Scheme of Examination-Semester System
for
M.Sc.(Honours) Mathematics

(Only for the Deptt. of Mathematics, M.D.University, Rohtak)

(*w.e.f. Session 2011-12*)

SEMESTER-I

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

Syllabus- 1st SEMESTER

MHM 411 : Advanced Abstract Algebra

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM 412 : Measure and Integration Theory

Max. Marks : 80
Time : 3 hours

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.

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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.

MHM 413 : Complex Analysis

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

Justification for the existence of complex numbers, Lagrange's identity for complex numbers, Cauchy's inequality for complex numbers, Binomial equation,analytic geometry in complex form, Spherical representation, Polynomial and zeros, Ratational functions and poles, sequences, series, uniform convergence, Weierstrass M-test, power series, Abel theorem, Hadamand's formula, Abels's limit theorem, periodicity.
{Relevant topics from Chapter-1 and Chapter-2 of Ahlfor's book}

Unit - II (2 Questions)

Elementry point set topology-connectedness, compactness,continuous functions, arcs and closed curves, Jordan curves, analytic functions in regions, conformal mappings, length and area, linear group, cross-ratio, symmetry, oriented circles, family of curves, elementry conformal mappings, use of level curves, a survey of elementry mappings, elementry Riemann surfaces, Morera's and Liouville's theorems.
{Relevant topics from Chapter-3 of Ahlfor's book }

Unit - III(2 Questions)

Complex integration, line integrals, rectifiable arcs, line integrals as functions of arcs, Cauchy's theorem for a rectangle, Cauchy's theorem in a disk, the index of point w.r.t. a closed curve, Cauchy's integral formula, higher derivatives, removable singularities, Taylor's theorem, zeros and poles, the local mapping, the maximum principle.
{Relevant topics from Chapter-4 of Ahlfor's book}

Unit - IV (2 Questions)

Chains and cycles, simple connectivity, homology, the general statement of Cauchy's theorem, proof of Cauchy's theorem, Locally exact differentials, multiply connected regions, the residue theorem, the argument principle, evaluation of definite integrals, harmonic functions, mean-value property, Poisson's formula, Schwarz's theorem, the reflection principle, Weierstrass's theorem, Taylor series, Laurent series, classifaction of singularities.
{Relevent topics from Chapter-4 and Chapter-5 of Ahlfor's book}

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Books Recommended :

1. Complex Analysis, L.V.Ahlfors, Mc-Graw-Hill 1979.
2. Complex variable and Applications, R.V.Churchull and J.W.Brown, McGraw Hill, 1990.

MHM 414 : Differential Equations and Calculus of Variations

Max. Marks : 80
Time : 3 hours

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)

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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.

MHM 415(Opt(i)) : Mathematical Modelling

Max. Marks : 80
Time : 3 hours

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** 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. 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.

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

Max. Marks : 60
Time : 3 hours

Unit - I (2 Questions)

Different paradigms for problem solving, need for OOP, differences between OOP and Procedure oriented programming, Abstraction, Overview of OOP principles, Encapsulation, Inheritance and Polymorphism.

Unit - II (2 Questions)

C++ Basics: Structure of a C++ program, 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, Parameter passing, Default arguments, inline functions, Recursive functions, Pointers to functions. Dynamic memory allocation and deallocation operators-new and delete.

Unit - III (2 Questions)

C++ Classes And Data Abstraction: Class definition, Class structure, Class objects, Class scope, this pointer, Friends to a class, Static class members, Constant member functions, Constructors and Destructors, Dynamic creation and destruction of objects, Data abstraction, ADT and information hiding.

Polymorphism: Function overloading, Operator overloading, Generic programming-necessity of templates, Function templates and class templates.

Inheritance: Defining a class hierarchy, Different forms of inheritance, Defining the Base and Derived classes, Access to the base class members, Base and Derived class construction, Destructors.

Unit - IV (2 Questions)

Virtual Functions And Polymorphism: Static and Dynamic bindings, Base and Derived class virtual functions, Dynamic binding through virtual functions, Abstract classes, Implications of polymorphic use of classes, Virtual destructors.

C++ I/O: I/O using C functions, Stream classes hierarchy, Stream I/O, File streams and String streams, Overloading << & >> operators, Error handling during file operations, 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.

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Books Recommended :

1. I.S. Robert Lafore, Waite's 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's Outline Series, Tata Mc Graw Hill Pub. Co.

4.J.N. Barakaki, Object Oriented Programming using C++, Prentic Hall of India, 1996.

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(*w.e.f. Session 2011-12*)

SEMESTER-II

Paper Code	**Title of the Paper**	**Theory Marks**	**Internal-Assessment Marks**	**Practical**	**Total Marks**
MHM 421	Mathematical Analysis	80	20	-	100
MHM 422	Rings and Modules	80	20	-	100
MHM 423	General Topology	80	20	-	100
MHM 424	Classical Mechanics	80	20	-	100
MHM 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

Syllabus- 2nd SEMESTER

MHM421 : Mathematical Analysis

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM422 : Rings and Modules

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM423 : General Topology

Max. Marks : 80
Time : 3 hours

Unit - I (2 Questions)

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

Unit - II (2 Questions)

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.

Unit - III (2 Questions)

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, Convergence of filter in a product space, Compactness and filter convergence, Canonical way of converting nets to filters and vice versa, Stone-Cech compactification.

Unit - IV(2 Questions)

Covering of a space, Local finiteness, Paracompact spaces, 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** 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. 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.

MHM424 : Classical Mechanics

Max. Marks : 80
Time : 3 hours

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.

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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.

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

Max. Marks : 80
Time : 3 hours

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.

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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.

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

Max. Marks : 60
Time : 3 hours

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.

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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.

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(*w.e.f. Session 2011-12*)

SEMESTER-III

Paper Code	**Title of the Paper**	**Theory Marks**	**Internal-Assessment Marks**	**Practical**	**Total Marks**
MHM 511	Functional Analysis	80	20	-	100
MHM 512	Mechanics of Solids	80	20	-	100
MHM 513	Statistical Methods	80	20	-	100
MHM 514	One paper out of Group A	80	20	-	100
MHM 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	**B_1 :** Advanced Fluid Dynamics
A_2 : Fuzzy Set Theory	**B_2 :** Bio-Mechanics
A_3 : Analytical Number Theory	**B_3 :** Space Dynamics
A_4 : Wavelets	**B_4 :** Integral Equations and Boundary Value Problem
A_5 : Algebraic Topology	**B_5 :** Difference Equations

Syllabus- 3rd SEMESTER

MHM511 : Functional Analysis

Max. Marks : 80
Time : 3 hours

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** 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.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.

MHM-512 : Mechanics of solids

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM 513 : Statistical Methods

Max. Marks : 80
Time : 3 hours

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** 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 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.

MHM514 : A_1 : Automata Theory

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM514 : A_2 : Fuzzy Set Theory

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM514 : A_3 : Analytical Number Theory

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM514 : A_4 : Wavelets

Max. Marks : 80
Time : 3 hours

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 $L^1(R)$ and $L^2(R)$, 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** 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. 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).

MHM514 : A_5 : Algebraic Topology

Max. Marks : 80
Time : 3 hours

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 $f : E^n \to E^n$, 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** 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. 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.

MHM515 : B_1 : Advanced Fluid Dynamics

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM515 : B_2 : Biomechanics

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM515 : B_3 : Space Dynamics

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM515 : B_4 : Integral Equations and Boundary Value Problems

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM515 : B_5 : Difference Equations

Max. Marks : 80
Time : 3 hours

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** 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. 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-Semester System
for
M.Sc.(Honours) Mathematics

(Only for the Deptt. of Mathematics, M.D.University, Rohtak)

(*w.e.f. Session 2011-12*)

SEMESTER-IV

Paper Code	**Title of the Paper**	**Theory Marks**	**Internal-Assessment Marks**	**Practical**	**Total Marks**
MHM 521	Inner Product Spaces and Advanced Measure Theory	80	20		100
MHM 522	Applied Mechanics of Solids	80	20		100
MHM 523	Harmonic Analysis	80	20		100
MHM 524	One paper out of Group C	80	20		100
MHM 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

MHM521 : Inner Product Spaces and Advanced Measure Theory

Max. Marks : 80
Time : 3 hours

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** 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.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.

MHM522 : Applied Mechanics of Solids

Max. Marks : 80
Time : 3 hours

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** 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. 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

MHM523 : Harmonic Analysis

Max. Marks : 80
Time : 3 hours

Unit-I (2 Questions)

The Fourier Series and Fourier Transform, Convolution; Approximate Identities; Fejer's Theorem, Unicity Theorem; Parseval relation; Fourier Stieltjes Coefficients; The Classical Kernals, Summability; metric theorems, Pointwise Summability, Positive definite Sequences; Herglotz's Theorem,

Unit-II (2 Questions)

The inequality of Hausdorff and Young, Multiple Fourier series; Minkowski's Theorem.Fourier Integral, Kernals on R, The Plancherel Theorem, Another Convergence Theorem; The Poisson Summation Formula, Finite Cyclic Groups; Gaussian's Sums.

Unit-III (2 Questions)

Hardy Spaces on the unit circle, Invariant Subspaces, Factoring, Proof of the F. and M.Riesz theorem, Theorems of Beurling and Szego in multiplication operator,structure of inner functions, Theorem of Hardy and Littlewood,; Hibert's inequality,Hardy spaces on the line.

Unit-IV (2 Questions)

Conjugate functions, Theorems of Kolmogorov and Zygmund, Theorems of M. Riesz and Zygmund, The conjugate function as a singular integral, the Hilbert transform, Maximal functions, Rademacher functions, absolute fourier multipliers.

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. Henry Helson, Harmonic Analysis, Addison-Wesley 1983, second edition, Hindustan pub. Corp., 1994.
2. E. Hewitt and K.A. Ross, Abstract Harmonic Analysis vol. 1, 4^{th} Edition, Springer-verleg, 1993.
3. Y. Katznelson, An introduction to Harmonic Analysis, John Wiley, 1968.
4. P.Koosis, Introduction of H^P spaces. Cambridge Univ. Press.

MHM524 : C_1 : Algebraic Number Theory

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM524 : C_2 : Bases in Banach Spaces

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM524 : C_3 : Theory of Linear Operators

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM524 : C_4 : Fuzzy Sets and Logic

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM524 : C_5 : Sobolev Spaces

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM525 : D_1 : Bio-Fluid Dynamics

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM525 : D_2 : Programming Techniques

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM525 : D_3 : Computational Fluid Dynamics

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM525 : D_4 : Information Theory

Max. Marks : 80
Time : 3 hours

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** 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. 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.

MHM525 : D_5 : Operating System and Internet

Max. Marks : 80
Time : 3 hours

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** 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. 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.