(2)

DSPM UNIVERSITY

RANCHI

Mathematics

[Syllabus for M.A./M.Sc]

[Under Choice Based Credit System]

15/5/18

15/5/18

UNIVERSITY DEPARTMENT OF MATHEMATICS, DSPMU, RANCHI
CBCS PATTERN SYLLABUS

Semester wise distribution of Courses, Credits, Lectures, Marks:

Semester I						
Course Code	Title	Credits	Lectures/week Lectures Tutorial		Max. Marks	
					UNIV. EXAM	Sessional
FCMATH101	Fundamental Course in Modern Algebra (Foundation Course)	5	5 (L)	1(T)	70	30
CCMATH102	Real Analysis (Core Course 1)	5	5 (L)	1(T)	70	30
CCMATH103	Topology (Core Course 2)	5	5 (L)	1(T)	70	30
CCMATH104	Complex Analysis (Core Course 3)	5	5 (L)	1(T)	70	30
Total		20	20	4		
Semester II						
ECMATH201	Programming in C & MATLAB (Skill Enhancement Course 1)	5	5 (L)	1(T)	70	30
CCMATH202	Ordinary Differential Equations (Core Course 4)	5	5 (L)	1(T)	70	30
CCMATH203	Differential Geometry and Tensor Analysis (Core Course 5)	5	5 (L)	1(T)	70	30
CCMATH204(P)	Programming in C & MATLAB(Practical) (Core Course(P)6)	5	10		70	30
Total		20				
Semester III						
Course Code	Title	Credits	Lectures/week Lectures Tutorial		Max. Marks	
					Univ. Exam	Sessional
CCMATH301	Functional Analysis (Core Course 7)	5	5(L)	1(T)	70	30
CCMATH302	PDE (Core Course 8)	5	5(L)	1(T)	70	30
ECMATH 303(A)	Any one of the following: A. Optimization	5	5(L)	1(T)	70	30

303(B) 303(C)	Techniques B. Adv. Discrete Mathematics C. Integral Transforms and Applications (Elective Course 2)					
ECMATH 304(A) 304(B) 304(C)	Any one of the following: A. Fluid Dynamics B. Analytical Dynamics and Calculus of Variations C. Fourier and Wavelet Analysis (Elective Course 3)	5	5(L)	1(T)	70	30
Total		20				

Semester IV						
CCMATH401	Numerical Solution of ODE/PDE (Core Course 9)	5	5(L)	1(T)	70	30
ECMATH 402(A) 402(B) 402(C)	Any one of the following: A. Mathematical Modeling B. Distribution Theory & Pseudo Differential Operators C. Operations Research (Elective Course 4)	5	5(L)	1(T)	70	30
ECMATH 403(A) 403(B) 403(C)	Any one of the following: A. Numerical Linear Algebra B. Hadamard Matrices and Combinatorial Designs C. Integral Equations (Elective Course 5)	5	5(L)	1(T)	70	30
MATH 404	Project	5	10		80 (Written)	20 (Viva)
Total		20				

SEMESTER I

Paper Code: FCMATH101
Fundamental Course in Modern Algebra
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q. No. 1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I - GROUP THEORY

Groups : Finite permutation groups S_n and A_n, Normal and Subnormal series, Jordan-Holder theorem, Solvable groups, Nilpotent groups. Group action, orbit -stabilizer theorem, Sylow's theorems (proofs using group actions).

(2 QUESTIONS)

UNIT II- LINEAR ALGEBRA

Matrix of a linear transformation, Canonical Forms – Similarity of linear transformations. Invariant subspaces. Eigen values and Eigen vectors, Reduction to diagonal, triangular and Jordan forms. The primary decomposition theorem.

(2 QUESTIONS)

UNIT III – FIELD EXTENSION

Field theory-Extension fields, finite extension, Algebraic and transcendental extensions. splitting fields- existence and uniqueness, Separable and inseparable extension. Normal extensions. Perfect fields.

(2 QUESTIONS)

UNIT IV – FINITE FIELD

Finite fields, Theorems on finite fields, Primitive elements. Algebraically closed fields. Automorphism of extensions, Galois extension. Fundamental theorem of Galois Theory.

(2 QUESTIONS)

Text/ Reference Books:

1. D.S. Dummit, R.M. Foote,*Abstract Algebra* –John Wiley&Sons (2003)
2. I.N. Herstein. *Topics in Algebra*, Wiley Eastern Ltd., New Delhi, 1975
3. M. Artin. *Algebra*, Prentice-Hall of India, 1991.
4. K. Hoffman and R. Kunze (2nd edition),*Linear Algebra*, Prentice Hall of India, New Delhi (1997)
5. N.S. Gopala Krishnan, *University Algebra,* New Age International Publishers.

Paper Code: CCMATH102
Real Analysis
Credits: 5, Full Marks: 70, Pass Marks:28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I- UNIFORM CONVERGENCE
Sequences and series of functions, pointwise and uniform convergence. Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's test for uniform convergence, uniform convergence, and continuity.

(2 QUESTIONS)

UNIT II – FUNCTION OF SEVERAL VARIABLES
Derivative of functions in an open subset of R^n into R^m as a linear transformation. Chain rule. Partial derivatives. Taylor's theorem. Inverse function theorem. Implicit function theorem, Jacobians.

(2 QUESTIONS)

UNIT III MEASURE AND OUTER MEASURES
Measure induced by an outer measure. Extension of a measure. Uniqueness of extension, Completion of a measure, Lebesgue outer mearure, Measurable sets, non-lebesgue measures.

(2 QUESTIONS)

UNIT IV Measurable functions and Lebesgue integrals
Measurable functions. Integration of non-negative functions. The general integral. Convergence theorems. Lebesgue integrals.

(2 QUESTIONS)

Text/ Reference Books:
1. Walter Rudin, *Principles of Mathematical Analysis,* 3rd ed. McGraw-Hill
2. T.M. Apostal, *Mathematical Analysis*, Narosa Publ., New Delhi, 1985.
3. R G Bartle and Donaid R Sherbert, Real Analysis, John Wiley & Sons

Paper Code: CCMATH103
Topology
Credits: 5, Full Marks:70, Pass Marks:28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Fundamentals of a topological space
Definition and examples of topological spaces. Closed sets, Closure. Dense subsets. Neighbourhoods, Interior, exterior and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topologies. Quotient topology. (2 QUESTIONS)

UNIT II Continuity and connectedness
Continuity and homeomorphism, Product of topological spaces, connected space and its properties.
(2 QUESTIONS)

UNIT III Countability and separation axioms
First and Second countable spaces. Lindelof's theorem, separable spaces, second countability and separability. Separation axioms To, T_1, T_2, T_3, T_4 : their Characterizations and basic properties. Urysohn's Lemma. Tietze extension theorem. (2 QUESTIONS)

UNIT IV Compactness
Compactness. continuous image of compact sets. Basic property of compactness. Compactness and finite intersection property Tychonoff's Theorem, One point compactification of a topological space.
(2 QUESTIONS)

Text/ Reference Books:

1. K.D. Joshi. *Introduction to General Toplogy,* Wiley Eastern Ltd. 1983.
2. W.J.Pervin. *Foundations of General Topology* Academic Press Inc. New York 1964.
3. G.F. Simmons, *Introduction to Topology and Modern Analysis*, Mc Graw Hill Int.book company.
4. J.R.Munkres, *Topolygy A first course*, Prentice hall India Pvt. Ltd.
5. S.Lipschutz, *General Topology*, Schaum's out line series.

Paper Code: CCMATH104
Complex Analysis
Credits: 5, Full Marks: 70, Pass Marks:28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Complex Integration
Cauchy-Goursat Theorem, Cauchy's Integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality, Liouville's theorem and Fundamental theorem of Algebra.
(2 QUESTIONS)

UNIT II Power Series
Circle of Convergence. Absolute and uniform convergence. Taylor's theorem, Laurent's theorem. Maximum modulus principle.
(2 QUESTIONS)

UNIT III Singularities and Cauchy Residue Theorem.
Isolated singularities. Meromorphic functions. The argument principle, Rouche's theorem Poles and Zeros. Residues. Cauchy's residue theorem. Contour Integration. Evaluation of integrals (2 QUESTIONS)

UNIT IV Analytic Continuation and its application
Definition of Analytic continuations and related problems, Uniqueness theorem of Analytic continuation, Standard method/ Power series method of Analytic continuation along a curve, Singularity on the circle of convergence of power series.
(2 QUESTIONS)

Text/ Reference Books:
1. Churchill and Brown, *Complex variables and applications*, McGraw-Hill Pub.Company.
2. Walter Rudin. *Real and Complex Analysis*. Mc Graw Hill Book Co. 1966
3. E.C. Titchmarsh. *The Theory of Functions*. Oxford University Press. London.

SEMESTER II

Paper Code: ECMATH201
Programming in C and MATLAB
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT-I
Planning the Computer Program: Concept of problem solving, Problem definition, Program design, Debugging, Types of errors in programming, Documentation. Techniques of Problem Solving: Flowcharting, algorithms, pseudo code, decision table, Structured programming concepts, Programming methodologies viz. top-down and bottom-up programming.
Overview of C: History of C, Importance of C, Structure of a C Program.
Elements of C: C character set, identifiers and keywords, Data types, Constants and Variables, Assignment statement, Symbolic constant.
Input/output: Unformatted & formatted I/O function, Input functions viz. scanf(), getch(), getche(), getchar(), gets(), output functions viz. printf(), putch(), putchar(), puts().
Operators & Expression: Arithmetic, relational, logical, bitwise, unary, assignment, conditional operators and special operators. Arithmetic expressions, evaluation of arithmetic expression, type casting and conversion, operator hierarchy & associativity.
Decision making & branching: Decision making with IF statement, IF-ELSE statement, Nested IF statement, ELSE-IF ladder, switch statement, goto statement.
Decision making & looping: For, while, and do-while loop, jumps in loops, break, continue statement. Understanding header files: stdio.h, math.h, ctype.h and its function prototypes. [2 Questions]

UNIT-II
Functions: Definition, prototype, passing parameters, recursion.
Storage classes in C: auto, extern, register and static storage class, their scope, storage, & lifetime.
Structure, Union, enum
Arrays: Definition, types, initialization, processing an array, Strings & arrays.
Pointer and Its implementation using Function, Structure, Union, Array
File Handling: Needs of File Handling, File Modes, Type of Files, Open/Create, Read, Write, Delete, Copy, Rename, Searching etc. [2 Questions]

Unit III
Introduction to MATLAB, Elementary MATH Built-in –Functions, Creating Arrays, one dimensional, two dimensional arrays, Variables, Strings. Mathematical operations with arrays, Sript files, Two dimensional plots, Functions and Function files.
[2 Questions]

Unit IV

Programming in MATLAB, Relational and Logical operators, Conditional statements, the switch-case statement., Loops, Nested Loops and Nested conditional statements, The break and continue commands, , Polynomials, Curve Fitting and Interpolation, Applications to Numerical Analysis. [2 Questions]

TEXT/REFERENCE BOOKS

1. Yashwant Kanetker, *Working with C*, BPB
2. Reema Tharej., *Programming with C*, Oxford
3. Balagurusamy, E., *Computing Fundamentals and C Programming*, Tata McGraw-Hill
4. Jeri R. Hanly & Elliot P. Koffman, *Problem Solving and Program Design in C*, Addison Wesley.
5. Yashwant Kanetker, *Let us C*, BPB
6. Rajaraman, V., *Computer Programming in C*, PHI
7. Amos Gilat, *MATLAB- An Introduction with Applications*, Wiley India

Paper Code: CCMATH202
Ordinary Differential Equations
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I First order ODE
Existence and uniqueness of the solution to ODE, Peano's existence theorem, Lipschitz condition, Uniqueness theorem, Picard's method of successive approximation. (2 QUESTIONS)

UNIT II Second and higher order ODE
Algebraic properties of solutions of homogeneous equations & Wronskian of second order ODE, nth order ODE, Wronskian of n functions and its properties, Annihilator method to solve non homogeneous ODE with constant coefficients, initial value problem, Existence and uniqueness theorem. (2 QUESTIONS)

UNIT III Linear System of ODE's
Linear system of ODEs, Existence and Uniqueness of linear system, linear homogeneous system with constant coefficients, method of eigen value and eigen vectors ,Fundamental solution,
Reduction of higher order linear equation into first order linear equations
(2 QUESTIONS)

UNIT IV Boundary Value Problem
Strum-Lioville boundary value problem with homogenous boundary conditions.Green's function, Green's function techniques for solving self-adjoint boundary value problem (2 QUESTIONS)

Text/ Reference Books:

1. E.A. Coddington and N. Levinson. *Theory of Ordinary Differential Equations.* Mc Graw-Hill, NY (1955).
2. M. Brawn, *Differential equations and their applications*, Springer-Verlag New York (1992),(abinged version published by Narosa Book Agency) Chakrabarti, *Elements of ordinary differential equations and special functions*, New Age, International Publisher (1990)
3. M.D. Raisinghania, *Advanced differential equations*, S. Chand and Company, 2001
4. A. Coddington, *An introduction to Ordinary Differential equations*, Prentice Hall of India, New delhi, 1987.

Paper Code: CCMATH203
Differential Geometry and Tensor Analysis
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Curves in Space
Curvature and torsion. Serret-Frenet formula. Circular helix, the circle of curvature. Osculating sphere, Bertrand curves.

(2 QUESTIONS)

UNIT II Curves on a Surface
Curves on a surface-parametric curves. fundamental magnitude, curvature of normal section. Principal directions and principal curvatures, lines of curvature, Rodrigue's formula. Dupin's theorem, theorem of Euler, Conjugate directions and Asymptotic lines.

(2 QUESTIONS)

UNIT III Family of Surfaces
One parameter family of surfaces – Envelope the edge of regression, Developables associated with space curves. Gaussian curvature, Surface of constant curvature.

(2 QUESTIONS)

UNIT IV Basics of tensor
Tensors, Tensor Algebra, Contraction, Quotient theorem. Metric Tensor, Angle between two vectors.

(2 QUESTIONS)

Text/ Reference Books:

1. C. E. Weatherburn. *Differential geometry of three dimensions.*
2. C.E. Weatherburn. *Tensor calculus.*
3. R.S. Mishra, *Tensor Calculus and Riemanian Geometry.*

Paper Code: CCMATH204 (P)
Programming in C & MATLAB (Practical)
Credits: 5, Full Marks: 100, Pass Marks: 45
Time: 3 Hours

Programming in C:

Write programs to display various messages on the screen in various forms

Write programs to illustrate the concepts of constants, variables and data types

Write programs to illustrate operators and expressions in C

Write programs to illustrate decision making and branching in C

Write programs to illustrate decision making and looping in C

Write programs to illustrate array in C

Write programs to illustrate of user defined functions

Write programs to illustrate structures and unions

Write programs to illustrate concept of pointers, character strings and string manipulations

Programming in MATLAB:

Write programs to illustrate Built-in functions and Arrays

Write Programs to illustrate Script files, functions and function files

Write programs to illustrate two dimensional plots

Write programs to illustrate curve fitting and interpolation

SEMESTER III

Paper Code: CCMATH301
Functional Analysis
Credits: 5, Full Marks: 70, Pass Marks: 28

Time: 3 Hours CCMATH 301

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Normed linear spaces

Banach spaces and examples. Quotient space of normed linear spaces and its completeness, equivalent norms.

(2 QUESTIONS)

UNIT II Transformation on linear spaces

Bounded linear transformations, normed linear spaces of bounded linear transformations, dual spaces with examples. Hahn-Banach theorem Open mapping and closed graph theorem, the natural imbedding of N in N**. Reflexive spaces.

(2 QUESTIONS)

UNIT III Hilbert space

Inner product spaces. Hilbert spaces. Orthonormal Sets. Bessel's inequality. Complete orthonormal sets and Parseval's identity. Projection theorem. Rietz representation theorem Reflexivity of Hilbert spaces

(2 QUESTIONS)

UNIT IV Operators in Hilbert Space

Linear transformation & linear functionals. Adjoint of an operator on a Hilbert space.. Self-adjoint operators. Positive, normal and unitary operators.

(2 QUESTIONS)

Text/ Reference Books:

1. G.F. Simmons, *Topology and modern analysis* TMH.
2. G. Bachman and L. Narici, *Functional Analysis*, Academic
3. Press, 1966
4. R.E. Edwards, *Functional Analysis*. Holt Rinehart and
5. Winston, New York 1958 Goffman and G. Pedrick. *First Course in Functional*
6. *Analysis*, Prentice Hall of India, New Delhi. 1987Kreyszing, *Functional analysis with application*, John
7. Wiley and sons
8. P. P. Gupta, *Functional Analysis*, Krishna Prakashan, Meerut.

Paper Code: CCMATH302
Partial Differential Equation
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Classification of 2nd order PDE & Laplace equation
Classification of second order PDE & reduction to Canonical forms, Fundamental solutions of two dimensional Laplace equation in Cartesian form.

(2 QUESTIONS)

UNIT II Heat equation
Derivation and fundamental solution of one dimensional Heat equation in Cartesian form. Application problems.

(2 QUESTIONS)

UNIT III Wave equation
Derivation and fundamental solution of one dimensional wave equation in Cartesian form. Application problems.

(2 QUESTIONS)

UNIT IV Solution by the methods of Transforms and Green's function
Solutions of p.d.e. using Separation of variables, Fourier transform and Laplace transform, Green's function and solutions of boundary value problems using Laplace transformation.

(2 QUESTIONS)

Text/ Reference Books:
1. L.C. Evans, *Partial Differential Equations*, Graduate Studies in Mathematics, Volume 19,AMS,1998.
2. I.N. Sneddon, *Use of integrals transforms*, McGraw Hill.
3. P. Prasad and R. Ravindran , *Partial Differential equation.*
4. K. Sankara Rao, Partial diffential eqution, new age.
5. E. Kreyszing, *Advanced Engineering Mathematics*, John Wiley & Sons.

ECMATH(303)

ANY ONE OF THE FOLLOWING

OPTIMIZATION TECHNIQUES/ ADVANCED DISCRETE MATHEMATICS/ INTEGRAL TRANSFORMS AND APPLICATIONS

Paper Code: ECMATH303 (A)

Optimization Techniques

Credits: 5, Full Marks: 70, Pass Marks:28

Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Dual Simplex Method

Infeasible optimal initial solution, procedure of dual simplex method, Advantage of dual simplex method over simplex method, difference between simplex and dual simplex method.

(2 QUESTIONS)

UNIT II Sensitivity Analysis

Changes in coefficients in the objective function, changes in the structure of the LPP due to

1. Addition of new variable
2. Deleting of existing variable
3. Addition of new constraints
4. Deletion of existing constraints

(2 QUESTIONS)

UNIT III Theory Of Games

Characteristics of game theory, maximin criteria and optimal strategy, solution of game with saddle points, Rectangular games without saddle points and its solutions by linear programming.

(2 QUESTIONS)

UNIT IV Queueing Theory

Basic characteristics of queueing system,different performance measures, Steady state solution of Markovian queueing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space. (2 QUESTIONS)

Text/Reference Books:

1. S.D.Sharma, *Operation Research*, Kedar Nath, Ram Nath and Company (1972)
2. H.A.Taha, *Operations Research*, Prentice-Hall of India Private Limited (2003)
3. R. K. Gupta, *Operations Research*, Krishna Prakashan.

Paper Code: ECMATH303 (B)
Advanced Discrete Mathematics
Credits:5,Full Marks:70, Pass Marks:28,Time:3Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Automata Theory
Finite state automata & types of automata, deterministic and non deterministic finite state automata, non deterministic finite state automata(NDFSA), transition diagram. Moor Machine, Mealy Machine Turing Machine.

(2 QUESTIONS)

UNIT II Eulerian and Hamiltonian Graphs
Eulerian graph and its characterizations, Hamiltonian graph and sufficient conditions for a graph to be Hamiltonian.

(2 QUESTIONS)

UNIT III Planar graph and vertex coloring of a graph
Planar graphs, Platonic graphs. Euler's theorem for planar graphs. Vertex coloring, chromatic number, chromatic polynomial, Brooks theorem, edge coloring, chromatic index, map coloring, Five color theorem.

(2 QUESTIONS)

UNIT IV Algorithms in graph theory
NP- complete problems, good algorithms, Connector problem and Kruskal's algorithm. Algorithms for Chinese postman problem. The Shortest path problem, Dijkstra's algorithm

(2 QUESTIONS)

Text/ Reference Books:

1. R. J. Wilson, *Graph Theory*.
2. John Clark and Derek Allan Holton, *A first look at Graph Theory*, Allied Publishers Ltd in association with world scientific.
3. Narsinghdeo, *Graph theory*, PHI New Delhi
4. Uday Singh Rajpoot, *Advanced Discreet Mathematics,* PHI (Eastern economic edition)

Paper Code: ECMATH303(C)
Integral Transforms And Applications
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

Unit I Laplace and Stieltjes Transforms
Laplace Transform: Definition and convergence theorem, Absolute convergence, Uniform Convergence, Complex inversion formula. convolution theorem, Tauberian Theorems.
Stieltjes Transform: Definition and convergence theorem, Hardy and Littlewood theorem. [2 Questions]

Unit II Fourier Series and Fourier Transforms
Orthogonal set of functions, Fourier series, Fourier sine and cosine series, Half range expansions, Fourier integral Theorem, Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, Conditions for existence of Fourier Transform, Convolution Integral, Parseval's Theorem for Cosine and Sine Transforms, Inversion Theorem. [2 Questions]

Unit III Mellin Transform
Definition and elementary properties of Mellin transform, Mellin Transform of derivatives and integrals, the Mellin inversion theorem, Convolution theorems, solution of some integral equations via Mellin transform. [2 Questions]

Unit IV Hankel Transform
Elementary properties, Inversion theorem, transform of derivatives of functions, transform of elementary functions, Parseval relation, relation between Fourier and Hankel transform, use of Hankel Transform in the solution of Partial differential equations, Dual integral equations and mixed boundary value problems. [2 Questions]

Text/Reference Books:

1. D V Widder, *The Laplace Transform*, Princeton Univ. Press.
2. Ian N. Sneddon, *The use of Integral Transforms*, McGraw Hill.
3. Ian N. Sneddon, *Fourier Transforms*, Dover Publications, 2010.
4. Loknath Debnath, *Integral Transforms and their Applications*, Chapman and Hall/CRC; 2nd ed., 2006.
5. R N Bracewell, *The Fourier Transform and Its Applications*, TMH, India.

ECMATH(304)

Any one of the following

FLUID DYNAMICS/ ANALYTICAL DYNAMICS AND CALCULUS OF VARIATIONS/FOURIER AND WAVELET ANALYSIS

Paper Code: ECMATH304 (A)
Fluid Dynamics
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Kinematics
Lagrangian and Eulerian methods. Equation of continuity in different coordinate system. Boundary surfaces. Stream lines. Path lines and streak lines. Velocity potential, Irrotational and rotational motions. Vortex lines. (2 QUESTIONS)

UNIT II Equations of Motion
Lagrange's and Euler's equations of motion. Bernoulli's theorem. Equation of motion by flux method. Impulsive actions. Stream function, Irrotational motion. (2 QUESTIONS)

UNIT III
Complex velocity potential. Sources, sinks doublets and their images in two dimension. Conformal mapping. Milne-Thomson circle theorem.
(2 QUESTIONS)

UNIT IV
Two-dimensional Irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid. Theorem of Blasius. Motion of a sphere through a liquid at rest at infinity. Liquid streaming past a fixed sphere. Equation of motion of a sphere. (2 QUESTIONS)

Text/ Reference Books:

1. W.H.Besaint & A. S. Ramsey. *A Treatise on Hydro mechanics.* Part II. CBS Publishers. Delhi.1988.
2. G.K. Batchelor. *An Introduction of Fluid Mechanics*. Foundation Books. New Delhi. 1994.
3. F. Choriton. *Textbook of Fluid Dynamics*. C.B.S. Publishers.Delhi 1985.
4. Bansal, *Fluid mechanics*.
5. M.D. Raisinghania, *Fluid dynamics*, S.Chand Publication.

Paper Code: ECMATH304 (B)
Analytical Dynamics and Calculus of Variations
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Lagrangian dynamics
Generalized coordinates, Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Energy equation for conservative fields.
(2 QUESTIONS)

UNIT II Equations of Hamilton and Routh
Hamilton canonical equations. Equation of energy from
Hamilton's equations, Cyclic coordinates, Routh's equations,
Jacobi-Poisson Theorem. (2 QUESTIONS)

UNIT III Calculus of Variations
Motivating problems of calculus of variations fundamental lemma of calculus of variations Euler's equation, Brachistochrone problem Shortest distance, Geodesic, Minimum surface of revolution. (2 QUESTIONS)

UNIT IV Variational Principal in Dynamics and brackets
Hamilton's Principle, Principle of least action. Jacobi's equations. Hamilton-Jacobi equations. Jacobi theorem. Lagrange brackets and Poisson brackets. Invariance of Langrange brackets and Poisson brackets under canonical transformations.
(2 QUESTIONS)

Text/Reference Books :

1. H.Goldstein,*Classical Mechanics*(2nd edition),Narosa Publishing House, New Delhi.
2. I.M.Gelfand and S.V.Fomin, *Calculus of variation*, prentice Hall.
3. S.L. Loney, *An elementary treatise on Statics*, Kalyani Publishers, N. Delhi 1979.
4. A.S.Ramsey, *Newtonian Gravitation*. The English Language Book Society and the Cambridge University Press.
5. N.C. Rana & P.S.Chandra Joag, *Classical Mechanics*. Tata McGraw Hill 1991.
6. Lours N. Hand and Janel, D. Finch, *Analytical Mechanics*, Cambri

Paper Code: ECMATH304(C)
Fourier and Wavelet Analysis
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

Unit I Fourier series of periodic functions
Fourier Coefficients, partial sums, the Dirichlet and Fejer kernels, convergence theorems. Fourier integrals: convolution, inversion, Plancherel's formula. Generalized Fourier Series, Orthogonality and completeness (2 Questions)

Unit II The Fourier Transform
Basic properties, Inversion, Convolution, Plancherrel Theorem, The Fourier Transform for L2 functions, Dilatations, Translations, and Modulations. Windowed Fourier Transform, Discrete Fourier Transform. (2 Questions)

Unit III Haar System And Transform
The Haar System, Dyadic Step Functions, Haar bases on [0, 1]. Comparison of Haar series and Fourier Series. The Discrete Haar Transform (DHT), the DHT in two dimensions, Image analysis with the DHT. (2 Questions)

Unit IV Orthognormal wavelet bases and Multiresolution analysis:
Definition and examples, Construction of Orthonormal wavelet bases, Scaling functions and their properties.
The Discrete Wavelet Transform, Wavelet frames, Multiscale Analysis, DWT for finite signals.
The Continuous Wavelet Transform, Inverse CWT and admissibility conditions.
(2 Questions)

Text/Reference Books:

1. D F Walnut, *An Introduction to Wavelet Analysis*, Birkhauser
2. M A Pinsky, *Introduction to Fourier Analysis and Wavelets*,AMS.
3. J S Walker, *A Primer on Wavelets and Their Scientific Applications*, CRC, 1999.
4. R M Rao, A S Bopardikar, *Wavelet Transforms*, Pearsons, India,2010
5. I. Daubechies, *Ten Lectures on Wavelets*, SIAM,1992
6. Y Meyer, *Wavelets: Algorithms and Applications*, SIAM, 1993
7. S V Narasinmhan et al, *Introduction to Wavelet Transform*, Narosa, India, 2012.
8. A K Louis et al, *Wavelets: Theory and Applications*, John Wiley & Sons, 1998.

SEMESTER IV

Paper Code: CCMATH401
Numerical Solution of ODE/PDE
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Numerical solutions of parabolic PDE in one space
Two and three levels explicit and implicit difference schemes. Convergence and stability analysis.

(2 Questions)

UNIT II Numerical solutions of parabolic PDE of second order in two space dimension
Implicit methods, alternating direction implicit (ADI) methods. Non linear initial BVP. Difference schemes for parabolic PDE in spherical and cylindrical cooprdinate systems in one dimension.

(2 Questions)

UNIT III Numerical solutions of hyperbolic PDE in one and two space dimension
Explicit and implicit schemes.ADI methods. Difference schemes for first order equations.

(2 Questions)

UNIT IV Numerical Solutions of some equations and Operators
Numerical solutions of elliptic equations, approximation of Laplace and biharmonic operators. Solution of Dirichlet, Neuman and mixed type problems

(2 Questions)

Text/Reference Books:

1. M. K. Jain, S. R. K. Iyenger and R. K. Jain, *Computationalmethod for Partial differential equations*, Wiley eastern,1994.
2. M. K. Jain, *Numerical solution of Differential Equations*, second edition, Wiley Eastern.
3. S. S. Sastry, *Introductory methods of Numerical Analysis*, Prentice Hall India, 2002.
4. V. Griffiths and I. M. Smith, *Numerical Methods of Engineers*, Oxford University Press, 1993.
5. F. General and P.O. Wheatley, *Applied Numerical Analysis*, Addison-Wesley, 1998.

ECMATH (402)
ANY ONE OF THE FOLLOWING
MATHEMATICAL MODELING/DISTRIBUTION THEORY AND PSEUDO DIFFERENTIAL OPERATORS/OPERATIONS RESEARCH

Paper Code: ECMATH402 (A)
MATHEMATICAL MODELING
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions.
Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Introduction to mathematical modeling
Simple situations requiring mathematical modeling, techniques of mathematical modeling, classifications, characteristics and limitations of mathematical models, some simple illustrations.

(2QUESTIONS)

UNIT II Mathematical modeling through differential equations
Linear growth and decay models, non linear growth and decay models, Compartment models, Mathematical modeling in dynamics through ordinary differential equations of first order.

(2 QUESTIONS)

UNIT III Mathematical models through difference equations
Some simple mathematical models, basic theory of linear difference equations with constant coefficients

(2 QUESTIONS)

UNIT IV Application of mathematical modeling in economics, finance & genetics
Mathematical modeling through difference equations in economics and finance, mathematical modeling through difference equations in population dynamics and genetics.

(2 QUESTIONS)

Text/Reference Books:
1. J. N. Kapur, *Mathematical Modeling*, Wiley Eastern.
2. D. N. Burghes, *Mathematical modeling in social Management and Life Science*, Ellie Herwood and John Wiley.
3. F. Charlton, *Ordinary Differential and Difference Equations*, Van Nostrand.

Paper Code: ECMATH402 (B)
DISTRIBUTION THEORY AND PSEUDO DIFFERENTIAL OPERATORS
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

Unit I

Introduction, Test Functions, Convergence in $D(\Omega)$. Operators on Distributions, Multiplication and Division of Distributions, A Boundedness Property, Convergence of a Sequence of Distributions,, Distributional Derivative, Derivative of a Locally Integrable Functions, Distributions of Copmpact Support.

(2 questions)

Unit II

Direct Product of Distributions, Convolution, Properties of Convolutions, Fundamental Solutions of Linear Diofferential Operators.

(2 questions)

Unit III

The Space of rapidly Decreasing Functions, The Space of Tempered Distributions, Multipliers in S"(R"), The Flurier Transform on S(R"), Convolution Theorem in S"(R").

Hilbert Space, The Sobolev Space, $H^{m,p}(\Omega)$, The Soboleve Space $H^s(R^n)$. The Space H^{-s}. Symbols, Pseudo-differential Operators.

(2 questions)

Unit IV

The Formal Adjoint of Pseudo-differential Ooperator. The Parametrix of an Elliptic Pseudo=differential Operators, L^p- Boundedness of Pseudo-differential Operators $1<P<\infty$. Minimal and Maximal Pseudo-differential Operators. Global Regularity of Elliptic Partial Differential Equations.

(2 questions)

Text/Reference Books:

1. R S Pathak, *A Course in Distribution Theory*, Narosa
2. F G Fried Laveler and M Joshi, *Introduction to Theory of Distribution*, CUP, 1999, IS
3. Machael E Taylor, *Pseudo Differential Operators*, Princeton Univ. Press, 1981.
4. M A Shubin, *Pseudo differential operators and Spectral Theory*, Springer, 2001

5. F Trever, *Introduction to Pseudo differential and Fourier Integral Operators*, Plenum Publication Co. 1981.

Paper Code: ECMATH402(C)
Operations Research
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Integer Programming
Branch and bound technique, Gomory's cutting plane method.
(2 QUESTIONS)

UNIT II Non Linear Programming
One and multi variable, Unconstrained optimization, Kuhn-Tucker Conditions for costrained optimization, Quadratic programming, Wolf's and Beal's method.
(2 QUESTIONS)

UNIT III Inventory
Known demand, probabilistic demand, Deterministic Models and probabilistic models without lead-time.
(2 QUESTIONS)

UNIT IV Project Planning And Control With PERT-CPM
Rules of network construction, Time calculation in networks, Critical path method, PERT, PERT calculation, advantages of network (PERT/CPM), Difference between CPM and PERT.

(2 QUESTIONS)

Text/Reference Books:

1. S.D.Sharma, *Operation Research*, Kedar Nath, Ram Nath and Company (1972)

2. H.A.Taha, *Operations Research*, Prentic-Hall of India Private Limited (2003)

3. R. K. Gupta, *Operations Research,* Krishna Prakashan.

ECMATH403

ANY ONE OF THE FOLLOWING

Numerical Linear Algebra/HADAMARD MATRICES AND COMBINATORIAL DESIGNS/INTEGRAL EQUATIONS

Paper Code: ECMATH403 (A)
Numerical Linear Algebra
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Basic Concepts and Review
Vector Spaces, Linear Independence, Rank, Bases, Orthogonality, Projectors, Eigenvalues, Multiplicity, Schur Form, Jordan Normal Form. Norms of vectors and matrices. Singular value decomposition. Function of Matrices.

(2 QUESTIONS)

UNIT II Direct Methods of Numerical Linear Algrbra
Triangular Systems, Gaussian Elimination and LU decomposition, Pivoting, Backword error analysis, Conditioning and round-off errors.

(2 QUESTIONS)

UNIT III Eigenvalue Computations
Power methods for symmetric and non-symmetric problems, QR Algorithm for symmetric problems, Jacobi methods and tridiagonal methods for symmetric problems, Hessenberg form, Schur form and QR algorithms for non-symmetric problems.

(2 QUESTIONS)

UNIT IV Iterative Methods of Numerical Linear Algebra
Classical Linear Iterations and their convergence, Line search methods and conjugate gradient methods. Other Krylov subspace methods, Preconditioning.

(2 QUESTIONS)

Text/Reference Books:

1. Gene H. Golub and Charles F. Van Loan. *Matrix computations.* Johns Hopkins Univ., Baltimore, 1996.
2. Eugene Isaacson and Herbert B. Keller. *Analysis of numerical methods.* Dover Publications, New York, 1994
3. Gilbert Strang. *Linear algebra and its applications.* Academic Press [Harcourt Brace Jo-vanovich Publishers], New York, second edition, 1980.
4. Lloyd N. Trefethen and David Bau, III. *Numerical linear algebra.* Society for Industrial and Applied Mathematics (SIAM), Philadelphia, PA, 1997.

Paper Code: ECMATH403 (B)
Hadamard Matrices and Combinatorial Designs
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours

Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Introduction to Hadamard matrices
Order of Hadamard Matrix, Hadamard Matrix Conjecture, Kronecker Product of Hadamard Matrices, Sylvestor Hadamard Matrices, Equivalence of Hadamard matrices, Maximum Determinant Theorem.
(2 QUESTIONS)

UNIT II Construction of Hadamard Matrices
Hadamard matrices by Paley type I and type II methods, Williamson's method of construction. Number of in-equivalent Hadamard matrices of order 16 & 20,
(2 QUESTIONS)

UNIT III Orthogonal Designs
Orthogonal-design, Weighing and Conference matrices, Baumert-Hall method for the construction of Hadamard matrices.
(2 QUESTIONS)

UNIT IV Application of Hadamard Matrices
Construction of BIBD's from Hadamard matrices. Error correcting codes. Application of Hadamard matrices in the construction of error correcting codes. (2 QUESTIONS)

Text/Reference Books:
1. Marshal Hall (Jr.), *Combinatorial Theory*, Blaisdel Publishing house, 1986

Paper Code: ECMATH403(C)
Integral Equations
Credits: 5, Full Marks: 70, Pass Marks: 28
Time: 3 Hours
Nine questions will be set, out of which candidates are required to answer 5 questions. Q.No.1 is compulsory, consisting of *ten* short answer type questions, each of 3 marks, covering entire syllabus of the paper uniformly. Rest *four* questions, each of 10 marks will be required to be answered, selecting *one* from each unit.

UNIT I Classification of Linear Integral Equations
Fredholm,Volterra,Integro-Differential Equations, Singular Integral Equations, Converting Volterra Equation to ODE, Conversion of IVP to Volterra equation, Conversion of BVP to Fredholm equation.

(2 QUESTIONS)

UNIT II Fredholm Integral Equations
Decomposition method, Direct Computation method,successive approximation method, metho of successive substitutions, Homogeneous Fredholm Equations, Comparison between alternative methods.

(2 QUESTIONS)

UNIT III Volterra Integral Equation
Adomian Decomposition method, Series solution method, Successive Approximation method, Successive substitution method,comparison between alternative methods.

(2 QUESTIONS)

UNIT IV Singular Integral Equations
Abel problem, Generalized Abel Integral Equation, Existence and uniqueness of solutions using fixed-point theorems in case of Linear and nonlinear Volterra and Fredholm integral equations. Solution of Integral equations by Laplace, Fourier transforms methods.

(2 QUESTIONS)

Text/Reference Books :
1. Murry R. Spiegal, *Laplace Transform*(SCHAUM OutlineSeries), McGraw-Hill.
2. Abdul J. jerry, *Introduction to integral equations with applications*, Marcel Dekkar Inc. NY.
3. R. P. Kanwal, *Linear Integral equations*, Springer Sc., 1997.
4. Harry Hochsdedt, *Integral Equations*, John Wiley & Sons.

MATH 404

PROJECT

ON ANY ONE OF SPECIAL PAPER

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