Approved by the Vice-Chancellor U/s 11(7) of University Act, 2014

Scheme of Examination of
M.Sc. Mathematics
Semester-1
(w.e.f. Session 2018-19)

Choice Based Credit System (CBCS)

Course Code	Title of the Course	Theory Marks	Internal Marks	Practical Marks
MM11	Advanced Abstract Algebra-I	80	20	--
MM12	Real Analysis-I	80	20	--
MM13	Topology-I	80	20	--
MM14	Ordinary Differential Equations -I	80	20	--
MM15	Programming in C	60	-----	40

Note 1 : The Criteria for awarding internal assessment of 20 marks shall be as under-

A) Class Test : 10 marks
B) Assignment & Presentation : 5 marks
C) Attendance : 5 marks

Less than 65% : 0 marks
Up to 70% : 2 marks
Up to 75% : 3 marks
Up to 80% : 4 marks
Above 80% : 5 marks

Note 2 : The syllabus of each course will be divided into four sections of two questions each. The question paper of each course will consist of five sections. Each of the sections 1 to IV will contain two questions and the students shall be asked to attempt one question from each. Section V shall be compulsory and contain eight short answer type questions without any internal choice covering the entire syllabus.

Syllabus SEMESTER-I

MM11: Advanced Abstract Algebra-I

Credits : 5:1:0

Max. Marks : 80

Time : 3 hours

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.

Section-I

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

Section—II

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 and pq, where p and q are distinct primes (In general survey of groups upto order 15)

Section-III

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

Section-IV

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.

Books Recommended :

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Combridge University Press, Indian Edition, 1997.
2. N. Jacobson, Basic Algebra, Vol. I & II, W.H. Freeman, 1980, 1980 (also published by Hindustan Publishing Company).
3. M. Artin, Algebra, Prentice-Hall of India, 1991.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol. I –Groups, Vol. III-Modules, Narosa Publishing House (Vol.I-2013, Vol.III -2013).
5. D.S. Malik, J.N. Mordenson, and M. K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
6. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
7. Charles Lanski, Concepts in Abstract Algebra American Mathematical Society First Indian Edition, 2010.
8. C. Musili, Introduction to Rings and Modules, Narosa Ppublication House, 1994.

MM12 : Real Analysis-I

Time : 3Hours **Credits : 5:1:0**

Max. Marks: 80

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.

Section - I

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

Section - II

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

Section - III

Power series, uniform convergence and uniqueness theorem, Abel theorem, Tauber theorem. Functions of several variables, Linear Transformations, Euclidean space R^n, Derivatives in an open subset of R^n, Chain Rule, Partial derivatives, Continuously Differentiable Mapping, Young and Schwarz theorems.

Section - IV

Taylor 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 multipliers method, Jacobian and its properties.

Books Recommended:

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International Student Edition.
2. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1974.
3. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
4. G. De Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd, 1976.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition, 2011.
7. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi, 2012.

MM- 13 : Topology – I

Time : 3 hours **Credits : 5:1:0**
Max. Marks : 80

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.

Section I

Statements only of (Axiom of choice. Zorn's lemma, Well ordering theorem and Continnum hypothesis).

Definition and examples of topological spaces, 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.

Base and subbase for a topology, Neighbourhood system of a point and its properties. Base for neighbourhood system.

Relative(Induced) topology, Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator.

Comparison of topologies on a set, Intersection and union of topologies on a set.

Section -II

Continuous functions, Open and closed functions. Homeomorphism, Tychonoff product topology, Projection maps, Characterization of Product topology as smallest topology, Contiunity of a function from a space into a product of spaces.

Connectedness and its characterization, Connected subsets and their properties, Centnuity and connectedness Connectedness and product spaces, Components, Locally connected spaces, Locally connected and product spaces.

Section-III

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, Product space as first axiom space, Lindelof theorem T_0 , T_1, T_2 (Hausdroff) separation axioms, their characterization and basic properties.

Section-IV

Compact spaces and subsets, Compactness in terms of finite intersection peoperty, Continuity and compact sets. Basic properties of compactness, Closedness of compact subset and a continuous map from a compact space into a Hausdorff and its consequence Sequentially and countably compact sets. Local compactiness, Compactness and product space. Tychonoff product theorem and one point compactification Quotient topology Continuity of function with domain a space having quotient topology, Hausdorffiness of quotient space.

Books Recommended

1. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd.
2. J.L. Kelly, General Topology Affiliated East West Press Pvt. Ltd., New Delhi.
3. J.R. Munkers, Topology Pearson Education Asia, 2002.

MM14: ORDINARY DIFFERENTIAL EQUATIONS-I

Time : 3 Hours **Credits : 5:1:0**

Max.Marks: 80

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.

Section -I

Initial-value problem and the equivalent integral equation, ε-approximate solution, Cauchy-Euler construction of an ε-approximate solution, Equicontinuous family of functions, Ascoli-Arzela theorem, Cauchy-Peano existence theorem. Uniqueness of solutions, Lipschitz condition, Picard-Lindelof theorem for local existence and uniqueness of solutions, solution of initial-value problems by Picard method.

Section -II

Approximate methods of solving first-order equations: Power Series Methods, Numerical Methods. Continuation of solutions, Maximum interval of existence, Extension theorem. Dependence of solutions on initial conditions and function. Matrix method for homogeneous first order systems, nth order equation (Relevant topics from the books by Coddington & Levinson, and by Ross).

Section -III

Total differential equations: Condition of integrability, Methods of Solution. Gronwall's differential inequality,Ccomparison theorems involving differential inequalities.

Section -IV

Zeros of solutions, Sturms separation and comparison theorems. Oscillatory and nonoscillatory equations, Riccati's equation and its solution, Pruffer transformation, Lagrange's identity and Green's formula for second-order equation, Sturm-Liouville boundary-value problems. properties of eigen values and eigen functions. (Relevant topics from the books by Birkhoff & Rota, and by Ross).

Referneces:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill , 2000.
2. S.L. Ross, Differential Equations, John Wiley & Sons.
3. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
4. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
5. G.F. Simmons, Differential Equations, Tata McGraw-Hill, 1993.
6. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
7. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub. 2001.
8. S.G. Deo. V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations. Tata McGraw-Hill, 2006.

MM 15 : PROGRAMMING IN C (ANSI FEATURES)

Time : 3 Hours

Max. Marks : 60
Credits :4:0:2

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.

Section – I

An overview of Programming, Programming Language, Classification. Basic structure of a C Program, C language preliminaries.

Operators and Expressions, Two's compliment notation, Bit - Manipulation Operators, Bitwise Assignment Operators, Memory Operators.

Section – II

Arrays and Pointers, Encryption and Decryption. Pointer Arithmetic, Passing Pointers as Function Arguments, Accessing Array Elements through Pointers, Passing Arrays as Function Arguments, Multidimensional Arrays. Arrays of Pointers, Pointers to Pointers.

Section – III

Storage Classes – Fixed vs. Automatic Duration. Scope. Global Variables. Definitions and Allusions. The register Specifier. ANSI rules for the Syntax and Semantics of the Storage-Class Keywords. Dynamic Memory Allocation.

Structures and Unions enum declarations. Passing Arguments to a Function, Declarations and Calls, Automatic Argument Conversions, Prototyping Pointers to Functions.

Section – IV

The C Preprocessors, Macro Substitution. Include Facility. Conditional Compilation Line Control.

Input and Output – Streams. Buffering. Error Handling. Opening and Closing a File. Reading and Writing Data. Selecting an I/O Method. Unbuffered I/O. Random Access. The Standard Library for I/O.

Books **Recommended :**

1. Peter A. Darnell and Philip E. Margolis, C: A Software Engineering Approach, Narosa Publishing House (Springer International Student Edition) 1993.
2. Samyel P.Harikison and Gly L. Steele Jr., C : A Reference Manual, Second edition, Prentice Hall, 1984.

3. Brian W. Kernighan & Dennis M. Ritchie, The C Programme Language, Second Edition (ANSI features), Prentice Hall 1989.
4. Balagurusamy E : Programming in ANSI C, Third Edition. Tata McGraw-Hill Publishing Co. Ltd.
5. Byron, S. Gottfried : Theory and Problems of Programming with C, Second Edition (Schaum's Outline Series), Tata McGraw-Hill Publishing Co. Ltd.
6. Venugopal K. R. and Prasad S. R. : Programming with C, Tata McGraw-Hill Publishing Co. Ltd.

PRACTICALS : Based on MM 15 : Programming in C (ANSI Features)

Max. Marks : 40

Time :4 Hours

Notes:

a) The question paper shall consist of **four** questions and the candidate shall be required to attempt any **two** questions.
b) The candidate will first write programs in C of the questions in the answer-book and then run the same on the computer, and then add the print-outs in the answer-book. This work will consist of 20 marks, 10 marks for each question.

The practical file of each student will be checked and viva-voce examination based upon the practical file and the theory will be conducted by external and internal examiners jointly. This part of the practical examination shall be of 20 marks.

Scheme of Examination of
M.Sc. Mathematics,

Semester-II

(w.e.f. Session 2018-19)

Course Code	Title of the Course	Theory Marks	Internal Marks	Practical Marks
MM21	Advanced Abstract Algebra-II	80	20	--
MM22	Real Analysis-II	80	20	--
MM23	Topology-II	80	20	--
MM24	Ordinary Differential Equations-II	80	20	--
MM25	Object Oriented Programming with C++	60	---	40
Foundation Elective				
To be Chosen from the pool of foundation electives provided by the University.				2
Open Elective				
To be Chosen from the pool of open electives provided by the university (excluding the open elective prepared by the Department of Mathematics).				3
Soft Core Courses for the students who will not opt for open elective.				
MM2SO1	Mathematics for Finance and Insurance	80	20	--	3:0:0
MM2SO2	Statistics through SPSS	40	--	60	1:0:2

Note 1 : The Criteria for awarding internal assessment of 20 marks shall be as under-

A) Class Test : 10 marks
B) Assignment & Presentation : 5 marks
C) Attendance : 5 marks

Less than 65% : 0 marks
Up to 70% : 2 marks
Up to 75% : 3 marks
Up to 80% : 4 marks
Above 80% : 5 marks

Note 2 : The syllabus of each course will be divided into four sections of two questions each. 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 contain eight short answer type questions without any internal choice covering the entire syllabus.

Syllabus SEMESTER-II

MM 21 : Advanced Abstract Algebra-II

Time : 3 Hours

Max. Marks : 80

Credits : 5:1:0

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.

Section - I

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

Section-II

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

Section-III

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.

Section-IV

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

Books **Recommended :**

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharys, 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. 1, 11 & 111, John Wiley & Sons, 1982, 1989, 1991.
5. I.S. Luther and I.B.S. Passi, Algebra, Vol. 1-Groups, Vol. 11-Rings, Narosa Publishing House (Vol. 1 – 1996, Vol. 11 -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 Delhi, 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- Vertag, 1999.

MM22: Real Analysis-II

Time : 3 HOurs

Credits : 5:1:0
Max Marks : 80

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.

Section - I

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.

Section - II

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 theorem, Lusin theorem, Convergence in measure and F. Riesz theorem. Almost uniform convergence.

Section - III

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 Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.

Section - IV

Vitali 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.

Books 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, 1976.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition, 2011.

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MM 23:Topology-II

Time : 3 Hours

Credits : 5:1:0
Max. marks:80

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.

Section-I

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 Hausdroff space, complete regularity, Complete normality, T_1 $_{3_2}$ and T_5 spaces, their characterization and basic properties.

Section-II

Nets : Nets in topological spaces, Convergence of nets, Hausdroffness 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 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.

Section - III

Covering of a space, Local finiteness, Paracompact spaces, Michaell theorem on characterization of paracompactness as normal space, A. H. Stone Theorem, Negata- Smirnov Metrization theorem.

Section-IV

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

Homotopy and Equivalence of paths, Fundamental groups, Simply connected spaces, Covering spaces, Fundamental group of circle and fundamental theorem of algebra.

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. Munkers, Topology, Pearson Education Asia, 2002.
5. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.

MM24 :ORDINARY DIFFERENTIAL EQUATIONS-II

Time : 3 Hours **Credits:5:0:1**

Max. Marks : 80

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.

Section-I

Linear systems, fundamental set and fundamental matrix of a homogeneous system. Wronskian of a system. Abel - Liouville formula, Adjoint systems, Reduction of the order of a homogeneous system.

Section-II

Systems with constant coefficients, Method of variation of constants for a non-homogeneous system, Periodic solutions, Floquet theory for periodic systems, Linear differential equations of order n, Lagrange's identity, Green's formula (Relevant topics from the book by Coddington and Levinson and by S.L.Ross).

Section-III

Critical points and paths of non-linear systems: basic theorems and their applications. Liapunov function. Liapunov's direct method for stability of critical points of non-linear systems.

Limit cycles and periodic solutions: Limit cycle, existence and non-existence of limit cycles, Benedixson's non-existence criterion. Half-path or Semiorbit, Limit set, Poincare-Benedixson theorem. Index of a critical point.

(Relevant portions from the book 'Differential Equations' by S.L. Ross and the book 'Theory of Ordinary Differential Equations' by Coddington and Levinson)

Section-IV

Second order boundary value problems(BVP): Linear problems, periodic boundary conditions, regular linear BVP, singular linear BVP; non-linear BVP. Sturm-Liouville BVP: definitions, eigen value and eigen function. Orthogonality of functions, orthogonality of eigen functions corresponding to distinct eigen values. Green's function. Applications of boundary value problems. Use of implicit function theorem and Fixed point theorems for periodic solutions of linear and non-linear equations.

(Relevant portions from the book "Textbook of Ordinary Differential Equations' by Deo et al.)

References:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations. Tata McGraw-Hill, 2000.
2. S.L. Ross, Differential Equations, John Wiley & Sons.
3. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 2006.
4. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
5. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
6. G.F. Simmons, Differential Equations, Tata McGraw-Hill 1993.
7. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
8. D. Somasundaram, Ordinary Differential Equations. A first Course. Narosa Pub. 2001.

MM25: Object oriented Programming with C++

Time : 3 Hours **Credits : 4:0:1**

Max. Marks : 60

Note : The questions paper will consist of five sections. Each of the first four sections will contain two questions from unit 1, 11, 111, 1V respectively and the students shall be asks to attempt one question from each sections. Section five contain eight to ten short answer type questions without any internal choice covering the entire syllabus and shall be compulsory.

Section – I

Basic concepts of Object-Oriented Programming (OOP). Advantages and applications of OOP. Object-oriented languages. Introduction to C++. Structure of a C++ program. Creating the source files. Compiling and linking.

C++ programming basics: Input/output, Data types, Operators, Expressions, Control structures, Library functions.

Section-II

Functions in C++ : Passing arguments to and returning values from functions, Inline functions, Default arguments Function overloading.

Classes and objects : Specifying and using class and object, Arrays within a class, Arrays of objects, Object as a function arguments, Friendly functions, Pointers to members.

Section-III

Constructors and destructors. Operator overloading and type conversions.

Inheritance : Derived class and their constructs, Overriding member functions, Class hierarchies, Public and private inheritance levels.

Polymorphism, Pointers to object, this pointer, Pointers to derived classes, virtual functions.

Section-1V

Streams, stream classes , Unformatted I/O operations, Formatted console I/O operations, Managing output with manipulators.

Classes for file stream operations, Opening and Closing a file. File pointers and their manipulations, Random access. Error handling during file operations, Commandline arguments Exceptional handling.

Books **Recommended :**

1. I.S. Robert Lafore, Object Oriented Programming using C++. Waite's Group Galgotia pub.
2. E. Balagrusamy, Object Oriented Programming with C++, 2nd Edition, Tata McGraw Hill Pub. Co.
3. Byron, S. Gottfried, Object Oriented Programming using C++, Schaum's Outline Series, Tata McGraw Hill Pub. Co.
4. J.N. Barakaki, Object Oriented Programming using C++, Prentice Hall of India, 1996.
5. Deitel and Deitel, C++: How to program, Prentice Hall of India.

PRACTICALS: Based on MM 25: Object Oriented Programming with C++

Time : 4 Hours **Max. Marks : 40**

Notes:

a) The question paper shall consist of **four** questions and the candidate shall be required to attempt any **two** questions.

b) The candidate will first write programs in C of the questions in the answer-book and then run the same on the computer, and then add the print-outs in the answer-book. This work
will consist of 20 marks, 10 marks for each question.

c) The practical file of each student will be checked and viva-voce examination based upon the practical file and the theory will be conducted by external and internal examiners jointly. This part of the practical examination shall be of 20 marks.

MMSO1 : Mathematics for Finance and Insurance

Time: 03 Hours *Credits : 5:1:0*

Max Marks : 80

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.

Section - I

Financial Management – overview. Nature and scope of financial management. Goals 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.

Section - II

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 Single Index Model- Systematic Risk and Unsystematic Risk.

Section - III

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

Insurance Fundamentals – Insurance defined. Meaning of loss. Chances of loss, Peril, Hazard, 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.

Section - IV

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, Claims of reinsurance. Calculation of a compound claim density function F, Recursive and approximate formulae for F.

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 India Private Ltd.
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.

MM2SO2: Statistics through SPSS

Part-A (Theory)

Credits : 1:0:2

Time : 03 Hours *Max Marks : 40*

Section – I

Data: Qualitative and quantitative data, Cross-sectional and time series data, Univariate and multivariate data. Scales of measurement of data.

SPSS data file: Opening a data file in SPSS, SPSS Data Editor, Creating a data file, Editing and manipulating data, Missing values, Editing SPSS output, Copying SPSS output, Printing from SPSS, Importing data.

Section – II

Descriptive statistics with SPSS: Measures of central tendency, Dispersion, Skewness, Kurtosis.

Charts and graphs with SPSS: Frequencies, Bar charts, Pie charts, Line graphs, Histograms, Box plots.

Section – III

Statistical tests using SPSS: Normality tests, t-tests, F-test, One way and Two way ANOVA, Non-parametric tests- Chi Square, Spearman rank, Maan Whitney U and Wilcoxon signed rank test.

Section – IV

Correlation and regression using SPSS: Linear correlation and regression, Multiple regression.

Factor analysis using SPSS.

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. S.L. Gupta and H. Gupta, SPSS for Researchers, International Book House Pvt. Ltd.
2. A. Field, Discovering Statistics using SPSS, SAGE Publications.
3. V. Gupta, SPSS for Beginners, VJ Books Inc.
4. A. Rajathi and P. Chandran, SPSS for you, MJP Publishers

Part-B (Practical)

Time: 03 Hours

Max Marks : 60

There will be a separate practical course based on the above theory course. All practicals are required to be done using SPSS (i.e. **MM2SO2: Statistics through SPSS).**

Scheme of Examination of

M.Sc. Mathematics, Semester-III

(w.e.f. Session 2018-19)

Course Code	Title of the Course	Theory Marks	Internal Marks	Practical Marks	Credit (L:T:P)
Hard Core					
MM-3H1	Functional Analysis-I	80	20	--	5:1:0
MM-3H2	Partial Differential Equations & Mechanics	80	20	--	5:1:0
MM-3H3	Complex Analysis	80	20	--	5:1:0
Soft Core					
Group A (Any One)					
MM-3SA1	Integral Equations and calculus of variations	80	20	--	
MM-3SA2	Mathematical Modeling	80	20	--	
MM-3SA3	Linear Programming	80	20	--	
MM-3SA4	Number Theory	80	20	--	
MM-3SA5	Elasticity				
Group B (Any One)					
MM-3SB1	Mathematical Statistics	80	20	---	
MM-3SB2	Fluid Dynamics	80	20	--	
MM-3SB3	Algebraic Coding Theory	80	20	--	
MM-3SB4	Fuzzy Set Theory-I	80	20	--	
MM-3SB5	Commutative Algebra	80	20	--	

Open Elective	
To be Chosen from the pool of open electives provided by the university (excluding the open elective prepared by the Department of Mathematics).	3

Soft Core Courses for the students who will not opt for open elective. These courses also be taken as open elective by the students of other departments (Choose any one)					
MM3SO1	Vedic Mathematics	80	20	--	3:0:0

Total Credits : 31

Note 1 : The Criteria for awarding internal assessment of 20 marks shall be as under:

A) Class test : 10 marks.

B) Assignment & Presentation : 5 marks

C) Attendance : 5 marks

Less than 65% : 0 marks

Upto 70% : 2 marks

Upto 75% : 3 marks

Upto 80% : 4 marks

Above 80% : 5 marks

Note 2 : The syllabus of each course will be divided into **four** Sections of **two** questions each. 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 contain **eight** short answer type questions without any internal choice covering the entire syllabus.

Note 3 : Elective courses can be offered subject to availability of requisite resources/ faculty.

SEMESTER-III

MM-3H1 **Functional Analysis-I**

Credits : 5:1:0 **Time : 3 Hours**

Max. Marks : 80

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.

Section -I

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 lp, Lp, Rn, Cn and C a,b. Incomplete normed spaces.

Section -II

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).

Section – III

Riesz Representation theorem for bounded linear functional on Lp 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.

Section -IV

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 5 operators, compactness of the limit of the sequence of compact operators, the closed range theorem.

Books Recommanded

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.

SEMESTER-III

MM3H2 Partial Differential Equations and Mechanics

Credits : 5:1:0 **Time : 3 Hours**

Max. Marks : 80

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.

Section – I

Methods of separation of variables to solve B.V.P. associated with one dimensional heat equation. Solution of two dimensional heat equation and two dimensional Laplace equation. Steady state temperature in a rectangular plate, in the circular disc, in a semi-infinite plate. The head equation in semi-infinite and infinite regions. Temperature distribution in square plate and infinite cylinder. Solution of three dimensional Laplace equation in Cartesian, Cylindrical and spherical coordinates. Dirichlets problem for a solid sphere. (Relevant topics from the book by O" Neil)

Section – II

Method of separation of variables to solve B.V.P. associated with motion of a vibrating string. Solution of wave equation for Semi-infinite and infinite strings. Solution of wave equation in two dimensions. Solution of three dimensional wave equation in Cartesian, cylindrical and spherical coordinates. Laplace transform transform solution of B.V.P.. Fourier transform solution of B.V.P. (Relevant topics from the books by O"Neil)

Section -III

Kinematics of a rigid body rotating about a fixed point, Euler's theorem, general rigid body motion as a screw motion, moving coordinates system-rectilinear moving frame, rotating earth. Two dimensional rigid body dynamics-problems illustrating the laws of motion and impulsive motion. (Relevant topics from the book of Chorlton).

Section-IV

Moments and products of inertia, angular momentum of a rigid body, principle axes and principal moment of intertia 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 rigid body. (Relevant topics from the book of Chorlton).

Books Recommended :

1.Sneddon, I.N. Elements of Partial Differential Equations, McGraw Hill, New York.
2. O'Neil, Peter V. Advanced Engineering Mathematics, ITP.
3. F. Chorlton Textbook of Dynamics, CBS Publishers, New Delhi
4. H.F. Weinberger A First Course in Partial Differential Equations, John Wiley & Sons.
5. M.D. Raisinghania Advanced Differential Equations, S. Chand & Co.

SEMESTER-III

MM -3H3 **Complex Analysis**

Credits : 5:1:0 **Time : 3 Hours**
Max. Marks : 80

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.

Section – I

Function of a complex variable, Continuity, Differentiability, Analysis functions and their properties, Cauchy-Riemann equations in certesian and polar coordinates, Power series, Radius of convergence, Differentiability of sum function of a power series, Branches of many valued functions with special reference of argz, logz and z^a.

Section – II

Path in a region, Contour, Complex intergration, Cauchy theorem, Cauchy integral formula, Extension of Cauchy integral formula for multiple connected domain, Poisson integral formula, Higher order derivatives, Complex integral as a function of its upper limit, Morera theorem, Cauchy inequality, Liouville theorem, Taylor theorem.

Section -III

Zeros of an analytic function, Laurent series, isolated singularities, Cassorati-Weierstrass theorem, Limit point of zeros and poles. Maximum modules principle, Schwarz lemma, Meromorphic functions, Argument principle, Rouche theorem, Fundamental theorem of algebra, Inverse function theorem.

Section – IV

Calculus of residues, Cauchy residue theorem, Evaluation of integrals of the types $\int_0^{2\pi} f(\cos\theta, \sin 0)d\theta$, $\int_{-\infty}^{\infty} f(x)dx$, $\int_0^{\infty} f(x) \sin mx\, dx$ and , $\int_0^{\infty} f(x) \cos mx\, dx$, Conformal mappings.

Space of analytical, functions and their completeness, Hurwitz theorem, Montel theorem, Riemann mapping theorem.

Books **Recommended** :

1. H.A. Priestly, Introduction to Complex Analysis, Clarebdon Press, Oxford, 1990.
2. J.B. Conway, Functions of One Complex Variable, Springer-Verlag, International-student Edition, Narosa Publishing House, 2002.

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, 1972.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
6. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company, 2009.
7. H.S. Kasana, Complex Variable Theory and Applications, PHI Learning Private Ltd, 2011.
8. Dennis G. Zill and Patrik D. Shanahan, A First Course in Complex Analysis with Applications, John Bartlett Publication, 2nd Edition, 2010.

SEMESTER-III

MM-3SA1 **Integral Equations and Calculus of Variations**

Credits : 5:1:0 **Time : 3 Hours**

Max. Marks : 80

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

Section-I

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

Section-II

Boundary value problems reduced to Fredholm integral equations. Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredhlom resolvent kernel as a ratio of two series. Fredhlom equations with separable kernels, Approximation of kernel by a separable kernel. Fredhlom Alternative, Non homogenous Fredhlom equations with degenerate kernels.

Section-III

Green's function. Use of method of variation of parameters to construct the Green's function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green's function, Orthogonal series representation of Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Reduction of a boundary value problem to a Fredhlom integral equation with kernel as Green's function. Hilbert-Schmidt theory for symmetric kernels.

Section-IV

Motivating problems of calculus of variations, Shortest distance Minimum surface of revolution, Branchistochrone problem, Isoperimetric problem, Geodesic Fundamental lemma of calculus of variations, Euler's equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints.

Books Recommended :

1. Jerri, A.J. Introduction to Integral Equations with Applications, A Wiley-Interscience Pub.
2. Kanwal, R.P. Linear Integral Equations, Theory and Techniques, Academic Press, New York.
3. Gelfand, J.M. and Fomin, S.V. , Calculus of Variations, Prentice Hall, New Jersy, 1963.
4. Weinstock, Calculus of Variations, McGraw Hall.
5. Abdul-Majid wazwaz, A first course in Intergral Equations, World Scientific Pub.
6. David, P and David, S.G. Stirling, Integral Equations, Combridge University Press.

SEMESTER-III

MM-3SA2 **Mathematical Modeling**

Time : 3 Hours

Credits :5:1:0

Max. Marks : 80

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

Section-I

The process of Applied Mathematics : mathematical modeling: need, techniques, classification and illustrative: mathematical modeling through ordinary differential equation of first order: qualitative solutions through sketching.

Section-II

Mathematical modeling in population dynamics, epidemic spreading and compartment models: mathematical modeling through systems of ordinary differential equations: mathematical modeling in economics, medicine, arm-race, battle.

Section-III

Mathematical modeling through ordinary differential equations of second order. Higher order (linear) models. Mathematical modeling through difference equations: Need, basic theory: mathematical modeling in probability theory, economics, finance, population dynamics and genetics.

Section-IV

Mathematical modeling through partial differential equations: simple models, mass-balance equations, variational principles, probability generating function, traffic flow problems, initial & boundary conditions.

Books recommended :

J.N. Kapur: Mathematical Modeling, Wiley Eastern Limited. 1990 (Relevant portions, mainly from Chapter 1 to 6.)

Recommended Text :

M.F. Atiyah, FRS and I.G. Macdonald — Introduction to Commutative Algebra (Addison-Wesley Publishing Company)

Reference Books:

1. N.S. Gopal Krishan, Oxonian Press Pvt. Ltd. — Commutative Algebra
2. Zariski, Van Nostrand Princeton (1958) — Commutative Algebra(Vol.I)

SEMESTER-III

MM-3SA3 **LINEAR PROGRAMMING**

Credits :5:1:0 **Time: 3 Hours**
Max. Marks : 80

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

Section – I

Simultaneous linear equations, Basic solutions, Linear transformations, Point sets, Lines and hyperplanes, Convex sets, Convex sets and hypeplanes, Convex cones, Restatement of the Linear programming problem, Slack and surplus variables, Preliminary remarks on the theory of the simplex method, Reduction of any feasible solution to a basic feasible solution, Definitions and notations regarding linear programming problems, Improving a basic feasible solution, Unbounded solutions, Optimality conditions, Alternative optima, Extreme points and basic feasible solutions.

Section – II

The simplex method, Selection of the vector to enter the basis, Degeneracy and breaking ties. Further development of the transformation formulas. The initial basic feasible solution-------artificial variables, Inconsistency and redundancy, Tableau format for simplex computations. Use of the tableau format, Conversion of a minimization problem to maximization problem, Review of the simplex method.

The two-phase method for artificial variables, Phase I, Phase II, Numerical examples of the two phase methods, Requirement space, Solutions space, Determination of all optimal solutions, Unrestricted variables, Charnes' perturbation method regarding the resolution of the degeneracy problem.

Section – III

Selection of the vector to be removed, Definition of b (€). Order of vectors in b(€), Use of perturbation technique with simplex tableau format, Geometrical interpretation of the perturbation method. The generalized linear programming problem, The generalized simplex method, Examples pertaining to degeneracy, An example of cycling.

Revised simplex method: Standard Form I, Computational procedure for Standard Form I, Revised simplex method: Standard Form II, Computational procedure for Standard Form II, Initial identity matrix for Phase I, Comparison of the simplex and revised simplex methods, The product form of the inverse of a non-singular matrix. Alternative formulations of linear programming problems.

Section – IV

Dual linear programming problems, Fundamental properties of dual problems, Other formulations of dual problems, Complementary slackness, Unbounded solution in the primal, Dual simplex algorithm, Alternative derivation of the dual simplex algorithm, Initial solution for dual simplex algorithm, The dual simplex algorithm; an example, geometric interpretations of the dual linear programming problem and the dual simplex algorithm. A primal dual algorithm, Examples of the primal-dual algorithm . Transportation problem, its formulation and simple examples.

Books :

1. G. Hadley : Linear Programming Narosa Publishing House (1995).
2. S.I. Gauss : Linear Programming : Methods and Applications (4th Edition) McGraw Hill, New York 1975.

SEMESTER-III

MM-3SA4 **Number Theory**

Credits :5:1:0

Time : 3 Hours
Max. Marks : 80

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

Section-I

The equation ax+by = c, simultaneous linear equations, Pythagorean triangles, assorted examples, ternary quadratic forms, rational points on curves.

Section-II

Elliptic curves, Factorization using elliptic curves, curves of genus greater than I, Farey sequences, rational approximations, Hurwitz theorem, irrational numbers, Geometry of Numbers, Blichfeldt's principle, Minkowski's Convex body theorem Lagrange's four square theorem.

Section-III

Euclidean algorithm, infinite continued fractions, irrational numbers, approximations to irrational numbers, Best possible approximations, Periodic continued fractions, Pell's equation.

Section-IV

Partitions, Ferrers Graphs, Formal power series, generating functions and Euler's identity, Euler's formula, bounds on P(n), Jacobi's formula, a divisibility property.

Recommended Text :

An Introduction to the Theory of Numbers Ivan Niven
Herbert S. Zukerman
Hugh L: Mongomery
John Wiley & Sons (Asia)Pte. Ltd.(Fifth Edition)

SEMESTER-III

MM-3SA5 **Elasticity** Time : 3 Hours
Max. Marks : 80

Credits : 5:1:0

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

Section-I

Tensor Algebra: Coordinates-transformation, Cartesian Tensor of different order. Properties of Tensor , Isotropic tensors of different orders and relation between them, Symmetric and skew symmetric tensors. Tensor invariants, Deviatoric tensors, Eigen-values and eigen-vectors of a tensor. Tensor Analysis: Scalar, vector, tensor functions, Comma notation, Gradient, divergence and curl of a vector/ tensor field. (Relevant portions of Chapters 2 and 3 of book by D.S. Chandrasekharaiah and L Debnath)

Section-II

Analysis of Strain : Affine transformation, Infinitesimal affine deformation, Geometrical Interpretation of the component of strain. Strain quadric of Cauchy, Principal strains and invariance, General infinitesimal deformation. Saint-Venant's equations of compatibility, Finite deformations.

Analysis of Stress : Stress Vecotr, Stress tensor, Equations of equilibrium, Transformation of coordinates.

(Relevant portion of Chapter I & II of books by I.S. Sokolnikoff).

Section-III

Stress quadric of Cauchy, Principal stress and invariants. Maximum normal and shear stresses. Mohr's circles, examples of stress. Equations of Elasticity : Generalised Hooks Law, Anisotropic symmetries, Homogeneous isotropic medium.

(Relevant portion of Chapter II & III of book by I.S. Sokolnikoff).

Section-IV

Elasticity moduli for Isotropic media. Equilibrium and dynamics equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's Law, Uniqueness of solution. Beltrami-Michell compatibility equations. Clapeyrom's theorem. Saint-Venant's principle.

Relevant portion of Chapter III of book by I.S. Sokolnikoff)

Books:

1. I.S. Sokolnikoff. Mathematical Theory of Elasticity, Tata-McGraw Hill Publishing Company Ltd. New Delhi, 1977.
2. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
3. Y.C. Fung, Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
4. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994.
5. Shanti Narayan, Text Book of Certesian Tensor, S. Chand & Co., 1950.
6. S. Timeshenki and N. Goodier. Theory of Elasticity, McGraw Hill, New York, 1970.
7. I.H. Shames, Introduction to Solid Mechanicw, Prentice Hall, New Delhi, 1975.

SEMESTER- III

Mathematical Statistics

MM-3SB1

Credits :5:1:0

Max .Marks: 80
Time : 3 Hours

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.

Section-I

Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Section-II

Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions.

Mathematical expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties.

Section-III

Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties.

Continuous distributions: Uniform, Exponential and Normal distributions with their properties.

Section - IV

Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors.

Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions.

Books recommended :

1. V. Hogg and T. Craig, Introduction to Mathematical Statistics , 7th addition, Pearson Education Limited-2014
2. A.M. Mood, F.A. Graybill, and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill Book Company.
3. J.E. Freund, Mathematical Statistics, Prentice Hall of India.
4. M. Speigel, Probability and Statistics, Schaum Outline Series.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

SEMESTER-III

MM-3SB2 **Fluid Dynamics**

Credits : 5:1:0 **Time: 03 Hours**

Max Marks : 80

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.

Section-I

Kinematics - Velocity at a point of a fluid. Eulerian and Lagrangian methods. Stream lines, path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vorticity and circulation. Equation of continuity. Boundary surfaces. Acceleration at a point of a fluid. Components of acceleration in cylindrical and spherical polar co-ordiantes.

Section-II

Pressure at a point of a moving fluid. Euler equation of motion. Equations of motion in cylindrical and spherical polar co-ordinates.

Bernoulli equation. Impulsive motion. Kelvin circulation theorem. Vorticity equation. Energy equation for incompressible flow. Kinetic energy of irrotational flow. Kelvin minimum energy theorem. Kinetic energy of infinite fluid. Uniqueness theorems.

Section-III

Axially symmetric flows. Liquid streaming part a fixed sphere. Motion of a sphere through a liquid at rest at infinity. Equation of motion of a sphere. Kinetic energy generated by impulsive motion. Motion of two concentric spheres.

Three-dimensional sources, sinks and doublets. Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface.

Section - IV

Two dimensional motion; Use of cylindrical polar co-ordinates. Stream function. Axisymmetric flow. Stoke stream function. Stoke stream function of basic flows.

Irrotational motion in two-dimensions. Complex velocity potential. Milne-Thomson circle theorem. Two-dimensional sources, sinks, doublets and their images. Blasius theorem.

Books Recommended:

1. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
2. T. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
3. O Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.
4. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
5. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

SEMESTER-III

MM-3SB3 **Algebraic Coding Theory**

Credits : 5:1:0

Time : 3 Hours
Max. Marks : 80

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.

Section-I

Block codes. Minimum distance of a code. Decoding principle of maximum likelihood. Binary error detecting and error correcting codes. Group codes. Minimum distance of a group code (m, m+1) parity check code. Double and triple repition codes. Matrix codes. Generator and parity check matrices. Dual codes. Polynomial codes. Exponent of a polynomial over the binary field. Binary representation of a number. Hamming codes. Minimum distance of a Hamming code. (Chapter 1,2, 3 of the book given at Sr. No. 1).

Section-II

Finite fields. Costruction of finite fields. Primitive element of a finite field. Irreducibility of polynomials over finite fields. Irreducible polynomials over finite fields. Primitive polynomials over finite fields. Automorphism group of GF (q^n). Normal basis of GF(q^n). The number of irreducible polynomials over a finite field. The order of an irreducible polynomials. Generator polynomial of a Bose-Chaudhuri-Hocqhenghem codes (BCH codes) construction of BCH codes over finite fields.(Chapter 4 of the book given at Sr. No. 1 and Section 7.1 to 7.3 of the book given at Sr. No. 2).

Section-III

Linear codes. Generator metrices of linear codes. Equivalent codes and permutation matrices. Relation between generator and parity-check matrix of a linear codes over a finite field. Dual code of a linear code. Self dual codes. Weight distribution of a linear code. Weight enumerator of a linear code. Hadamard transform. Macwilliams identity for binary linear codes.

Section-IV

Maximum distance separable codes. (MDS codes). Examples of MDS codes. Characterization of MDS codes in terms of generator and parity check matrices. Dual code of a MDS code. Trivial MDS codes. Weight distribution of a MDS code. Number of code words of minimum distance d in a MDS code. Reed Solomon codes. (Chapter 5 & 9 of the book at Sr. No. 1).

Books :

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Part-11 CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text-book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
3. Michael E.O. Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics , John Wiley & Sons, 1986.
4. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.
5. A.J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics Springer-Verlag, New York, 1993.
6. L.D. Landau and E.M. Lipschitz, Fluid Mechanics Pergamon Press, London, 1985.
7. H. Schlichting, Boundary Layer Theory, McGraw Hill Book Company, New York, 1979.
8. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
9. A.D. Young, Boundary Layers, AIAA Education Series, Washington DC, 1989.
10. S. w. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Ltd., New Delhi, 1976.

SEMESTER-III

MM-3SB4 **Fuzzy Set Theory-I**

Time : 3 Hours

Credits : 5:1:0

Max. Marks : 80

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.

Section-I

Fuzzy Sets: Basic definitions, α-cuts, strong α-cuts, level set of a fuzzy set, support of a fuzzy set, the core and height of a fuzzy set, normal and subnormal fuzzy sets, convex fuzzy sets, cutworthy property, strong cutworthy property, standard fuzzy set operations, standard complement, equilibrium points, standard intersection, standard union, fuzzy set inclusion, scalar cardinality of a fuzzy set, the degree of subsethood (Scope as in relevant parts of sections 1.3-1.4 of Chapter 1 of the book given at Sr. No,1)

Additional properties of α-cuts involving the standard fuzzy set operators and the standard fuzzy set inclusion. Representation of fuzzy sets, three basic decomposition theorems of fuzzy sets, Extension principle for fuzzy sets: the Zedah's extension principle, Images and inverse images of fuzzy sets, proof of the fact that the extension principle is strong cutworthy but not cutworthy (Scope as in relevant parts of Chapter 2 of the book mentioned at the end).

Section-II

Operators on fuzzy sets: types of operations, fuzzy complements, equilibrium of a fuzzy complement, equilibrium of a continuous fuzzy complement, first and second characterization theorems of fuzzy complements, fuzzy intersections (t-norms), standard fuzzy intersection as the only idempotent t-norm, standard intersection, algebraic product, bounded difference and drastic intersection as examples of t-norms, decreasing generator, the Pseudo-inverse of a decreasing generator, increasing generators and their Pseudo-inverses, conversion of decreasing generators and increasing generators to each other, characterization theorem of t-norms (statement only). Fuzzy unions (t-conorms), standard union, algebraic sum, bounded sum and drastic union as examples of t-conorms, characterization theorem of t-conorms (Statement only) (Scope as in relevant parts of section 3.1 to 3.4 of Chapter 3 of the book mentioned at the end).

Section- III

Fuzzy numbers, relation between fuzzy number and a convex fuzzy set, characterization of fuzzy numbers in terms of its membership functions as piecewise defined functions. Fuzzy cardinality of a fuzzy set using fuzzy numbers, arithmetic operators on fuzzy numbers, extension of standard arithmetic operations on real numbers to fuzzy numbers, lattice of fuzzy numbers, (R, MIN, MAX) as a distributive lattice, fuzzy equations, equation A+X = B, equation A.X = B (Scope as in relevant parts of sections Chapter 4 of book mentioned at the end).

Section-IV

Fuzzy Relations: Crisp and fuzzy relations, projections and cylindrical extensions, binary fuzzy relations, domain, range and height of a fuzzy relation, membership matrices. Sagittal diagram, inverse of a fuzzy relation, composition of fuzzy relations, standard composition, max-min composition, relational join, binary relations on a single set, directed graphs, reflexive , irreflexive, antireflexive symmetric, asymmetric, antisymmetric, transitive (max-min transtitive), non transitive antitransitive fuzzy relations.

Fuzzy equivalence relations, fuzzy compatibility relations, α-compatibility class, maximal α-compatibles, complete α-cover, reflexive undirected graphs, fuzzy ordering relations, fuzzy upper bound, fuzzy pre ordering. Fuzzy weak ordering, fuzzy strict ordering, fuzzy morphisms.

(Scope of this section is as in the relevant parts of sections 5.1 to 5.8 of Chapter 5 of the book mentioned at the end).

Recommended Text :

G.J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications. Sixth Indian Reprint, Prentice Hall of India. New Delhi, 2002.

SEMESTER-III

MM-3SB5 **Commutative Algebra**

Credits :5:1:0

Time : 3 Hours

Max. Marks : 80

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.

Section-I

Zero divisors, nilpotent elements and units, Prime ideals and maximal ideals. Nil radical and Jacobson radical, Comaximal ideals, Chineese remainder theorem, Ideal quotients and annihilator ideals. Extension and contraction of ideals. Exact sequences. Tensor product of module Restriction and extension of scalars. Exactness property of the tensor product. Tensor products of algebras.

Section-II

Rings and modules of sections. Localization at the prime ideal P. Properties of the localization. Extended and contracted ideals in rings of fractions.

Primary ideals, Primary decomposition of an ideal, Isolated prime ideals, Multiplicatively closed subsets.

Section-III

Integral elements, Integral closure and integrally closed domains. Going-up theorem and the Going-down theorem, valuation rings and local rings, Noether's normalization lemma and weak form of nullstellensatz Chain condition, Noetherian and Artinian modules, composition series and chain conditions.

Section-IV

Noetherian rings and primary decomposition in Noetherian rings, radical of an ideal. Nil radical of an Artinian ring, Structure Theorem for Artinian rings, Discrete valuation rings, Dedekind domains, Fractional ideals.

(Scope of the course is as given in Chapter 1 to 9 of the Recommended text).

Hadamard matrices, Existence of a Hadamard matrix of order n. Hadamard codes from Hadamard matrices Cyclic codes. Generator polynomial of a cyclic code. Check polynomial of a cyclic code. Equivalent code and dual code of a cyclic code. Indecpotent generator of a cyclic code. Hamming and BCH codes as cyclic codes. Perfect codes. The Gilbert-varsha-move and Plotkin bounds. Self dual binary cyclic codes. (Chapter n 6 & 11 of the book given at Sr. No. 1)

Recommended Text :

1. L.R. Vermani : Elements of Algebraic Coding Theory (Chapman and Hall Mathematics)
2. Steven Roman : Coding and Information Theory (Springer Verlag)
3. A.C. Rencher, (2002), Methods of Multivariate Analysis, 2nd Ed., John Wiley & Sons.

वैदिक गणित का 6 माह का प्रमाण-पत्र पाठ्यक्रम

प्रश्नपत्र 1– वैदिक अंकगणित **अधिकतम अंकः 100**

इकाई 1– गुणा 20 अंक

कः एकाधिकेन पूर्वेण विधि (द्विअंकीय दो संख्याओं का गुणा)
खः एकन्यूनेन पूर्वेण विधि (त्रिअंकीय दो संख्याओं का गुणा)
गः ऊर्ध्वतिर्यग्भ्याम् विधि (त्रिअंकीय दो संख्याओं का गुणा)
घः मिश्रित गणना

इकाई 2 – भाग व विभाजकता 20 अंक

भाग
कः निखिलं नवतः चरमं दशतः विधि (भाजक द्विअंकीय संख्या)
खः परावर्त्य योजयेत् विधि (भाजक त्रिअंकीय संख्या)

विभाजकता
कः एकाधिकेन पूर्वेण विधि (भाजक द्विअंकीय संख्या)
खः एकन्यूनेन पूर्वेण विधि (भाजक द्विअंकीय संख्या)

इकाई 3 – लघुतम समापवर्त्य व महत्तम समापवर्तक 20 अंक

इकाई 4 – घात व मूल 20 अंक

घात
कः वर्ग (द्विअंकीय संख्या)
खः घन (द्विअंकीय संख्या)

मूल
कः वर्गमूल (संख्या 4 अंकीय)
खः घनमूल (संख्या 6 अंकीय)

इकाई 5 – भारतीय गणितज्ञों का योगदान 20 अंक
(अंकगणित के संदर्भ में)
कः आर्यभट
खः ब्रह्मगुप्त
गः महावीराचार्य
घः भारती कृष्ण तीर्थ

संदर्भग्रन्थः अध्याय सहित

1. वैदिक गणित निर्देशिका भाग–1, विद्या भारती अखिल भारतीय शिक्षा संस्थान, कुरुक्षेत्र
2. वैदिक गणित, मोतीलाल बनारसीदास, नई दिल्ली
3. वैदिक गणितःविहंगम दृष्टि–1, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
4. वैदिक गणित प्रणेता, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
5. वैदिक गणितः अतीत, वर्तमान एवं भविष्य, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
6. लीलावती, चौखम्भा विद्या भवन, वाराणसी

संदर्भदाताः

1. श्री बचु भाई रावल, अहमदाबाद
2. डॉ. महेन्द्र कुमार गोखरु, अजमेर
3. डॉ. अनन्त व्यवहारे, नागपुर
4. डॉ. कैलाश, राठ

प्रश्नपत्र 2– वैदिक बीजगणित अधिकतम अंकः 100

इकाई 1– गुणा (एक चर के द्विघातीय व्यंजक) 20 अंक

कः ऊर्ध्वतिर्यग्भ्याम् विधि

खः मिश्रित गणना

इकाई 2 – भाग व गुणनखण्ड 20 अंक

भाग (भाजक – एकचर एकघातीय व्यंजक)

गुणनखण्ड (एकचर द्विघातीय व्यंजक)

इकाई 3 – लघुतम समापवर्त्य व महत्तम समापवर्तक 20 अंक

इकाई 4 – समीकरणों के हल 20 अंक

इकाई 5 – भारतीय गणितज्ञों का योगदान 20 अंक

(बीजगणित के संदर्भ में)

कः वाराहमिहिर

खः भास्कराचार्य

गः नीलकण्ठ सोमैय्या

घः भारती कृष्ण तीर्थ

संदर्भग्रन्थः

1. वैदिक गणित निर्देशिका भाग–2, विद्या भारती अखिल भारतीय शिक्षा संस्थान, कुरुक्षेत्र
2. वैदिक गणित, मोतीलाल बनारसीदास, नई दिल्ली
3. वैदिक गणितः विहंगम दृष्टि–1, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
4. वैदिक गणित प्रणेता, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
5. वैदिक गणितः अतीत, वर्तमान एवं भविष्य, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
6. बीजगणितम्, चौखम्भा विद्या भवन, वाराणसी

संदर्भदाताः

1. डॉ. वीरेन्द्र कुमार गुप्त, उज्जैन
2. डॉ. सुशील कुमार बिरसु, अजमेर
3. श्री बचु भाई रावल, अहमदाबाद
4. डॉ. अनन्त व्यवहारे, नागपुर
5. डॉ. कैलाश, राठ

प्रश्नपत्र 3– वैदिक रेखागणित अधिकतम अंकः 100

इकाई 1– बौधायन त्रिक की अवधारणा 20 अंक
किसी कोण के त्रिक
किसी त्रिक में अचर का गुणा
कोटिपूरक कोण के त्रिक
दो कोणों के योग व अन्तर के त्रिक
अर्द्धकोण के त्रिक

इकाई 2 – त्रिकोणमितीय 20 अंक
फलनों की परिभाषा
सर्वसमिकायें

इकाई 3 – निर्देशांक ज्यामिति 20 अंक
सरल रेखा के विविध रूप

इकाई 4 – सम्मिश्र संख्या 20 अंक
गुणा, भाग व वर्गमूल

इकाई 5 – भारतीय गणितज्ञों का योगदान 20 अंक
(रेखागणित के संदर्भ में)
कः भास्कराचार्य
खः माधवन
गः परमेश्वरन
घः भारती कृष्ण तीर्थ

संदर्भग्रन्थः

1. वैदिक गणित निर्देशिका भाग–2, विद्या भारती अखिल भारतीय शिक्षा संस्थान, कुरुक्षेत्र
2. वैदिक गणित, मोतीलाल बनारसीदास, नई दिल्ली
3. वैदिक गणितःविहंगम दृष्टि–1, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
4. वैदिक गणित प्रणेता, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
5. वैदिक गणितः अतीत, वर्तमान एवं भविष्य, शिक्षा संस्कृति उत्थान न्यास, नई दिल्ली
6. लीलावती, चौखम्बा विद्या भवन, वाराणसी

संदर्भदाताः

1. डॉ. नन्द किशोर सोनी, अजमेर
2. श्री बबु भाई रावल, अहमदाबाद
3. डॉ. अनन्त व्यवहारे, नागपुर
4. डॉ. कैलाश, राठ

प्रश्नपत्र 4– व्यावहारिक अभ्यास अधिकतम अंकः 100

1. कक्षाकक्ष में 06 व्याख्यान का अभ्यास
2. प्रत्येक प्रश्नपत्र से 02 व्याख्यान अपेक्षित
3. एक व्याख्यान का मूल्यांकन

अथवा

एक शोधपत्र का प्रस्तुतीकरण व मूल्यांकन

संदर्भदाताः

1. डॉ. नन्द किशोर सोनी, अजमेर
2. श्री बचु भाई रावल, अहमदाबाद
3. डॉ. अनन्त व्यवहारे, नागपुर
4. डॉ. कैलाश, राठ
5. डॉ. वीरेन्द्र कुमार गुप्त, उज्जैन
6. डॉ. सुशील कुमार बिस्सु, अजमेर

10.डॉ. महेन्द्र कुमार गोखरु, अजमेर

प्रश्नपत्र का प्रारूप

क्र.	प्रश्न का प्रकार	प्रश्न संख्या	एक प्रश्न का अंक	कुल
1.	वस्तुनिष्ठ	10	02	20
2.	अतिलघु उत्तरीय	06	03	18
3.	लघु उत्तरीय	06	05	30
4.	दीर्घ उत्तरीय	04	08	32
	कुल योग	26	--	100

उद्देश्यः

(1) गणित के भय से मुक्त करना।
(2) सरल व संक्षिप्त गणितीय विधियों की जानकारी देना।
(3) शुद्धता व शीघ्रता से प्रश्न हल करने की क्षमता विकसित करना।
(4) तर्कशक्ति का विकास करना।
(5) गणित में अभिरुचि उत्पन्न करना।
(6) गणनाओं की वैकल्पिक विधियों की जानकारी देना।

अर्हताः

किसी मान्यता प्राप्त बोर्ड से कक्षा 12वीं अथवा समकक्ष परीक्षा उत्तीर्ण

Scheme of Examination of
M.Sc. Mathematics,

Semester- IV

(w.e.f. Session 2018-19)

Course Code	Title of the Course	Theory Marks	Internal Marks	Practical Marks	Credit (L:T:P)
		Hard Core			
MM-4H1	Functional Analysis-II	80	20	--	5:1:0
MM-4H2	Classical Mechanics	80	20	--	5:1:0
MM-4H3	Advanced Complex Analysis	80	20	--	5:1:0
MM-4H4	Matlab	--	20	80	0:0:4
		Soft Core			
		Group C (Any One)			
MM-4SC1	Discrete Mathematics	80	20	--	5:1:0
MM-4SC2	Boundary Value Problems	80	20	--	5:1:0
MM-4SC3	Dynamical Systems	80	20	--	5:1:0
MM-4SC4	Algebraic Number Theory	80	20	--	5:1:0
MM-4SC5	Mechanics of Solids	80	20	--	5:1:0
		Group D (Any One)			
MM-4SD1	Oriented Operational Research	80	20	----	5:1:0
MM-4SD2	Viscous Fluid Dynamics	80	20	--	5:1:0
MM-4SD3	Mathematical Aspects of Seismology	80	20	--	5:1:0
MM-4SD4	Fuzzy Sets & Applications-II	80	20	--	5:1:0
MM-4SD5	Non Commutative Rings	80	20	----	5:1:0
		Total Credits	:	**25**	

Note 1 : The Criteria for awarding internal assessment of 20 marks shall be as under:

A) Class test : 10 marks.

B) Assignment & Presentation : 5 marks

C) Attendance : 5 marks

Less than 65% : *0 marks*

Upto 70% : *2 marks*

Upto 75% : *3 marks*

Upto 80% : *4 marks*

Above 80% : *5 marks*

Note 2 : The syllabus of each course will be divided into **four** Sections of **two** questions each. 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 contain **eight** short answer type questions without any internal choice covering the entire syllabus.

Note 3 : Elective courses can be offered subject to availability of requisite resources/ faculty.

SEMESTER– IV

MM-4H1 **Functional Analysis -II**

Credits :5:1:0

Time : 3 Hours
Max. Marks : 80

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

Section -I

Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon – Nikodyn theorem Lebesgue decomposition Lebesgue – Stueltjes integral. Product measures, Fabini's theorem.

Section -II

Baire sets. Baire measure, continuous functions with compact support, Regularity of measures on locally compact spaces, Riesz-Markoff theorem, Hilbert Spaces Inner product spaces. Hilbert spaces, Schwarz's inequality, Hilbert space as normed linear space.

Section -III

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.

Section -IV

Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert space, Self-adjoint operators, Positive and projection operators, Normal and Sectionary operators, Projections on Hilbert space. Spectral theorem on finite dimensional space.

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.

Dahiya

SEMESTER – IV

MM-4H2 **Classical Mechanics**

Credits :5:1:0 **Time : 3 Hours**

Max. Marks : 80

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

Section -I

Free & constrained systems, constrained and their classification, holonomic and non-holonomic systems, degree of freedom and generalized coordinates, virtual displacement and virtual work, statement of principle of virtual work (PVW), possible velocity and possible acceleration, D' Alembert's principle, **Lagrangian Formulation :** Ideal constraints, general equation of dynamics for ideal constraints, Lagrange's equation of the first kind.

Section -II

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. qi). Lagrange's equations for potential forces, generalized momenta pi, Hamiltonian variable and Hamiltonian function H (t, qi, pi). Donkin's theorem, ignorable coordinates.

Section -III

Hamilton canonical 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, Poincare - Carton integral invariant, Whittaker's equations, Jacobi's equations. Lagrangian action and the principle of least action.

Section -IV

Canonical transformation, necessary and sufficient condition for a canocial transformation. univalent Canonical transformation, free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, method of separation of 42 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 canocnicity of a transformation in terms of Poison brackets, invariance of Poison Brackets under canonical transformation.

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	Prentice Hall of India, 2005.
6.	M.R. Spiegal	Theoretical Mechanics, Schaum Outline Series.

SEMESTER-IV

MM-4H3 **Advanced Complex Analysis**

Credits : 5:1:0

Time : 3 Hours
Max. Marks : 80

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

Section – I

Integral Functions, Factorization of an integral function. Weierstrass primary factors. Weierstrass' factorization theorem, Gamma function and its properties, Stirling formula, Integral version of gamma function, Riemann Zeta function, Riemann functional equation, Mittag-Leffler theorem, Runge theorem (Statement only)

Section -II

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, Germ of an analytic function. Monodromy theorem and its consequences, Harmonic functions on a disk, Poisson kernel, The Dirichlet problem for a Section disc.

Section -III

Harnack inequality, Harnack theorem, Dirichlet region. Green function, Canonical product Jensen formula, Poisson-Jenson formula, Hadamard three circles theorem, Growth and order of an entire function. An estimate of number of zeros, Exponent of convergence. Borel theorem, Hadamard factorization theorem.

Section -IV

The range of an analytic function, Bloch theorem, Schottky theorem, Little Picard theorem, Montel Caratheodory theorem, Great Picard theorem, Univalent functions, Bieberbach conjecture (Statement only) and the "1/4 theorem.

Books **Recommended**

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 2011.
3. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International Student-Edition, Narosa Publishing House, 2002.
4. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
5. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variab Oxford University Press, London.
6. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
7. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
8. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company.

   H.S. Kasana, Complex Variable, Theory and Applications, PHI Learning Private Ltd. 2011.

SEMESTER-IV

PRACTICAL MM-4H4 **MATLAB**

Max. Marks :80

Credits : 0:0:4

Introduction of Starting MATLAB, Creating Arrays, Mathematical operations with Arrays, creating M. files, script-files and functions and files and managing data, Two-dimensional plots, Programming in MATLAB, User-defined functions and function files, Polynomials, Applications in numerical analysis, Symbolic Math.

Books Recommended :

1. Amos Gilat, MATLAB : An Introduction with Applications, John and Wiley & Sons.
2. Brian R. Hunt, Ronald Lipsman and Jonathan M. Rosenberg, A Guide to Matlab, Cambridge University Press.

SEMESTER-IV

MM-4SC1 **Discrete Mathematics**

Credits : 5:1:0

Time : 3 Hours
Max. Marks : 80

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

Section -I

Recurrence Relations and Generating Functions, Some number sequences, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Generating functions, Recurrences and generating functions, Exponential generating functions.

Section -II

Statements Symbolic Representation and Tautologies, Quantifiers, Predicates and validity.

Prepositional Logic. Lattices as partially ordered sets, their properties, Lattices as Algebraic systems, Sub lattices, Direct products and Homomorphism, Some special lattices e.g. complete, Complemented and Distributive Lattices.

Section -III

Boolean Algebras as Lattices, Various Boolean identities, The switching Algebra. Example, Sub algebras, Direct products and Homomorphism, Joint-irreducible elements, Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms.

Sum of Products, Cononical forms, Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates.) The Karnaugh method.

Section -IV

Finite state Machines and their Transition table diagrams, Equivalence of Finite State, Machines, Reduced Machines, Homomorphism. Finite automata, Acceptors, Non-deterministic, Finite Automata and equivalence of its power to that of deterministic. Finite automata, Moore and Mealy Machines Grammars and Language: Phrase-Structure Grammars, Requiting rules, Derivation, Sentential forms, Language generated by a Grammar, Regular, Context-Free and context sensitive grammars and Languages, Regular sets, Regular Expressions and the pumping Lemma.

Books Recommended:

1. Kenneth. H Rosen, Discrete Mathematics and Its Applications, Tata McGraw Hill, Fourth Edition.
2. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co. New York.
3. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, Fifth Edition.
4. J.P. Tremblay, R. Manohar, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt. Ltd.
5. J.E. Hopcraft and J. D. Ullman Introduction to Automata Theory, Languages and Computation, Narosa Publishing House.
6. M.K. Das, Discrete Mathematical Structures for Computer Scientist and Engineers, Narosa Publishing House.
7. C.L. Liu and D.P. Mohapatra, Elements of Discrete Mathematics – A Computer Oriented Approach, Tata McGraw-Hill, Fourth Edition.

SEMESTER-IV

MM-4SC2 **Boundary Value Problems**

Credits: 5:1:0 **Time : 3 Hours**
Max. Marks : 80

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

Section – I

Applications to Ordinary Differential Equations: Initial value problems. Boundary Value Problems. Dirac Delta functions. Green's function approach to reduce boundary value problems of a self-adjoint-differential equation with homogeneous boundary conditions to integral equation forms. Green's function for N^{th} -order ordinary differential equation. Modified Green's function.

(Relevant portions from the Chapter 5 of the book "Linear Integral Equation. Theory and Techniques by R.P. Kanwal")

Section – II

Applications to Partial equations equations: Integral representation formulas for the solution of the Laplace and Poisson Equations. The New tonian. single-layer and double-layer potentials, Interior and Exterior Dirichlet problems, Interior and Exterior Neumann problems. Green's function for Laplace's equation in a free space as well as in a space bounded by a ground vessel. Integral equation formulation of boundary value problems for Laplace's equation. Poisson's integral formula. Green's function for the space bounded by grounded two parallel plates or an infinite circular cylinder. The Helmholtz equation.

(Relevant portions from the Chapter 6 of the book "Linear Integral Equation. Theory and Techniques by R.P. Kanwal")

Section – III

Integral Transform methods: Introduction. Fourier transform. Laplace transform. Convolution Integral. Application to Volterra Integral Equations with convolution-type Kernels. Hilbert transform.

Applications to mixed Boundary Value Problems, Generalized Three-part Boundary Value problems.

(Relevant portions from the Chapter 9 and 10 of the book "Linear Integral Equation. Theory and Techniques by R.P. Kanwal").

Section – IV

Integral equation perturbation methods: Basic procedure, Applications to Electrostatics. Low-Reynolds-Number Hydrodynamics: Steady stokes flow. Boundary effects on Stokes flow. Longitudnal oscillations of solids in stokes Flow. Steady Rotary Stokes Flow, Rotary Oscillations in Stokes Flow, Rotary Oscillation in Stokes Flow, Oseen Flow-Translation Motion, Oseen Flow-Rotary motion Elasticity, Boundary effects, Rotation, Torsion and Rotary Oscillation problems in elasticity, crack problems in elasticity. Theory of Diffraction.

(Relevant portions from the Chapter 11 of the book "Linear Integral Equation, Theory and Techniques by R.P. Kanwal").

References:

1. R.P. Kanwal, Linear Integral Equations. Theory and Techniques. Academic Press, New York.
2. S.G. Mikhlin, Linear Integral Equations (translated from Russian) Hindustan Book Agency, 1960.
3. I.N. Sneddon, Mixed Boundary Value Problems in potential theory, North Holland, 1966.
4. I. Stakgold, Boundary Value Problems of Mathematical Physics Vol.1, 11, Mac. Millan, 1969.
5. Pundir and Pundir, Integral equations and Boundary value problems, Pragati Prakashan Meerut.

SEMESTER – IV

MM-4SC3 **Dynamical Systems**

Time : 3 Hours **Credits :5:1:0**
Max. Marks : 80

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

Section -I

Orbit of a Map: fixed point; Periodic point; Circular Map. Configuration space & phase space.

Section -II

Origin of bifurcation; Stability of a fixed point, equilibrium point: Concept of limit cycle &torus; Hyperbolicity ; Quadratic map: Feigenbaum's universal constant.

Section -III

Turning point, transcritical, pitch work: Hopf bifurcation: Period doubling phenomenon Non-linear oscillators.

Section -IV

Conservative systems; Hamiltonian system: Various types of oscillators : Solutions of non-linear differential equations.

Books :

1. D.K. Arrowsmith, Introduction to Dynamical Systems, CUP. 1990.
2. R.L. Davaney, An Introduction to Chaotic Dynamical Systems, Addison-Wesley, 1989.
3. P.G. Drazin, Nonlinear System, CUP. 1993.
4. V.I. Arnold, Nonlinear Systems 111-Mathematical Aspects of Classical and Celestial Mechanics, Springer-Verlag, 1992.
5. V.I. Arnold, Nonlinear Systems V-Bifurcation Theory and Catastrophe Theory Springer-Verlag, 1992.

SEMESTER – IV

MM-4SC4 **Algebraic Number Theory**

Time : 3 Hours **Credits : 5:1:0**
Max. Marks : 80

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

Section – I

Algebraic numbers and algebraic integers. Transcendental Numbers. Liouville's Theorem for real Algebraic numbers. Thue Theorem and Roth's theorem (statement only). Algebraic numberfield K. Theorem of Primitive elements. Liouville's Theorem for complex algebraic numbers. Minimal polynomial of an algebraic integer, Primitive m-th roots of unity. Cyclotomic polynimals. Norm and trace of algebraic numbers and algebraic integers. Bilinear form on algebraic number field K.

Section – II

Integral basis and discriminant of an algebraic number field. Index of an element of K. Ring O_k of algebraic integers of an algebraic number field K. Ideals in the ring of algebraic number field K. Integrally closed domains. Dedekind domains. Fractional ideals of K. Factorization of ideals as a product of prime ideals in the ring of algebraic integers of an algebraic number field K. G.C.D. and L.C.M. of ideals in O_k Chinese Remainder theorem.

Section – III

Different of an algebraic number field K. Dedekind theorem. Euclidean rings. Hurwitz Lemma and Hurwitz constant. Equivalent fractional ideals. Ideals class group. Finiteness of the ideal class group. Class number of the algebraic number field K Diophantine equations Minkowski's bound.

Section – IV

Quardatic reciprocity Legendre symbol. Gauss sums. Law of quadratic reciprocity. Quardratic fields. Primes in special progression.

Recommended Text:

Jody Esmonde and M. Ram Murty — Problems in Algebraic Number Theory (Springer Verlag, 1998)

Reference Books:

1. Paulo Ribenboim — Algebraic Numbers
2. R. Narasimhan And S. Raghwan — Algebraic Number Theory Mathematical Pamphlets-4 Tata Institute of Fundamental Research (1966).

SEMESTER – IV

MM-4SC5 **Mechanics of Solids**

Time : 3 Hours **Credits :5:1:0**
Max. Marks : 80

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

Section – I

Two dimensional problems : Plane stress, Generalized plane stress, Airy stress function General solution of biharmonic equation. Stresses and displacements in terms of complex potentials. The structure of functions of $\phi(z)$ and $\psi(z)$. First and second boundary-value problems in plane elasticity. Existence and uniquencess of the solutions.
(Section 65-74 of the book by I.S. Sokolnikoff).

Section – II

Waves : Propagation of waves in an isotropic elastic solid medium. Waves of dilatation and distortion. Plane waves. Elastic surface waves : Rayleigh waves and Love waves.
Extension : Extension of beams, bending of beams by own weight and terminal couples. bending of rectangular beams.
(Section 204 of A.E.H. Love. Sections 7.7-8, 10 of Y.C. Fung: Chapter -4 Sections 30 to 32 and 57 of book by I.S. Sokolnikoff).

Section – III

Torsion : Torsion of cylindrical bars; Torsional rigidity, Torsion and stress functions, Lines of shearing stress. Torsion of anisotropic beams; Simple problems related to circle, ellipse and equilateral triangle.
(Chapter 4 : Section 33 to 39 and 51 of the book : I.S. Sokolnikoff. Section 221 of A.E.H. Love).

Section – IV

Variational Methods : Theorems of minimum potential energy. Theorems of minimum complementary energy. Reciprocal theorem of Betti and Rayleigh. Deflection of elastic string central line of beam and elastic membrane. Solution of Euler's equation by Ritz Galerkin and Kantorovich methods.
(Chapter 7: Sections 107-110, 112, 113, 115 & 117 of I.S. Sokolnikoff).

Books :

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd. New Delhi, 1977.
2. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
3. Y.C. Fung, Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
4. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994.
5. S. Timeshenki and N. Goodier. Theory of Elasticity, McGraw Hill, New York, 1970.
6. I.H. Shames Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975.

SEMESTER – IV

MM-4SD1 Oriented Operational Research

Time : 3 Hours **Credits : 5:1:0**
Max. Marks : 80

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

Section -I

Operations Research : Origin, definition, methodology and scope, Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big – M and two phase methods, Degeneracy, Duality in linear programming.

Section -II

Transportation Problems: Basic feasible solutions, optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems. Transhipment problem. Assignment problems: Solution by Hungarian method, unbalanced problem case of maximization, travelling salesman and crew assignment problems.

Section -III

Queuing models: Basic components of a queuing system, General birth-death equations steady-state solution of Markovin queuing models with single and multiple servers (M/M/1, M/M/C, M/M/1/k, M/MC/k) Inventory control models: Economics order quantity (EOQ) model with uniform demand and with different rates of demands in different cycles. EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.

Section -IV

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

Books recommended :

1. Taha, H.A., Operation Research-An introduction, Printice Hall of India.
2. Gupta, P.K. and Hira, D.S., Operations Research, S. Chand & Co.
3. Sharma, J.K., Mathematical Model in Operation Research, Tata McGraw Hill.
4. Sharma, J.K., Mathematical Model in Operation Research, Tata McGraw Hill.

SEMESTER – IV

MM-4SD2 **Viscous Fluid Dynamics**

Time : 3 Hours **Credits : 5:1:0**

Max. Marks : 80

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.

Section - I

Vorticity in two dimensions, Circular and rectilinear vortices. Vortex doublet, Images, Motion due to vortices, Single and double infinite rows of vortices. Karman vortex street.

Wave motion in a Gas. Speed of sound in a gas. Equation of motion of a Gas. Subsonic, sonic and supersonic flows. Isentropic gas flow, Flow through a nozzle.

Section - II

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. Newtonian and non-Newtonian fluids.

Navier-Stoke 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.

Section - III

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. Unsteady flow over a flat plate. Steady flow past a fixed sphere. Flow in convergent and divergent chennals.

Section - IV

Dynamical similarity. Inspection analysis. Non-dimensional numbers. Dimensional analysis. Buckingham π-theorem and its application. Physical importance of non-dimensional parameters.

Prandtl 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. .

Books Recommended:

1. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers,Delhi, 1988.
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
3. O'Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.

4. O'Neill, M.E. and Chorlton, F. , Viscous and Compressible Fluid Dynamics, Ellis Horwood Limited, 1989.
5. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
6. H. Schlichting, Boundary-Layer Theory, McGraw Hill Book Company, New York, 1979.
7. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
8. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

SEMESTER – IV

MM-4SD3 **Mathematical Aspects of Seismology**

Time : 3 Hours **Credits: 5:1:0**
Max. Marks : 80

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.

Section – I

General form of progressive waves, Harmonic waves, Plane waves, the wave equation. Principle of superposition. Special types of solutions: Progressive and Stationary type solutions of wave equation. Equation of telegraphy. Exponential form of harmonic waves. D' Alembert's formula. Inhomogeneous wave equation Dispersion Group velocity.
(Relevant articles from the book "Waves" by Coulson & Jefferey).

Section – II

Reduction of equation of motion to wave equations. P and S waves and their characteristics. Polarisation of plane P and S waves. Snell's law of reflection and refraction. Reflection of Plane P and SV waves at a free surface. Partition of reflected energy. Reflection at critical angles. Reflection and reflection of plane P.S.V. and SH waves at an interface. Special cases of Liquid-Liquid interface, Liquid-Solid interface and Solid-Solid interface. Rayleigh waves, Love waves and Stoneley waves. (Relevant articles from the Book "Elastic waves in Layered Media" by Ewing et al).

Section – III

Two dimensional Lamb's problems in an isotropic clastic solid: Area sources and Line Sources in an unlimited elastic solid. A normal force acts on the surface of a semi-infinite elastic solid, tangential forces acting on the surface of a semi-infinite elastic solid. Three dimensional Lamb's problems in an isotropic elastic solid: Area sources and Point sources in an unlimited elastic solid, Area source and Point source on the surface of semi-infinite elastic solid.
Haskell matrix method for Love waves in multilayered medium. (Relevant articles from the book "Mathematical Aspects of Seismology" by Markus Bath).

Section – IV

Spherical waves. Expansion of a spherical wave into plane waves: Sommerfield's integral Kirchoff's solution of the wave equation. Poisson's formula. Helmhotz's formula.
(Relevant articles from the book "Mathematical Aspects of Seismology" by Markus Bath).
Introduction on Seismology: Location of earthquakes, Aftershocks and Foreshocks, Earthquake magnitude, Seismic moment, Energy released by earthquakes, observation of earthquakes, interior of the earth.
(Relevant articles from the book "The Solid Earth" by C.M.R. Fowler).

References :

1. P.M. Shearer, Introduction to Seismology, Cambridge University Press, (UK) 1999.
2. C.M.R. Fowler, The Solid Earth, Cambridge University Press, 1990.
3. C.A. Coulson and A. Jefferey, Waves, Longman, New York, 1977.
4. M. Bath, Mathematical Aspects of Seismology, Elsevier Publishing Company, 1968.

W. M. Ewing, W.S. Jardetzky and F. Press, Elastic Waves in Layered Media, McGraw Hill Book Company, 195

Semester – IV

MM-4SD4 **Fuzzy Sets and Applications-II**

Time : 3 Hours **Credits: 5:1:0**

Max. Marks : 80

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.

Section – I

Possibility Theory : Fuzzy measures, continuity from below and above, semi continuous fuzzy measures, examples and simple properties: Evidence Theory, belief measure, super additivity, monotonicity, plausibility measure, subadditivity, basic assignment, its relation with belief measure and plausibility measure, focal element of basic assignment, ibody of evidence total ignorance. Dempster's rule of combination, examples Possibility Theory, necessity measure, possibility measure, implications, possibility distribution function, lattice of possibility distributions, joint possibility distribution.

Fuzzy sets and possibility theory, degree of compatibility, degree of possibility, relation with possibility distribution function and possibility measure, example of possibility distribution for fuzzy proposition. Possibility theory versus probability theory, characterization of relationship between belief measures and probability measures probability distribution function, joint probability distribution function, marginal probability distributions, non interactive, independent marginal distributions (Scope as in the relevant parts of Chapter 7 of the book mentioned at the end.

Section – II

Fuzzy Logic: An overview of classical logic, about logic functions of two variables Multi valued logics about three-valued logic, n-valued logic, degrees of truth definition of primitives. Fuzzy propositions, classification, canonical forms, relation with possibility distribution function, Fuzzy Quantifiers, their two kinds, relation with possibility distribution function. Linguistic hedges, as a unary operation and modifiers, properties Inference from conditional fuzzy propositions, relations with characteristic and membership functions. Compositional rule of inference modus ponens and tollens hypothetical syllogism, inference from conditional and qualified propositions equivalence of the method of truth-value restrictions to the generalized modus ponens. (Scope as in the relevant parts of sections 8.1 to 8.7 of Chapter 8 of the book mentioned at the end).

Section – III

Approximate reasoning: An overview of fuzzy expert system, Fuzzy implications as functions and operators, S-implications, R-implications, Godel implication, QL-implications, Zadeh implication, examples properties, combinations axioms of fuzzy, implications and characterization (only statement).

Selection of fuzzy implications, selection of approximate fuzzy implications to reasoning with unqualified fuzzy propositions, relation with compositional rule of inference, modus ponens and tollens hypothetical syllogism Multi conditional approximate reasoning, method of interpolation, an illustration of the method for two if-then rules, as special case of compositional rule of inference and related result of fuzzy sets involved, The role of fuzzy relation equations, necessary and sufficient condition for a solution of the system of fuzzy relation equations for a fuzzy relation, its implications.(Scope as in the relevant parts of sections 11.1 to 11.5 of Chapter 11 of the book mentioned at the end.)

Section – IV

An introduction to fuzzy control: Fuzzy controllers, its modules, Fuzzy rule base, Fuzzy inference enzinc, fuzzificationm and defuzzifications, steps of design of fuzzy controllers, defuzzification method, center of area method, center of maxima method and mean of maxima method. (Scope as in the relevant part of section 12.2 of chapter 12 of the book mentioned at the end).

Decision-making in Fuzzy environment: Individual decision-making, Fuzzy decision, simple examples, idea of weighting coefficients, Multiperson decision-making, fuzzy group decision, examples, Multicriteria decision-making, matrix representation of fuzzy relation, convertion to single-criterion decision, examples, Multistage decision-making idea of principle of optimality. Fuzzy ranking methods, Hamming distance, priority set, examples Fuzzy linear programming, two different methods one with only one side involving fuzzy numbers and other where only the coefficients of constraint matrix are fuzzy numbers. (Scope as in the relevant parts of Chapter 15 of the book mentioned at the end).

Book :

G.J. Klir and B. Yuan : Fuzzy Sets and Fuzzy Logic Theory and Applications.

SEMESTER – IV

MM-4SD5 **Non-Commutative Rings**

Time : 3 Hours **Credits: 5:1:0**
Max. Marks : 80

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.

Section – I

Basic terminology and examples of non-commutative rings i.e. Hurwitz's ring of integral quaternions, Free k-rings, Rings with generators and relations. Hilbert's Twist, Differential polynomial ring. Group rings, Skew group rings, Triangular rings. D. C. C. and A.C.C. in triangular rings. Dedekind finite rings. Simple and semi-sample modules and rings. Spliting homomorphisms. Projective and Injective modules. (Section 1.1 to 1.26 and Section 2.1 to 2.9 of the book given at Sr. No. 1).

Section – II

Ideals of matrix ring M_n (R), Structure of semi simple rings. Wedderburn-Artin Theorem Schur's Lemma. Minimal ideals. Indecomposable ideals. Inner derivation δ, δ-simple rings. Amitsur Theory on non-inner derivations. Jacobson radical of a ring R. Annihilator ideal of an R-module M. Jacobson semi-simple rings. Nil and Nilpotent ideals. Hopkins-Levitzki Theorem. Jacobson radical of the matrix ring M_n (R). Amitsur Theorem on radicals. Nakayama's Lemma. Von Neumann regular rings. E. Snapper's Theorem. Amitsur Theorem on radicals of polynomial rings. (Section 3.1 to 3.19 Sections 4.1 to 4.27, Section 5.1 to 5.10 of the book given at Sr. No.1).

Section – III

Prime and semi-prime ideals m-systems. Prime and semi-prime rings, Lower and upper nil radical of a ring R Amitsur theorem on nil radical of polynomial rings. Brauer's Lemma. Levitzki theorem on nil radicals. Primitive and semi-primitive rings. Left and right primitive ideals of a ring R. Density theorem. Structure theorem for left primitive rings.(Section 10.1 to 10.30, Section 11.1 to 11.20 of the book given at Sr. No. 1).

Section – IV

Sub direct products of rings. Subdirectly reducible and irreducible rings. Birchoff's Theorem. Reduced rings. G. Shin's Theorem. Commutativity Theorems of Jacobson. Jacobson-Herstein and Herstein Kaplansky. Division rings. Wedderburn's Little Theorem. Herstein's Lemma. Jacobson and Frobenius Theorem. Cartin-Braucer-Hua Theorem. Herstein's Theorem. (Sections 12.1 to 12.11 and Sections 13.1 to 13.26 of the book given at Sr. No. 1).

Recommended Book :

1. T.Y. Lam — A first Course in Noncommutative Rings, (Springer Verlag 1990)
2. I.N. Herstein — Non-Commutative Rings carus monographs in Mathematics Vol. 15 Math Asso. of America 1968.