Applications. Equations with variable coefficients.

Stability Theory - Initial value problems for linear systems. Stability of linear systems.

Unit-III (2 Questions)

Stability of nonlinear systems. Chaotic behaviour.

Asymptotic methods - Introduction, Asymptotic analysis of sums. Linear equations. Nonlinear equations.

Unit-IV (2 Questions)

Self-adjoint second order linear equations –Introduction. Sturmian Theory. Green's functions. Disconjugacy. The Riccati Equations. Oscillation.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Walter G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications, Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.
2. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccatti Equations. Kluwer, Boston, 1996.

Scheme of Examination of
5 – Year Integrated M.Sc.(Honours) Mathematics, Semester- X
(w.e.f. Session 2013-14)

Paper Code	Title of the Paper	Theory Marks	Internal-Assessment Marks	Practical	Total Marks
12MHM 521	Inner Product Spaces and Advanced Measure Theory	80	20		100
12MHM 522	Applied Mechanics of Solids	80	20		100
12MHM 523	Harmonic Analysis	80	20		100
12MHM 524	One paper out of Group C	80	20		100
12MHM 525	One paper out of Group D	80	20		100
				Total Marks of Semester - IV	500
				Total Marks of Semester - III	500
				Total Marks of Semester - II	500
				Total Marks of Semester - I	500
				Grand Total	2000

Group C	Group D
C_1 : Algebraic Number Theory	**D_1 :** Bio-Fluid Dynamics
C_2 : Bases in Banach Spaces	**D_2 :** Programming Techniques
C_3 : Theory of Linear Operators	**D_3 :** Computational Fluid Dynamics
C_4 : Fuzzy Sets and Logic	**D_4 :** Information Theory
C_5 : Sobolev Spaces	**D_5 :** Operating System and Internet

(w.e.f. 2018-19)

12MHM521 : Inner Product Spaces and Advanced Measure Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand Hilbert spaces and related terms.

CO2 Introduce the concept of projections, measure and outer measure.

CO3 Learn about Hahn, Jordan and Radon-Nikodyn decomposition theorem, Lebesgue-stieltjes integral, Baire sets and Baire measure.

Unit-I (2 Questions)

Hilbert Spaces: Inner product spaces, Hilbert spaces, Schwarz's inequality, Hilbert space as normed linear space.

Convex sets in Hilbert spaces, Projection theorem. Orthonormal sets, Bessel's inequality, Parseval's identity, conjugate of a Hilbert space, Riesz representation theorem in Hilbert spaces.

Unit-II (2 Questions)

Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert space, Self-adjoint operators, Positive and projection operators, Normal and unitary operators, Projections on Hilbert space, Spectral theorem on finite dimensional space.

Unit-III (2 Questions)

Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon – Nikodyn theorem Lebesgue decomposition, Lebesgue - Stieltjes integral, Product measures, Fubini's theorem.

Unit-IV (2 Questions)

L^p spaces, Convex functions, Jensen's inequalities, Measure space, Generalized Fatou's lemma, Measure and outer measure, Extension of a measure, Caratheodory extension theorem.

Baire sets, Baire measure, continuous functions with compact support, Regularity of measures on locally compact spaces, Riesz-Markoff theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.
3. S.K. Berberian, Measure and Integration, Chelsea Publishing Company, New York, 1965.
4. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.

5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

(w.e.f. 2018-19)
12MHM522 : Applied Mechanics of Solids

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Be familiar with the concept of generalized plane stress and solution of two-dimensional biharmonic equations.

CO2 Solve the problems based on thick-walled tube under external and internal pressures.

CO3 Understand the concept of torsional rigidity, lines of shearing stress and solve the problems of torsion of beams with different cross-sections.

CO4 Describe Ritz method, Galerkin method, Kantrovich method and their applications to the torsional problems.

CO5 Get familiar with simple harmonic progressive waves, plane waves and wave propagation in two-dimensions.

Unit-I (2 Questions)

Extension of beams by longitudinal forces. Beam stretched by its own weight. Bending of beams by terminal couples. Bending of a beam by a transverse load at the centroid of the end section along a principal axis.

Torsion of a circular shaft, Torsion of cylindrical bars. Torsional rigidity. Torsion and stress functions. Lines of shearing stress. Simple problems of torsion of bars having circle, ellipse and equilateral triangle cross-section. Circular groove in a circular shaft,Torsion of a shaft of varying circular cross-section.

Unit-II (2 Questions)

Generalized plane stress. Airy stress function for plane strain problems. General solutions of a Biharmonic equation using fourier transform and in terms of two analytic functions. Stresses and displacements in terms of complex potentials. Thick walled tube under external and internal pressures. Rotating shaft.

Unit-III (2 Questions)

Simple harmonic progressive waves, scalar wave equation and its progressive type solutions, plane waves, cylindrical waves, spherical waves, stationary type solutions in Cartesian and cylindrical coordinates.

Propagation of waves in an unbounded isotropic elastic solid. P-, SV- and SH-waves. Wave propagation in two-dimensions. Elastic surface waves such as Rayleigh and Love waves.

Unit-IV (2 Questions)

Variational problem related to biharmonic equation. Ritz method-one dimensional and two-dimensional cases, Galerkin methods and its applications to torsion of beams and deformation of plates,method of Kantorovich ,Trfftz methods and its application for upper bound, for the torsional rigidity of beam,Rafalson method for the biharmonic equation.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. I.S. Sokolnikoff - Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. C.A. Coulson - Waves,Longman.
3. Teodar M. Atanackovic and Ardeshiv Guran - Theory of Elasticity for Scientists and Engineers Birkhausev, Boston, 2000.
4. A.S. Saada - Elasticity: Theory and applications, Pergamon Press, New York.
5. A. Udias - Principles of Seismology,Cambridge University Press,1999.
6. P.M. Sheare r-I ntroduction to Seismology, Cambridge University Press,1999
7. Mal A.K. and S.J. Singh - Deformation of Elastic Solids,Printice-Hall.
8. Allan F. Bowen - Applied Mechanics of Solids,C R C Press,NY,2010

(w.e.f. 2018-19)

12MHM523 :Harmonic Analysis

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand Fourier series, Fourier transformations, Fourier Stieltjes coefficients and Herglotz's theorem.

CO2 Learn about summability, pointwise summability, Minkowski's theorem and the Plancherel theorem.

CO3 Familiar with Poisson summation formula, finite cyclic groups and Gaussian's sums.

CO4 Demonstrate theorem of Hardy and Littlewood, Hilbert's inequality and Hardy spaces on the line.

CO5 Describe the conjugate function as a singular integral, maximal functions, Rademacher functions and absolute Fourier multipliers.

Section-I (2 Questions)

Fourier series and some special kernals, Fourier transforms and its properties, Convolution theory, Approximate identities, Plancherel's theorem, Harnack's Theorem, Mean value property.

Section -II (2 Questions)

Summability of Fourier series, Fourier series of $f \in L^2(T)$, Bessel's inequality, Riemann-Lebesgue lemma, Best approximation theorem, Parseval's Theorem, Poisson integral of a measure, Boundary behavior of Poisson integrals, Maximal functions, Non-tangential limits.

Section-III (2 Questions)

Subharmonic functions in upper half-plane, Hardy Spaces H^p over the unit disc, H^p as a Banach space, Boundary behavior of Hardy Space over the upper half-plane, Canonical factorization, Cauchy integrals , Paley- Wiener theorem.

Section–IV (2 Questions)

Blaschke product and its properties, Theorem of F and M Riesz, Inner and outer functions.Trigonometric Series, Conjugate Functions, Theorem of M. Riesz, Kolomogrov Theorem, Zygmund Theorem, Hardy- Littlewood Theorem.

Note : The question paper of each course will consist of **five** Sections. Each of the sections **I to IV** will contain **two** questions and the students shall be asked to attempt **one** question from each. **Section-V** shall be **compulsory** and will contain **eight** short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:

1. Peter L. Duren : Theory of H^p Spaces, Academic Press.
2. Walter Rudin : Real and Complex Analysis, Third Edition, Mc Graw Hill Book Co.
3. J.B. Carnett : Bounded Analysis Functions, Academic Press.
4.Y. Katznelson : An Introduction to Harmonic Analysis, John Wiley, 1968.
5. R. Lasser : Introduction to Fourier Series, Marcel Dekker.

6. K. Hoffman : Banach Spaces of Analytic Functions, New York.

(w.e.f. 2018-19)

12MHM524 : C_1 :Algebraic Number Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Learn the arithmetic of algebraic number fields.
CO2 Prove theorems for integral bases and unique factorization into ideals.
CO3 Factorize an algebraic integer into irreducibles.
CO4 Obtain the ideals of an algebraic number ring.
CO5 Understand ramified and unramified extensions and their related results.

Unit -I (2 Questions)

Algebraic Number and Integers : Gaussian integers and its properties. Primes and fundamental theorem in the ring of Gaussian integers. Integers and fundamental theorem in $Q(\omega)$ where $\omega^3 = 1$. Algebraic fields. Primitive polynomials. The general quadratic field $Q(\sqrt{m})$, Units of $Q(\sqrt{2})$. Fields in which fundamental theorem is false. Real and complex Euclidean fields. Fermat'' theorem i the ring of Gaussian integers. Primes of $Q(\sqrt{2})$ and $Q(\sqrt{5})$. (Relevant sections of Recommended Book at Sr. No. 2).

Unit -II (2 Questions)

Countability of set of algebraic numbers, Liouville's theorem and generalizations, transcendental numbers, algebraic number fields, Liouville's Theorem of Primitive elements, ring of algebraic integers, Theorem of Primitive Elements(Chapter 3 of book at Sr. No. 1).

Unit -III (2 Questions)

Norm and trace of an algebraic number, non degeneracy of bilinear pairing, existence of an integral basis, Discriminant of an algebraic number field, Ideals in the ring of algebraic integers, explicit construction of integral basis, Sign of the discriminant, cyclotomic fields, calculation for quadratic and cubic cases (Chapter 4 of book at Sr. No. 1).

Unit -IV (2 Questions)

Integral closure, Noetherian ring, characterizing Dedekind domains, fractional ideals and unique factorization, g.c.d. and L.C.M. of Ideals, Chinese remainder theorem, Dedekind's theorem, ramified and unramified extensions. Different of an algebraic number field, factorization in the ring of algebraic integers (Chapter 5 of book at Sr. No. 1).

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Esmonde and M Ram Murty, Problems in Algebraic Number Theory, GTM Vol. 190, Springer Verlag, 1999.
2. Hardy, G.H. and Wright, E.M., An Introduction to the Theory of Numbers

3. Leveque, W.J., Topics in Number Theory – Vols. I, III Addition Wesley.
4. Narasimhan and others, Algebraic Number Theory, TIFR Pamphlet No. 4
5. Pollard, H., The Theory of Algebraic Number, Carus Monogrpah No. 9, Mathematical Association of America.
6. Riebenboim, P., Algebraic Numbers – Wiley Inter-science.
7. Weiss, E., Algebraic Number Theory, McGraw Hill.

(w.e.f. 2018-19)

12MHM524 : C_2 : Bases in Banach Spaces

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Learn about the coefficient functionals associated to a basis, Hamel bases, Schauder bases, normalized bases and their properties.

CO2 Get familiar with Biorthogonal systems, associated sequences and Banach space.

CO3 Describe the concept of linear independence of sequences and problem of uniqueness of basis

CO4 Demonstrate the ideas of strong duality, Schauder bases, weak* bases and shrinking bases.

Unit-I (2Questions)

Hamel bases. The coefficient functionals associated to a basis. Schauder bases. Bounded bases and normalized bases. Examples of bases in concrete Banach spaces.

Unit-II (2Questions)

Biorthogonal systems. Associated sequences of partial sum operators -E-complete, regular and irregular biorthogonal systems. Characterizations of regular biorthogonal systems. Basic sequences. Banach space (separable or not) and basic sequence.

Unit-III (2Questions)

Some types of linear independence of sequences - Linearly independent (finitely) W-linearly independent and minimal sequences of elements in Banach spaces. Their relationship together with examples and counter-examples.

Problem of uniqueness of basis - Equivalent bases, Stability theorems of Paley-Winer type. Block basic sequences with respect to a sequence (basis) and their existence. Bessaga-Pelczynski theorem.

Unit-IV (2 Questions)

Properties of strong duality. Weak bases and weak Schauder bases in a Banach space. Weak basis theorem. Weak* bases in conjugate spaces and their properties.

Shrinking bases and boundedly complete bases together with their relationship.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books recommended :

1. Jurg t. Marti, Introduction to Theory of Bases, Springer Tracts in Natural Philosophy 18, 1969.
2. Ivan Singer, Bases in Banach Spaces I, Springer-Verlag, Berlin, Vol. 154 1970.
3. Ivan Singer, Bases in Banach Spaces II, Springer-Verlag, Berlin, 1981.
4. J. Linderstrauss and I. Tzafriri, Classical banach Spaces (Sequence spaces), Springer Verlag, Berlin, 1977.

5. Ivan Singer, Best Approximation in Normed Linear Spaces by Elements of Linear Spaces, Springer-Verlag, Berlin, 1970.

(w.e.f. 2018-19)

12MHM524 : C_3 : Theory of Linear Operators

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Learn about the compact linear operators on normed spaces and operator equations involving compact linear operators.

CO2 Understand the spectral representation of bounded self adjoint linear operators, extension of the spectral theorem to continuous functions.

CO3 Learn about the spectral representation of unitary operators and self adjoint operators.

CO4 Describe the concept of Fredholm alternative for integral equations.

Unit-I (2 Questions)

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

Unit-II (2 Questions)

Elementary theory of Banach algebras. Properties of Banach algebras. General properties of compact linear operators. Spectral properties of compact linear operators on normed spaces.

Unit-III (2 Questions)

Behaviour of compact linear operators with respect to solvability of operator equations. Fredholm type theorems. Fredholm alternative theorem. Fredholm alternative for integral equations. Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space.

Unit-IV (2 Questions)

Positive operators, Monotone sequence theorem for bounded self-adjoint operators on a complex Hilbert space. Square roots of a positive operator. Projection operators, Spectral family of a bounded self-adjoint linear operator and its properties.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. E. Kreyszig, Introductory Functional Analysis with Applications, John-Wiley & Sons, New York, 1978.
2. P.R. Halmos, Introduction to Hilbert Space and the Theory of Spectral Multiplicity, Second-Edition, Chelsea Publishing Co., New York, 1957.
3. N. Dunford and J.T. Schwartz, Linear Operators -3 Parts, Interscience/Wiley, New York, 1958-71.
4. G. Bachman and L. Narici, Functional Analysis, Academic Press, York, 1966.

(w.e.f. 2018-19)
12MHM524 : C_4 : Fuzzy Sets and Logic

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Describe relatively new paradigm fuzzy access to some part of the classical mathematics and logic.

CO2 Get knowledge about the need and relevance of fuzzy logic to develop computerized systems in medicine.

CO3 Combine some of the traditional design approaches with fuzzy-logic concepts and design fuzzy-logic based controllers and explore their unique characteristics.

CO4 Be familiar with modeling fuzzy sets, handling with arithmetic of fuzzy quantities, and to acquire operations with fuzzy relations.

CO5 Understand the mechanism of fuzzy reasoning and the role of the essential models in fuzzy inference.

Unit-I (2 Questions)

Probability Theory, Probability Distribution, Comparison of Probability and Possibility, Fuzzy event, Crisp Probability of Fuzzy Event, Fuzzy Probability of Fuzzy Event, Uncertainty Level of Element, Fuzziness of Fuzzy Set, Measure of Fuzziness, Measure using Entropy, Measure using Metric Distance. (Chapter 7 of book at serial no. 1)

Unit-II (2 Questions)

Proposition Logic, Logic Function, Tautology and Inference Rule, Predicate Logic, Quantifier, Fuzzy Expression, Operators in Fuzzy Expression, Some Examples of Fuzzy Logic Operations, Linguistic Variable, Fuzzy Predicate, Fuzzy Modifier, Fuzzy Truth Values, Examples of Fuzzy Truth Quantifier, Inference and Knowledge Representation, Representation of Fuzzy Predicate by Fuzzy Relation, Representation of Fuzzy Rule. (Chapter 8,9 of book at serial no. 1)

Unit-III (2 Questions)

Extension Principle and Composition, Composition of Fuzzy Sets, Composition of Fuzzy Relation, Example of Fuzzy Composition, Fuzzy if-then Rules, Fuzzy Implications, Examples of Fuzzy Implications, Decomposition of Rule Base, Two- Input/ Single-Output Rule Base, Compositional Rule of Inference, Fuzzy Inference with Rule Base, Inference Methods, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method. (Chapter 8,9 of book at serial no. 1)

Unit-IV (2 Questions)

Advantage of Fuzzy Logic Controller, Configuration of Fuzzy Logic Controller, Choice of State Variables and Control Variables, Fuzzification Interface Component, Data Base, Rule Base, Decision Making Logic, Mamdani Method, Larsen Method, Tsukamoto Method, TSK Method, Mean of Maximum Method, Center of Area Method(COA), Bisector of Area, Lookup Table, Design Procedure of Fuzzy Logic Controller,

Application Example of FLC Design, Fuzzy Expert Systems. (Chapter 10 of book at serial no. 1)

Applications of Fuzzy Set Theory in Natural, Life and Social Sciences, Engineering, Medicine, Management and Decision Making, Computer Science, System Sciences. (Chapter 6 of book at serial no. 2)

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended:

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall of India Private Limited, New Delhi-110 001, 2005.
3. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
4. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education.

(w.e.f. 2018-19)

12MHM524 : C_5 : Sobolev Spaces

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Explain the concept of test function spaces and distributions, convergence distributional derivatives.

CO2 Define L^1-Fourier transform, Fourier transform of a Gaussian, L^2-Fourier transform, Inversion formula, L^p-Fourier transform and convolutions.

CO3 Learn about the spaces $W^{l,p}{}_\infty(\Omega)$, $W^{l,p}(\Omega)$ and their characteristic properties, density results.

CO4 Interpret the space $H^1(\Omega)$ and its properties, density results and imbedding theorems.

Unit-I (2 Questions)

Distributions – Test function spaces and distributions, convergence distributional derivatives.

Unit-II (2 Questions)

Fourier Transform – L^1-Fourier transform. Fourier transform of a Gaussian, L^2-Fourier transform, Inversion formula. L^p-Fourier transform, Convolutions.

Unit-III (2 Questions)

Sobolev Spaces - The spaces $W^{l,p}{}_\infty(\Omega)$ and $W^{l,p}(\Omega)$. Their simple characteristic properties, density results. Min and Max of $W^{l,p}$ – functions. The space $H^1(\Omega)$ and its properties, density results.

Unit-IV (2 Questions)

Imbedding Theorems - Continuous and compact imbeddings of Sobolev spaces into Lebesgue spaces. Sobolev Imbedding Theorem, Rellich – Kondrasov Theorem.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. R.A. Adams, Sobolev Spaces, Academic Press, Inc. 1975.
2. S. Kesavan, Topics in Functional Analysis and Applications, Wiley Eastern Limited, 1989.
3. A. Kufner, O. John and S. Fucik, Function Spaces, Noordhoff International Publishing, Leyden, 1977.
4. A. Kufner, Weighted Sobolev Spaces, John Wiley & Sons Ltd., 1985.
5. E.H. Lieb and M. Loss, Analysis, Narosa Publishing House, 1997.
6. R.S. Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House, 2001.

(w.e.f. 2018-19)

12MHM525 : D_1 :Bio-Fluid Dynamics

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Understand the basic concepts of physiological and biological fluid dynamics.

CO2 Know about the systematic and pulmonary circulations, specific flow properties of blood and identify diseases related to obstruction of blood flow in human body.

CO3 Get familiar with important models of bio-fluid flows and their applications to duct and pipe flows.

CO4 Able to describe non-Newtonian fluid flow models and peristaltic flows along with their applications in blood flow in human body.

Unit-I (2 Questions)

Basic concepts of fluid dynamics. Viscosity. Reynold's transport theorem. Continuity equation. Navier-Stokes equations of motion. Simplification of basic equations. Reynolds number of flows.

The cardiovascular system. The circulatory system. Systemic and pulmonary circulations. The circulation in the heart. Diseases related to circulation.

Unit-II (2 Questions)

Blood composition. Structure of blood. Viscosity of blood. Yield stress of blood. Blood vessel structure. Diseases related to obstruction of blood flow.

Flow in pipes and ducts. Developing and fully developed flow. Special characteristics of blood flow. Poiseuille's flow and its consequence. Applications of Poiseuille's law for the study of blood flow.

Unit-III (2 Questions)

Pulsatile flow in circular rigid tube and its quantitative aspects. The pulse wave. Mones-Korteweg expression for wave velocity in an inviscid fluid-filled elastic cylindrical tube and its applications in the cardiovascular system. Blood flow through artery with mild stenosis, expressions for pressure drop across the stenosis and across the whole length of artery, shear stress on stenosis surface.

Unit-IV (2 Questions)

Non-Newtonian fluids and their classification. Laminar flow of non-Newtonian fluids, Power-law model, Herschel-Bulkley model, Casson model. Peristaltic flows. Peristaltic motion in a channel, characteristic dimensionless parameters. Long-wavelength analysis. Flow in the renal tubule. Solutions when radial velocity at the wall decreases (i) linearly with z (ii) exponentially with z.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Jagan N. Mazumdar; Biofluid Mechanics, World Scientific Pub.

2. J.N. Kapur; Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd.
3. T.J. Pedley; The Fluid Mechanics of Large Blood Vessels, Cambridge Uni. Press, 1980.
4. M. Stanley; Transport Phenomenon in Cardiovascular System, 1972.
5. O'Neill, M.E. and Chorlton, F. , Viscous and Compressible Fluid Dynamics, Ellis Horwood Limited, 1989.
6. J. L. Bansal, Viscous Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 2000.

(w.e.f. 2018-19)

12MHM525 : D_2 :Programming Techniques

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Formulate goal programming models and solve them using graphical and simplex methods.

CO2 Explain the integer programming problems and Gomory's cutting plane method and branch & bound technique to solve them.

CO3 Understand various concepts of dynamic programming problems including shortest route problems and dynamic programming approach for solving linear programming problems.

CO4 Apply different optimization methods to the problems with equality and inequality constraints.

CO5 Discuss and solve separable, geometric and stochastic programming problems.

Unit-I (2 Questions)

Concepts of Goal Programming, Difference between linear programming and goal programming approach, Goal programming model formulation approach, Graphical and Simplex methods for solving goal programming problems.

Integer Programming, Types of integer programming problems, Gomory's cutting plane method and Branch and Bound technique for solving integer programming problems.

Unit-II (2 Questions)

Dynamic programming, Bellman's principle of optimality, Dynamic programming under certainty, shortest route problem, multiplicative separable return function and single additive constraint, additive separable return function and single additive constraint, additively separable return function and single multiplicative constraint, Dynamic programming approach for solving linear programming problem.

Unit-III (2 Questions)

Classical optimization methods, unconstrained optimization, constrained multivariable optimization with equality and inequality constraints.

The general non-linear programming problem and its solution by graphical method.

Unit-IV (2 Questions)

Quadratic programming, Kuhun-Tucker conditions, Wolfe's and Beale's methods.

Concepts, formulation and solution of Separable, Geometric and Stochastic programming problems.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books recommended:

1. Taha, H.A., Operation Research-An introduction, Tata McGraw Hill, New Delhi.
2. Gupta, P.K. and Hira, D.S., Operations Research, S. Chand & Co.

3. Sharma, S.D., Operations Research, Kedar Nath Ram Nath Publications.
4. Sharma, J.K., Operations Research, Mc Millan India Ltd.

(w.e.f. 2018-19)
12MHM525 : D_3 : Computational Fluid Dynamics

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Possess a good understanding of the basics of fluid mechanics and the governing equations of the fluid dynamics.

CO2 Learn the art of numerical methods employed in computational aspects of fluid dynamics and related applications.

CO3 Acquire a good knowledge of the mathematical concepts of the finite difference and finite volume discretizations.

CO4 Describe the major theories, approaches and the methodologies used in CFD along with their limitations on accuracy.

Unit-I (2 Questions)

Basic equations of Fluid dynamics. Analytic aspects of partial differential equations- classification, boundary conditions, maximum principles, boundary layer theory.

Unit-II (2 Questions)

Finite difference and Finite volume discretizations. Vertex-centred discretization. Cell-centred discretization. Upwind discretization. Nonuniform grids in one dimension.

Unit-III (2 Questions)

Finite volume discretization of the stationary convection-diffusion equation in one dimension. Schemes of positive types. Defect correction. Non-stationary convection-diffusion equation. Stability definitions. The discrete maximum principle.

Unit-IV (2 Questions)

Incompressible Navier-Stokes equations. Boundary conditions. Spatial discretization on collocated and on staggered grids. Temporal discretization on staggered grid and on collocated grid.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. P. Wesseling :Principles of Computational Fluid Dynamics, Springer Verlag, 2000**.**
2. J.F. Wendt, J.D. Anderson, G. Degrez and E. Dick : Computational Fluid Dynamics : An Introduction, Springer-Verlag, 1996.

3. J.D. Anderson, Computational Fluid Dynamics : The basics with applications, McGraw-Hill, 1995.
4. K. Muralidher and T. Sundarajan : Computational Fluid Flow and Heat Transfer, Narosa Pub. House.
5. T.J. Chung : Computational Fluid Dynamics, Cambridge Uni. Press.
6. J.N. Reddy : An introduction to the Finite Element Methods,McGraw Hill International Edition, 1985.

(w.e.f. 2018-19)

12MHM525 : D_4 :Information Theory

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Learn measure of information and axioms of measures of uncertainty

CO2 Define Shannon entropy; joint and conditional entropies, and derive proofs of their important properties.

CO3 Understand the noiseless coding, different codes and construction of optimal codes.

CO4 Analyse information processed by the channels and obtain channel capacity.

CO5 Derive fundamental theorem of information theory and its converse.

Unit-I (2 Questions)

Measure of information – Axioms for a measure of uncertainty, The Shannon entropy and its properties, Joint and conditional entropies, Transformation and its properties.

Unit-II (2 Questions)

Noiseless coding – Ingredients of noiseless coding problem, Uniquely decipherable codes, Instantaneous codes, Condition for uniquely decipherable and instantaneous codes. Noiseless Coding Theorem. Optimal codes, Construction of optimal codes. Huffman procedure, Shannon-Fano encoding procedure.

Unit-III (2 Questions)

Discrete Memoryless Channel: Classification of channels, information processed by a channel, Calculation of channel capacity, Decoding schemes, The ideal observer, The fundamental theorem of Information Theory and its strong and weak converses.

Unit-IV (2 Questions)

Some intuitive properties of a measure of entropy – Symmetry, normalization, expansibility, boundedness, recursivity, maximality, stability, additivity, subadditivity, nonnegativity, continuity, branching, etc. and interconnections among them.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended:

1. Robert Ash, Information Theory, Inter-Science Publishers, New York, 1965.
2. F. M. Reza, An Introduction to Information Theory, McGraw Hill Book Company Inc., 1961.
3. J. Aczel and Z. Daroczy, On Measures of Information and their Characterizations, Academic Press, New York, 1975.

(w.e.f. 2018-19)

12MHM525 : D_5 : Operating System and Internet

Time: 3 Hours **Max. Marks: 80**

Course Outcomes

Students would be able to:

CO1 Analyze the structure of operating system and basic architectural components involved in its design.

CO2 Get familiar with concepts of memory management including virtual memory and disk management.

CO3 Have knowledge of different types of operating systems including UNIX.

CO4 Understand the network structures, browsers and working of search engines.

CO5 Learn about social networking sites and video teleconferencing.

Unit - I (2 Questions)

Operating system overview: Operating systems classification, Operating systems and System calls, Operating systems architecture.

Process management functions: Process model, Hierarchies and implementation, Process states and transitions, Multiprogramming, Multitasking, Levels of schedulers and scheduling algorithms.

Unit - II (2 Questions)

Memory management function: Memory management of single user operating systems, Partition, Swapping, Paging, Segmentation, Virtual Memory. Device management function: I/O devices and controllers, Interrupt handlers.

Unit - III (2 Questions)

Linux Operating System: Introducing Linux, History of Linux, Distributions, Linux Kernel, Basic requirement of Linux installation, Drives in Linux.

File system Hierarchy, Linux Commands, Adding User and Groups Administration, File & Directory Permission & Security.

Unit - IV (2 Questions)

Internet Technology: Connecting to the Internet, Study of various Browsers, Email & MIME types, Searching Documents on Internet, Social Networking, Video teleconferencing, Search Engines.

Note : The question paper will consist of **five** units. Each of the first four units will contain **two** questions from unit **I , II , III , IV** respectivelyand the students shall be asked to attempt **one** question from each unit. Unit five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory**.

Books Recommended :

1. Milan Milankovic, Operating System, McGraw Hill.
2. Peterson and Solserchatz, Operating System Concepts, Addison Wesley.
3. Achyut S. Godbole, Operating System, Tata McGraw Hill.
4. H.M.I. Deitel, An Introduction to Operating Systems, Addison Wesley.

5. Ritchie. Operating System, BPB Publication.
6. Behrou A. Forouan, Data Communication & Networking, Tata Mc-Graw Hill
7. Andrew S. Tanenbaum, Computer Networks,
8. Nasib S. Gill, Essentials of computer and Network Technology, Khanna Book Publishing.

9. Publishing.