BABU BANARASI DAS UNIVERSITY, LUCKNOW

M. Sc. (Mathematics)

COURSE STRUCTURE

(Effective from 2017-18)

Course	Code	Title	Teaching			Evaluation					Credits
						Theory		Lab/Seminar/ Viva Voce/ Thesis		Total	
			L	T	P	CIA	ESE	CIA	ESE		
SEMESTER – I											
Core	MM 1101	Algebra	3	1	-	40	60	-	-	100	4
Core	MM1102	Real Analysis	3	1	-	40	60	-	-	100	4
Core	MM 1103	Topology	3	1	-	40	60	-	-	100	4
Core	MM 1104	Ordinary and Partial Differential Equations	3	1	-	40	60	-	-	100	4
Core	MM 1105	Programming in C	4	-	-	40	60	-	-	100	4
Lab	MM 1151	Programming in C Lab	-	-	2	-	-	40	60	100	1
											21
SEMESTER – II											
Core	MM 1201	Advance Algebra	3	1	-	40	60	-	-	100	4
Core	MM1202	Advance Real Analysis	3	1	-	40	60	-	-	100	4
Core	MM 1203	Functional Analysis	3	1	-	40	60	-	-	100	4
Core	MM 1204	Discrete Mathematics	3	1	-	40	60	-	-	100	4
Core	MM 1205	Numerical Analysis	3	1	-	40	60	-	-	100	4
											20

SEMESTER – III												
Core	MM 1301	Complex Analysis	3	1	-	40	60	-	-	100	4
Core	MM1302	Special Functions	3	1	-	40	60	-	-	100	4
Core	MM 1303	Differential Geometry of Manifolds	3	1	-	40	60	-	-	100	4
Core	MM 1304	Mathematical Methods	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective - I	3	1	-	40	60	-	-	100	4
Lab	MM S13	Seminar	-	-	-	-	-	100	-	100	1
											21
SEMESTER – IV												
Core	MM 1401	Theory of Operators	3	1	-	40	60	-	-	100	4
Core	MM1402	Fluid Mechanics	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective – II	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective - III	3	1	-	40	60	-	-	100	4
Lab	MM T14	Thesis						50	50	100	4
Lab	MM V14	Viva Voce	-	-	-	-	-	-	100	100	2
											22

Discipline Specific Elective - I

MM E1301	Probability & Statistics
MM E1302	Numerical Solution of PDE
MM E1303	Classical Mechanics
MM E1304	Graph Theory

Discipline Specific Elective - II

MM E1401	Operations Research
MM E1402	Mathematical Modeling
MM E1403	Fuzzy Mathematics
MM E1404	Structures on Even Dimensional Differentiable manifolds

Discipline Specific Elective - III

MM E1405	Artificial Intelligence
MM E1406	Dynamical System
MM E1407	Financial Mathematics
MM E1408	Structures on Odd Dimensional Differentiable manifolds

Semester	First		
Course Name	**Algebra**		
Category: Core	Code: **MM 1101**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Structure theorems of groups; Direct product, Finitely generated abelian groups, Invariants of a finite abelian group, Sylow's theorems, Groups of orders p^2, pq ([1] Chapter 8).

Module II: Ideals; Sum and direct sum of ideals, Maximal and prime ideals, Nilpotent and nil ideals, Zorn's lemma. ([1] Chapter 10).

Module III: Unique factorization domains and Euclidean domains**;**Principal ideal domains, Euclidean domains, Polynomial rings over UFD.
([1] Chapter 11).

Module IV: Ring of fraction, Ring with ore condition,Modules;Definition and examples.([1] Chapter 12 &14).

Text Book:

[1] Bhattacharya, Jain and Nagpal: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.

References Books:

[1] I. N. Herstein: Topics in algebra, Wiley Eastern Limited, 1975.

[2] John B. Fraleigh: A first course in Abstract Algebra (3rd Edition), Narossa Publishing House.

[3] I. S. Luther and I.B.S. Passi: Algebra, Vol. I- Groups, Vol. II- Rings, Narossa Publishing House, (Vol. I -1996, Vol. II-1999).

[4] N. Jacbson: Basic Algebra, Hind. Pub. Corp, 1984.

[5] VivekSahai and VikasBist: Algebra, Narosa Publishing House, 1997.

[6] M. Artin: Algebra, Prentice-Hall of India, 1991.

Semester	First		
Course Name	**Real Analysis**		
Category: Core	Code: **MM 1102**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Metric spaces, Compact sets, Perfect sets, Connected sets ([1] Chapter 2)

Module II: Limits of functions, Continuous functions, Continuity and compactness Continuity and connectedness, Discontinuities, Monotone functions. ([1] Chapter 4)

Module III: Definition and existence of the Riemann, Stieltjes integral. Properties of theintegral.Integration of vector, valued functions. Rectifiable curves. ([1] Chapter 6)

Module IV: Sequences and series of functions: Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Approximation of a continuous function by a sequence of polynomials. ([1] Chapter 7)

Text Book:

[1] Walter Rudin, *Principle of Mathematical Analysis* (3rd edition) McGraw-HillKgakusha, 1976, International Student Edition.

References Books:

[1] K. Knopp, *Theory and Application of Infinite Series*.

[2] T. M. Apostol, *Mathematical Analysis*, Narosa Publishing House, New Delhi, 1985.

[3] I. P. Natanson: Theory of Functions of a Real Variable, Volume 1, Frederick Pub. Co., 1964

[4] H. L. Royden: Real Analysis, McMillan Publication Co. Inc. New York.

Semester	First		
Course Name	**Topology**		
Category: Core	Code: **MM 1103**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Topological Spaces; The Definition and examples, Elementary concepts, Open bases and open subbases, Weak topologies. ([1] Chapter 3).

Module II: Compactness; Compact spaces, Products of spaces, Tychonoff's theorem and locally compact spaces, Compactness for metric spaces, Ascoli's theorem. ([1] Chapter 4).

Module III: Separation; T_1 spaces and Hausdorff spaces, Completely regular spaces and normal spaces, Urysohn's lemma and the Tietze extension theorem, The Urysohn imbedding theorem. ([1] Chapter 5).

Module IV: Connectedness; Connected spaces, The components of a spaces, Totally disconnected spaces, Locally connected spaces. ([1] Chapter 6).

Text Book:

[1] G.F. Simmon's: *Introduction to Topology and Modern Analysis*, Tata McGraw Hill Edition.

References Books:

[1] W. J. Pervin: *Foundations of General Topology*.

[2] Willard: *Topology*, Academic press.

[3] Vicker: *Topology via logic*, (School of Computing, Imperial College, London).

[4] J. R. Munkers: *Topology, A First Course*, Prentice Hall of India Pvt. Ltd.

Semester	First		
Course Name	**Ordinary and Partial Differential Eqautions**		
Category: Core	Code: **MM 1104**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Linear Second Order Equations; Initial value problem, Existence and Uniqueness by Picard's Theorem, Wronskian, Separation and comparison theorems, Poincare phase plane, Variation of parameters. ([1] Chapter 3, 4, 8, 11).

Module II: Power series solutions; Solution near ordinary and regular singular point, Convergence of the formal power series, Applications to Legendre, Bessel, Hermite, Laguerre and hypergeometric differential equations with their properties. ([1] Chapter 5,6).

Module III: Partial Differential Equations; Cauchy problems and characteristics, Classification of Second order PDE's, Reduction to canonical forms, Derivation of the equations of mathematical physics and their solutions by separation of variables.([2] Chapter 2).

Module IV: Boundary Value Problems; Sturm–Liouville system, Eigen values and eigen functions, Simple properties, Expansion in eigen functions, Green's function method.([3] Chapter 5,6).

Text Book:

[1] G. F. Simmons, *Ordinary Differential Equations with Applications and Historical Notes*. Tata McGraw Hill Edition, **2003**.
[2] I. N. Sneddon: *Theory of Partial differential equations*, McGraw-Hill, International Student Edition.
[3] R. Courant and D. Hilbert: *Methods of Mathermatical Physics*, Vol. I. & II, Tata McGraw-Hill, New Delhi, 1975.

References BooksBooks:

[1] G.F. Simmons and S.G. Krantz: *Differential Equations Theory, Technique and Practice*. (The Walter Rudin Student Series in Advanced Mathematics), Tata McGraw Hill Edition, 2006.
[2] E.A. Coddington: *An Introduction to Ordinary Differential Equations*, Prentice-Hall, Englewood Cliffs, N.J., 1961.
[3] E. A. Coddington and N. Levinson: *Theory of Ordinary Differential equations*, Tata McGraw-Hill, New Delhi.

Semester	First		
Course Name	**Programming in C**		
Category: Core	Code: **MM 1105**	Credits: 4	
L-4 T-0 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Programming environment, Strategy for designing algorithms, Top-down development, Stepwise refinement, Concept of algorithm, Flowchart.

Types of programming languages, Types of translators: Assembler, Compiler, Interpreter.

Systematic development of programs, Program writing and execution, Structured Programming Concept.

Working with Binary, Octal and hexadecimal numbers.

Introduction to C language, C Tokens: Identifiers, Keywords, Constants and Variables in C, Fundamental data types in C, integer, short, long, char, single and double precision floating point.

Module II: Storage Classes in C: Automatic, register, static, extern.

Operators and Expressions in C: Arithmetic, Relational, Logical, Assignment, Bitwise, Conditional, Increment and Decrement, Special operators such as comma, sizeof etc. Operator precedence and associativity, Mixed mode operations.

Type conversion and Type casting in C, Standard Input/Output functions: printf(), scanf(), getch(), getchar(), getche(), etc.

Control Statements: Conditional - if statement, if-else statement, nested if-else statement, else if ladder, switch statements, restrictions on switch values, Use of break and default statement with switch. Iteration - while, for and do-while loops, nesting of loops. Jump statements - use of break and continue statements.

Module III: Array, notation and representation using one dimensional, two dimensional and multi-dimensional arrays, Arrays of unknown and varying size, Sparse matrices. Searching and sorting in arrays.

Strings: String declaration and initialization, String taxonomy, String manipulation.

Structures: Utility and usage, Array of structures, Arrays within structures.

Union: Utility and usage, Union of structures. Enumerated data types.

Pointers: Introduction to Pointers, Declaration and initialization of pointer variables, Null pointer, Wild pointer, Generic pointer, Accessing the address of the variable, Pointer arithmetic, Pointers and arrays.

Dynamic Memory Allocation: Memory allocation process, Allocating a block of memory, Releasing the used space, Stack, Linked list.

Module IV: Function declaration, Function definition, Function call, Return statement, Scope of variables, Passing values between functions, Call by value and call by reference. Recursive function and their types. Pointers to functions, Declaration of a pointer to a function, Initialization of function pointers, Calling a function using a function pointer, Passing a function to another function, returning a function pointer.

Standard C library functions: Math functions, String handling functions.

The C preprocessor: Preprocessor directives, Defining and calling macros, Conditional compilation, Passing values to the compiler.

File Handling in C: Types of files, defining, opening and closing of a file, Reading data from files, Writing data to files, Multiple file handling in C, Function for selecting a record randomly.

Text Book:

[1] E Balaguruswamy, Computer Concepts and Programming in C, TataMcGraw Hill Publications
[2] Yashavant P. Kanetkar, ‖Let UsC , BPB Publications

Reference Books:

[1] Jeri R. Hanly, Elliot B.Koffman, Problem Solving and ProgramDesign in C, Pearson Addison-Wesley.
[2] BehrouzA.Computer Science-A Structured Programming Approach Using C.

Semester	First		
Course Name	**Programming in C Lab**		
Category: Lab	Code: **MM 1151**	Credits: 1	
L-0 T-0 P-2	Exam Duration: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Suggested Lab Exercises:

1. WAP to print the sum and product of digits of an integer.
2. WAP to compute the sum of the first n terms of the following series S = 1+1/2+1/3+1/4+……
3. Write a function that checks whether a given string is Palindrome or not. Use this function to find whether the string entered by user is Palindrome or not.
4. Write a function to find whether a given no. is prime or not. Use the same to generate the prime numbers less than 100.
5. Write a program to swap two numbers using function and pointers.
6. WAP to compute the factors of a given number.
7. WAP to print a triangle of stars as follows (take number of lines from user):
   *
   ***
   *****
   ****
   ****
8. WAP to perform following actions on an array entered by the user:
   i) Print the even-valued elements
   ii) Print the odd-valued elements
   iii) Calculate and print the sum and average of the elements of array
   iv) Print the maximum and minimum element of array
   v) Remove the duplicates from the array
   vi) Print the array in reverse order
   The program should present a menu to the user and ask for one of the options. The menu should also include options to re-enter array and to quit the program.
9. WAP that prints a table indicating the number of occurrences of each alphabet in the text entered as command line arguments.
10. Write a program that swaps two numbers using pointers.
11. Write a program which takes the radius of a circle as input from the user, passes it to another function that computes the area and the circumference of the circle and displays the value of area and circumference from the main() function.
12. Write a program to find sum of n elements entered by the user. To write this program, allocate memory dynamically using malloc() /calloc() functions.
13. Write a menu driven program to perform following operations on strings:
    a) Show address of each character in string
    b) Concatenate two strings without using strcat() function.
    c) Concatenate two strings using strcat() function.
    d) Compare two strings
    e) Calculate length of the string .
    f) Convert all lowercase characters to uppercase
    g) Convert all uppercase characters to lowercase
    h) Calculate number of vowels
    i) Reverse the string

14. Given two ordered arrays of integers, write a program to merge the two-arrays to get an ordered array.
15. WAP to display Fibonacci series using iteration.
16. WAP to calculate Factorial of a number using iteration.
17. WAP to calculate GCD of two numbers .
18. Write a program which takes 10 numbers as input and search a particular number using binary search.
19. Create Matrix using arrays. Write a menu-driven program to perform following Matrix operations (2-D array implementation): a) Sum b) Difference c) Product d) Transpose .
20. Create a structure Student containing fields for Roll No., Name, Class, Year and Total Marks. Create 10 students and store them in a file.
21. Write a program to retrieve the student information from file created in previous question and print it in following format:
    Roll No. Name Marks
22. Copy the contents of one text file to another file, after removing all whitespaces.
23. Write a function that reverses the elements of an array in place. The function must accept only one pointer value and return void
24. Write a program that will read 10 integers from user and store them in an array. Implement array using pointers. The program will print the array elements in ascending and descending order.
25. Write a C Program to illustrate reading of data from a File.
26. Write a C Program delete a specific line from a Text File.
27. Write a C Program to append the content of one File at the end of another.
28. Write a C Program to evaluate polynomial f(x) = a4x + a x 3 + a x 2 + a1x + a0, for a given value of x and its coefficients using Horner's method.
29. Write a C program that reads N integer numbers and arrange them in ascending order using Bubble Sort.
30. Given two university information files "studentname.txt" and "usn.txt" that contains students Name and USN respectively. Write a C program to create a new file called "output.txt" and copy the content of files "studentname.txt" and "usn.txt" into output file in the sequence show. Display the contents of output file "output.txt" on to the screen.

Semester	Second		
Course Name	**Advance Algebra**		
Category: Core	Code: **MM 1201**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Algebraic extensions of fields; Irreducible polynomials and Eisenstein criterion, Adjunction of roots-Algebraic extensions, Algebraically closed fields. ([1] Chapter 15).

Module II: Normal and separable extensions;Splitting fields, Normal extensions, Multiple roots, Finite fields-Separable extensions. ([1] Chapter 16).

Module III: Galois theory;Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of Algebra. ([1] Chapter 17).

Module IV: Roots of unity, Polynomials solvable by radicals, Ruler and Compass constructions. ([1] Chapter 18).

Text Book:

[1] Bhattacharya, Jain and Nagpal: *Basic Abstract Algebra* (2nd Edition), Cambridge University Press, Indian Edition, 1997.

References Books:

[1] I.N. Herstein: *Topics in Algebra*, Wiley Eastern Limited, 1975.

[2] John B. Fraleigh: *A first course in Abstract Algebra*, (3rd Edition), Narossa Publishing House.

[3] I.S. Luther and I.B.S. Passi: *Algebra*, Vol. I- Groups, Vol. II- Rings, Narossa Publishing House, (Vol. I -1996, Vol. II-1999).

[4] N. Jacbson: *Basic Algebra*, Hind. Pub. Corp, 1984.

[5] VivekSahai and VikasBist: *Algebra*, Narosa Publishing House, 1997.

[6] M. Artin: Algebra, Prentice-Hall of India, 1991.

Semester	Second		
Course Name	**Advance Real Analysis**		
Category: Core	Code: **MM 1202**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Algebra of sets, Borel sets, Outer measure, Measurable sets and Lebesgue measure, A non-measurable set, Measurable functions, Little word's three principles. ([1] Chapter 3).

Module II: The Lebesgue integral of a bounded function over a set of finite measure, The integral of a non-negative function, The general Lebesgue integral. ([1] Chapter 4).

Module III: Convergence in measure, Differentiation of a monotone functions, Functions of bounded variation. ([1] Chapter 5).

Module IV: Differentiation of an integral, Absolute continuity, The Lp-spaces, The Minkowski and Holder's inequalities, Convergence and completeness. ([1] Chapter 4 & 5).

Text Book:

[1] H. L. Royden: *Real Analysis* , Pearson Education (3rd Edition) (Low Price Edition).

References BooksBooks:

[1] P. R. Halmos: *Measure Theory*, Van Nostrand, 1950.

[2] G. de Barra: *Measure Theory and Integration*, Wiley Eastern, 1981.

[3] E. Hewitt and K. Stromberg: *Real and Abstract Analysis*, Springer, 1969.

[4] P. K. Jain and V. P. Gupta: *Lebesgue Measure and Integration*, New Age International, New Delhi, 2000.

[5] Walter Rudin: *Principle of Mathematical Analysis* (3rd edition) McGraw-Hill

Kogakusha, International Student Edition, 1976.

Semester	Second		
Course Name	**Functional Analysis**		
Category: Core	Code: **MM 1203**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Banach Spaces; The definition and some examples, continuous linear transformations,The Hahn-Banach theorem.([1] Chapter 9).

Module II: The natural imbedding of N in N**, the open mapping theorem,the conjugate of anoperator.([1] Chapter 9).

Module III: Hilbert spaces; The definition and some simple properties, Orthogonalcomplements,orthogonal sets, the conjugate space H*.([1] Chapter 10).

ModuleIV: The adjoint of an operator, Self adjoint operators, normal and unitaryoperators,Projections. Finite dimensional spectral theory; Spectrum of an operator, the spectral theorem.([1] Chapter 10& 11).

Text Book:

[1] G F Simmons: Introduction to Topology & Modern Analysis (McGraw Hill).

References Books:

[1] B.V.Limaye: *Functional Analysis*, 2nd Edition.

[2] A. L. Brown and Page: Elements of Functional Analysis.

[3] P.K.Jain, O.P.Ahuja and Khalil Ahmed: Functional Analysis.

[4] G. Bachman and Narici: Functional Analysis, Academic Press, 1964.

[5] E.Kreyszig: Introductory Functional Analysis, John-wiley and Sons, New York, 1978.

Semester	Second		
Course Name	**Discrete Mathematics**		
Category: Core	Code: **MM 1204**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Lattices; Partial Ordering, Lattices as Posets, Some properties of Lattices, Lattices as Algebraic Systems, Sublattices, Direct products and Homomorphisms, Some special Lattices, Complete, Complemented and distributive lattices. ([1] Chapter 2, 4).

Module II: Boolean Algebra; Boolean Algebras as Lattices, Bolean Identities, The switching Algebra, Sub algebra, Direct product and homomorphism, Join irreducible elements, Atoms (minterms), Boolean forms and their equivalence, minterm Boolean forms, Sum of products canonical forms, Values of Boolean expressions and Boolean functions, Minimization of Boolean functions, The Karnaugh map method.([1] Chapter 4).

Module III: Graphs And Planer Graphs**;**Directed and undirected graphs, Isomorphism of graphs,Subgraph, Complete graph, Multigraphs and weighted graphs, Paths, Simple and elementary paths, Circuits, Connectedness, Shortest paths in weighted graphs, Eulerian paths and circuits, Incoming degree and outgoing degree of a vertex, Hamiltonian paths and circuits, Planar graphs, Euler's formula for planar graphs. ([2] Chapter 4).

Module IV: Trees And Cut-Sets; Properties of trees, Equivalent definitions of trees, Rooted trees, Binary trees, Path lengths in rooted trees, Prefix codes, Binary search trees, Spanning trees and Cut-sets, Minimum spanning trees. ([2] Chapter 5).

Text Books:-

[1] J P Tremblay and R. Manohar: *Discrete Mathematical Structures with applications to Computer Science*, McGraw Hill Book Company.

[2] C. L. Liu and D P Mohapatra: *Elements of Discrete Mathematics*, Tata McGraw Hill Publishing Company Ltd. New Delhi.

Semester	Second		
Course Name	**Numerical Analysis**		
Category: Core	Code: **MM 1205**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Transcendental & Polynomial Equations; Bisection method, Iteration methods based on First degree equation (Secant method, RegulaFalsi method, Newton Raphson method), Rate of Convergence, Iteration methods, Birge –Vieta method, Bairstow method. ([1] Chapter 2).

Module II: System of Linear Algebraic Equations and Eigen Value Problems; Iteration methods (Jacobi iteration method, Gauss seidel iteration method), Convergence analysis, Matrix factorization methods (Doo little reduction, Crout reduction), Eigen values and eigenvectors, Householder's method for symmetric matrices, Power method. ([1] Chapter 4, 5).

Module III: Finite difference operators, Newton's formulae forinterpolation, Gauss formula for Interpolation, Lagranges and Newtons divided difference formulae for interpolation, Numerical differentiation; Methods based on interpolation, Numerical integration; Newton cotes methods, Trapezoidal rule, Simpson's 1/3 rd, 3/8thrule. ([1] Chapter 6).

Module IV: Numerical Solution of Differential Equations; Euler's method, Analysis of Euler's method, Backward Euler's method, Order of Euler's method, Explicit Runge–Kutta method of order two and four, Taylor series method, Convergence and stability of numerical methods. ([1] Chapter 3, 7).

Text Book:

[1] M. K. Jain, S. R. K. Iyengar and R. K. Jain: *Numerical methods for scientific and Engineering Computation*, New Age International Limited Publishers, 2012.

References Books:

[1] M. K. Jain: *Numerical Mathematics, Numerical solutions of Differential Equations*.

[2] S. S. Sastry: *Introductory methods of Numerical Analysis*, Prentice Hall of India New Delhi

Semester	Third		
Course Name	**Complex Analysis**		
Category: Core	Code: **MM 1301**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Integration and differentiation of power series, Absolute and uniform convergence of power series, Linear transformations, The transformation $w = 1/z$, Möbius transformations and its geometric properties, Conformal mappings, Schwarz theorem, Riemann mapping theorem and its applications. (Chapter 5, 8, 9[1]).

Module II: Branch point, Branch cut, Branches of a multi-valued function, Analyticity of the branches of L$og\ z, z^a$,Singularities and their classification, Weierstrass-Casorati's theorem.(Chapter 2, 3[1]).

Module III: Residue calculus, Zeros, Poles and meromorphic functions, Cauchy residue theorem, Argument principle, Rouche's theorem.(Chapter 6, 7[1]).

Module IV: Jordan's lemma, Evaluation of proper and improper integrals, Integration along a branch cut, Analytic continuation, Schwarz reflection principle, Monodromy theorem.(Chapter 2, 7[1]).

Text Book:

[1] J.W Brown and R.V. Churchill: *Complex Variables and Applications*, Tata McGraw Hill, 8th Edition, 2009.

Recommended Books:

[1] E.C. Titchmarsh: *The Theory of Functions*, Oxford University Press.

[2] J.B. Conway: *Functions of One Complex Variable*, Narosa Publishing House, 1980.

[3] E.T. Copson: *Complex Variables*, Oxford University Press.

[4] L.V. Ahlfors: *Complex Analysis*, McGraw-Hill, 1977.

[5] D. Sarason: *Complex Function Theory*, Hindustan Book Agency, Delhi, 1994.

[6] S.Ponnusamy: *Foundation of complex analysis*, Narosa publication, 2003.

Semester	Third		
Course Name	**Special Functions**		
Category: Core	Code: **MM 1302**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Infinite products: Introduction, definition of an infinite product, a necessary condition for convergence, the associated series of logarithms, absolute convergence, uniform convergence. (Chapter 1 – Sections 1 to 6)

The Gamma and Beta functions:- The Euler and Mascheroni constant γ , the Gamma function, a series for Γ' (*z*) / Γ (*z*), evaluation of Γ (1) and Γ'(1), the Euler product for Γ (*z*), the difference equation Γ (*z* + 1) = *z* Γ (*z*), the order symbols o and O, evaluation of certain infinite products, Euler's integral for Γ (*z*), the Beta function, the value of Γ (*z*) Γ (1 - *z*), the factorial function, Legendre's duplication formulae, Gauss' multiplication theorem, a summation formula due to Euler, the behavior of log Γ (*z*) for large |*z*|. (Chapter 2 – Sections 7 to 22)

Module II: The hypergeometric function: The function *F* (*a*, *b*, *c*, *z*), a simple integral form, *F* (*a*, *b*, *c*, 1) as a function of the parameters, evaluation of *F* (*a*, *b*, *c*, 1), the contiguous function relations, the hypergeometric differential equation, logarithmic solution of the hypergeometric equation, *F* (*a*, *b*, *c*, *z*) as a function of its parameters, elementary series multiplications, simple transformations, relation between functions of *z* and 1 – *z*. (Chapter 4 – Sections 29 to 39)

Module III: Generalized Hypergeometric Functions: The function ${}_pF_q$, the exponential and binomial functions, a differential equation, other solutions of the differential equation, the contiguous function relations, a simple integral, the ${}_pF_q$ with unit argument (Chapter 5 – Sections 44 to 50). The Confluent Hypergeometric Functions: Basic properties of the ${}_1F_1$, Kummer's first formula, Kummer's second formula. (Chapter 7 - Sections – 68 to 70)

Module IV: Legendre Polynomials: A generating function, Differential recurrence relations, the pure recurrence relation, Legendre's differential equation, the Rodrigue's formula, Bateman's generating function, additional generating functions, Hypergeometric

forms of $p_n(x)$, Brafman's generating function, special properties of $p_n(x)$. (Chapter 10 – Sections 86 to 95)

Hermite Polynomials: Definition of $H_n(x)$, recurrence relations, the Rodrigue's formula, other generating functions, integrals. Chapter 11 - Sections – 103 to 107)

Text Book:

[1] Earl. D. Rainville, Special functions, Chelsa Publishing Company, New York, 1060

Recommended Books:

[2] G.E. Andrews, R. Askey, R. Roy, Special .Functions, Encyclopedia of Mathematics and its Applications 71, Cambridge University Press, Cambridge.1999.

[3] E.T. Copson, *An Introduction to the theory of the functions of a complex variable*, Oxford University Press, 1935.

[4] M.A. Pathan, V.B.L.Chaurasia, P.K.Banerji, M.C.Goyal , Special Functions and Calculus of Variations, Ramesh Book Depot, New Delhi, 2007.

[5] Z.X. Wang, D.R. Guo, Special Functions, World Scientific Publishing Company, London, 1989.

[6] N.M. Temme, Special Functions – An Introduction to the Classical Functions of Mathematical Physics, John Wiley & Sons, New York, 1996.

[7] A.M. Mathai, H.J. Haubold, Special Functions for Applied Scientist, Springer, New York, 2008.

Semester	Third		
Course Name	**Differential Geometry of Manifolds**		
Category: Core	Code: **MM 1303**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Definition and examples of differentiable manifolds, Tangent spaces, Vector fields, Jacobian map, Distributions, Hypersurface of R^n.(Chapter 1, 2[1]).

Module II: Standard connection on R^n, Covariant derivative, Sphere map, Weingarten map, Gauss equation, The Gauss curvature equation and Coddazi-Mainardi equations.(Chapter 2[1]).

Module III: Invariant view point, Cartan view point, Coordinate view point, Difference tensor of two connections, Torsion and curvature tensors. (Chapter 3[1]).

Module IV: Riemannian Manifolds, Length and distance in Riemannian manifolds, Riemanian connecton and curvature, Curves in Riemannian manifolds, Submanifolds.(Chapter 6[1]).

Text Book:

[1] N.J. Hicks: *Notes on Differential Geometry*, D. Van Nostrand, 1965.

Recommended Books:

[1] S.S. Chern, W.H. Chen and K.S. Lam: *Lectures on Differential Geometry*, World Scientific, 2000.

[2] E.J. Flaherty: *Hermitian and Kahlerian Geometry in Relativity*, LNP 46, Springer, 1976.

[3] Y. Matsushima: *Differentiable Manifolds*, Dekker, 1972.

Semester	Third		
Course Name	**Mathematical Methods**		
Category: Core	Code: **MM 1304**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Volterra integral equations, Basic concepts, Relationship between linear differential equations and Volterra integral equations, Resolvent kernel of Volterra integral equation, Solution of integral equations by resolvent kernel, The method of successive approximations, Convolution type equations, Solution of integral differential equations with the aid of Laplace transformation. (Chapter 1[1]).

Module II: Fredholm integral equations, Fredholm equations of the second kind, Iterated kernels, Constructing the resolvent kernel with the aid of iterated kernels, Integral equations with degenerate kernels, Characteristic numbers and eigen functions, Solution of homogeneous integral equations with degenerate kernel, Non homogeneous symmetric equations, Fredholm alternative. (Chapter 1, 2[1]).

Module III: Calculus of variations, Extrema of functionals, The variation of a functional and its properties, Euler's equation, Field of extremals, Sufficient conditions for the extremum of functional conditional extremum, Moving boundary problems, Discontinuous problems, One sided variations, Ritz method. (Chapter 1, 5[2]).

Module IV: The problem of minimum surface of revolution, Minimum energy problem, Brachistochrone problem, Variational problems involving several functions, Isoperimetric problem, Euler's equations in two dependent variables, Variational problems in parametric form, Functional dependent on higher order derivatives, Euler Poisson equation. (Chapter 1, 2, 5[2]).

Text Book:

[1] R.P. Kanwal: *Linear Integral Equations*, Birkhäuser, Inc., Boston, MA, 1997.

[2] L.E. Elsgolts: *Differential Equation and Calculus of Variations*, Pergamon Press, Poland.

Recommended Books:

[1] J.W. Brown and R.V. Churchill: *Fourier Series and Boundary Value Problems*, McGraw Hill, 8th Edition, 2011.

[2]A. Chakraborty: *Applied Integral Equations*, Tata McGraw Hill, 2008.

[3] Zafar Ahsan: *Differential Equations and their Applications*, Prentice Hall of India, New Delhi, 2012.

Semester	Fourth		
Course Name	**Theory of Operators**		
Category: Core	Code: **MM 1401**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Spectrum, Basic concepts, Point, Continuous and residue spectrum, Approximate point spectrum and compression spectrum, Spectral mapping theorem for polynomials, Uniform, Strong and weak operator on convergence on the space of bounded linear operators. (Chapter 7[1]).

Module II: Compact linear operators and its properties, Adjoint of compact operators, Spectral properties of compact operators, Fredholm theory of compact operators and operator equations. (Chapter 8[1]).

Module III: Spectral properties of self-adjoint of linear operators, Positive operators and their properties, Projection operators and their properties, Spectral representation of self-adjoint compact operator, Spectral family of self-adjoint operator, Spectral representation of self-adjoint operator, Continuous functions of self-adjoint operator, Properties of spectral family of a bounded self-adjoint operator. (Chapter 9[1]).

Module IV: Polar decomposition, Singular values, Traces class operators, Trace norm and trace Hilbert-Schmidt operators. (Chapter 11[1]).

Text Book:

[1]E. Kreyszig: *Introductary Functional Analysis with Applications*, John Wiley and Sons, 2001.

Recommended Books:

[1] Rajendra Bhatia: *Notes on Functional Analysis, Texts and Reading in Mathematics,* Hindustan Book Agency,2009.

[2] J.E. Conway: *A Course inFunctionalAnalysis*, Springer, 1990.

[3] Y. Eidelrnan, V. Miknan and A. Tsolomitis: *Functional Analysis, An Introduction*, American Mathematical Society, 2004.

[4] P.D. Lax: *Functional Analysis*, John Wiley and Sons, 2002.

Semester	Fourth		
Course Name	**Fluid Mechanics**		
Category: Core	Code: **MM 1402**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: General orthogonal curvilinear coordinates, Kinematics, Lagrangian and Eulerian methods, Equation of continuity, Boundary surface, Stream lines, Path lines and Streak lines, Velocity potential, Irrotational and rotational motions, Vortex lines.(Chapter 1, 2[1]).

Module II: Equation of motion, Lagrange's and Euler's equation of motion, Bernoulli's theorem, Stream functions,Irrotational motion in twodimensions, Complex velocity potential sources, Sinks, Doublets and their images, Milne-Thompson circle theorem.(Chapter 3, 4, 5[1]).

Module III: Two dimensional irrotational motions 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.(Chapter 5[1]).

Module IV: Stress components in a real fluid, Relation between rectangular components of stress, Connection between stresses and gradient of velocity,Navier-Stoke'sequations of motion, Plane Poiseulle and Couette flows between two parallel plates.(Chapter 8[1]).

Text Book:

[1]F.Chorlton: *Text book of Fluid Dynamics*, CBS Publishers, Delhi, 1985.

Recommended Books:

[1] W.H. Besaint and A.S. Ramsay: *A Treatise on Hydromechanics*, Part-II CBS Publishers, Delhi, 1988.

[2] S.W. Yuan, *Foundations of Fluid Dynamics*, Prentice-Hall of India, 1988.

[3] T. Allen and I.L. Ditsworth: *Fluid Mechanics*, McGraw Hill, 1972.

[4] I.G. Currie: *Fundamentals of Mechanics of Fluids*, CRC, 2002.

[5] F.M. White: *Fluid Mechanics*, McGraw Hill, 2003.

[6] R.W. Fox, A.T. McDonald and P.J. Pritchard: *Introduction to Fluid Mechanics*, John Wiley and Sons, 2003.

Semester	Third		
Course Name	**Probability & Statistics**		
Category: **DSE I**	Code: **MME 1301**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Sample space, Probability axioms, Mathematical expectation, Expectation of product of independent random variables, Expectation of a liner combination of random variables, Cauchy-Schwarz Inequality, Characteristic function, Discrete distributions: Uniform, Geometric, Negative binomial. Continuous distributions: Logarithmic normal distribution, Exponential distribution.(Chapter 4, 5, 6, 7 [1]).

Module II: Joint cumulative distribution function and its properties, Joint probability density function, Marginal and conditional distributions, Expectation of the function of two random variables, Conditional expectation, Independent random variable, Bivariate normal distribution, Joint moment generating function (jmgf) and calculation of covariance from jmgf. (Chapter 5, 12, 13[1]).

Module III: Time series analysis: Concept, Component of time series – Trend, Seasonality, Moving averages, Index number: Meaning, Types of index number, Usages of index numbers, Constructions of indices – Price, Quality and volume, Fixed base and chain base methods.(Chapter 24, 25[2]).

Module IV: Estimation, point estimation, Unbiasedness, Consistency, Efficiency and sufficiency of estimators, Factorization criterion, Maximum likelihood method of moments, Interval estimations. (Chapter 17 [2]).

Text Book:

[1] J.N. Kapur and H.C. Saxena: *Mathematical Statistics*, S. Chand Publishers.

[2] A.M. Goon, M.K. Gupta and B. Dasgupta: *Fundamental of Applied Statstics*, World Press, India.

Recommended Books:

[1] I. Miller, M. Miller and J.E. Freunds: *Mathematical Statistics with Applications*, 7th Edition, Prentice Hall, 2006.

[2] R.V. Hogg, J. McKean and A. Craig: *Introduction to Mathematical Statistics*, 7th Edition, Pearson Education, 2006.

[3] C.R. Rao: *Linear Statistical Inference and its Applications*, 2nd Edition, Wiley Eastern Ltd., 2002.

[4] A. Papoulis and S.U. Pillai: *Probability, Random Variables and Stochastic Processes*, 4th Edition, Tata McGraw-Hill, 2002.

Semester	Third		
Course Name	**Numerical Solutions of Partial Differential Equations**		
Category: **DSE I**	Code: **MME 1302**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Numerical solutions of parabolic PDE in one space: Two and three levels explicit and implicit difference schemes, Convergence. (Chapter 1, 2[1]).

Module II: Numerical solution of parabolic PDE of second order in two space dimension: Implicit methods, Alternating direction implicit (ADI) methods, Nonlinear initial BVP, Difference schemes for parabolic PDE in spherical and cylindrical coordinate systems in one dimension.(Chapter 2[1]).

Module III: Numerical solution of hyperbolic PDE in one and two space dimension: Explicit and implicit schemes, ADI methods, Difference schemes for first order equations.(Chapter 3[1]).

Module IV: Numerical solutions of elliptic equations, Approximations of Laplace and biharmonic operators, Solutions of Dirichlet, Neumann and mixed type problems.(Chapter 4[1]).

Text Book:

[1] M.K. Jain, S.R.K. Iyenger and R.K. Jain: *Computational Methods for Partial Differential Equations*, New Age Publication, 1994.

Recommended Books:

[1] M.K. Jain: *Numerical Solution of Differential Equations*, 2nd edition, Wiley Eastern.

[2] S.S. Sastry: *Introductory Methods of Numerical Analysis*, Prentice-Hall of India, 2002.

[3] D.V. Griffiths and I.M. Smith: *Numerical Methods of Engineers*, Oxford University Press, 1993.

[4] C.F. General and P.O. Wheatley: *Applied Numerical Analysis*, Addison- Wesley, 1998.

Semester	Third		
Course Name	**Classical Mechanics**		
Category: **DSE I**	Code: **MME 1303**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Variationalprinciple and Lagrange's equations: Hamilton's principle, Some techniques of calculus of variations, Derivation of Lagrange equations from Hamilton's principle, Extension of principle to nonholonomic systems, Conservation theorems and symmetry properties.(Chapter 1, 2[1]).

Module II: Legendre transformations and the Hamilton equations of motion, Cyclic coordinates and conservation theorems, Routh's procedure and oscillations about steady motion, The Hamiltonian formulation of relativistic mechanics, The Principle of least action.(Chapter 8[1]).

Module III: The equations of canonical transformation, Examples of canonical transformation, The symplectic approach to canonical transformations, Poisson brackets and other canonical invariants.(Chapter 9[1]).

Module IV: Equations of motion, Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The angular momentum, Poisson bracket relations, Symmetry groups of mechanical systems,Liouville's theorem.(Chapter 9[1]).

Text Book:

[1] H. Goldstein: *Classical Mechanics*, Second Edition, Narosa publishing house, New Delhi.

Recommended Books:

[1] F. Gantmacher: *Lectures in Analytic Mechanics*, MIR Publishers, Moscow, 1975.

[2] N.C. Rana and P.S.C. Jog: *Classical Mechanics*, Tata McGraw-Hill.

Semester	Fourth		
Course Name	**Graph Theory**		
Category: **DSE I**	Code: **MME 1304**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Graph and Trees:Introduction of graph, Operations on graphs, Trees and their properties, Pendent vertex in a tree, Distance and centers in a tree, Rooted and binary trees, Counting trees, Spanning trees, Spanning trees in a weighted graph, Fundamental circuits. (Chapter 2, 3[1]).

Module II: Graph Representation: Matrix representation of graphs, Incidence matrices, Sub matrix of A(G), Circuit matrix, Fundamental circuit matrix, Cut set and cut set matrix, Relations among A_f, B_f and C_f- path matrix and adjacency matrix, Vector space associated with a graph, Basis vector of a graph, circuit and cut set subspaces. (Chapter 5, 6[1]).

Module III: Graph Coloring: coloring, covering and partitioning of graphs, Chromatic number, Chromatic partitioning, Chromatic polynomial, matching, Covering and the four color problem, Five color problem. (Chapter 7, 8[1]).

Module IV: Application: Applications of graph theory, Signal flow-graphs, Graphs in Markov process, Graphs in computer programming, Graphs in chemistry. (Chapter 15[1]).

Text Book:

[1] Narsing Deo: *Graph Theory with application to Engineering and computer science*, Prentice Hall of India.

Recommended Books:

[1]D.B. West: *Introduction to Graph Theory*, Prentice Hall India, 2nd Edition, 2009.

[2] J. Clark and J.A. Holton: *A First Look at Graph Theory*, World Scientific 1991.

[3] J.M. Aldous, R.J. Wilsonand S. Best: *Graphs and Applications: An Introductory Approach*, Springer, 2003.

[4]R. Deistel: *Graph Theory*, Springer, 4thEdition, 2010.

Semester	Fourth		
Course Name	**Operations Research**		
Category: **DSE II**	Code: **MME 1401**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Linear programming problems (LPP), Formulation of a LPP, Graphical method, Simplex method, Big-M method, Two phase method, Dual simplex method, Primal dual problem, Integer programming, Dynamic programming. (Chapter 3, 4, 9, 10[1]).

Module II: Assignment and Transportation problems and algorithm, Optimal solution, Replacement problem, Game Theory: Two persons zero sum games, The maxmin and minimax principles. Games without saddle points, Dominance property, Graphical solution of two person's game.(Chapter 5, 13[1]).

Module III: CPM and PERT network diagram, Events and activities, Project planning reducing critical events and activities, Critical path, Resources and man power leveling, Sequencing problems, Travelling salesman problems, Machine-scheduling problem. (Chapter 6[1]).

Module IV: Non-linear programming: Mathematical formulation, Constrained optimization, Kuhn Tucker conditions of optimality, Quadratic programming, Beale method, Wolfe method.(Chapter 18, 19[1]).

Text Book:

[1] H.A. Taha: *Operations Research – An Introduction*, Pearson Prentice Hall, 2007.

Recommended Books:

[1] F.S. Hiller and G.J. Leiberman: *Introduction to Operations Research*, 6th Edition, McGraw-Hill, International Edition, 1995.

[2] G. Hadley: *Nonlinear and Dynamic Programming*, Addison Wesley.

[3]Kanti Swarup, P.K. Gupta and M. Mohan: *Operations Research*, Sultan Chand & Sons, New Delhi.

[4] S.S. Rao: *Optimization Theory and Applications*, Wiley Eastern.

[5] N.S. Kambo: *Mathematical Programming Techniques*, Affiliated East-West Press Pvt. Ltd., New Delhi.

Semester	Fourth		
Course Name	**Mathematical Modeling**		
Category: **DSE II**	Code: **MME 1402**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Simple situations requiring mathematical modeling, Techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models, Some simple illustrations. (Chapter 1[1]).

Module II: Mathematical modeling through differential equations, Linear growth and decay models, Nonlinear growth and decay models, Mathematical modeling in dynamics through ordinary differential equations of first order. (Chapter 2[1]).

Module III: Mathematical models through graphs, Mathematical models in terms of directed graph, Mathematical models in terms of singed graphs, Mathematical models in terms of weighted digraphs. (Chapter 7[1]).

Module IV: Mathematical modeling through linear programming, Linear programming models in Transportation and assignment. (Chapter 10[1]).

Text Book:

[1] J.N. Kapur: *Mathematical Modeling*, New Age International Publisher, 2005.

Recommended Books:

[1] D.N. Burghes: *Mathematical Modeling in the Social Management and Life Science*, Ellie Herwood and John Wiley.

[2] F. Charlton: *Ordinary Differential and Difference Equations*, Van Nostrand.

Semester	Fourth		
Course Name	**Fuzzy Mathematics**		
Category: **DSE II**	Code: **MME 1403**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Classical and Fuzzy sets: Crisp sets, Crisp relation, Maxmin composition, Properties of membership function, Fuzzy sets and their basic concepts, Operations on fuzzy sets, Fuzzy arithmetic, Fuzzy relations, Fuzzy relation equations based on sup–i composition and Inf–i composition, Fuzzification and Defuzzification.(Chapter 2, 3[1]).

Module II: Possibility theory and fuzzy sets: Possibility theory, Fuzzy measure, Evidence theory, Fuzzy sets and possibility theory. (Chapter 1, 15[1]).

Module III: Fuzzy and Classical logic: Multivalued logic, Fuzzy propositions, Fuzzy quantifiers, Inference from conditional fuzzy propositions, Fuzzy statistical process control. (Chapter 5, 8, 10[1]).

Module IV: Uncertainty based Information: Information and Uncertainty, Non specificity of Crisp sets, Non specificity of Fuzzy sets, Fuzziness of Fuzzy sets, Fuzzy sets in Business management, Psychology, Foods and nutrition with good number of case studies.(Chapter 1, 8, 13[1]).

Text Book:

[1] T.J. Ross: *Fuzzy Logic with Engineering and Applications*,Wiley Student Edition, 2010.

Recommended Books:

[1]B.M Ayyub and L.N. Kanal: *Analysis and Management of Uncertainty: Theory and Application*, North Holland, New York, 1992.

[2] W. Bandler and W. Nather: *Fuzzy Data Analysis*, Kluwer Academic Press, 1996.

[3] A. Wesley: *Fuzzy Mathematical Techniques with Applications*, 1985.

[4] J.K. George: *Fuzzy Sets and Fuzzy Logic, Theory and Applications*, Yuan Prentice Hall,2006.

Semester	Fourth		
Course Name	**Structures on Even Dimensional Differentiable Manifolds**		
Category: **DSE II**	Code: **MME 1404**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Almost complex manifolds, Nijenhuis tensor, Contravariant and covariant analytic vector, Almost Hermite manifold, Almost analytic vector fields curvature tensors, linear connections.(Chapter 2, 3[1]).

Module II: Kahler manifolds, Affine connections, Curvature tensors, Contravariant almost analytic vectors.(Chapter 4[1]).

Module III: Nearly Kahler manifold, Curvature identities, Curvature tensors, Almost analytic vectors.(Chapter 5[1]).

Module IV: Almost Kahler manifolds, Analytic vectors conformal transformations, Curvature identities.(Chapter 6[1]).

Text Book:

[1] R.S. Mishra, *Structures on a Differentiable Manifold and their Applications*, Chandrama Prakashan, Allahabad.

Recommended Books:

[1] K. Yano and M. Kon: *Structures on Manifolds*, World Scientific Publishing Company, 1984.

Semester	Fourth		
Course Name	**Artificial Intelligence**		
Category: **DSE III**	Code: **MME 1405**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: AI: Definition, Introduction to AI techniques, Problem spaces and search state space search problem, Production system, Problem characteristics, Heuristic search, Generate and test Hill climbing, Breadth first search, Problem reduction, Constraint satisfaction, Knowledge representation issues, Representation using predicate logic, Predicate logic unification, Resolution. (Chapter 1, 2, 3, 4[1]).

Module II: Procedural vs. Declarative knowledge, Logic programming, Forward vs. Backward Reasoning, Matches-Declarative knowledge representation, Semantic Nets, Frames, Conceptual dependency scripts, CYC–Symbolic reasoning under uncertainty, Non-Monotonic reasoning, Logic for non-monotonic reasoning, Implementation of depth first search and breadth first search, Statistical reasoning, Certainty factors and rule based systems, Bayesian networks, Dempster Shafer theory, Fuzzy logic. (Chapter 6, 7, 8[1]).

Module III: Game playing, Minimax search, Alpha beta heuristics, Refinement iterative deepening Planning, Components, Goal stack planning, Nonlinear planning, Hierarchical planning, Learning, Rote learning, Learning by taking advice, Learning from examples, Explain based learning, Connectist models, Natural language processing, Syntax, Semantic and pragmatic processing perception, Expert system representation and using domain knowledge. (Chapter 12, 13, 15[1]).

Module IV: The brain as a dynamical system, Neurons as functions, Signal monotonicity Biological activations and signals, Neuron fields, Neural networks and its applications, Theory of fuzzy sets, Definition, Dilation, Concentration, Normalization, Reasoning with fuzzy logic, Natural language computations, Fuzzy matching algorithms. (Chapter 22, 23, 24[1]).

Text Books:

[1] E. Rich, K. Knight and S.B. Nair, *Artificial Intelligence: A Modern Approach*, McGraw-Hill, International Edition, 2009.

Recommended Books:

[1] D.W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, Prentice Hall of India.

[2] W.F. Clocksin and C.S.Mellish, *Programming in PROLOG*, Spinger International Student Edition, 2003.

[3] S. Russel and P. Norving, *Artificial Intelligence: A Modern Approach*, Prentice Hall International Editions Series, 1995.

Semester	Fourth		
Course Name	**Dynamical System**		
Category: **DSE III**	Code: **MME 1406**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Fixed points and stability, Population growth, Linear stability analysis,Existence and Uniqueness, Impossibility of oscillations.(Chapter 2 [1]).

Module II: Saddle-Node Bifurcation, Trans critical bifurcation, Pitch forkbifurcation, Over damped bead on a rotating hoop, Imperfect bifurcations and catastrophes.(Chapter 3[1]).

Module III: Linear systems: Definitions and examples, Classification of linear systems, Love affairs. Phase plane, Phase portraits, Existence and uniqueness and topological consequences, Fixed points and linearization, Rabbits versus sheep, Conservative systems, Reversible systems, Pendulum.(Chapter 5, 6[1]).

Module IV: Limit cycles: Ruling out closed orbits, Point care Bendixson thermo,Lienard systems Relaxation oscillators, Weakly, Non- linear oscillators.(Chapter 7[1]).

Text Book:

[1] Steven H. Stogatz: *Nonlinear Dynamics and Chaos,* Perseus Books Publishing, LLC.

Recommended Books:

[1] Robert C. Hilborn: *Chaos and Nonlinear Dynamics,* Oxford University Press.

Semester	Fourth		
Course Name	**Financial Mathematics**		
Category: **DSE III**	Code: **MME 1407**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Some basic definitions and terminology, Basic option theory: Single and multi-period binomial pricing models, Cox-Ross-Rubinstein (CCR) model, Black Scholes formula for potion pricing as a limit of CCR model.(Chapter 6, 7[1]).

Module II: Brownian ad Geometric Brownian Motion, Theory of Martingales, Stochastic Calculus, Stochastic differential equations, Ito's formula to solve SDE's, Feymann Kac theorem, Application of stochastic calculus in option pricing, Black Scholes partial differential equations and Black Scholes formula.(Chapter 7, 8, 9[1]).

Module III: Mean variance portfolio theory: Markowitz model for Portfolio optimization and Capital Asset Pricing Model (CAPM).(Chapter 9[1]).

Module IV: Interest rates and interest rate derivatives: Binomial lattice model, Vasicek, Hull and white and Cox-Ingersoll-Ross (CIR) model for bond pricing.(Chapter 10[1]).

Text Book:

[1] S.Ross:*An Introduction to Mathematical Finance,* Cambridge University press, 1999.

Recommended Books:

[1] D.G. Luembergar: *Investment Science,* Oxford University press, 1999.

[2] J.C.Parikh: *Stochastic Process and Financial Markets*, Narosa Publishing House, New Delhi,2003.

[3] S. Roman: *An Introduction to Mathematics of Finance*, Springer, 2000.

Semester	Fourth		
Course Name	**Structures on Odd Dimensional Differentiable Manifolds**		
Category: **DSE III**	Code: **MME 1408**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Almost contact manifold, Lie derivative, Affinely almost Co-Symplectic manifold.(Chapter 8[1]).

Module II: Almost Grayan manifold, Almost Sasakian manifold, K-contact Riemannian manifold, Properties of curvature on these manifolds.(Chapter 9[1]).

Module III: Co-symplectic structure, F- structure manifold. (Chapter 10, 11[1]).

Module IV: Submanifolds of almost Hermite manifolds and Kahler manifolds, Almost Grayan submanifolds.(Chapter 6, 9[1]).

Text Book:

[1] R.S. Mishra, *Structures on a Differentiable Manifold and their Applications*, Chandrama Prakashan, Allahabad.

Recommended Books:

[1] K. Yano and M. Kon: *Structures on Manifolds*, World Scientific Publishing Company, 1984.