GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

(Deemed to be University, Estd. u/s 3 of UGC Act 1956)

VISAKHAPATNAM ∗HYDERABAD ∗BENGALURU

Accredited by NAAC with ‘A+’ Grade

REGULATIONS & SYLLABUS

of

Master of Science

in

APPLIED MATHEMATICS

(w.e.f 2019-20 admitted batch)

GITAM Committed to Excellence

M.Sc. Applied Mathematics
REGULATIONS*
(w.e.f. 2019-20 admitted batch)

1. ADMISSION

1.1 Admission into M.Sc. Applied Mathematics program of GITAM is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

2.1. A pass in B.Sc. with Mathematics as one of the Subject(s) and with a minimum aggregate of 50% marks in degree or any other equivalent examination approved by GITAM.

2.2. Admission into M.Sc. (Applied Mathematics) will be based on an All India GITAM Science Admission Test (GSAT) conducted by GITAM and the rule of reservation, wherever applicable.

3. CHOICE BASED CREDIT SYSTEM

Choice Based Credit System (CBCS) is introduced with effect from the admitted Batch of 2015-16 based on UGC guidelines in order to promote:

- Student Centered Learning
- Cafeteria approach
- Inter-disciplinary learning

Learning goals/ objectives and outcomes are specified leading to what a student should be able to do at the end of the program.

4. STRUCTURE OF THE PROGRAM:

4.1 The Program Consists of

i) Foundation Courses (compulsory) which give general exposure to a Student in communication and subject related area. (Skill Enhancement courses and Ability Enhancement courses)

ii) Core Courses (compulsory).

iii) Discipline centric electives which

a) are supportive to the discipline
b) give expanded scope of the subject
c) give inter disciplinary exposure
d) Nurture the student skills

iv) Open electives are of general nature either related or unrelated to the discipline.

v) Practical Proficiency Courses, Laboratory and Project work

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials) per week.

4.3 In general, one credit for each Lecture / Tutorial hour per week are assigned to the courses based on the contact hours per week per semester.

4.4 The curriculum of the four semesters M.Sc. Applied Mathematics program is designed to have a total of **85** credits for the award of M.Sc. degree

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register himself/herself for each semester individually at the time specified by the Institute / University.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors.

7.2 However, the Vice Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 66% and 74% on genuine grounds and on payment of prescribed fee.

8. EVALUATION

8.1 The assessment of the student's performance in a Theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end examination (60 marks).

8.2 A student has to secure an aggregate of 40% in the course in the two components Continuous Evaluation and Semester-end examination put together to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum of 24 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3 Details of Assessment procedure are furnished below in Table 1.

Table 1: Assessment Procedure

S. No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory	40	Continuous evaluation	(i) Three mid semester examinations shall be conducted for 15 marks each. The performance in best two shall be taken into consideration. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	100		
2	Practicals	100	Continuous evaluation	60 marks for performance, regularity, record/ and case study. Weightage for each component shall be announced at the beginning of the semester. 40 marks (30 marks for experiment(s) and 10 marks for practical Viva-voce.) for the test conducted at the end of the Semester conducted by the concerned lab Teacher.
	Total	100		
3	Project work	200	Project evaluation	150 marks for evaluation of the project work dissertation submitted by the candidate. 50 marks are allocated for the project Viva-Voce. The project work evaluation and the Viva-Voce shall be conducted by one external examiner outside the University and the internal examiner appointed by the Head of the Department.

9. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS:

9.1 The odd semester supplementary examinations will be conducted on daily basis after conducting regular even semester examinations in April/May.

9.2 The even semester supplementary examinations will be conducted on daily basis after conducting regular odd semester examinations during November/December

9.3 A student who has completed his/her period of study and still has “F” grade in final semester courses is eligible to appear for Special Examination normally held during summer vacation.

10. PROMOTION TO THE NEXT YEAR OF STUDY

10.1 A student shall be promoted to the next academic year only if he/she completes the academic requirements of 60% of the credits till the previous academic year.

10.2 Whenever there is a change in syllabus or curriculum he/she has to continue the course with new regulations after detention as per the equivalency established by the BoS to continue his/her further studies

11. BETTERMENT OF GRADES

11.1 A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations only in ‘n’ (where ‘n’ is no.of semesters of the program) theory courses of any semester of his/her choice, conducted in summer vacation along with the Special Examinations.

11.2 Betterment of Grades is permitted ‘only once’, immediately after completion of the program of study.

12. REPEAT CONTINUOUS EVALUATION:

12.1 A student who has secured ‘F’ grade in a theory course shall have to reappear at the subsequent examination held in that course. A student who has secured ‘F’ grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

12.2 A student who has secured ‘F’ grade in a practical course shall have to attend Special Instruction classes held during summer.

12.3 A student who has secured ‘F’ grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examination held in that course. A student who has secured ‘F’ grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

12.4 The RCE will be conducted during summer vacation for both odd and even semester students. Student can register a maximum of 4 courses. Biometric attendance of these RCE classes has to be maintained. The maximum marks in RCE be limited to 50% of Continuous Evaluation marks. The RCE marks are considered for the examination held after RCE except for final semester students.

12.5 RCE for the students who completed course work can be conducted during the academic semester. The student can register a maximum of 4 courses at a time in slot of 4 weeks. Additional 4 courses can be registered in the next slot.

12.6 A student is allowed to Special Instruction Classes (RCE) ‘only once’ per course.

13.GRADING SYSTEM

13.1 Based on the student performance during a given semester/trimester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades & Grade Points

SI.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

13.2 A student who earns a minimum of four grade points (P grade) in a course is declared to have successfully completed the course, subject to securing an average GPA (average of all GPAs in all the semesters/Trimesters) of 5 at the end of the Program to declare pass in the program.

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Candidates who could not secure an average GPA of 5 at the end of the program shall be permitted to reappear for a course(s) of their choice to secure the same.

14 GRADE POINT AVERAGE

14.1 A Grade Point Average (GPA) for the semester/trimester will be calculated according to the formula:

$$\text{GPA} = \frac{\sum C \times G}{\sum C}$$

where

C = number of credits for the course,

G = grade points obtained by the student in the course.

14.2 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken, in all the semesters up to the particular point of time.

14.2 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for award of Class

Class	CGPA Required
First Class with Distinction	≥ 8.0*
First Class	≥ 6.5
Second Class	≥ 5.5
Pass Class	≥ 5.0

* In addition to the required CGPA of 8.0 or more the student must have necessarily passed all the courses of every semester in first attempt.

15 .ELIGIBILITY FOR AWARD OF THE M.Sc. DEGREE

15.1 Duration of the program: A student is ordinarily expected to complete M.Sc. program in four semesters of two years. However a student may complete the program in not more than four years including study period.

15.2 However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

15.3 A student shall be eligible for award of the M.Sc Degree if he / she fulfills all the following conditions.

a) Registered and successfully completed all the courses and projects.

b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.

c) Has no dues to the Institute, hostels, Libraries, NCC / NSS etc, and

d) No disciplinary action is pending against him / her.

15.4 The degree shall be awarded after approval by the Academic Council

16. DISCRETIONARY POWER

Not with standing anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

M.Sc. (Applied Mathematics) - Scheme of Instruction
(Effective from 2019-20 Admitted Batch)
FIRST SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction			Scheme of Examination		
					Hours per Week		Total	Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con Eva
1	SAM701	Real Analysis	PC	4	4	0	4	3	60	40
2	SAM703	Differential Equations	PC	4	4	0	4	3	60	40
3	SAM705	Programming with C	PC	4	4	0	4	3	60	40
4	SAM707	Discrete Mathematical Structures	PC	4	4	0	4	3	60	40
5	SSE 701/ SSE 703	Skill Enhancement Course*	SEC	2	0	3	3	---	--	100
6	SAM 721	Programming with C Lab	PP	2	0	3	3	3	--	100
7	SAM723	Differential Equations using MATLAB	PP	2	0	3	3	3	--	100
Total			---	22	16	9	25	--	240	460

*** SKILL ENHANCEMENT COURSE (CHOOSE ONE THE FOLLOWING)**

1. SSE 701: BASIC COMPUTER CONCEPTS
2. SSE 703: INFORMATION TECHNNOLOGY TOOLS

SECOND SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction			Scheme of Examination		
					Hours per Week		Total	Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con Eva
1	SAM702	Complex Analysis	PC	4	4	0	4	3	60	40
2	SAM704	Techniques of Applied Mathematics	PC	4	4	0	4	3	60	40
3	SAM 706	Numerical Analysis	PC	4	4	0	4	3	60	40
4	SAM708	Classical Mechanics	PC	4	4	0	4	3	60	40
5	SAE 702	Professional Communication Skills	AEC	2	0	3	3	--	--	100
6.	SAM 720	Numerical Methods using MATLAB	PP	2	0	3	3	3	--	100
7.	SAM 722	Techniques of Applied Mathematics using MATLAB	PP	2	0	3	3	3	--	100
Total			---	22	16	9	25	--	240	460

THIRD SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction			Scheme of Examinatio		
					Hours per Week		Total	Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con Eva
1	SAM801	Functional Analysis	PC	4	4	0	4	3	60	40
2	SAM803	Descriptive Statistics & Probability Theory	PC	4	4	0	4	3	60	40
3	SAM 805	Optimization Techniques	PC	4	4	0	4	3	60	40
4	SAM841 SAM843 SAM845 SAM847	Applied Group Theory Boundary Value Problems Theory of Computation Fuzzy Mathematics	GE	4	4	0	4	3	60	40
5		OPEN ELECTIVE	OE	3	3	0	3	3	60	40
6.	SAM 821	Descriptive Statistics Lab using SPSS/MATLAB	PP	2	0	3	3	3	--	100
7.	SAM 823	Optimization Techniques Lab using TORA	PP	2	0	3	3	3	--	100
Total			---	23	19	6	25	--	300	400

FOURTH SEMESTER

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction			Scheme of Examination		
					Hours per Week		Total	Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con Eval
1	SAM802	Probability Distributions and Statistical Methods	PC	4	4	0	4	3	60	40
2	SAM842 SAM844 SAM846 SAM 848	Graph Theory Fluid Dynamics Relativity and Cosmology Elasticity	GE	4	4	0	4	3	60	40
3	SAM 822	Probability Distributions and Statistical Methods Lab using R-Programming	PP	2	0	3	3	3	--	100
5	SAM 892	Project work	PP	8	0	0	0	3	--	200
Total			---	18	08	3	16	--	120	380

M.Sc. (Applied Mathematics)
I SEMESTER
SAM 701: REAL ANALYSIS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble : Real analysis studies the behavior of real numbers and real valued functions. This course deals with basic topology of sets, properties of real valued functions, measuring a subset of real numbers, measurable functions and integration, differentiation of measurable functions.

Learning Objectives :

- To introduce the basic topological properties of the real number system
- To discuss limits of functions, continuous functions, uniform continuity, compactness and continuity.
- To increase mathematical maturity, including writing their own proofs
- To introduce the abstract measure theory, Lebesgue integration and main properties of the lebesgue integral
- To discuss Lebesgue's measure of any subset of real numbers

UNIT-I

Basic Topology: Finite, countable and uncountable sets, Metric spaces, compact sets, perfect sets, connected sets.

Learning Outcomes:

By the end of this Unit, the student will be able to

- recognize the basic topological properties of real number system,
- define countable and uncountable sets and their properties
- define and prove properties of compact sets, connected sets, perfect sets.

UNIT-II

Continuity : Limits of Functions, Continuous Functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic Functions , Infinite Limits and Limits at Infinity

Learning Outcomes:

By the end of this Unit, the student will be able to

- define and recognize the continuity, uniform continuity of real functions
- know the importance of compactness when studied with continuity and connectedness

UNIT-III

Lebesgue Measure: Introduction, Outer measure, Measurable sets and Lebesgue measure, A non measurable set, measurable functions, Littlewood's three principles.

Learning Outcomes:
By the end of this Unit, the student will be able to

- explain the outer measure of set and its properties
- define a measurable sets and its properties
- acquainted with the proofs of the fundamental theorems

UNIT-IV

The Lebesgue integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a non negative function, The general Lebesgue integral.

Learning Outcomes:
By the end of this Unit, the student will be able to

- explain the importance of lebesgue integral over Riemann integral
- define Lebesgue integral and explain the properties of lebesgue integral
- discuss the fundamental results in the theory with accuracy and proper formalism.

UNIT-V

Differentiation and Integration: Differentiation of Monotone functions, Functions of bounded variation, Differentiation of an integral, absolute continuity..

Learning Outcomes:
By the end of this Unit, the student will be able to

- explain the properties of differentiation of measurable function
- prove fundamental theorems on differentiation of an integral and convex functions

Text Book:

1. Principles of Mathematical analysis by Walter Rudin (Third edition) Mc. Graw Hill, 2013
2. Real Analysis by H.L.Royden, 3rd edition, Prentice Hall India, 2004.

Reference Books:

1. Mathematical Analysis by Tom.M.Apostol,2nd edition,Narosa publication, 2002
2. Measure Theory and Integration by G.de.Barra, Horwood Publishing, 2011

Course Learning Outcomes:
On successful completion of this course, students will be able to:

- give examples of metric spaces and classifies different metrics
- describe fundamental properties of real numbers that lead to the development of real analysis
- understand the concept of continuity, connectedness on compact metric space
- discuss the importance of measuring sets
- prove basic results in measure theory
- appreciate how the abstract ideas can be applied to practical problems

M.Sc. (Applied Mathematics)
I SEMESTER
SAM 703: DIFFERENTIAL EQUATIONS

Hours per week: 4 | **End Examination: 60 Marks**
Credits: 4 | **Continuous Evaluation: 40 Marks**

Preamble :

Many physical laws and relations can be expressed mathematically in the form of differential equations. Thus it is natural that this course opens with the study of differential equations and their solutions. Indeed, many engineering problems appear as differential equations. The main objectives of this course are twofold: the study of ordinary differential equations and their most important methods for solving them and the study of modeling.

Course Objectives :

- To solve initial value problem for the homogeneous equation
- To define Wronskian condition and linear independence
- To evaluate reduction of the order of the homogeneous equation and non-homogeneous equation,
- To explain Frobenious series method
- To define regular singular points
- To explain orthogonal trajectories
- To solve Paffian differential equations in three variables
- To solve non-linear equations of first order
- To explain non-linear partial differential equations of first order
- To evaluate problems using Charpit's method and Jacobi's method
- To solve second order partial differential equations

UNIT-I

Linear Equation with variable coefficients, Initial value problem for the homogeneous equation, solutions of the homogeneous equation, the Wronskian and linear independence, reduction of the order of the homogeneous equation, the non homogeneous equation.

Learning Outcomes:
By the end of this Unit, the student will be able to

- evaluate linear differential equations with variable coefficients
- define Wronskian condition and linear independence
- reduce the order of the homogeneous equation and non homogeneous equation

UNIT-II

Homogeneous equations with analytical coefficients, Frobenious Series Method, linear equations with regular singular points, the Euler's equation second order equations with regular singular points –an example, the general case, Regular singular points at infinity.

Learning Outcomes:

By the end of this Unit, the student will be able to

- explain solutions of homogeneous equations with analytical coefficients
- evaluate problems using Frobenious series method
- define second order differential equations with regular singular points and regular singular points at infinity

UNIT-III

Equations of the form $\frac{dx}{P} \quad \frac{d}{\ } \quad \frac{d}{\ }$, Orthogonal trajectories, Paffian differential equations, solutions of Paffian differential equations in three variables.

Learning Outcomes:

By the end of this Unit, the student will be able to

- evaluate partial differential equations
- explain orthogonal trajectories
- explain Paffian differential equations and their solutions

UNIT-IV

Partial differential equations of the first order, Origin, linear equations of first order, Nonlinear equations of first order, integral surfaces passing through a given curve, surfaces orthogonal to a given system of surfaces, non linear PDE'S of first order, compatible system of first order equation.

Learning Outcomes:

By the end of this Unit, the student will be able to

- evaluate partial differential equations of the first order
- explain nonlinear partial differential equations of first order
- explain non linear partial differential equations of first order
- evaluate compatible system of first order partial differential equations

UNIT-V

Partial Differential Equations of First order, Charpit's method, special types of first order equations, Jacobi's method, PDE'S of second order, Origin, equations with variable coefficients, separation of variables.

Learning Outcomes:

By the end of this Unit, the student will be able to

- explain Charpit's methods to solve partial differential equations of first order
- evaluate special types of first order partial differential equations
- demonstrate solutions of second order partial differential equations
- evaluate problems on partial differential equations with variable coefficients

Text Books:

1. An introduction to ordinary differential equations by Earl A. Coddington,, Prentice-Hall of India private limited, 2013.
2. Elements of partial differential equations , I.A.N.Sneddon, , Mc Graw Hill, International students edition,2002

Reference Books:

1. Elements of ordinary differential equations by Golomb & Shanks, Mc Graw Hill, 2002
2. An Introduction to Theory of Differential Equations by Leighton, Mc Graw Hill, 2002

Course Learning Outcomes:

On successful completion of this course, students will be able to:

- evaluate linear differential equations with variable coefficients
- define second order differential equations with regular singular points and regular singular points at infinity
- evaluate partial differential equations
- explain orthogonal trajectories
- explain non linear partial differential equations of first order
- evaluate compatible system of first order partial differential equations
- evaluate special types of first order partial differential equations
- demonstrate solutions of second order partial differential equations

M.Sc. (Applied Mathematics)
I SEMESTER
SAM 705: PROGRAMMING WITH C

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble :

C is a general purpose programming language. It is basis for Java and C++. This course deals with the same objects that are manipulated by computers : single characters, numbers and memory addresses. Any other type of object is created, by the programmer, by combining those objects (e.g., character strings, arrays, records, fields, etc.).

Course Objectives:
- To understand the difference between different data types
- To learn the basic concept , applications of control statements
- To identify and practice the functions and program structures
- Ability to process arrays, multi-dimensional arrays and character arrays.
- To understand the concept of pointers and functions.
- To understand the concept of structures and unions

UNIT – I

Data types, operators and some statements, Identifiers and key words, constants, C operators, Type conversion. Writing a program in C: Variable declaration, statements, simple C programs, simple input statement, simple output statement, feature of stdio.h.
Control statements: conditional expressions, If statement, If –else statement, switch statement, Loop statements, for loop, while loop, do- while loop, Breaking, control statements, Break statement, continue statement, Goto statement.

Learning Outcomes:

By the end of this Unit, the student will be able to
- list the data types, operators and some statements in C
- describe the basic concepts of control statements
- explain the concepts of Loop statements

UNIT- II

Functions and Program structures: Introduction, Defining a function, Return statement, Types of functions, Actual and formal arguments, Local Global variables, Automatic variables, register variables, static variables, External variables, Recursive functions.

By the end of this Unit, the student will be able to

- describe the basic concepts of functions
- explain different types of functions used in C
- explain difference between Local and Global variables
- explain the concept of recursive functions

UNIT -III

Arrays: Array Notation, Array declaration, Array initialization, Processing with arrays, Arrays and functions, Multidimensional array, Character array.

By the end of this Unit, the student will be able to

- describe the basic concepts of arrays
- explain different types of arrays and functions
- explain multidimensional arrays and character arrays

UNIT-IV

Pointers: Pointer declaration, Pointer operator, address operator, pointer expressions, pointer arithmetic, pointers and functions, call by value. Call by reference, pointers and arrays, pointer and one dimensional array, pointer and multidimensional array, pointer and strings, array of pointers, pointers to pointers.

By the end of this Unit, the student will be able to

- describe the basic concepts of pointers
- explain different types of pointers and functions
- explain the concept of pointer and strings and also pointers to pointers

UNIT-V

Structures, Unions : Declaration of structure, Initializing a structure, Functions and structures, Arrays of structures, arrays within a structure, structure within a structure, Flow charts and structures, Unions.

By the end of this Unit, the student will be able to

- describe the basic concepts of structures and unions
- explain different types of functions and structures
- explain the concept of arrays of structures, structures within a structure and flowcharts and structures

Text Book:

1. Programming in C by D.Ravi Chandran, New Age international Publishers,2006.

Reference Books:

1. Let Us C by Yashwant Kanetkar, 13th Edition, Bpb Publications, 2012.
2. Programming in ANSI C by E. Balaguruswamy, 6th Edition, McGraw Hill Education, 2012.
3. Programming in C by Smarajit Ghosh, Prentice Hall India Pvt.Ltd(2004).

Course Learning Outcomes:
On successful completion of this course, students will be able to

- describe the basic concepts of control statements in C
- explain the concepts of Loop statements in C
- explain difference between Local and Global variables
- explain the concept of recursive functions
- explain multidimensional arrays and character arrays
- explain different types of pointers and functions
- explain the concept of pointer and strings and also pointers to pointers
- explain different types of functions and structures in C
- explain the concept of arrays of structures, structures within a structure and flowcharts and structures in C

M.Sc. (Applied Mathematics)
I SEMESTER
SAM 707: DISCRETE MATHEMATICAL STRUCTURES

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble :

Discrete Mathematical structures introduces students to the mathematics of networks, social choice, and decision making . This course provides students with a hands-on exploration of the relevancy of mathematics in the real world. Applications and modeling are essential to discrete mathematical structures course. Proper technology should be used frequently for instruction and assessment . This course reflects the rigor taught in many entry-level mathematics courses.

Course Objectives:

- To introduce the statements and different types of connectives
- To familiarize the concepts of normal forms
- To explain statement calculus
- To discuss the relation between statement calculus and predicate calculus
- To learn theory of recursive functions
- To illustrate the applications of set theory and relations
- To discuss about lattices and Boolean algebra

UNIT-I

Mathematical logic : statements, structures and notation, connectives, well formed formulas, tautologies, equivalences, implications, normal forms- disjunctive and conjunctive, principal disjunctive and conjunctive normal forms. Theory of Inference: Theory of inferences for statement calculus, validity using truth tables, values of inference.

By the end of this Unit, the student will be able to

- discuss connectives and well formed formulas
- evaluate normal forms
- illustrate theory of inference for statement calculus

UNIT-II

Predicate calculus: predicates, predicates formulas, quantifiers, free and bound variables, inference theory of predicate calculus.
Theory of recursion: Recursive functions, primitive recursive functions, partial recursive functions and Ackerman's functions.

By the end of this Unit, the student will be able to

- describe predicates and predicate formulas
- explain quantifiers
- describe recursive functions
- explain primitive and partial recursive functions

UNIT-III

Set Theory : Basic concepts of Set Theory, Notation, Inclusion and Equality of sets, The power set, some operations on sets, Venn diagrams, some basic set identities, The principle of specification, ordered pairs and n-tuples, Cartesian products.
Relations and ordering: partially ordered relations, partially ordered sets, representation and associated terminology.

By the end of this Unit, the student will be able to

- define different types of sets and operations on sets
- explain representation of Venn diagrams
- describe Cartesian products of sets
- explain partial ordered relations and posets
- explain representation and associated terminology of relations

UNIT-IV

Lattices: Lattices as partially ordered sets, some properties of Lattices, Lattices as algebraic systems, sub-lattices, direct product and homomorphism, some special Lattices.

By the end of this Unit, the student will be able to

- define lattice using partially ordered set
- explain some properties of lattices
- describe algebraic system of lattices
- explain sub-lattices, direct product and homomorphism of lattices

UNIT-V

Boolean algebra: Definition and Examples, sub-algebra, direct product and Homomorphism, Boolean Functions, Boolean forms and free Boolean Algebras, values of Boolean expressions and Boolean functions, Representation and Minimization of Boolean functions

By the end of this Unit, the student will be able to

- define Boolean algebra and sub-algebra
- explain Boolean functions and free Boolean algebras
- explain representation and minimization of Boolean functions

Text Books:

1. Discrete Mathematical structures with applications to computer science by J.P. Trembly and R.Manohar, Tata Mc. Graw Hill edition, 2008.
2. Discrete Mathematical Structures by Kolman, Busby and Ross,Pearson Education,Asia, Fourth Edition, 2002.

Reference Books:

1. Discrete Mathematical Structures by Prism, 4^{th} Edition, Prism Books Pvt Limited, 2011.
2. Elements of Discrete Mathematics by CL Liu, Tata Mc Graw –Hill, Publishing company(second edition), 2010.

Course Learning Outcomes:

On successful completion of this course, students will be able to

- discuss connectives and well formed formulas
- evaluate normal forms and illustrate theory of inference for statement calculus
- explain quantifiers
- describe recursive functions
- describe Cartesian products of sets
- explain partial ordered relations and posets
- explain sub-lattices, direct product and homomorphism of lattices
- explain Boolean functions and free Boolean algebras
- explain representation and minimization of Boolean functions

M.Sc. (Applied Mathematics)
I SEMESTER
SSE 701: BASIC COMPUTER CONCEPTS

Hours per week: 3
Credits: 2 **Continuous Evaluation: 100 Marks**

Preamble: The course gives an understanding about the characteristics and classification of computers, various components of computer along with different operating systems that are available. It gives a hands on training on the packages MS-Word, MS-Power Point and MS-Excel. The course also comprehends AI tools.

Objectives:

- To introduce components of digital computer and their working along with the outline of Operating Systems.
- To give hands on training on MS-Word, Power Point and Excel features.

Basics of Computers: Definition of a Computer - Characteristics and Applications of Computers – Block Diagram of a Digital Computer – Classification of Computers based on size and working – Central Processing Unit – I/O Devices, Primary, Auxiliary and Cache Memory – Memory Devices. Software, Hardware, Firmware and People ware – Definition and Types of Operating System – Functions of an Operating System – MS-DOS –MS Windows, UNIX.

MS-Word: Features of MS-Word – MS-Word Window Components – Creating, Editing, ormatting and Printing of Documents – Headers and Footers – Insert/Draw Tables, Table Auto format – Page Borders and Shading – Inserting Symbols, Shapes, Word Art, Page Numbers, Equations – Spelling and Grammar – Thesaurus – Mail Merge.

MS-PowerPoint : Features of PowerPoint – Creating a Blank Presentation - Creating a Presentation using a Template - Inserting and Deleting Slides in a Presentation – Adding Clip Art/Pictures - Inserting Other Objects, Audio, Video- Resizing and Scaling of an Object –Slide Transition – Custom Animation.

MS-Excel : Overview of Excel features – Creating a new worksheet, Selecting cells, Entering and editing Text, Numbers, Formulae, Referencing cells – Inserting Rows/Columns –Changing column widths and row heights, auto format, changing font sizes, colors, shading.

Reference Books:

1. Fundamentals of Computers by V.RajaRaman, PHI Learning Pvt. Ltd, 2010.
2. Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh andFaithe Wempen, Wiley Publications, 2010.

Course Outcomes:

- Able to understand fundamental hardware components that make up a computer's hardware and the role of each of these components
- Understand the difference between an operating system and an application program, and what each is used for in a computer.
- Acquire knowledge about AI tools.
- Create a document in Microsoft Word with formatting that complies with the APA guidelines.
- Write functions in Microsoft Excel to perform basic calculations and to convert number to text and text to number.
- Create a presentation in Microsoft PowerPoint that is interactive and legible content

M.Sc. (Applied Mathematics)
I SEMESTER
SSE 703 : INFORMATION TECHNOLOGY TOOLS

Hours per week: 3
Credits: 2 **Continuous Evaluation: 100 Marks**

Preamble: The course enables the student to understand networking concepts related to Internet and introduce the social Networking sites and working of Email. It gives orientation of Block Chain technology. It give hands on training in SPSS, R Programming and creation of simple HTML documents.

Objectives:

- To enable the student to understand networking concepts related to Internet and introduce the social Networking sites and working of Email.
- To give orientation of Block Chain technology.
- To give hands on training in SPSS, R Programming and creation of simple HTML documents

Introduction to Internet: Networking Concepts, Data Communication –Types of Networking, Internet and its Services, Internet Addressing –Internet Applications–Computer Viruses and its types –Browser –Types of Browsers.

Internet applications: Using Internet Explorer, Standard Internet Explorer Buttons, Entering a Web Site Address, Searching the Internet– Introduction to Social Networking: twitter, tumblr, Linkedin, facebook, flickr, skype, yahoo!, google+, youtube, WhatsApp, etc.
E-mail : Definition of E-mail, Advantages and Disadvantages,User Ids, Passwords, Email Addresses, Domain Names, Mailers, Message Components, Message Composition, Mail Management, Email Inner Workings.
WWW-Web Applications, Web Terminologies, Web Browsers ,URL–Components of URL, Searching WWW –Search Engines and Examples.
Block Chain technology: What is Block Chain, Blockchain Architecture, How Block chain Transaction Works? Why do we need Blockchain? Block chain versions, Block chain Variants, Block chain Use Cases, Important Real-Life Use Cases of Block chain Bitcoin cryptocurrency: Most Popular Application of Block chain, Block chain vs. Shared Database, Myths about Block chain, Limitations of Block chain technology.

SPSS : SPSS Commands, Descriptive Statistics, Hypothesis Testing, Test of Difference, Analysis of Variance- One Way ANOVA, Non Parametric Tests, Correlation Analysis, Regression Analysis.

R Programming: Becoming familiar with R, Working with Objects, Introduction to Graphical Analysis.

HTML: WEB Terminology, Structure of HTML Document, HTML – Head and Body tags, Semantic tags- HR- Heading, Font, Image & Anchor tags, Different Types of Lists using Tags, Table Tags, Image Formats – Creation of Simple HTML Documents.

Reference Books:

- In-line/On-line : Fundamentals of the Internet and the World Wide Web by Raymond Greenlaw and Ellen Hepp, 2nd Edition, TMH.

- Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh and Faithe Wempen, WileyPublications.

Course Outcomes:

- Enable to understand the basic networking concepts, types of networks, Internet Explorer and www.
- Outline the Block chain architecture, Bitcoin Crypto currency and Limitations of Block Chain.
- Choose different statistical tests to be performed on the data sets.
- Demonstrate the R programming with simple graphs.
  To make use of commands to structure HTML document

M.Sc. (Applied Mathematics)
I SEMESTER
SAM 721: PROGRAMMING WITH C LAB

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Program to convert a given decimal number to octal number
2. Program to solve quadratic equation using switch case structure
3. Program to check a given integer is a palindrome
4. Program to check a given integer is a prime number
5. Sorting of numbers
6. Multiplication of two matrices
7. Inverse of a matrix
8. Finding norm of a matrix using fuction
9. Program to check a given string is a palindrome or not
10. Using pointers copying a string to another string
11. Using pointers and functions sorting of number
12. Computer binomial coefficients using recursive function for factorial

Course Outcomes:

- Able to solve problems using switch case structure
- Differentiate the sorting of numbers using different methods
- Explain looping structure to create a matrix
- Identify the differences in matrix multiplication and to find inverse of a matrix
- Examine the working of Control structures in C programs(L4)
- Able to develop and implement pointers
- Able to develop applications with the help of pointers and functions
- Understand various types of subroutine programs and apply in applications

M.Sc. (Applied Mathematics)
I SEMESTER
SAM 723: DIFFERENTIAL EQUATIONS USING MATLAB

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Linear differential equations of first order
2. Riccati Ordinary differential equations
3. Newton's Law of cooling
4. RLC circuit
5. Linear differential equations of second order with constant coefficients
6. Wronskian of a given set of functions
7. Variation of parameters
8. Total differential equations

Course Outcomes:

- Able to solve problems of first order linear differential equations
- Differentiate the methods to solve differential equations
- Apply methods to solve differential equations for various application problems
- Able to solve linear differential equations of second order with constant coefficiens
- Examine the working of Wronskian condition
- Able to solve problems using variation of parameters
- Understand various types of methods to solve total differential equations

Text Book : Ordinary Differential Equations for Engineers (Problems with MATLAB solutions) by Ali Umit Keskin, Springer Publications,

M.Sc. (Applied Mathematics)
II SEMESTER
SAM 702: COMPLEX ANALYSIS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble:

Complex analysis can be thought of as the subject that applies the theory of calculus to imaginary numbers. The complex differentiable functions in any of its neighborhood have many remarkable properties which are not followed by real differentiable functions. These functions usually known as, analytic functions. This course aims at the study of analytic functions and their basic properties, applications.

Course Objectives:

- To introduce the theories of functions of complex variable.
- To familiarize the concepts of analyticity, Cauchy-Riemann relations, harmonic functions
- To present complex and contour integration
- To discuss the relation between analytic functions and power series
- To discuss the classification of isolated singularities
- To illustrate the applications of the calculus of residues in the evaluation of integrals
- To discuss about conformal mappings, bilinear transformations.

UNIT-I

Functions of a complex variable: Analytic functions and Harmonic functions, Cauchy-Riemann equations, sufficient conditions.

Learning Outcomes:

By the end of this Unit, the student will be able to

- discuss the functions of complex variable
- identify analytic functions
- explain the basic properties of analytic and harmonic functions
- explain the importance of Cauchy-Riemann equations

UNIT-II

Complex integration: Contour integration, Cauchy-Goursat theorem antiderivatives, Integral representation for analytic functions, theorems of Morera and Liouville and some applications.

Learning Outcomes:

By the end of this Unit, the student will be able to

- evaluate complex and contour integrals
- make use of Cauchy-Goursat theorem, Cauchy integral formulae in evaluating contour integrals of analytic functions
- explain the qualitative properties of analytic and harmonic functions

UNIT-III

Series: Uniform convergence of series, Taylor and Laurent series representations, singularities, zeros and poles.

Learning Outcomes:

By the end of this Unit, the student will be able to

- describe the uniform convergence of the series
- find the series expansions of analytic functions
- classify isolated singularities to know the use of Taylor and Laurent series in deriving important properties of analytic functions

UNIT-IV

Residue theory: Residue theorem, calculus of residues, evaluation of improper real integral, indetermined contour integrals.

Learning Outcomes:

By the end of this Unit, the student will be able to

- explain the importance of Residue theorem in evaluating contour integrals
- acquire the skill of contour integration to evaluate complicated real integrals through residue calculus

UNIT-V

Conformal mapping: Basic properties of conformal mapping, Bilinear transformation.

Learning Outcomes:

By the end of this Unit, the student will be able to

- explain conformal mapping and its properties
- construct Bilinear transformations
- discuss about the properties of Bilinear Transformations
- study the mapping of the bilinear transformations

Text Book:

1. Complex analysis for Mathematics and Engineering by John H.Mathews and Russel W, Howell,5th edition(Chapter 3,6,7,8 , 10.1and 10.2), Narosa publication, 2009

Reference Book:

1. Complex variables – Introduction and applications by Mark J. Ablowitz, Anthanassios S. Fokas, Cambridge University Press, second edition, 2003.

Course Learning Outcomes:

On successful completion of this course, students will be able to

- explain the basic concepts of complex analysis
- prove important results in complex analysis
- apply Cauchy-Riemann equations in determining analytic functions
- apply the methods of complex analysis in evaluating contour integrals, definite real integrals
- obtain the power series of an analytic functions
- describe conformal mappings and bilinear transformations

M.Sc. (Applied Mathematics)
II SEMESTER
SAM 704: TECHNIQUES OF APPLIED MATHEMATICS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble :
Techniques of Applied Mathematics develops mathematical techniques which are useful in solving real world problems involving differential equations, and is a development of ideas which arise in Laplace transforms, integral equations, Calculus of variations, integral transforms, and tensor analysis.

Course Objectives:

- To discuss the properties of Laplace transforms.
- To familiarize the concepts of transforms of derivatives
- To explain convolution theorem
- To discuss the application to differential equations
- To classify the integral equations
- .To evaluate the method of successive approximations
- To describe solutions of Euler's equations
- To explain the properties of the Fourier sine and cosine transforms
- To demonstrate tensor analysis

UNIT-I

Laplace transforms: Transformation of elementary functions, properties, Transforms of derivatives, Transforms of integrals, inverse transforms, convolution theorem, Application to differential equations, simultaneous linear equation with constant coefficients, periodic functions and special functions.

Learning Outcomes:

By the end of this Unit, the student will be able to
- explain transformation of elementary functions and properties
- illustrate the concepts of transforms of derivatives and integrals
- develop application to differential equations

UNIT-II

Integral equations: Classification of integral equations, connection with differential equations, integral equations of convolution type, method of successive approximations.

Learning Outcomes:

By the end of this Unit, the student will be able to

- classify integral equations
- describe the connection with differential equations
- explain method of successive approximations

UNIT-III

Calculus of variations: Euler's equations, other forms, Solutions of Euler's equations, several dependent variables. Functions involving higher order derivatives.

Learning Outcomes:
By the end of this Unit, the student will be able to
- explain Euler's equations and other forms
- explain calculus of variations
- evaluate functions involving higher order derivatives

UNIT-IV

Integral transforms: Fourier sine, cosine transforms, properties, Applications to Boundary value problems.

Learning Outcomes:
By the end of this Unit, the student will be able to
- explain properties of Fourier sine and cosine transforms
- explain applications to boundary value problems

UNIT-V

Tensor Analysis: N-dimensional space, covariant and contra variant vectors, contraction, second and higher order tensors, quotient law, fundamental tensor, associate tensor, Christoffel symbols, covariant derivatives.

Learning Outcomes:
By the end of this Unit, the student will be able to
- explain properties of covariant and contra variant vectors
- evaluate problems on second and higher order tensors
- define Christoffel symbols

Text Books:

1. Higher Engineering Mathematics by B.S.Grewal, Khanna publishers, 2012.
2. Tensor calculus a concise course by Barry Spain, Mc Graw Hill, 2002

Reference Books:

1. Vector and Tensor Analysis by Lass, Mc Graw Hill , 2002
2. Calculus of variations by Weinstock, Mc Graw Hill , 2002
3. Differential Equations and Calculus of Variations by Elsgolts L, MIR Publishers, 1998

Course Learning Outcomes:
On successful completion of this course, students will be able to

- explain transformation of elementary functions and properties
- illustrate the concepts of transforms of derivatives and integrals
- classify integral equations and describe the connection with differential equations
- explain calculus of variations
- explain properties of Fourier sine and cosine transforms
- explain properties of covariant and contra variant vectors

M.Sc. (Applied Mathematics)
II SEMESTER
SAM 706: NUMERICAL ANALYSIS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble:
Numerical analysis is the study of algorithms that use numerical approximation for the problems of mathematical analysis. Numerical analysis naturally finds application in all fields of engineering and the physical sciences. Numerical analysis can only be applied to real-world measurements by translation into digits; it gives approximate solutions within specified error bounds.

Course Objectives:

- The course is framed to extend the student's knowledge about understanding numerical techniques
- To solve various categories of problems.
- It will also help in developing deep understanding of the approximation techniques and problem solving capabilities.

UNIT-I
Transcendental and Polynomial Equations: Iteration Methods Based on First Degree: Secant and Regula Falsi Methods, Newton-Raphson Method; Iteration Methods Based on Second Degree Equation: Chebyshev Method; Rate of Convergence for Newton-Raphson Method
System of Linear Algebraic Equations: Introduction; Gauss Elimination Method, Gauss-Jordan Elimination Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method.

Learning Outcomes:
By the end of this Unit, the student will be able to

- explain transcendental and polynomial equations
- evaluate problems using Newton-Raphson method and iteration methods
- evaluate system of linear algebraic equations

UNIT-II

Interpolation: Lagrange, Newton divided difference, Iterated Interpolations-Linear, Quadratic, Higher Order Interpolations; Interpolating Polynomials using Finite differences: Gregory-Newton Forward Difference Interpolation, Gregory-Newton Backward Difference Interpolation
Numerical Differentiation: Methods based on Interpolation, Methods based on Finite difference operators.
Numerical Integration: Methods based on Interpolation – Newton-Cotes Methods, Methods based on Undetermined Coefficients – Newton-Cotes Methods, Composite integration method; Gauss Quadrature Methods – Gauss-Legendre Integration Methods

Learning Outcomes:
By the end of this Unit, the student will be able to

- explain different types of methods to solve equal and unequal interval problems

- evaluate problems using numerical differentiation
- evaluate numerical integration problems using different methods

UNIT-III
Ordinary Differential Equations: Initial Value Problems
Numerical Methods – Euler Method, Backward Euler Method, Mid-Point Method; Single Step Methods – Taylor Series Method, Explicit Runge-Kutta Methods – Second order, Third Order, Fourth Order Methods

Learning Outcomes:
By the end of this Unit, the student will be able to
- solve ordinary differential equations using numerical methods
- explain single step methods, Runge-Kutta methods
- explain second order, third order and fourth order methods of Runge-Kutta.

UNIT-IV
Difference Methods for Parabolic Partial Differential Equations:
One Space Dimension – Two Level Difference Methods.
Difference Methods for Hyperbolic Partial Differential Equations:
One Space Dimension, First Order Equations.

Learning Outcomes:
By the end of this Unit, the student will be able to
- explain difference methods for parabolic partial differential equations
- explain difference methods for hyperbolic partial differential equations

UNIT-V
Numerical Methods for Elliptic Partial Differential Equations:
Difference Methods for Linear Boundary Value Problems – Dirichlet Problem for Laplacian, Neumann Problem; Quasi linear Elliptic Equations – second order method

Learning Outcomes:
By the end of this Unit, the student will be able to
- explain difference methods for linear boundary value problems
- explain Dirichlet problem for Laplacian
- evaluate problems on Quasi linear elliptic equations

Text Book:
1. Numerical Methods for Scientific and Engineering Computation by M.K. Jain, S.R.K. Iyengar, R.K. Jain, 4th Edition, New Age International Publishers,2004.
2. Computational Methods for Partial Differential Equations by M.K. Jain, S.R.K. Iyengar, R.K. Jain, 2005, New Age International (P) Limited, Publishers, reprint 2002.

Reference Books: (For Algorithms and Computations)

1. Elementary Numerical Analysis An Algorithmic Approach by Samuel D. Conte / Carl de Boor, 3rd Edition, McGraw-Hill International Editions, Mathematics and Statistics Series,2005
2. Numerical Methods using MATLAB by John H. Mathews, Kurtis D.Fink, 4th edition,Pearson Education, 2006.

Course Learning Outcomes:

On successful completion of this course, students will be able to

- explain transcendental and polynomial equations
- evaluate problems using numerical differentiation
- evaluate numerical integration problems using different methods
- explain difference methods for parabolic and hyperbolic partial differential equations
- explain difference methods for linear boundary value problems
- explain Dirichlet problem for Laplacian
- evaluate problems on Quasi linear elliptic equations

M.Sc. (Applied Mathematics)
II SEMESTER
SAM 708: CLASSICAL MECHANICS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble :

Classical mechanics is important backbone of physics which deals with understanding the motion of particles. This course covers Newtonian Mechanics, Lagrangian and Hamilotonian dynamics, canonical transformations, and theory of relativity.

Course Objectives:

- To know the concepts of Newtonian mechanics
- To differentiate holonomic and Non holonomic constraints
- To explain D Alembert's principle
- To understand the concept of Hamilton's principle
- To identify the difference between Euler's and Hamiltonian
- Ability to know the concepts of Lagrange's brackets
- To understand the special theory of relativity

UNIT-I

Introductory Concepts of Newtonian Mechanics: Mechanics of particle-law of conservation of Linear Momentum, Angular Momentum and conservation of Energy. Mechanics of System of Particles-Conservation of linear and Angular Momentum and conservation of energy.

Learning Outcomes:
By the end of this Unit, the student will be able to

- explain conservation of linear momentum
- explain concept of conservation of energy
- use mechanics of system of particles
- use conservation of linear and angular momentum and conservation of energy

UNIT-II
Lagrangian Dynamics: Constraints-Types of Constraints-Holonomic and Non holonomic. Generalized coordinates ,principle of virtual work, D Alemberts Principle, Lagranges Equation from D Alemberts Principle.Hamiltons principle -Lagrange's equation from Hamiltons principle, Superiority of Lagrangian mechanics over Newtonian approach.
Learning Outcomes:
By the end of this Unit, the student will be able to

- explain types of constraints of generalized coordinates
- use D Alemberts principle and Lagranges equation
- explain difference between Lagrangian mechanics over Newtonian approach

UNIT-III
Hamiltonian Dynamics and Variational Principles: Generalized Momentum and Cyclic coordinates, Conservation of Linear Momentum, Conservation of Angular Momentum and Jacobi

Integral. Hamiltons Equation. Calculus of variation and Euler- Lagranges Equation, Deduction of hamiltons principle from D Alemberts principle.Modified Hamiltons principle and Principle of Least action.

Learning Outcomes:

By the end of this Unit, the student will be able to

- use generalized momentum and cyclic coordinates
- explain conservation of angular momentum and Jacobi integral
- demonstrate principle of least action

UNIT-IV

Canonical Transformations: Legendre Transformations, Generating Functions, Condition for canonical Transformations,Poissons Brackets, Lagrange's Brackets and their relation, Invariance of Poissons Barckets with canonical Transformations. Hamiltons Jacobi Method- Application of Harmonic Oscillator.

Learning Outcomes:

By the end of this Unit, the student will be able to

- explain Legendre transformations
- evaluate problems using Lagrange's brackets
- explain application of Harmonic Oscillator

UNIT-V

Special Theory of Relativity: Galelian Transformations, principle of relativity, Postulates of special theory of relativity ,Lorentz transformations and Inverse Lorentz transformations, Consequences of Lorentz transformations-Length contraction, simultaneity and time dilation.

Learning Outcomes:

By the end of this Unit, the student will be able to

- explain principle of relativity
- use postulates of special theory of relativity
- differentiate Lorentz transformations and inverse transformations

Text Book

Classical Mechanics by J.C.Upadhya, Himalaya Publishers

Reference Books

1. Classical mechanics by H.Goldstein, 2nd edition, Narosa publishing House, 2001.
2. Relevant topics from special relativity by W.Rindler, Oliver & Boyd, 2005
3. Classical Mechanics by Aruldhas, 1st Edition, PHI Learning Pvt. Ltd., 2009
4. N.C.Rane and P.S.C. Joag, Classical Mechanics, Tata Mc Graw-Hill ,1991.

Course Learning Outcomes:
On successful completion of this course, students will be able to

- explain conservation of linear momentum
- explain concept of conservation of energy
- use mechanics of system of particles
- explain difference between Lagrangian mechanics over Newtonian approach
- explain conservation of angular momentum and Jacobi integral
- explain application of Harmonic Oscillator
- use postulates of special theory of relativity
- differentiate Lorentz transformations and inverse transformations

M.Sc. (Applied Mathematics)
II SEMESTER
SAE 702: PROFESSIONAL COMMUNICATION SKILLS

Hours per week: 3
Credits: 2 **Continuous Evaluation: 100 Marks**

Preamble
This course is designed to expose students to the basics of academic and professional communication in order to develop professionals who can effectively apply communication skills, theories and best practices to meet their academic, professional and career communication needs.

Course Objectives :
To enable students to
- acquaint themselves with basic English grammar
- acquire presentation skills
- develop formal writing skills
- develop creative writing skills
- keep themselves abreast with employment-readiness skills

UNIT I
BACK TO BASICS
Parts of Speech, Tenses, Concord – Subject Verb Agreement, Correction of Sentences-Error Analysis, Vocabulary building
Learning Outcomes:
At the end of the unit, the student will be able to:
- use structures and tenses accurately
- apply the right verb to the right subject in a sentence
- detect incorrect sentences in English and write their correct form
- acquire new vocabulary and use in speaking and writing

UNIT II
ORAL PRESENTATION
What is a Presentation? Types of Presentations, Technical Presentation – Paper Presentation
Effective Public Speaking, Video Conferencing,
Learning Outcomes:
At the end of the unit, the student will be able to:
- overcome speaking anxiety prior to presentation
- plan and structure effective presentations that deliver persuasive messages
- prepare slides that can catch the attention of the audience
- engage the audience
- skills in organizing, phrasing, and expressing the ideas, opinions and knowledge.
- facilitate and participate in a video conference effectively

UNIT III
DOCUMENTATION

Letter –Writing, E-mail Writing & Business Correspondence, Project Proposals, Report Writing, Memos, Agenda, Minutes, Circulars, Notices, Note Making

Learning Outcomes:

At the end of the unit, the student will be able to:

- write a business letter, which includes appropriate greetings, heading, closing and body and use of professional tone.
- draft crisp and compelling emails
- draft project proposals, reports and memos
- prepare agenda and draft minutes
- prepare circulars, notices and make notes.

UNIT IV
CREATIVE WRITING

Paragraph Writing, Essay writing, Dialogue Writing, Précis Writing, Expansion of Hints, Story Writing

Learning Outcomes:

At the end of the unit, the student will be able to:

- write paragraphs on familiar and academic topics using a topic sentence, supporting detail sentences and a conclusion sentence.
- learn the structure of a five-paragraph essay and write essays that demonstrate unity, coherence and completeness
- structure natural, lucid and spontaneous dialogues
- draft clear, compact logical summary of a passage
- recognize the elements of a short story and develop their functional writing skills.

UNIT V
PLACEMENT ORIENTATION

Resume preparation, group discussion – leadership skills, analytical skills, interviews –Types of Interviews, Preparation for the Interview, Interview Process.

Learning Outcomes:

At the end of the unit, the student will be able to:

- write a professional resume that highlights skills, specific to the student's career field
- acquire the personality traits and skills required to effectively participate in a G.D
- understand the purpose of interviews
- be aware of the processes involved in different types of interviews
- know how to prepare for an interview
- learn how to answer common interview questions

Text Books :

1.Essentials of Business Communication by Rajendra Pal and J S KorlahaHi, Sultan Chand & Sons, New Delhi.
2. Advanced Communication Skills by V. Prasad, Atma Ram Publications, New Delhi.
3. Effective Communication by Ashraf Rizvi, McGraw Hill Education; 1 edition (27 June 2005)
4. Interviews and Group Discussions How to face them, T.S.Jain, Gupta, First Edition, New Delhi.
5. High School English Grammar and Composition, P.C.Wren & Martin, N.D.V.Prasada Rao (Editor), S.Chand, 1995.

M.Sc. (Applied Mathematics) - II SEMESTER
SAM 720: NUMERICAL METHODS USING MATLAB

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Regula Falsi Method
2. Secant Method
3. Newton's Raphson Method
4. Gauss Seidal, Gauss Jordan, Gauss Seidal Iteration methods
5. Lagrange's Interpolation and Divided difference
6. Newton's forward and backward interpolation
7. Trapezodial and Simpson's rule for numerical integration
8. Euler method and R-K methods

Course Outcomes:

- Able to solve problems using regula falsi method and Secant method
- Differentiate the methods to solve a root of an equationns
- Apply methods to solve problems using Gauss Seidal, Gauss Jordan, Gauss Seidal Iteration methods
- Able to find a function or function value using interpolation
- Examine the working of Trapezoidal and Simpson's rule for numerical integration
- Able to solve problems using Euler and R-K methods

Reference Book : Laurence V. Fausett, Applied Numerical Analysis using MATLAB, second edition, Pearson Publications, 2009

M.Sc. (Applied Mathematics)
II SEMESTER
SAM 722: TECHNIQUES OF APPLIED MATHEMATICS USING MATLAB

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Laplace transforms of basic functions
2. Laplace inverse transform of functions
3. I.V.P. by Laplace transform
4. Convolution
5. Fourier series
6. Fourier Sine series, Cosine series
7. Fourier Sine and Cosine transforms
8. Applications to Boundary value problems

Course Outcomes:

- Able to solve problems using Laplace transforms of basic functions
- Able to solve problems using inverse Laplace transforms of basic functions
- Apply methods to solve problems using Convolution
- Able to find fourier sine and cosine series problems
- Examine the applications to Boundary value problems

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 801: FUNCTIONAL ANALYSIS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble:

Functional analysis is the study of certain topological-algebraic structures and the properties of bounded linear maps on these structures. The aim of this course is to study the topological spaces, Banach spaces, Hilbert spaces and spectral theory.

Course Objectives:

- To introduce the fundamentals of topology to meet the needs of modern mathematics
- To show the use of abstract algebraic/topological structures in studying spaces of functions
- To give a working knowledge on basic properties of Banach, Hilbert spaces and bounded linear operators
- To introduce the ideas behind some fundamental theorems
- To present the notions of duals and adjoints
- To demonstrate the use of normal operators in studying the spectrum

UNIT-I

Topological spaces: The definition and some examples, Elementary concepts, open bases and open subbases, weak topologies, The function algebras C(X,R) and C(X,C).

Learning Outcomes:
At the end of the unit, the student will be able to:
- explain the concept of a general topological space
- classify the standard examples.
- explain the properties of topological spaces

UNIT-II

Compactness: compact spaces, products of spaces, Tychonoff's theorem and locally compact spaces, compactness for metric spaces.
Learning Outcomes:
At the end of the unit, the student will be able to:
- explain the concept of compactness in topological spaces
- differentiate the basic properties of compact topological spaces
- explain the continuous functions they carry one these spaces

UNIT-III

Banach spaces: The definition and some examples, continuous linear transformations, The Hahn-Banach theorem, The natural imbedding of N in N^{**} , The open mapping theorem, The conjugate of an operator.

Learning Outcomes:

At the end of the unit, the student will be able to

- explain the concepts of Banach space and classify the standard examples.
- use properly the specific techniques for bounded operators over Banach Spaces.
- explain the fundamental results in the theory with accuracy and proper formalism

UNIT-IV

Hilbert spaces: The definition and some simple properties, orthogonal complements, orthonormal sets, the conjugate space H^*, the adjoint of an operator, self adjoint operators.

Learning Outcomes:

At the end of the unit, the student will be able to

- differentiate between the Banach and Hilbert Spaces
- explain the concepts of Hilbert space and classify the standard examples.
- explain operators over Hilbert Space.
- explain the fundamental results in the theory with accuracy and proper formalism

UNIT-V

Normal and Unitary operators, Projections, the spectrum of an operator, the spectral theorem.

Learning Outcomes:

At the end of the unit, the student will be able to

- explain the importance of normal operators in defining a spectral resolution
- explain spectral theorem
- recognize the importance of finite dimension of Hilbert space in discussing spectral theory

Text Book:

1. Introduction to Topology and Modern Analysis by G.F. Simons, Mc Graw Hill, 2004

Reference Books:

1. Functional Analysis by B.V.Limaye, Wiley Eastern Ltd, 1981
2. Functional Analysis by J.N.Sharma & A. Vasishta, 31st edition, Krishna Prakashan, 2010.

Learning Outcomes

On successful completion of this course, students will be able to:

- understand how functional analysis uses and unifies the ideas from vector spaces, the theory of matrices and complex analysis
- understand the notions of dot product and Hilbert space.
- use properly the specific techniques for bounded operators over normed and Hilbert spaces.
- recognize the fundamental properties of Banach spacesspacesand Hilbert spaces
- acquainted with the statement of the Hahn-Banach theorem and its corollaries, the open mapping theorem and the closed graph theorem
- understand the fundamentals of spectral theory

M.Sc. (Applied Mathematics) III SEMESTER
SAM 803: DESCRIPTIVE STATISTICS & PROBABILITY THEORY

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble:
Probability theory is important when it comes to evaluating statistics. This course treats the most common discrete and continuous distributions, showing how they find use in decision and estimation problems, and constructs computer algorithms for generating observations from the various distributions.

Course Objectives:
- To understand the collection, analysis, interpretation, and presentation of data.
- To understand the difference between discrete and continuous random variables and probability
- To evaluate problems on discrete and continuous probability distributions
- To understand the concept of mathematical expectation
- Ability to explore certain statistical concepts in expectation and generating functions

UNIT-I
Descriptive measures: Introduction, Frequency distribution, Graphic representation of a frequency distribution, measures of central tendency , measures of dispersion, coefficients of dispersion, moments, skewness, kurtosis.(Chapter 2 of text book 1)

Learning Outcomes:
By the end of this Unit, the student will be able to
- Explain the diagrammatic and graphic representation of data
- Describe the basic concepts of Measures of central tendency
- Describe the basic concepts of Measures of dispersion
- Describe the basic concepts of moments
- Describe the basic concepts of skewness, kurtosis

UNIT-II
Probability : Introduction, definition, axiomatic approach to probability, probability- Addition, multiplication and conditional law of probability, extended axiom of addition and axiom of continuity,Bayee's theorem.(Chapter 3 and 4 of text book 1)
Learning Outcomes:
By the end of this Unit, the student will be able to
- Define probability
- Describe the basic concepts of axiomatic approach to probability
- Concept of conditional probability and problems
- Evaluate problems on addition theorem , multiplication theorems
- Evaluate problems on Bayee's theorem

UNIT-III

Random variables and distribution functions: Distribution functions,discrete and continuous random variables,two dimensional probability mass functions,distribution function ,marginal distribution function joint and marginal density functions, conditional distribution function and conditional probability function.Probability density functions. (Chapter 5 of text book 1)

Learning Outcomes

By the end of this Unit, the student will be able to

- Describe the basic concepts of probability distributions
- List the difference between discrete random variable and continuous random variable
- Explain the need of two dimensional probability mass functions
- Evaluate problems on joint and marginal density functions
- Describe the concept of Probability density functions

UNIT-IV

Mathematical expectation: Expectedvalue of a random variable and function of a randomvariable ,properties of expectation, properties of variance, variance of linear combination of random variable moments of bivariate probability distributions ,conditional expectation and conditional variance.probability generating functions, moment generating functions, characteristic functions and their properties, Markov and Chebychev moment inequalities. (Chapter 6 of text book 1)

Learning Outcomes

By the end of this Unit, the student will be able to

- Explain the procedure of random variable and function of a random variable
- Describe the concept of moments of bivariate probability distributions
- Explain Probability generating functions and evaluate problems on it
- Describe the concept of characteristic functions and their properties
- Describe the concept and evaluate problems on Markov and Chebychev moment inequalities

UNIT-V

Expectation and generating functions: Some inequalities involving expectation: Cauchy-Schwartz, Jenson's inequality. Moment generating functions, characteristicfunctions, Multi variate moment generating functions, Chebychevinequality, generalized form of Bienayme-chebyche's inequality.. (Chapter 6,7 of text book 1)

Learning Outcomes

By the end of this Unit, the student will be able to

- Explain inequalities involving expectation
- Describe the concepts of importance of inequalities i.e Cauchy-Schwartz, Jenson's inequality
- Describe the concept and evaluate problems on Multi variate moment generating functions
- Describe the concept and evaluate problems on generalized form of Bienayme-chebyche's inequality

Text Book:

1. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K. Kapoor, Sultan Chand and sons, New Delhi.

Reference Books:

1. Statistical Methods by N. G. Das, 1st Edition, McGraw Hill, 2008.
2. Statistical Methods Concept, Application and Computation by Y. P. Aggarwal, Sterling Publishers, 1998.

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 805: OPTIMIZATION TECHNIQUES

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble:
In mathematics, computer science and operations research, mathematical optimization or mathematical programming is the selection of a best element from some set of available alternatives. In the simplest case, an optimization problem consists of maximizing or minimizing a real function by systematically choosing input values from within an allowed set and computing the value of the function. The generalization of optimization theory and techniques to other formulations constitutes a large area of applied mathematics. More generally, optimization includes finding "best available" values of some objective function given a defined domain (or input), including a variety of different types of objective functions and different types of domains. The classical optimization techniques are useful in finding the optimum solution or unconstrained maxima or minima of continuous and differentiable functions. These are analytical methods and make use of differential calculus in locating the optimum solution.

Course Objectives:
The course is framed to extend the student's knowledge about understanding the techniques to solve optimization problems of various categories and the application of modern methodologies in the area of optimization. It will also help in developing deep understanding of the classical and numerical optimization techniques and problem solving capabilities.

UNIT-I
Linear Programming : Formulation and Graphical Method, slack and surplus variables, convex sets and their properties, Simplex method, artificial variables techniques-Two Phase method, Big M-method, Degeneracy, Duality in linear programming, the dual simplex method

Learning Outcomes :
By the end of this Unit, the student will be able to
- understand the problem of linear programming problem
- know the technique to solve LPP graphically and some special cases of LPP solution
- know the definitions Basic solution(BS), Basic Feasible solution(BFS), Non-degenerate BFS, Degenerate BFS and finding them for a given problem
- know convex sets and some important theoretical concepts about convex sets
- know simplex method and using this to solve given LPP
- know duality in LPP and dual simplex method

UNIT-II
Integer linear programming: Gomory's cutting plane method, Branch and Bound method.
Transportation problems: Methods for initial basic feasible solutions, MODI method, degeneracy in transportation problems.
Assignment models: Hungarian method, the travelling salesman problem

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the problem of integer linear programming problem
- know the technique to solve IPP using Gomory's cutting plane and branch and bound method
- understand the problem of assignment problem
- know the technique to solve assignment problem using Hungarian method
- understand the problem of travelling sales man problem as a special class of assignment problem
- know the technique to solve travelling sales man problem
- understand the problem of transportation problem
- know the terms Feasible solution (FS), Basic Feasible Solution (BFS), Optimum Solution (OS) related to transportation problem
- know the techniques of NW rule, Row minima, Column minima, Matrix method and Vogel's approximation to find Initial Basic Feasible Solution (IBFS)
- know the technique of MODI method for minimum transportation cost
- know the techniques to resolve degeneracy in transportation problems

UNIT-III

Inventory : classification, costs involved in inventory, inventory models, EOQ models with and without shortages.

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the problem of Inventory control and Economic Ordering Quantity (EOQ)
- understand different inventory costs and why inventory is maintained?
- Know the techniques of algebraic method and calculus method for various inventory models for with and without shortages
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UNIT-IV

Queuing theory, distribution in queueing systems, Poisson process, classification and solutions of queuing model, models 1-3.

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the problem of Queueing models
- know the characteristics of the Queueing system
- know the arrival and departure patterns of queue
- know the pure birth and pure death process
- know the techniques of different queueing models for their measures

UNIT-V

Project Management by PERT/CPM : Network analysis, PERT / CPM Techniques network diagram representation time estimates and critical path in net work analysis, uses of PERT/ CPM techniques

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the problem of network models
- know the terms activity, node, labeling
- know the rules to draw the network diagram
- Know the techniques of Critical Path Method (CPM) and Project Evaluation Review Techniques (PERT)

Text Book:

Operations Research by S.D.Sarma, Kedarnath, Ramnath and company, 15th edition, 2008.

Reference Book:

1. Operations Research An Introduction by Hamdy A. Taha, 8th edition, Pearson, 2007.
2. Operations Research Theory and Applications by J K Sharma, 4th edition, Macmillan Publishers India Ltd, 2009.

Learning Outcomes

On successful completion of this course, students will be able to:

- understand the linear programming problem and its solution using graphical method when it contains two variables only
- understand the simplex method which is very efficient algorithm to solve linear programming problem
- understand Hungarian method for assignment problems and MODI method for minimum transportation cost
- understand the inventory problems for economic ordering quantity and also for minimum cost
- understand the queueing models
- understand the network models for minimum time required to complete the project

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 841: APPLIED GROUP THEORY

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble :

Group theory studies the algebraic structures known as groups. The concept of a groups is central to algebraic structures such as rings, fields , and vector spaces. Various physical systems , such as crystals and hydrogen atom, may be modeled by symmetry groups. Group theory is related to representation theory which has many applications in physics, chemistry, material science, and computer science.

Course Objectives:

- To understand definition of group, composition table, and isomorphism.
- To understand the difference between reducible and irreducible representations
- To evaluate problems on reducible representation and direct product of groups
- To understand the concept of symmetric group and character of the symmetric group
- Ability to explore certain Young tableaux to find characters of a representation

UNIT-I

Group of transformation, Groups of symmetry of a square, the multiplication table, the rearrangement theorem, generators of finite group, direct product of groups, Isomorphism and Homomorphism, permutation groups, direct sum and direct product of matrices.

Learning Outcomes :
By the end of this Unit, the student will be able to

- understand the group of transformation
- evaluate problems on groups and direct product of groups
- understand the concept of permutation groups

UNIT-II

Representation theory of finite groups: Definition of a representation of a group. Invariant subspaces reducible and irreducible representation. Schur's lemmas and the orthogonality theorem. Character of a representation, orthogonality of characters,

Learning Outcomes :
By the end of this Unit, the student will be able to

- define representation of a group
- understand the difference between reducible and irreducible representations
- evaluate problems using Schur's lemmas
- explain the method to find characters of a representation

UNIT-III

Reduction of a reducible representation, criterion for irreducibility, the regular representation, Direct product of representation of a group, Representation of a direct product groups.

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand reduction of a reducible representation
- explain criterion for irreducibility of a representation
- evaluate problems on representation of a direct product groups

UNIT-IV

The symmetry group: The characters of a group frame work of a sub group, Frobenius formula for the characters of the symmetric group, Graphical methods, Lattice permutation.

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the characters of a group frame work of a sub group
- explain procedure to find characters of the symmetric group using Frobenius formula
- explain graphical methods in symmetric group

UNIT-V

Young patterns, Young tableaux, graphical method for determining characters, calculation of characters by means of the Frobenius formula. The matrices of IR's of S_n , Yamanouchi symbols .

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the Young patterns
- explain procedure to find characters using graphical method
- explain matrices of irreducible representation of symmetric group of degree n.

Text Books:

1. Elements of group theory for physicists by A.W.Joshi, New Age International Publishers, 1997.
2. Group theory and its application to physical problems by M.Hamermesh, Doverpublications, 1989

Reference Books:

1. Concept and Application of Group Theory by Arora Kishore, Anmol Publications, 2003

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 843: BOUNDARY VALUE PROBLEMS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble :

Boundary value problem is a differential equation together with a set of boundary conditions. Boundary value problems arise in several branches of physics and biology.This course provides the two point boundary value problem.

Course Objectives:

- To understand existence and uniqueness theorem via the principle of contraction.
- To understand the continuation of solutions
- To evaluate problems on n^{th} order linear homogenous and non-homogeneous equations
- To understand the concept of linear equations with constant coefficients
- Ability to explore certain adjoint boundary value problems
- Ability to explain controllability

UNIT-I

Elementary Topology on Metric spaces : Mappings on metric spaces, Existence and uniqueness theorem via the principle of contraction. Continuation of solutions, Dependence of solutions on initial conditions and on parameters. (Chapter 2of text book 1)

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the existence and uniqueness theorem
- explain dependence of solution on initial conditions and on parameters
- evaluate problems on metric spaces

UNIT-II

General theory for linear first order system of equations, solution space, The non- homogeneous equation. The nth order linear homogeneous equation, The nth order non-homogeneous equation. The adjoint vector equations. The adjoint nth order equation. The relationship between scalar and vector adjoints (Chapter 3 of text book 1)

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand general theory for linear first order system of equations
- explain n^{th} order linear and non-homogeneous equations
- differentiate relationship between scalar and vector adjoints

UNIT-III

Linear equation with constant coefficients, Real distinct eigen values. The general solution (Chapter 4, section : 4.1, 4.2, 4.3 of text book1)

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand linear equation with constant coefficient
- evaluate problems on eigen values
- find general solution

UNIT-IV

The two point boundary value problem: The two point homogeneous boundary value problems, the adjoint boundary value problem. The non- homogeneous boundary value problem and Green's matrix. (Chapter 6 of text book 1)

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand two point boundary value problem
- explain adjoint boundary value problem
- explain about Green's matrix

UNIT-V

Linear control system: Controllability, observability (Chapter 4 of text book 2)

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand the concept of controllability
- explain the concept of observability

Text Books:

1. Theory of Ordinary differential equations by Randal H. Cole Appleton , Century- Crafts, New York, 2009.
2. Introduction to mathematical control theory by S.Barnett, R.G.Camarol, Clarrendon press,2005.

Reference Book:

1. Theory of ordinary differential equations by E.A Coddington and Normal Levinson, Tata McgGaw Hill , Inc. New York, 2005

M.Sc. (Applied Mathematics)
IIISemester
SAM 845: THEORY OF COMPUTATION

Hours per week :4 **End Examination : 60 Marks**
Credits : 4 **Sessionals : 40 marks**

Preamble:
Theory of computation helps the learners to know the models of computation, along with their variants in the context of formal languages and their recognizers. This course can be applied in designing compilers and pattern recognition system.

Course Objectives:

- To define deterministic finite automata .
- To understand the concept of non deterministic finite state machines
- To establish equivalences of DFA and NDFA
- To understand the concept of grammars and langauages
- To classify Chomsky type of languages
- Ability to explore languages and their corresponding automata
- Ability to explain pumping lemma for regular sets
- To discuss the ambiguity in context-free grammars
- To design Turing machines

UNIT-I

The Theory of Automata : Definition of an Automata, Description of a Finite Automation, Transition systems, properties of transition functions, acceptability of a string by a finite automaton, Non Deterministic finite state machines, the equivalences of DFA and NDFA, Melay and Moore models, Minimization of finite automata.

Learning Outcomes :

By the end of this Unit, the student will be able to

- define deterministic and non-deterministic finite state machines
- explain the equivalences of DFA and NDFA
- differentiate Melay and Moore models
- explain minimization of finite automata

UNIT-II

Formal languages : basic definitions and examples, Chomsky classification of Languages, Languages and their relation, Recursive and recursively enumerable sets, operations of languages, languages and automata.

Learning Outcomes :

By the end of this Unit, the student will be able to

- define phrase structure grammar and language
- explain languages and their relation
- understand the concept of recursive and recursively enumerable sets

UNIT-III

Regular sets and regular grammars: Regular expressions, finite automata and regular expressions, pumping lemma for regular sets, application of pumping lemma, closure properties of regular sets, regular sets and regular grammars.

Learning Outcomes :

By the end of this Unit, the student will be able to

- explain regular expression and finite automata
- understand the concept of pumping lemma for regular sets
- explain application of pumping lemma
- explain properties of regular sets and regular grammars

UNIT-IV

Context –free Languages: Context- free languages and derivation trees, ambiguity in context-free Grammars, simplification of context-free grammars, normal forms for context-free grammars.

Learning Outcomes :

By the end of this Unit, the student will be able to

- explain context-free languages
- understand the concept of derivation trees and ambiguity in context free grammars
- explain normal forms of context- free grammars

UNIT-V

Turing Machines and Linear Bounded Automata: Turing Machine model, Representation of Turing Machines, Language acceptability by Turing Machines, Design of Turing Machines, Universal Turing Machines and other modifications.

Learning Outcomes :

By the end of this Unit, the student will be able to

- define Turing machine model
- explain representation of Turing machines
- design a Turing machine

Text Book: Theory of Computer science (Automata, Languages and computation) Chapters : 2,3,4,5.1 to 5.4 and 7.1 to 7.5 by K.L.P.Mishra, N.Chandrasekaran, PHI , Second edition, 1998

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 847: FUZZY MATHEMATICS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble :

Fuzzy set theory provides a major newer paradigm in modeling and reasoning with uncertainty. Main objective of Fuzzy Mathematics course is to introduce the basic concepts of fuzzy sets which include representations and operations of fuzzy set, fuzzy relations, fuzzy relation equations and fuzzy classifications. These topics have wide range of applications in engineering, biology, medicine, management, economics, computer science , psychology , and many other disciplines.

Course Objectives:

- To define fuzzy sets .
- To understand the concept of extension principle for fuzzy sets
- To define operations on fuzzy sets
- To understand the concept of t-norms and fuzzy unions
- To explain arithmetic operations on intervals
- Ability to explain arithmetic operations on fuzzy numbers
- Ability to explain fuzzy relations
- To discuss the fuzzy relation equations based on sup-i compositions

UNIT – I

Fuzzy sets – Basic types – Basic concepts – α-cuts – Additional properties of α cuts – Extension principle for Fuzzy sets.

Learning Outcomes :

By the end of this Unit, the student will be able to

- define fuzzy set with membership function
- explain α cut and its properties
- understand the concept of extension principle for fuzzy sets

UNIT – II

Operations on Fuzzy sets – Types of operations – Fuzzy complements – t-Norms – Fuzzy Unions – Combinations of operations.

Learning Outcomes :

By the end of this Unit, the student will be able to

- understand types of operations
- explain fuzzy complements, fuzzy unions
- differentiate combinations of operations

UNIT – III

Fuzzy Arithmetic – Fuzzy numbers – Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers.

Learning Outcomes :
By the end of this Unit, the student will be able to

- understand arithmetic operations on intervals
- explain different types of fuzzy numbers
- explain arithmetic operations on fuzzy numbers

UNIT – IV

Fuzzy relations – Binary fuzzy relations – Fuzzy equivalence relations – Fuzzy compatibility relations – Fuzzy ordering relations – fuzzy morphisms.

By the end of this Unit, the student will be able to

- define binary fuzzy relations
- understand the concept of fuzzy equivalence relations
- explain the concepts of compatibility and ordering relations

UNIT - V

Fuzzy Relation Equations – General discussion – Problem partitioning – Solution method – Fuzzy Relation Equations based on Sup-i Compositions - Fuzzy Relation Equations based on inf-ωi Compositions.
By the end of this Unit, the student will be able to

- define problem partitioning
- explain solution for fuzzy relation equations
- solve fuzzy relation equations based on Sup-i Compositions and inf- ωi Compositions.

Text Book:

1. Fuzzy Sets and Fuzzy Logic by George J.Klir and Bo Yuan, Prentice Hall of India, New Delhi, 2004.

Reference Book:

1. Fuzzy Set Theory and its Applications by H.J. Zimmermann, Allied Publishers Limited, New Delhi, 1991.

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 821: DESCRIPTIVE STATISTICS LAB USING SPSS/MATLAB

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Graphical representation
2. Measures of central tendency
3. Measures of Dispersion
4. Moments
5. Skewness & Kurtosis

Course Outcomes:

- Able to represent statistical data graphically using SPSS/ MATLAB
- Able to solve problems on mean, median and mode for grouped data and ungrouped data
- Able to solve mean deviation, quartile deviation, standard deviation using MATLAB
- Able to solve problems on Moments, skewness and kurtosis

M.Sc. (Applied Mathematics)
III SEMESTER
SAM 823: OPTIMIZATION TECHNIQUES LAB USING TORA

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Linear Programming
2. Integer Programming
3. Transportation Model
4. Queuing Analysis
5. Network Models

Course Outcomes:

- Able to maximize /minimize object function subject to the given constraints using TORA
- Able to solve all types of linear programming problems
- Able to solve integer linear programming problems
- Able to find initial basic feasible solutions and optimization of transportation problem
- Able to solve problems on queuing model
- Able to find characteristics of a project network

M.Sc. (Applied Mathematics)
IV SEMESTER
SAM 802: PROBABILITY DISTRIBUTIONS AND STATISTICAL METHODS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble:
This course covers the concepts on probability distributions and Correlation and Regression Analysis, curvilinear regression, techniques for large sample theory exact sampling distributions.

Course Objectives:
- To understand different types of correlation
- To learn the basic concept and applications of correlation coefficient and rank correlation coefficient
- To identify and practice the difference between correlation and regression analysis

UNIT-I
Probability distribution: Discrete distributions – Binomial, Poisson distributions; moments,mode , moment generating functions,characteristic functions,probability generatingfunctions.
Continuous distributions-Normal distributions; moments,median, ,mode , moment generating functions , Area property, Fitting of the distribution,Exponential and beta distributions (Chapter and their properties and applications. (Chapter 8,9 of text book 1)

Learning Outcomes:
By the end of this Unit, the student will be able to
- explain Binomial and Poisson distributions
- explain difference between binomial and Poisson distributions and moments
- explain the need of normal distribution
- explain properties of normal distribution
- explain area under the bell shaped curve using normal distribution
- evaluate normal curve with given data
- fitting of the distributions of Exponential and beta distributions

UNIT-II

Correlation: Introduction, meaning of correlation, scatter diagram, Karl Pearson's coefficient of correlation, calculation of the correlation coefficient for a bivariate frequency distribution, probable error of correlation coefficient, rank correlation. . (Chapter 10 of text book 1)

Learning Outcomes:
By the end of this Unit, the student will be able to
- describe the basic concepts of correlation coefficient and rank correlation coefficient
- evaluate correlation coefficient for given ungrouped data
  - evaluate rank correlation coefficient for given ungrouped data

UNIT-III

Linear and curvilinear regression: Introduction, linear regression, curvilinear regression, regression curves, multiple and partial correlation, plane of regression and coefficient of multiple correlation. (Chapter 11,12 of text book 1)

Learning Outcomes

By the end of this Unit, the student will be able to

- list the difference between correlation and regression analysis
- describe the basic concepts of regression analysis
- evaluate the problems on regression lines (X on Y and Y on X)
    - describe the basic concepts of multiple regression analysis

UNIT-IV

Large sample theory;Types of sampling ,parametric and statistic, Tests of significance, procedure for testing of hypothesis, Tests of significance for large samples ,Sampling of attributes, Sampling of variables. (Chapter 14 of text book 1)

Learning Outcomes

By the end of this Unit, the student will be able to

- explain the procedure of testing of hypothesis
- evaluate Types of sampling
- explain tests of significance for large samples
- explain difference between small and large samples

UNIT-V

Exact sampling distributions : Derivation of chi-square distribution , moment generating functions, limiting form, characteristic function, mode and skewness, application and good ness of fit ,tests of independence, Yates's correction .t distribution, constants, limiting form,t-test for singlemean,difference of means, paired t- test for difference of means.F- distribution; constants,mode and points of inflexion, equality of population variance. (Chapter 15,16 of text book 1)

Learning Outcomes

By the end of this Unit, the student will be able to

- explain chi-square test and goodness of fit
- explain t-test for single mean, difference of means
- apply the concept of χ^2 –test to given data
- apply the concept of F –test to given data

Text Book:

1. Fundamentals of Mathematical statistics by S.C. Gupta and V.K. Kapoor, Sultan chand and sons, New Delhi.

Reference Books:

1. Statistical Methods by N. G. Das, 1st Edition, McGraw Hill, 2008.
2. Statistical Methods Concept, Application and Computation by Y. P. Aggarwal, Sterling Publishers, 1998.

M.Sc. (Applied Mathematics)
IV SEMESTER
SAM 842: GRAPH THEORY

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble :
Graph theory is an introductory course to the basic concepts of graphs. This includes definition of graphs, vertex degrees, directed graphs, connectivity, trees, optimization involving trees, paths and shortest paths**.**

Course Objectives:
- To understand different types of graphs and their properties
- To learn the basic concept and applications of graphs
- To learn the basic concept and applications of paths and circuits using connectivity
- To learn spanning trees
- To identify and practice the difference between Eulerian and Hamiltonian graphs
- To develop optimization involving trees
- To understand the concept of shortest path algorithms

UNIT-I

GRAPHS AND DIGRAPHS : Introduction, Graph Isomorphism, Subgraphs, Degrees, Indegrees, and Outdegrees , Adjacency Matrices and Incidence Matrices, Degree Vectors of Simple Graphs
Learning Outcomes
By the end of this Unit, the student will be able to
- define graph, subgraph, degree of a vertex
- explain directed graphs , indegree of a vertex and outdegree of a vertex
- explain adjacency matrices

UNIT-II

CONNECTIVITY : Paths, Circuits, and Cycles, Connected Graphs and Digraphs, Trees and Spanning Trees, Strong Orientations of Graphs

Learning Outcomes
By the end of this Unit, the student will be able to
- understand paths, circuits and cycles
- explain connected graphs
- explain trees and spanning trees

UNIT-III

EULERIAN AND HAMILTONIAN GRAPHS: Eulerian Graphs and Digraphs,Hamiltonian Graphs and Digraphs, Tournaments

Learning Outcomes

By the end of this Unit, the student will be able to

- define Eulerian graphs
- explain Hamiltonian graphs
- explain tournaments

UNIT-IV

OPTIMIZATION INVOLVING TREES: Minimum Weight Spanning Trees ,Maximum Weight Branchings, Minimum Weight Arborescences , Matroids and the Greedy Algorithm

Learning Outcomes

By the end of this Unit, the student will be able to

- explain about minimum weight spanning trees
- explain maximum weight brachings
- explain Greedy algorithm

UNIT-V

SHORTEST PATH PROBLEMS: Two Shortest Path Algorithms ,The Steiner Network Problem , Facility Location Problems

Learning Outcomes

By the end of this Unit, the student will be able to

- explain shortest path algorithms
- evaluate problems on shortest path
- explain the Steiner Network Problem
- explain Facility Location Problems

Text Books:

Graph Theory by V.K. Balakrishnan**,**Schaum's Outline Series , Tata Mc Graw – Hill edition.,2007

Reference Books:

1. Discrete Mathematics , Schaum's outlineserie, by Seymour Lipschutz and Marc Lipson Tata Mc Graw Hill, 2nd Edition.
2. Discrete Mathematical Structures by Prism, 4th Edition, Prism Books Pvt Limited, 2011.
3. Graph theory with applications to engineering and computer science by Narsingh Deo, Prentice-Hall of India Pvt.ltd, 2014

M.Sc. (Applied Mathematics)
IV SEMESTER
SAM 844: FLUID DYNAMICS

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble :
This course aims to study the fundamentals of fluid mechanics such as kinematics of fluid, incompressible flow and boundary layer flows.

Course Objectives:
- To understand general equations of motion and equation of continuity
- To learn the basic concept of two dimensional motion
- To learn the basic concept of Navier stokes equatons of motion
- To learn about boundary layer theorem
- To identify integral equations of the boundary layer
- To develop methods for analytical solutions of the boundary layer equation

UNIT-I

General equations of motion – Equation of continuity, Equations of motion of an inviscid fluid, irrotational motion, Persistence of irrotational motion, Bernoulli's equation, motion of a fluid element, Kinetic energy, uniqueness theorem, Euler's momentum theorem. (Chapter 2 of the Ref.1.2.1 to 2.6)

Learning Outcomes
By the end of this Unit, the student will be able to
- establish equation of continuity
- understand the concept of Bernoulli's equation
- explain the concept of kinetic energy and uniqueness theorem

UNIT-II

Two dimensional motion introduction, Basic singularities source, sink, doublet, Ranking technique of constructing stream lines method of images circle theorem, Blasius theorem lift force. (Chapter 3 of the Ref.1 3.1 to 3.5 and 3.7.4, 3.75)
Learning Outcomes
By the end of this Unit, the student will be able to
- explain two dimensional motion
- evaluate problems on ranking technique of construction stream lines
- explain Blasius theorem lift force

UNIT-III

Dynamics of real fluids- introduction, Navier stokes equations of motion- vorticity and circulation in a Viscous fluid, Exact solutions of N.S. equations. Unsteady of flows. (Chapter 5 of the Ref.1.5.1 to 5.3 – excluding 5.3.4)

Learning Outcomes

By the end of this Unit, the student will be able to

- explain Navier stokes equations of motion
- understand the concept of vorticity and circulation in a viscous fluid
- explain unsteady of flows

UNIT-IV

Boundary layer theory- introduction derivation of two dimensional boundary layer equations- integral equations of the boundary layer.

Learning Outcomes

By the end of this Unit, the student will be able to

- explain boundary layer theory
- understand derivation of two dimensional boundary layer equations
- explain integral equations of the boundary layer

UNIT-V

Analytical solutions of the boundary layer equation. Flow parallel to a semi-infinite flat plate. Flow near the stagnation points of a cylinder. (Chapter 6 of the Ref.1 - 6.1, 6.2 and 6.3.1 and 6.3.2)

Learning Outcomes

By the end of this Unit, the student will be able to

- explain analytical solutions of the boundary layer equation
- evaluate problems on flow parallel to a semi-infinite flat plate
- understand the concept of flow near the stagnation points of a cylinder

Text Book:

1. Modern Fluid Dynamics on Compressible flow, Volume 1 by N.Curle and H.J.Davie D.Van Nostrand Company Ltd., London, 1968

Reference Books:

1. Fluid Dynamics by M. D. Raisinghania, S. Chand and Co., 2010
2. Text book of Fluid Dynamics by F. Chorlton, CBS Publications,Delhi, 1985

M.Sc. (Applied Mathematics)
IV SEMESTER
SAM 846: RELATIVITY AND COSMOLOGY

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Continuous Evaluation: 40 Marks**

Preamble :

General relativity is the theory of gravity that supersedes the Newtonian theory of gravity. It forms the basis for the disciplines of cosmology (the structure and origin of the Universe on the largest scales) and has led to a number of dramatic predictions concerning the physical world such as black holes, gravitational lensing, Gravitational waves, Big-bang origin of the universe etc**.**

Course Objectives:

- To understand difference between covariant and contra variant vectors
- To learn the basic concept of Christoffel symbols
- To learn the basic concept of Lorentz rotation of axes
- To learn about the relations between mass, energy and momentum
- To identify Maxwell – Lorenz field equations
- To develop methods for Tensor and explain its properties

UNIT-I

Tensor Analysis: N-dimensional space, covariant and contravariant vectors, contraction, second & higher order tensors, quotient law, fundamental tensor, associate tensor, angle between the vectors, christoffel symbols, covariant derivatives, geodesics.

Learning Outcomes

By the end of this Unit, the student will be able to

- explain N-dimensional space with examples
- explain difference between covariant and contra variant vectors
- understand the concept of Christoffel symbols

UNIT-II

Space –time continuum, the three plus one dimensions of space-time, the geometry corresponding to space-time, the signature of the line element and the three kinds of interval, Lorentz rotation of axes, transformation to proper coordinates.

Learning Outcomes

By the end of this Unit, the student will be able to

- explain space time continuum
- understand the concept of space-time
- evaluate problems on Lorentz rotation of axes

UNIT-III

The mass of a moving particle, the transformation equations for mass, work and kinetic energy, the relations between mass, energy and momentum, Four dimensional expressions of the mechanics of a particle.

Learning Outcomes

By the end of this Unit, the student will be able to

- explain transformation equations for mass, work and kinetic energy
- understand the difference between mass, energy and momentum
- explain four dimensional expressions of the mechanics of a particle

UNIT-IV

The Maxwell- Lorentz Field Equations, The transformation equations for E.H. and P. The force on a moving charge, the energy and momentum of electromagnetic field, electro magnetic stresses, Four dimensional expressions for electron theory.

Learning Outcomes

By the end of this Unit, the student will be able to

- derive the Maxwell – Lorentz field equations
- explain the energy and momentum of electromagnetic field
- explain four dimensional expressions for electron theory

UNIT-V

Riemann Christoffel Tensor, covariant curvature, Tensor and its properties, Ricci Tensor, Curvature invariant, Einstein space Bianchi's identity, Riemannian Curvature, flat space, space of constant curvature, Schur's Theorem.

Learning Outcomes

By the end of this Unit, the student will be able to

- define Riemann Christoffle Tensor
- explain Ricci tensor with an example
- explain Schur's theorem

Text Books:

1. Thermodynamics and Cosmology by .C. Tolman, Relativity, Clarendon Press, Oxford, 1987.
2. Tensor Calculus by Barry Spain, Radha Publishing House, Calcutta, 1998.

Reference Books:

1. Introduction to special relativity by Robert Resnick, John wiley & sons, New York, 2007.
2. Theory of relativity by S.R. Roy and Raj bali, Jaipur Publishing House, Jaipur, 1980.
3. Theory of Relativity by J.K. Goyal and K.P. Gupta Krishna Prakasan media (P)Ltd. Meerut, 1975.

M.Sc. (Applied Mathematics) - IV SEMESTER
SAM 848: ELASTICITY

Hours per week: 4 **End Examination: 60 Marks**
Credits: 4 **Sessionals: 40 Marks**

Preamble :

Elasticity is a measure of a variable's sensitivity to a change in another variable. This course introduces Hooke's law, elastic module for isotropic media, dynamical equations, torsion, two dimensional Electrostatic problems.

Course Objectives:

- To understand the concept of elastic moduli for isotropic media
- To learn the basic concept of strain energy function
- To learn the basic concept of bending of beams by terminal couples
- To learn about the torsion of a circuit shaft
- To identify torsion of a rectangular beam and of a triangular prism

UNIT-I

Hook's law, generalized Hook's law, Isotropic media, Elastic moduli for isotropic media, equilibrium equations

Learning Outcomes

By the end of this Unit, the student will be able to

- define generalized Hook's law
- understand the concept of elastic moduli for isotropic media
- explain equilibrium equations

UNIT-II

Dynamical equation, strain energy function and its connection with Hook's law, uniqueness of solution, Saint Venant's principle, statement Extension of problem, extension of beams by longitudinal forces, Beam stretched by its own weight, Bending of beams by terminal couples.

Learning Outcomes

By the end of this Unit, the student will be able to

- define strain energy functions and its connection with Hook's lawi
- explain extension of beams by longitudinal forces
- explain bending of beams by terminal couples

UNIT-III

Torsion, Torsion of a circular shaft, Torsion of cylindrical bars, Stress function, Torsion of elliptical cylinders, simple solution of torsion problem, effect of grooves

Learning Outcomes

By the end of this Unit, the student will be able to

- define torsion of a circular shaft
- define torsion of cylindrical bars
- explain simple solution of torsion problem

UNIT-IV

Torsion of a rectangular beam and of a triangular prism, solution of Torsion problem by means of conformal mapping, Applications of conformal mapping, membrane and other analogies

Learning Outcomes

By the end of this Unit, the student will be able to

- explain torsion of a rectangular beam and of a triangular prism
- obtain solution of torsion problem by means of conformal mapping
- explain the applications of conformal mapping

UNIT-V

Two Dimensional Electrostatic Problems : Plane deformation, plane stress and generalized plane stress, plane elastostatic problems, Airy's stress function, General solution of biharmonic equation, Formula's for stress and displacements, First and second Boundary value problems in plane elasticity

Learning Outcomes

By the end of this Unit, the student will be able to

- understand the concepts of plane deformation, plane stress and generalized plane stress
- obtain the solution of biharmonic equation
- explain first and second boundary value problems in plane elasticity

Text Book:

1. Mathematical theory of Elasticity by I.S.Sokolinkoff, Tata Mcgraw-Hill, 1977

Reference Book:

1. Elasticity: Theory, Applications, and Numerics by Martin H. Sadd, 3rd edition,Elsevier, 2014.
2. Introduction to Linear Elasticity by Phillip L. Gould, 3rd edition, Springer, 2013.

M.Sc. (Applied Mathematics) - IV SEMESTER
SAM 822: PROBABILITY DISTRIBUTIONS AND STATISTICAL METHODS LAB USING R- PROGRAMMING

Hours per week: 3 **Continuous Evaluation: 100 Marks**
Credits: 2

1. Binomial Distribution
2. Poisson Distribution
3. Normal Distribution
4. Coefficient of Correlation
5. Rank correlation coefficient
6. Regression lines

Course Outcomes:

- Able to write a R-programming for fit a binomial distribution
- Able to solve problems on Poisson distribution using programming of R
- Able to fit a normal curve using R
- Able to solve problems of correlation coefficient
- Able to solve problems on rank correlation coefficient
- Able to derive regression lines

M.Sc. (Applied Mathematics) - IV SEMESTER

SAM 892 PROJECT WORK

The student should submit a project report by the end of the IV semester based on the results of his/her research work done on a topic relevant to Applied Mathematics and should give a seminar on that work. The research work may be carried out in universities/ institutes/ research labs/ industries.

OPEN ELECTIVES OFFERED BY DEPARTMENT OF APPLIED MATHEMATICS

(Effective from 2019-20 Admitted Batch)

Sl. No.	Course Code	Name of the Course	Credits	Scheme of Instruction	Scheme of Examination		
				Hours per Week	Duration in Hrs.	Maximum Marks	
				L/T		Sem. End Exam	Con. Eval
1	**SOE 811**	Probability and Statistics	3	3	3	60	40
2	**SOE 813**	Linear Algebra	3	3	3	60	40
3	**SOE 815**	Operations Research	3	3	3	60	40

OPEN ELECTIVE
III SEMESTER
SOE 811 : PROBABILITY AND STATISTICS

Hours per week: 3 **End Examination: 60 Marks**
Credits: 3 **Continuous Evaluation: 40 Marks**

Preamble :

Probability theory is important when it comes to evaluating statistics. Probability and Statistics for Computer Science treats the most common discrete and continuous distributions, showing how they find use in decision and estimation problems, and constructs computer algorithms for generating observations from the various distributions.

Course Objectives:

- To understand the concept of graphical representation of statistical data
- To learn the basic concepts of measures of central tendency
- To learn the basic concepts of measures of dispersion
- To evaluate the problems on correlation and rank correlation
- To understand the concept of regression lines
- To learn the concept of fitting of curves
- To define probability and explain theorems on probability
- To identify the difference between discrete random variable and continuous random variable
- To find the difference between binomial and poisson distributions

UNIT I

Meaning and Scope of the Statistics –Introduction, Frequency distribution, Graphic representation of a frequency distribution, measures of central tendency , measures of dispersion, coefficients of dispersion, moments, skewness, kurtosis

Learning Outcomes

By the end of this Unit, the student will be able to

- understand the concepts of frequency distribution and graphical representation of a frequency distribution
- explain the methods of measures of central tendency
- evaluate problems on measures of dispersion

UNIT-II

Introduction, meaning of correlation, Karl Pearson’s coefficient of correlation, rank correlation. linear regression, Curve fitting, fitting of straight line, fitting of second degree parabola.

Learning Outcomes

By the end of this Unit, the student will be able to

- understand the concepts of coefficient of correlation and coefficient of rank correlation
- explain methods to obtain regression lines
- evaluate problems on fitting of curves

UNIT-III

Probability **:** Introduction, definition, axiomatic approach to probability, probability- mathematical notation, probability function, law of addition of probabilities, multiplication law of probability and conditional law of probability, independent events, Baye's theorem.

Learning Outcomes

By the end of this Unit, the student will be able to

- define probability
- explain axiomatic approach to probability
- evaluate problems using addition theorem on probability, multiplication theorem on probability and Baye's theorem

UNIT-IV

Random variables and distribution functions: One and two dimensional random variables (discrete and continuous).

Learning Outcomes

By the end of this Unit, the student will be able to

- understand the concepts of random variables and distribution functions
- explain one dimensional discrete and continuous random variables
- explain two dimensional discrete and continuous random variables

UNIT V

Probability distribution: Discrete distributions – Binomial, Poisson distributions and their properties and applications.

Learning Outcomes

By the end of this Unit, the student will be able to

- describe discrete probability distributions
- explain Binomial distribution and its properties
- explain poisson distribution and its properties

Text Book:

1. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K. Kapoor, Sultan chand and sons, New Delhi.

Reference Books:

1. Statistical Methods by N. G. Das, 1st Edition, McGraw Hill, 2008.
2. Statistical Methods Concept, Application and Computation by Y. P. Aggarwal, Sterling Publishers, 1998.

OPEN ELECTIVE
III SEMESTER
SOE 813 : LINEAR ALGERBRA

Hours per week: 3 **End Examination: 60 Marks**
Credits: 3 **Continuous Evaluation: 40 Marks**

Preamble :

Linear algebra applies to several branches of science, as well as different mathematical disciplines. This course aims to provide basic concepts of matrices, rank of a matrix and consistency of matrices. The focus of the course is to study the fundamental properties of matrices, applications of matrices ,vector spaces and inner product spaces.

Course Objectives:

- To understand the concept of vector spaces and subspaces
- To learn the difference between linear dependence and linear independence of vectors
- To learn the basic concepts of linear transformations
- To evaluate the problems on rank and nullity of a linear transformation
- To understand the concept of representation of transformation by matrices
- To learn the concept of projections
- To explain the concept of characteristic values and characteristic vectors
- To identify the difference between orthogonality and orthonormal in inner product spaces
- To define bilinear forms as vectors and matrix of a bilinear form

UNIT-I

Vector Spaces: Vector space-Definition, Vector subspaces, algebra of subspaces, linear combination of vectors, linear dependence and linear independence of vectors, basis of a vector space, dimension of a vector space, homomorphism of vector spaces or linear transformations, isomorphism of vector spaces, quotient spaces.

Learning Outcomes

By the end of this Unit, the student will be able to

- define vector space and explain its properties
- explain dimension of a vector space
- explain isomorphism of vector spaces and quotient spaces

UNIT-II

Linear Transformations: Range and null space of a linear transformation, Rank and nullity of a linear transformation, matrices-definition, representation of transformations by matrices, similarity, determinant of linear transformation, trace of a matrix, trace of a linear transformation, linear functional, dual spaces, dual bases.

Learning Outcomes

By the end of this Unit, the student will be able to

- define linear transformation and explain its properties
- explain rank and nullity of a linear transformation
- explain determinant of linear transformation

UNIT-III

Projections, the adjoint or the transpose of a linear transformation, sylvestor's law of nullity, characteristic values and characteristic vectors, the Cayley-Hamilton theorem, diagonalizable operators, minimal polynomial and minimal equation.

Learning Outcomes

By the end of this Unit, the student will be able to

- define projections
- explain the adjoint or the transpose of a linear transformation
- explain Cayley-Hamilton therem

UNIT-IV

Inner Product Spaces: Definition, norm of a vector, Schwarz's inequality, orthogonality, orthonormal set, complete orthonormal set, Gram-Schmidt orthogonalization process, projection theorem, linear functional and adjoints, self-adjoint transformations.

Learning Outcomes

By the end of this Unit, the student will be able to

- define inner product space and explain its properties
- explain difference of orthogonality and orthonormal set
- explain projection theorem

UNIT-V

Bilinear Forms: Definition, bilinear forms as vectors, matrix of a bilinear form, symmetric bilinear forms, skew-symmetric bilinear forms.

Learning Outcomes

By the end of this Unit, the student will be able to

- define bilinear forms
- explain matrix of a bilinear form
- understand the concept of skew-symmetric bilinear forms

Text Book:

1. Linear Algebra by Sharma-Vasishtha,; Krishna Prakashan Media, 2010.

Reference Books:

1. Linear Algebra by Friedberg. H. Stephen, Insel J. Arnold, Spence E. Lawrence, PHI Learning Pvt Ltd., 2009
2. Linear algebra by S. Kumaresan, Prentice Hall of India,2000.

OPEN ELECTIVE
III SEMESTER
SOE 813: OPERATIONS RESEARCH

Hours per week: 3 **End Examination: 60 Marks**
Credits: 3 **Continuous Evaluation: 40 Marks**

Preamble :
The optimization techniques are useful in finding the optimum solution or unconstrained maxima or minima of continuous and differentiable functions. This course have had successful applications in business and public services.

Course Objectives:
- To understand the concept of linear programming problem
- To learn the simplex method to solve LPP
- To learn the concept of dual simplex method
- To evaluate the problems on integer programming
- To develop transportation model and to find optimal solution
- To develop assignment problem
- To develop strategy games
- To explain Job sequencing

UNIT-I

Overview of operations Research: OR models – OR Techniques.
Linear Programming: Introduction – Mathematical Formulation - Graphical solution; Basic feasible solutions -simplex algorithm – artificial variables – Big M and two phase method – Degeneracy - alternative optima – unbounded solutions – infeasible solutions.

Learning Outcomes
By the end of this Unit, the student will be able to
- formulate linear programming for a given business problem
- solve linear programming problem using graphical method
- explain simplex algorithm

UNIT - II

Dual problems: Relation between primal and dual problems – Dual simplex method.
Integer Programming: Cutting plane algorithm - Branch and Bound Algorithms

Learning Outcomes
By the end of this Unit, the student will be able to
- differentiate primal and dual problems
- explain dual simplex method
- explain cutting plane algorithm
- explain branch and bound algorithms

UNIT - III

Transportation model: initial solutions. North West corner Rule - lowest cost method –Vogels approximation method – Optimal solution – MODI method –Assignment problem –Hungarian Method - Traveling Sales man problem.

Learning Outcomes

By the end of this Unit, the student will be able to

- construct transportation model
- explain methods of initial basic feasible solution of a transportation problem
- explain assignment problem
- understand the concept of traveling sales man problem

UNIT - IV

Game theory: Two person Zero Sum Games – Mixed strategy games and their Algorithms.

Learning Outcomes

By the end of this Unit, the student will be able to

- explain zero sum games
- explain mixed strategy games

UNIT - V

Job Sequencing: Introduction – Solution of sequencing problems – processing of n jobs through 2 Machines, n jobs through 3 machines and n jobs through m machines.

Network Models: Definitions – CPM and PERT – Their Algorithms

Learning Outcomes

By the end of this Unit, the student will be able to

- process n jobs through 2 machines
- process n jobs through 3 machines
- draw project network diagram
- explain methods of CPM and PERT

Text Book:

1. Operations Research – An Introduction by Handy A Taha, Pearson Education, 8th edition, 2008.

Reference Books:

1. Operations Research by Sharma. S.D, Keder Nath Ram Nath & co., 1992.
2. Operations Research by Kanti Swaroop, Manmohan and P.K.Gupta– Sultan Chand & sons,4th edition 1990 .