BABU BANARASI DAS UNIVERSITY, LUCKNOW

M. Sc. (Mathematics)

Learning Outcomes Based Curriculum

Course Structure & Evaluation Scheme

(Effective from 2021-22 and After)

Course	Code	Title	Teaching			Evaluation					Credits
						Theory		Lab/Seminar/ Viva Voce/ Thesis		Total	
			L	T	P	CIA	ESE	CIA	ESE		
SEMESTER – I											
Core	MM2101	Algebra	3	1	-	40	60	-	-	100	4
Core	MM2102	Real Analysis	3	1	-	40	60	-	-	100	4
Core	MM2103	Topology	3	1	-	40	60	-	-	100	4
Core	MM2104	Ordinary and Partial DifferentialEquations	3	1	-	40	60	-	-	100	4
Core	MM2105	Programming in C	4	-	-	40	60	-	-	100	4
SEC	MM2151	Programming in C Lab	-	-	2	-	-	40	60	100	1
											21
SEMESTER – II											
Core	MM2201	Advance Algebra	3	1	-	40	60	-	-	100	4
Core	MM2202	Advance Real Analysis	3	1	-	40	60	-	-	100	4
Core	MM2203	Functional Analysis	3	1	-	40	60	-	-	100	4
Core	MM2204	Discrete Mathematics	3	1	-	40	60	-	-	100	4
Core	MM2205	Numerical Analysis	3	1	-	40	60	-	-	100	4
											20
SEMESTER – III											

Core	MM2301	Complex Analysis	3	1	-	40	60	-	-	100	4
Core	MM2302	Special Functions	3	1	-	40	60	-	-	100	4
Core	MM2303	Differential Geometry of Manifolds	3	1	-	40	60	-	-	100	4
Core	MM2304	Mathematical Methods	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective - I	3	1	-	40	60	-	-	100	4
SEC	MM S23	Seminar	-	-	-	-	-	100	-	100	1
											21
SEMESTER – IV											
Core	MM2401	Theory of Operators	3	1	-	40	60	-	-	100	4
Core	MM2402	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
SEC	MM T14	Thesis						50	50	100	4
VV	MM V14	Viva Voce	-	-	-	-	-	-	100	100	2
											22

Discipline Specific Elective – I	
MME2301	Probability & Statistics
MME2302	Numerical Solution of PDE
MME2303	Approximation Theory
Discipline Specific Elective – II	
MME2401	Operations Research
MME2402	Mathematical Modeling
MME2403	Fuzzy Mathematics
Discipline Specific Elective – III	
MME2405	Classical Mechanics
MME2406	Dynamical System
MME2407	Financial Mathematics

Semester	First		
Course Name	**Algebra**		
Category: Core	Code: **MM2101**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I

Normal Series, Jordan-Holder theorem, 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 6 & 8)

Module II

Ideals: Sum and direct sum of ideals, Maximal and prime ideals, Nilpotentand 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 andexamples, submodules and direct sums, R-homomorphism and quotient module, completely reducible modules, Free modules. ([1] Chapter 12 &14)

Recommended Books:

1. Bhattacharya, Jain and Nagpal: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
2. I. N. Herstein: Topics in algebra, Wiley Eastern Limited, 1975.
3. John B. Fraleigh: A first course in Abstract Algebra (3rd Edition), Narossa PublishingHouse.
4. I.S. Luther and I.B.S. Passi: Algebra, Vol. I- Groups, Vol. II- Rings, NarossaPublishing House, (Vol. I -1996, Vol. II-1999).
5. N. Jacbson: Basic Algebra, Hind. Pub. Corp, 1984.
6. VivekSahai and VikasBist: Algebra, Narosa Publishing House, 1997.
7. M. Artin: Algebra, Prentice-Hall of India, 1991

Semester	First		
Course Name	**Real Analysis**		
Category: Core	Code: **MM2102**		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 the integral, 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).

Recommended Books

1. Walter Rudin, *Principle of Mathematical Analysis* (3rd edition) McGraw-HillKgakusha, 1976, International Student Edition.
2. K. Knopp, *Theory and Application of Infinite Series.*
3. T. M. Apostol, *Mathematical Analysis,* Narosa Publishing House, New Delhi, 1985.
4. I. P. Natanson: Theory of Functions of a Real Variable, Volume 1, FrederickPub. Co., 1964
5. H. L. Royden: Real Analysis, McMillan Publication Co. Inc. New York

Semester	First		
Course Name	**Topology**		
Category: Core	Code: **MM2103**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I

Topological spaces & Continuous functions: Topological spaces, Basis for a **Topology,** The order topology, The product topology of X ×Y, The Subspace Topology, Closed sets and Limit points , Continuous function , The Product Topology. ([1] Chapter2)

Module II

Connectedness and compactness: connected spaces, connected subspaces of the real line, Components and Local connectedness, compact spaces, compact subspace of real line, Limit Point compactness, Local compactness. ([1] Chapter 3)

Module III

Countability and Separation of Axioms: The Countability Axioms, The Separation Axioms, Normal spaces, The Urysohn Lemma, The Urysohn Metrization Theorem, The Tietze Extension Theorem,([1] Chapter 4)

Module IV

The Tychonoff Theorem: The Tychonoff Theorem, The Stone-Cech Compactification, Local Finiteness, The Nagata-Smimov Metrization Theorem. ([1] Chapter 5,6)

Recommended Books

1. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd. NewDelhi
2. G. F. Simmons , Introduction to topology and TS modern analysis, McGraw- Hill Book Company.
3. Willard : Topology, Academic press

Semester	First		
Course Name	**Ordinary and Partial Differential Equations**		
Category: Core	Code: **MM 2104**	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, Operator Methods for Finding Particular Solutions ([1] Chapter 3, 4, 13)

Module II

Fourier series and orthogonal functions: The Fourier coefficients, The Problem of convergence, Even and Odd Functions. Cosine and Sine Series, Extension to arbitrary intervals, Orthogonal functions, The mean convergence of Fourier series ([1] Chapter 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).

Recommended Books:

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

Semester	First		
Course Name	**Programming in C**		
Category: Core	Code: **MM 2105**	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

Recommended Books:

1. E Balaguruswamy, Computer Concepts and Programming in C, TataMcGraw Hill Publications
2. Yashavant P. Kanetkar, ‖Let UsC , BPB Publications
3. Jeri R. Hanly, Elliot B.Koffman, Problem Solving and ProgramDesign in C, PearsonAddison-Wesley
4. Behrouz A.Computer Science-A Structured Programming Approach Using C

Semester	First		
Course Name	**Programming in C Lab**		
Category: Lab	Code: **MM 2151**	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 theprime 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 textentered 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 displaysthe 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 anordered 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 usingbinary 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 TotalMarks. Create 10 students and store them in a file.
21. Write a program to retrieve the student information from file created in previous questionand 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 acceptonly 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 ascendingand 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 orderusing 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 filein the sequence show. Display the contents of output file "output.txt" on to the screen.
31. Given two ordered arrays of integers, write a program to merge the two-arrays to get anordered array.
32. WAP to display Fibonacci series using iteration.
33. WAP to calculate Factorial of a number using iteration.
34. WAP to calculate GCD of two numbers.
35. Write a program which takes 10 numbers as input and search a particular number usingbinary search.
36. 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.
37. Create a structure Student containing fields for Roll No., Name, Class, Year and TotalMarks. Create 10 students and store them in a file.
38. Write a program to retrieve the student information from file created in

previous questionand print it in following format:

Roll No. Name Marks

39. Copy the contents of one text file to another file, after removing all whitespaces.
40. Write a function that reverses the elements of an array in place. The function must acceptonly one pointer value and return void
41. 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 ascendingand descending order.
42. Write a C Program to illustrate reading of data from a File.
43. Write a C Program delete a specific line from a Text File.
44. Write a C Program to append the content of one File at the end of another.
45. 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.
46. Write a C program that reads N integer numbers and
    arrange them in ascending orderusing Bubble Sort.
47. 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 2201**	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).

Recommended Book:

1. Bhattacharya, Jain and Nagpal: *Basic Abstract Algebra* (2nd Edition), CambridgeUniversity Press, Indian Edition, 1997.
2. I.N. Herstein: *Topics in Algebra*, Wiley Eastern Limited, 1975.
3. John B. Fraleigh: *A first course in Abstract Algebra*, (3rd Edition), Narossa Publishing H.
4. I.S. Luther and I.B.S. Passi: *Algebra*, Vol. I- Groups, Vol. II- Rings, Narossa Publishing House, (Vol. I -1996, Vol. II-1999).
5. N. Jacbson: *Basic Algebra*, Hind. Pub. Corp, 1984.
6. VivekSahai and VikasBist: *Algebra*, Narosa Publishing House, 1997.
7. M. Artin: Algebra, Prentice-Hall of India, 1991

Semester	Second		
Course Name	**Advance Real Analysis**		
Category: Core	Code: **MM 2202**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I

Algebra and Sigma Algebra of sets, Borel sets, Outer measure, Measurable sets and Lebesgue measure, 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, Convergence in measure, ([1] Chapter 4).

Module III

Differentiation of a monotone functions, Functions of bounded variation; Differentiation of an integral, Absolute continuity ([1] Chapter 5)

Module IV

The L^p-spaces, The Minkowski and Holder's inequalities, Convergence and completeness, Riesz-Fischer Theorem, Bounded Linear Functional on L^p Spaces, Riesz Representation Theorem ([1] Chapter 6).

Recommended Book:

1. H. L. Royden: *Real Analysis* , Pearson Education (3rd Edition) (Low Price Edition).
2. P. R. Halmos: *Measure Theory*, Van Nostrand, 1950.
3. G. de Barra: *Measure Theory and Integration*, Wiley Eastern, 1981.
4. E. Hewitt and K. Stromberg: *Real and Abstract Analysis*, Springer, 1969.
5. P. K. Jain and V. P. Gupta: *Lebesgue Measure and Integration*, New Age International, New Delhi, 2000.
6. 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 2203**		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, Closed Graph Theorem, The conjugate of an operator, The uniform boundedness Theorem. ([1] Chapter 9).

Module III: Pre-Hilbert space and Hilbert spaces; The definition and some simple properties, Orthogonal complements, orthogonal sets, the conjugate space H*. ([1] Chapter 10, [2] Chapter 3).

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

Recommended Book:

1. G. F Simmons: Introduction to Topology & Modern Analysis (McGraw Hill).
2. E.Kreyszig: Introductory Functional Analysis, John-wiley and Sons, New York, 1978.

Semester	Second		
Course Name	**Discrete Mathematics**		
Category: Core	Code: **MM 2204**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I

Partially ordered set, Hasse Diagram, Lattices, Boolean functions, Representing Boolean function, Logic Gates, Minimization of Circuits ([1] Chapter 9, 12)

Module II

Languages and Grammars, Finite-State Machines with Output, Finite-State Machines with No Output, Language Recognition, Turing Machines. ([1] Chapter 13)

Module III

Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. ([1] Chapter 10).

Module IV

Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees ,Minimum Spanning Trees ([1] Chapter 11).

Recommended book-

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications- Seventh Edition, Published by McGraw-Hill.
2. J. P. Tremblay and R. Manohar : Discrete Mathematics Structures with applications to Computer Science, McGraw-Hill Book Company
3. 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 2205**	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).

Recommended 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.
2. M. K. Jain: *Numerical Mathematics, Numerical solutions of Differential Equations*.
3. S. S. Sastry: *Introductory methods of Numerical Analysis*, Prentice Hall of India New Delhi

Semester	Third		
Course Name	**Complex Analysis**		
Category: Core	Code: **MM 2301**	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

Integration along a branch cut, Analytic continuation, Schwarz reflection principle, Removable and essential singular points; (Reimann theorem), Reimann surface for *Logz*, Monodromy theorem. (Chapter 2, 7[1]).

Recommended Book:

1. J.W Brown and R.V. Churchill: *Complex Variables and Applications*, Tata McGrawHill, 8th Edition, 2009.
2. E.C. Titchmarsh: *The Theory of Functions*, Oxford University Press.
3. J.B. Conway: *Functions of One Complex Variable*, Narosa Publishing House, 1980.
4. E.T. Copson: *Complex Variables*, Oxford University Press.
5. L.V. Ahlfors: *Complex Analysis*, McGraw-Hill, 1977.
6. D. Sarason: *Complex Function Theory*, Hindustan Book Agency, Delhi, 1994.
7. S.Ponnusamy: *Foundation of complex analysis*, Narosa publication, 2003

Semester	Third		
Course Name	**Special Functions**		
Category: Core	Code: **MM 2302**	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. ([1] Chapter 1 – Sections 1 to 6); The Gamma and Beta functions ([1] 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. ([1] Chapter 4 – Sections 29 to 39). The Confluent Hypergeometric Functions: Basic properties of the 1F1, Kummer's first formula, Kummer's second formula. ([1] Chapter 7 - Sections – 68 to 70).

Module III

Generating Functions, Generating functions of the form $G(2xt - t^2)$, Sets generated by $e^t \psi(xt)$, Generating functions A(t) exp (-xt/(1-t)), other class of generating functions, Boas and Buck generating functions ([1] Chapter 8, Sections – 71 to 76);

Orthogonal Polynomials: Orthogonality, zeros of orthogonal polynomials, expansion of polynomials, recurrence relations, Christoffel – Darboux formula, normalization ([1] Chapter 8, Sections – 78 to 85)

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 $p_n(x)$, special properties of pn(x). ([1] Chapter 10 – Sections 86 to 95)

Hermite Polynomials: Definition of $H_n(x)$, recurrence relations, the Rodrigue's formula, other generating functions, integrals ([1] Chapter 11 - Sections – 103 to 107).

Laguerre Polynomials: Generating functions, recurrence relations, Rodrigue's formula, orthogonality, expansion and properties . ([1] Chapter 12 - Sections – 112 to 119)

Recommended Books

1. Earl. D. Rainville, Special functions, Chelsa Publishing Company, New York, 1060
2. G.E. Andrews, R. Askey, R. Roy, Special .Functions, Encyclopedia of Mathematicsand 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 2303**	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. ([1] Chapter 1, 2)

Module II

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

Module III

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

Module IV

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

Recommended Books:

1. N.J. Hicks: *Notes on Differential Geometry*, D. Van Nostrand, 1965.
2. S.S. Chern, W.H. Chen and K.S. Lam: *Lectures on Differential Geometry*, World Scientific, 2000.
3. E.J. Flaherty: *Hermitian and Kahlerian Geometry in Relativity*, LNP 46, Springer,1976.
4. Y. Matsushima: *Differentiable Manifolds*, Dekker, 1972

Semester	Third		
Course Name	**Mathematical Methods**		
Category: Core	Code: **MM 2304**	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]).

Recommended Books:

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.
3. J.W. Brown and R.V. Churchill: *Fourier Series and Boundary Value Problems*, McGraw Hill, 8thEdition, 2011
4. A.Chakraborty: *Applied Integral Equations*, Tata McGraw Hill, 2008
5. Zafar Ahsan: *Differential Equations and their Applications*, Prentice Hall of India, New Delhi, 2012

Semester	Third		
CourseName	**Probability & Statistics**		
Category: **DSE I**	Code: **MME 2301**	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])

Recommended 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.
3. I.Miller, M. Miller and J.E. Freunds: *Mathematical Statistics with Applications*,

7th Edition, Prentice Hall, 2006.

4. R.V. Hogg, J. McKean and A. Craig: *Introduction to Mathematical Statistics*, 7th Edition, Pearson Education, 2006
5. C.R. Rao: *Linear Statistical Inference and its Applications*, 2nd Edition, Wiley EasternLtd., 2002.
6. A. Papoulis and S.U. Pillai: *Probability, Random Variables and Stochastic Processes*,4th Edition, Tata McGraw-Hill, 2002.

Semester	Third		
CourseName	**Numerical Solutions of Partial Differential Equations**		
Category: **DSE I**	Code: **MME 2302**	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 orderequations.(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])

Recommended Books:

1. M.K. Jain, S.R.K. Iyenger and R.K. Jain: *Computational Methods for Partial Differential Equations*, New Age Publication, 1994.
2. M.K. Jain: *Numerical Solution of Differential Equations*, 2nd edition, Wiley Eastern.
3. S.S. Sastry: *Introductory Methods of Numerical Analysis*, Prentice-Hall of India, 2002.
4. D.V. *Griffiths and I.M. Smith: Numerical Methods of Engineers, Oxford University Press, 1993.*
5. *C.F. General and P.O.* Wheatley: *Applied Numerical Analysis*, Addison- Wesley, 1998

Semester	Third		
CourseName	**Approximation Theory**		
Category: **DSE I**	Code: **MME 2303**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I

Metric spaces- An existence Theorem for best approximation from a compact subset; Convexity - Caratheodory's Theorem- Theorem on linear inequalities; Normed linear spaces - An existence Theorem for best approximation from finite dimensional subspaces - Uniform convexity – Strict convexity

([1] Chapter 1)

Module II

The Tchebycheff solution of inconsistent linear equations -Systems of equations with one unknown-Three algebraic algorithms; Characterization of best approximate solution for m equations in n unknowns- The special case m=n+1; Poly's algorithm.

([1] Chapter 2)

Module III

Interpolation- The Lagrange formula-Vandermonde's matrix- The error formula- Hermite interpolation; The Weierstrass Theorem- Bernstein polynomials- Monotone operators- Fejer's Theorem; General linear families- Characterization Theorem- Haar conditions- Alternation Theorem. ([1] Chapter 3)

Module IV

Rational approximation - Conversion or rational functions to continued fractions; Existence of best rational approximation- Extension of the classical Theorem; Generalized rational approximation the characterization of best approximation- An alternation Theorem- The special case of ordinary rational functions; ([1] Chapter 5). Stone Approximation Theorem, Muntz Theorem - Gram's lemma, Approximation in the Mean - Jackson's Unicity Theorem - Characterization Theorem, Marksoff's Therem ([1] Chapter 6).

Recommended books

1. EW Cheney, "*Introduction to Approximation Theory",* Mc Graw Hill
2. P.J Davis. "*Interpolation and Approximation"*, Blaisdell Publications

Semester	Fourth		
Course Name	**Theory of Operators**		
Category: Core	Code: **MM 2401**	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. ([1] Chapter 7]).

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. ([1] Chapter 8).

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. ([1] Chapter 9).

Module IV

Polar decomposition, Singular values, Traces class operators, Trace normand trace Hilbert-Schmidt operators. ([2] Chapter 19 & 23).

Recommended Books:

1. E. Kreyszig: *Introductary Functional Analysis with Applications*, John Wiley and Sons, 2001.
2. *Rajendra Bhatia: Notes on Functional Analysis, Texts and Reading in Mathematics,*
3. *Hindustan Book Agency,2009.*
4. *J.E. Conway: A Course inFunctionalAnalysis, Springer, 1990.*
5. Y. Eidelrnan, V. Miknan and A. Tsolomitis: *Functional Analysis, An Introduction*, American Mathematical Society, 2004.

6. P.D. Lax: *Functional Analysis*, John Wiley and Sons, 2002

Semester	Fourth		
Course Name	**Fluid Mechanics**		
Category: Core	Code: **MM2402**	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.(Chapter1, 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]).

Recommended Books

1. F.Chorlton: *Text book of Fluid Dynamics*, CBS Publishers, Delhi, 1985.
2. W.H. Besaint and A.S. Ramsay: *A Treatise on Hydromechanics*, Part-II CBS Publishers, Delhi, 1988.
3. S.W. Yuan, *Foundations of Fluid Dynamics*, Prentice-Hall of India, 1988.
4. T. Allen and I.L. Ditsworth: *Fluid Mechanics*, McGraw Hill, 1972.
5. I.G. Currie: *Fundamentals of Mechanics of Fluids*, CRC, 2002.
6. F.M. White: *Fluid Mechanics*, McGraw Hill, 2003

Semester	Fourth		
Course Name	**Operations Research**		
Category: **DSE II**	Code: **MME2401**	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]).

Recommended Books

1. H.A. Taha: *Operations Research – An Introduction*, Pearson Prentice Hall, 2007.
2. F.S. Hiller and G.J. Leiberman: *Introduction to Operations Research,* 6thEdition, McGraw-Hill, International Edition, 1995.
3. G. Hadley: *Nonlinear and Dynamic Programming,* Addison Wesley.
4. Kanti Swarup, P.K. Gupta and M. Mohan: *Operations Research,* Sultan Chand & Sons, New Delhi.
5. S.S. Rao: *Optimization Theory and Applications*, Wiley Eastern.
6. N.S. Kambo: *Mathematical Programming Techniques*, Affiliated East-West Press

Pvt.Ltd., New Delhi.

Semester	Fourth		
Course Name	**Mathematical Modeling**		
Category: **DSE II**	Code: **MME2402**	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]).

Recommended Books

1. J.N. Kapur: *Mathematical Modeling*, New Age International Publisher, 2005.
2. D.N. Burghes: *Mathematical Modeling in the Social Management and Life Scienc* Ellie Herwood and John Wiley.
3. F. Charlton: *Ordinary Differential and Difference Equations,* Van Nostrand

Semester	Fourth		
Course Name	**Fuzzy Mathematics**		
Category: **DSE II**	Code: **MME2403**	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]).

Recommended Books

1. T.J. Ross: *Fuzzy Logic with Engineering and Applications*,Wiley Student Edition, 2010.
2. B.M Ayyub and L.N. Kanal: *Analysis and Management of Uncertainty: Theory and Application*, North Holland, New York, 1992.
3. W. Bandler and W. Nather: *Fuzzy Data Analysis*, Kluwer Academic Press, 1996.
4. A. Wesley: *Fuzzy Mathematical Techniques with Applications*, 1985.

5. J.K. George: *Fuzzy Sets and Fuzzy Logic, Theory and Applications*, Yuan PrenticeHall,2006.

Semester	Third		
Course Name	**Classical Mechanics**		
Category: **DSE I**	Code: **MME2405**	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'stheorem.(Chapter 9[1]).

Recommended Books:

1. H. Goldstein: *Classical Mechanics*, Second Edition, Narosa publishing house, New Delhi.
2. F. Gantmacher: *Lectures in Analytic Mechanics*, MIR Publishers, Moscow, 1975.
3. N.C. Rana and P.S.C. Jog: *Classical Mechanics*, Tata McGraw-Hill

Semester	Fourth		
Course Name	**Dynamical System**		
Category: **DSE III**	Code: **MME2406**	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, Insect outbreak model. (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]).

Recommended Books

1. Steven H. Stogatz: *Nonlinear Dynamics and Chaos*, Perseus Books Publishing, LLC.
2. Robert C. Hilborn: *Chaos and Nonlinear Dynamics*, Oxford University Press

Semester	Fourth		
Course Name	**Financial Mathematics**		
Category: **DSE III**	Code: **MME2407**	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])

Recommended Books

1. S.Ross:*An Introduction to Mathematical Finance*, Cambridge University press, 1999.
2. D.G. Luembergar: *Investment Science*, Oxford University press, 1999.
3. J.C.Parikh: *Stochastic Process and Financial Markets*, Narosa Publishing House, NewDelhi,2003.
4. S. Roman: *An Introduction to Mathematics of Finance*, Springer, 2000.