

**GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)  
(Deemed to be University)  
VISAKHAPATNAM \* HYDERABAD \* BENGALURU**

**Accredited by NAAC with A<sup>+</sup> Grade**



**REGULATIONS AND SYLLABUS**

**OF**

**M.Sc. Applied Mathematics**

**(for 2020-21 admitted batch)**

# **M.Sc. Applied Mathematics REGULATIONS\***

**( 2020-21 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 87 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.

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	$\geq 8.0^*$
First Class	$\geq 6.5$
Second Class	$\geq 5.5$
Pass Class	$\geq 5.0$

\* 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.

## Program Educational Objectives

PEO1	To apply basic knowledge of mathematics and science to understand the real world problems.
PEO2	To establish the methodologies for core mathematical problems.
PEO3	To implement computer solution methods for large systems.
PEO4	To perform inter-disciplinary research objectives
PEO5	To imbibe professional and ethical responsibility towards the society



**Program Outcomes (POs) & Program Specific Outcomes(PSOs) for M.Sc.Applied Mathematics**

PO 1	Apply basic knowledge of mathematics and science to understand the real world problems.
PO 2	Develop complexity problem solving techniques using mathematical tools.
PO 3	Establish the methodologies for core mathematical problems.
PO 4	Implement computer solution methods for large systems.
PO 5	Assess the influence of global changes on organization for effective decision making business problems.
PO 6	Acquire knowledge of fast changing methodologies for solving engineering and science problems.
PO 7	Exhibit leadership capabilities
PO 8	Perform inter-disciplinary research objectives
PO 9	Communicate effectively in peer and research related conferences
PO 10	Acquire skills to become a good researcher
PO 11	Engage in life-long learning environment.
PO 12	Imbibe professional and ethical responsibility towards the society.
PSO1	Create Mathematical Models (along with solution) for various physical needs.
PSO2	Use Mathematics, not only in the discipline of Mathematics, but also in other disciplines and in their future endeavours
PSO3	Develop the statistical and computer programming skill for solving various physical problems.

**M.Sc. (Applied Mathematics) – Curriculum Structure  
(2020-21 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. Eval
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
8	VDC 111	Venture Discovery	VDC	2	2	0	2	---	---	100
Total			---	24	18	9	27	--	240	560

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

1. SSE 701: BASIC COMPUTER CONCEPTS
2. SSE 703: INFORMATION TECHNOLOGY 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. Eval
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
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### THIRD 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	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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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.

**Course 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

**Course 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

**Text Book:**

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

**Reference Books:**

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

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

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 non-linear partial differential equations of first order
- To evaluate problems using Charpit's method and Jacobi's method

**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, Frobenius 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 Frobenius series method

- define second order differential equations with regular singular points and regular singular points at infinity

### UNIT-III

Equations of the form  $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ , 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

#### Course 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

**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



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

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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.

**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

### Course 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 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

### Text Book:

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

### Reference Books:

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

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

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 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

#### Course 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
- 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<sup>th</sup> Edition, Prism Books Pvt Limited, 2011.
2. Elements of Discrete Mathematics by CL Liu, Tata Mc Graw –Hill, Publishing company(second edition), 2010.

**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.

**Course Objectives:**

- To introduce components of digital computer
- To work along with the outline of Operating Systems.
- To give hands on training on MS-Word,
- To give hands on training on Power Point
- To give hands on training on 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.

**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.

## 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.

## **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.

### Course Objectives:

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

**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

**Reference Books:**

- In-line/On-line : Fundamentals of the Internet and the World Wide Web by Raymond Greenlaw and Ellen Hepp, 2<sup>nd</sup> Edition, TMH.
- Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh and Faithe Wempen, WileyPublications.

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

**Hours per week: 3**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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 function
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



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

**Hours per week: 3**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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 coefficients
- Examine the working of Wronskian condition

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

<b>Course Code:</b> VDC111	<b>Course Title:</b> Venture Discovery	
<b>Semester:</b> I	<b>Course Type:</b> Continuous Evaluation	<b>Credits:</b> 2
<b>Program:</b> M.Sc. Applied Mathematics		
<b>Course Leader:</b> Venture Discovery Centre		

### Course description and learning outcomes

India as part of its Make in India initiative has been focusing on creating incubation centers within educational institutions, with an aim to generate successful start-ups. These start-ups will become employment creators than employment seekers, which is the need of the hour for our country.

This common course for all the disciplines is a foundation on venture development. It is an experiential course that lets students venture and find out what is a business, financial and operating models of a business are. How to design and prototype a solutions that meets their customers' needs and generate revenue for the business.

### LEARNING OBJECTIVES

- Discover who you are – Values, Skills, and Contribution to Society.
- Gain experience in actually going through the innovation process.
- Conduct field research to test or validate innovation concepts with target customers.
- Understand innovation outcomes: issues around business models, financing for start-ups, intellectual property, technology licensing, corporate ventures, and product line or service extensions.

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

	Learning Outcome	Assessment
1	Understand conceptual framework of the foundation of a venture	A1, A2
2	Understand the concept of purpose, mission and value-add service offered by a venture	A3
3	Analyze design and positioning of the product	A3
4	Demonstrate prototyping	A3
5	Analyze business, revenue and operating models	A3

### Course outline and indicative content

#### Unit I (6 sessions)

**Personal Values:** Defining your personal values, Excite & Excel, Build a Team, Define purpose for a venture. Four stages: Personal Discovery, Solution Discovery, Business Model Discovery, Discovery Integration.

#### Unit II (6 sessions)

**Solution Discovery:**Craft and mission statement, Experience design, Gaining user insight, Concept design and positioning, Product line strategy, Ideation & Impact.

**Unit III (6 sessions)**

**Business Model Discovery:**Prototyping solutions, Reality Checks, Understand your industry, Types of business models, Define Revenue Models, Define Operating Models

**Unit IV (6 sessions)**

**Discovery Integration:**Illustrate business models, Validate business models, Define company impact

**Unit V (6 sessions)**

**Tell a Story:**Can you make money, Tell your venture story.

**Assessment methods**

Task	Task type	Task mode	Weightage (%)
A1. Assignments	Individual	Report/Presentation	20
A2. Case / Project/Assignment	Groups* or Individual	Presentations/Report/Assignment	40
A3. Project	Individual/Group	Report/Pitch	40

**Transferrable and Employability Skills**

	Outcomes	Assessment
1	Know how to use online learning resources: G-Learn, online journals, etc.	A1 & A2
2	Communicate effectively using a range of media	A1& A2
3	Apply teamwork and leadership skills	A2
4	Find, evaluate, synthesize & use information	A1 & A2
5	Analyze real world situation critically	A3
6	Reflect on their own professional development	A3
7	Demonstrate professionalism & ethical awareness	A2
8	Apply multidisciplinary approach to the context	A2

**Learning and teaching activities**

Mixed pedagogy approach is adopted throughout the course. Classroom based face to face teaching, directed study, independent study via G-Learn, case studies, projects and practical activities (individual & group)

**Teaching and learning resources**

Soft copies of teaching notes/cases etc. will be uploaded onto the G-learn. Wherever necessary, printouts, handouts etc. will be distributed in the class. Prescribed text book will be provided to all. However you should not limit yourself to this book and should explore other sources on your own. You need to read different books and journal papers to master certain relevant concepts to analyze cases and evaluate projects. Some of these reference books given below will be available in our library.

***Prescribed Modules:***

Access to NU-IDEA online modules will be provided.

***Referential text books and journal papers:***

Personal Discovery Through Entrepreneurship, Marc H. Meyer and Chaewon Lee, The Institute of Enterprise Growth, LLC Boston, MA.

***Suggested journals:***

Vikalpa, Indian Institute of Management, Ahmedabad  
Journal of General Management, Mercury House Business Publications, Limited  
Harvard Business Review, Harvard Business School Publishing Co. USA

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

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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

**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

#### **Course 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

#### **Text Book:**

1. Complex analysis for Mathematics and Engineering by John H.Mathews and Russel W, Howell,5<sup>th</sup>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.

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

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 classify the integral equations
- .To evaluate the method of successive approximations
- 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

**Course 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

**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



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

**Hours per week: 4**

**Credits: 4**

**End Examination: 60 Marks**

**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.
- explain transcendental and polynomial equations
- evaluate problems using Newton-Raphson method and iteration methods
- explain second order, third order and fourth order methods of Runge-Kutta

**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

#### **Course 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

#### **Text Book:**

1. Numerical Methods for Scientific and Engineering Computation by M.K. Jain, S.R.K. Iyengar, R.K. Jain, 4<sup>th</sup> 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, 3<sup>rd</sup> Edition, McGraw-Hill International Editions, Mathematics and Statistics Series,2005
2. Numerical Methods using MATLAB by John H. Mathews, Kurtis D.Fink, 4<sup>th</sup> edition,Pearson Education, 2006.

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

**Hours per week: 4**

**Credits: 4**

**End Examination: 60 Marks**

**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 Hamiltonian 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 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 Brackets 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:** Galilean 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

**Course 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

**Text Book**

Classical Mechanics by J.C.Upadhyaya, 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, 1<sup>st</sup> Edition, PHI Learning Pvt. Ltd., 2009
4. N.C.Rane and P.S.C. Joag, Classical Mechanics, Tata Mc Graw-Hill, 1991.

**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.

#### **Course 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**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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. Trapezoidal 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
- 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**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 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  $C(X, \mathbb{R})$  and  $C(X, \mathbb{C})$ .

**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 on 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

#### Course 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 spaces and Hilbert spaces
- acquainted with the statement of the Hahn-Banach theorem and its corollaries, the open mapping theorem and the closed graph theorem

#### 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, 31<sup>st</sup> edition, Krishna Prakashan, 2010.

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

**Hours per week: 4**

**Credits: 4**

**End Examination: 60 Marks**

**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, Bayes'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 Bayes'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:** Expected value of a random variable and function of a random variable, 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, Jensen's inequality. Moment generating functions, characteristic functions, Multi variate moment generating functions, Chebychev inequality, 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, Jensen'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

#### Course Outcomes

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

- Describe the basic concepts of Measures of central tendency
- Describe the basic concepts of Measures of dispersion
- Explain Probability generating functions and evaluate problems on it
- Describe the concepts of importance of inequalities i.e Cauchy-Schwartz, Jensen's inequality
- Describe the concept and evaluate problems on Multi variate moment generating functions

**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, 1<sup>st</sup> 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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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

- understand the problem of linear programming problem
- know the technique to solve LPP graphically and some special cases of LPP solution
- understand the problem of assignment problem
- Know the techniques of algebraic method and calculus method for various inventory models for with and without shortages
- understand the problem of network models

**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
- 

**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)

**Course 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 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

**Text Book:**

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

**Reference Book:**

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

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

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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.

**Course Outcomes**

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

- understand the group of transformation
- evaluate problems on groups and direct product of groups
- understand the difference between reducible and irreducible representations
- evaluate problems using Schur's lemmas
- explain criterion for irreducibility of a representation

**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**

**Credits: 4**

**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  $n^{\text{th}}$  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

**End Examination: 60 Marks**

**Sessionals: 40 Marks**

#### 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 2 of 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  $n^{\text{th}}$  order linear homogeneous equation, The  $n^{\text{th}}$  order non-homogeneous equation. The adjoint vector equations. The adjoint  $n^{\text{th}}$  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  $n^{\text{th}}$  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 book 1)

**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

### **Course Outcomes**

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

- explain dependence of solution on initial conditions and on parameters
- explain  $n^{\text{th}}$  order linear and non-homogeneous equations
- differentiate relationship between scalar and vector adjoints
- evaluate problems on eigen values
- explain adjoint boundary value problem

### **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)**  
**III Semester**  
**SAM 845: THEORY OF COMPUTATION**

**Hours per week :4**  
**Credits : 4**

**End Examination : 60 Marks**  
**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 understand the concept of non deterministic finite state machines
- To establish equivalences of DFA and N DFA
- To classify Chomsky type of languages
- Ability to explore languages and their corresponding automata
- To design Turing machines

**UNIT-I**

**The Theory of Automata :** Definition of an Automata, Description of a Finite Automaton, Transition systems, properties of transition functions, acceptability of a string by a finite automaton, Non Deterministic finite state machines, the equivalences of DFA and N DFA, 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 N DFA
- 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

#### **Course Outcomes**

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

- define deterministic and non-deterministic finite state machines
- explain minimization of finite automata
- explain languages and their relation
- 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**

**Credits: 4**

**End Examination: 60 Marks**

**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 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 –  $\alpha$ -cuts – Additional properties of  $\alpha$  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  $\alpha$  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- $\omega$ i 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-  $\omega$ i Compositions.

#### Course Outcomes

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

- define fuzzy set with membership function
- explain  $\alpha$  cut and its properties
- explain fuzzy complements, fuzzy unions
- explain different types of fuzzy numbers
- understand the concept of fuzzy equivalence relations

#### 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**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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 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**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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

**M.Sc. (Applied Mathematics)**  
**IV SEMESTER**

**SAM 802: PROBABILITY DISTRIBUTIONS AND STATISTICAL METHODS**

**Hours per week: 4**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 of correlation coefficient
- To learn the applications of correlation coefficient
- To learn the applications of 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 generating functions.

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 single mean,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  $\chi^2$  –test to given data
- apply the concept of F –test to given data

### **Course Outcomes**

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

- explain the need of normal distribution
- describe the basic concepts of correlation coefficient and rank correlation coefficient
- evaluate Types of sampling
- explain tests of significance for large samples
- explain t-test for single mean, difference of means

### **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, 1<sup>st</sup> 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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 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

##### Course Outcomes

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

- define graph, subgraph, degree of a vertex
- explain trees and spanning trees
- explain Hamiltonian graphs
- explain about minimum weight spanning trees
- explain the Steiner Network Problem

##### 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 outlineseerie, by Seymour Lipschutz and Marc Lipson Tata Mc Graw Hill, 2<sup>nd</sup> Edition.
2. Discrete Mathematical Structures by Prism, 4<sup>th</sup> 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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 equations of motion
- To learn about boundary layer theorem
- To identify integral equations of the boundary layer

**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, Rankine 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 Rankine 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 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

#### **Course Outcomes**

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

- establish equation of continuity
- understand the concept of Bernoulli's equation
- evaluate problems on ranking technique of construction stream lines
- explain Blasius theorem lift force
- understand the concept of vorticity and circulation in a viscous fluid

#### **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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 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

#### Course Outcomes

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

- explain N-dimensional space with examples
- explain difference between covariant and contra variant vectors
- understand the concept of space-time
- evaluate problems on Lorentz rotation of axes
- explain Ricci tensor with an example

#### 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**  
**Credits: 4**

**End Examination: 60 Marks**  
**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 circular 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 law
- 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

##### Course Outcomes

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

- understand the concept of elastic moduli for isotropic media
- explain equilibrium equations
- explain extension of beams by longitudinal forces
- explain bending of beams by terminal couples
- define torsion of cylindrical bars

##### 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, 3<sup>rd</sup> edition, Elsevier, 2014.
2. Introduction to Linear Elasticity by Phillip L. Gould, 3<sup>rd</sup> edition, Springer, 2013.

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

**Hours per week: 3**  
**Credits: 2**

**Continuous Evaluation: 100 Marks**

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

## **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.