



**DEPARTMENT OF MATHEMATICS**  
**Scheme B. Sc.(Honours) MATHEMATICS**

**Choice Based Credit System (CBCS)**

**Course Effective from Academic Year 2022-23**

## I. About the Department

The Department of Mathematics at Sri Sai University, Palampur (H.P) has been established in the year 2015. The main objective of the department is to develop the inherent Mathematics talent in student's right after from +2 levels to post graduate level and guide them into research level to promote research in Mathematics. This Department offers a two year M.Sc. / M.A. Mathematics programme along with three years **Bachelor of Mathematics (Hons.)** programme. Ph. D. (Mathematics) is also there from the current session. We have also introduced project work for 4<sup>th</sup> semester students to promote research at M.Sc. level.

## II. Introduction to CBCS (Choice Based Credit System)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional markssystem. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

### Definitions:

- (i) '**Academic Programme**' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department /Centre.
- (ii) '**Course**' means a segment of a subject that is part of an Academic Programme.
- (iii) '**Programme Structure**' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.
- (iv) '**Core Course**' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.
- (v) '**Elective Course**' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.
- (vi) '**Discipline Specific Elective (DSE)**' Course is the domain specific elective course offered by the main discipline/subject of study. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature also, but these are needed to be offered by main discipline/subject of study.
- (vii) '**Dissertation/Project**' is an elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member. Project work /Dissertation is considered as a special course involving application of knowledge in solving/analysing/exploring a real life situation/difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.
- (viii) '**Generic Elective (GE)**' Course is an elective course chosen generally from an unrelated

discipline/subject, with an intention to seek exposure to other disciplines. A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

(ix) ‘**Ability Enhancement Courses (AEC)**’ also referred as Competency Improvement Courses/Skill Development Courses/Foundation Course. The Ability Enhancement Courses (AEC) may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC).

(x) ‘**AECC**’ are the courses based upon the content that lead to Knowledge enhancement. The Two AECC are: Environmental Science, English/MIL Communication.

(xi) ‘**AEEC**’ are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction. These courses are also referred to as Skill Enhancement Courses (SEC).

(vii) ‘**Credit**’ means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 Hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course

(viii) ‘**CGPA**’ is cumulative grade points calculated for all courses completed by the students at any point of time.

(ix) ‘**SGPA**’ means Semester Grade Point Average calculated for individual semester.

(x) ‘**CGPA**’ is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

(xi) ‘**Grand CGPA**’ is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into % age marks is given in the Transcript.

### **III. B.Sc. (Hons) Mathematics Program**

The main objectives of the B.Sc. in Mathematics is to provide a solid education in the basic subjects of mathematical knowledge and its applications, essential to access the 2nd cycle (Master) programs in Mathematics or Mathematics Teaching. With the B.Sc. in Mathematics, the students must be able to: use and construct logical arguments, in particular, be familiar with proof techniques and know how to apply the laws of logic in mathematical proofs; understand and communicate concepts and mathematical ideas with clarity and coherence; use computational tools to solve mathematical problems; create/use mathematical models to solve real problems.

Duration: B.Sc. /B.A. Mathematics is a undergraduate level program offered by the Department of Mathematics. This is a 3-years program, consisting of six semesters with two semesters per year.

## COURSES FOR B.Sc. (HONOURS) MATHEMATICS PROGRAMME

### *Core Courses*

<b>Semester I</b>	MATH-CC-311	Differential Calculus
	MATH-CC-312	Linear Algebra
<b>Semester II</b>	MATH-CC-321	Differential Equations
	MATH-CC-322	Sequences & Series
<b>Semester III</b>	MATH-CC-331	Real Analysis
	MATH-CC-332	Number Theory
	MATH-CC-333	Group Theory and Rings
<b>Semester IV</b>	MATH-CC-341	Integral Calculus
	MATH-CC-342	Solid Geometry
	MATH-CC-343	Complex Analysis
<b>Semester V</b>	MATH-CC-351	Metric Space
	MATH-CC-352	Probability and Statistics
<b>Semester VI</b>	MATH-CC-361	Ring Theory and Linear algebra II
	MATH-CC-362	Vector Calculus
<b>Semester V</b>	MATH-DSE-001	Transformations
	MATH-DSE-002	Cryptography and Network security
	MATH-DSE-003	Discrete Mathematics
	MATH-DSE-004	Research Methodology
<b>Semester VI</b>	MATH-DSE-005	Linear Programming and applications
	MATH-DSE-006	Numerical Analysis
	MATH-DSE-007	Mechanics
	MATH-DSE-008	Dissertation

### *Ability Enhancement Compulsory Courses (AEC)*

ENG-AE-011	Technical Writing and Communication in English
ENV-AE-011	Environmental Studies

### *Skill Enhancement Courses (SEC)*

MATH-SE-001	Basics Of MATLAB
MATH-SE-002	Logics and Sets
MATH-SE-003	Time Series Analysis
MATH-SE-004	Boolean Algebra

**Generic Elective (GE) Courses (for other disciplines)**

MATH-GE-001	Matrices and Polynomials
MATH-GE-002	Differentiation and Integration
MATH-GE-003	Queueing and Reliability Theory
MATH-GE-004	Sample Surveys and Design of Experiments

**Generic Elective (GE) Courses (offered by other disciplines)**

**Department of Computer Applications:**

CA002	Fundamentals of Information Technology
CA090	Information Technology Trends
CA010	System Analysis and Design
CA091	Computer Hardware and Troubleshooting
CA0	Multimedia and Animation
CA092	Linux Server Administration
CA007	Operating Systems
CA093	Cyber Security
CA058	System Administration
CA094	E-Commerce And E-Governance
CA027	Information Security
CA095	Mobile Computing

**Department of Chemistry :**

CHEM-GE-001	General Chemistry-I
CHEM-GE-002	General Chemistry-II
CHEM-GE-003	General Chemistry-III
CHEM-GE-004	General Chemistry-IV

**Department of Physics**

PHY-GE-001	Physics-I
PHY-GE-002	Physics-II
PHY-GE-003	Physics-III
PHY-GE-004	Physics-IV

**The detailed structure of courses under B.Sc. (Honours) with Mathematics Programme:**

Sl. No.	Details of Courses	Credits		
		Theory	Tutorials	TOTAL
I	<b>Core Courses</b> (6 Credits) ( <b>14 Courses</b> )	14 X 5 = 70	14 X 1 = 14	84
II	<b>Elective Courses</b> (6 Credits) ( <b>8 Courses</b> )			
	(a) Discipline Specific Elective (DSE) Courses ( <b>4 Courses</b> )	4 X 5 = 20	4 X 1 = 4	24
	(b) Generic Elective (GE) Courses ( <b>4 Courses</b> )	4 X 5 = 20	4 X 1 = 4	24
III	<b>Ability Enhancement Courses</b>			
	(a) Ability Enhancement Compulsory Courses (AEC) (4 Credits) ( <b>2 Courses</b> )	2 X 4 = 8		8
	(b) Skill Enhancement Courses (SEC) (2 Credits) ( <b>2 Courses</b> )	2 X 2 = 8		4
Grand Total Credit				<b>144</b>

**Scheme for Choice Based Credit System (CBCS) in B.Sc. (Honours) Mathematics.**

Semester	Core Course (CC)	Elective Course		Ability Enhancement Course	
		Discipline Specific Course (DE)	Generic Elective (GE)	Ability Enhancement (AE) Compulsory Course	Skill Enhancement (SE) Course
I	CC I, CC II		GE I	AEC I	
II	CC III, CC IV		GE II	AEC II	
III	CC V, CC VI, CC VII		GE III		SEC I
IV	CC VIII, CC IX, CC X		GE IV		SEC II
V	CC XI, CC XII	DSE I, DSE II			
VI	CC XIII, CC XIV	DSE III, DSE IV			

**1. SEMESTER-WISE DISTRIBUTION OF COURSES FOR B.SC. (HONOURS) MATHEMATICS PROGRAMME UNDER CBCS AND CREDIT DISTRIBUTION**

**(a) Core Courses**

Semester	Course Code	Course Title	Credit (L:T:P)	Total Credit
<b>I</b>	MATH-CC-311	Differential Calculus	5:1:0	6
	MATH-CC-312	Linear Algebra	5:1:0	6
<b>II</b>	MATH-CC-321	Differential Equations	5:1:0	6
	MATH-CC-322	Sequences & Series	5:1:0	6
<b>III</b>	MATH-CC-331	Real Analysis	5:1:0	6
	MATH-CC-332	Number Theory	5:1:0	6
	MATH-CC-333	Group Theory and Rings	5:1:0	6
<b>IV</b>	MATH-CC-341	Integral Calculus	5:1:0	6
	MATH-CC-342	Solid Geometry	5:1:0	6
	MATH-CC-343	Complex Analysis	5:1:0	6
<b>V</b>	MATH-CC-351	Metric Space	5:1:0	6
	MATH-CC-352	Probability and Statistics	5:1:0	6
<b>VI</b>	MATH-CC-361	Ring Theory and Linear algebra II	5:1:0	6
	MATH-CC-362	Vector Calculus	5:1:0	6

**(b) Discipline Specific Elective (DSE) Courses**

Semester	Course Code	Course Title	Credit (L:T:P)	Total Credit
<b>V</b> (Any two for <b>DSE I</b> and <b>DSE II</b> )	MATH-DSE-001	Transformations	5:1:0	6
	MATH-DSE-002	Cryptography and Network security	5:1:0	6
	MATH-DSE-003	Discrete Mathematics	5:1:0	6
	MATH-DSE-004	Research Methodology	5:1:0	6
<b>VI</b> (Any two for <b>DSE III</b> and <b>DSE IV</b> )	MATH-DSE-005	Linear Programming and applications	5:1:0	6
	MATH-DSE-006	Numerical Analysis	5:1:0	6
	MATH-DSE-007	Mechanics	5:1:0	6
	MATH-DSE-008	Dissertation		6

**(c) Generic Elective (GE) Courses**

(i) Please refer to the syllabus of following departments/disciplines for GE 1 to GE4

1. Chemistry
2. Physics
3. Computer Science

(ii) The students may choose either four Generic Elective papers exclusively from one department/ discipline *OR* two papers each from two different departments/disciplines.

**(d) Ability Enhancement Courses(AEC)\***

Semester	Course Code	Course Title	Credit (L:T:P)	Credit
<b>I</b>	ENG-AE-011	Technical Writing and Communication in English	4:0:0	4
<b>II</b>	EVS-AE-021	Environmental Studies	4:0:0	4

**(e) Skill Enhancement Courses(SEC)\***

Semester		Course Title	Credit (L:T:P)	Credit
<b>I &amp; III</b>	MATH-SEC-001	Basics Of MATLAB	1:0:1	2
	MATH-SEC-002	Logics and Sets	2:0:0	2
<b>II &amp; IV</b>	MATH-SEC-003	Time Series Analysis	2:0:0	2
	MATH-SEC-004	Boolean Algebra	2:0:0	2

(i) A student shall select at least 2 (two) SEC of total 4 credits from his/her concerned discipline.

(ii) For remaining 4 credits, he/she may select course(s) from either from his/her own discipline or other under-graduate disciplines of Science and Technology in the College/University.



## Scheme B. Sc. /B.A. (Hons) Mathematics

### SEMESTER-I

Paper Code	CC/AEC C/SEC/D SE/GE	Name of Paper	Marks							Credits
			Theory	Practical	Internal Assessm	Total Marks	L	T	P	
										Total
<b>Core Papers</b>										
MATH-CC-311	CC	Differential Calculus	60	-	40	100	5	1	0	6
MATH-CC-312	CC	Linear Algebra	60	-	40	100	5	1	0	6
<b>Ability Enhancement Compulsory Course</b>										
ENG-AE-011	AECC	Technical Writing and Communication in English	30	-	20	50	4	0	0	4
<b>Skill Enhancement Course-NIL</b>										
<b>Elective: Discipline Specific –NIL</b>										
<b>Elective: Generic</b>										
	GE-I	One Generic Elective Course paper is to be Opted by the students as offered by other departments of the School.								6
<b>TOTAL</b>										<b>22</b>
MATH-GE-001	GE	Matrices and Polynomials	60	-	40	100	5	1	0	6

## SEMESTER-II

Paper Code	CC/AE CC/SE C/DSE/ GE	Name of Paper	Marks							Credits
			Theory	Practical	Assessm Internal	Total Marks	L	T	P	
										Total
<b>Core Papers</b>										
MATH-CC-321	<b>CC</b>	Differential Equations	60	-	40	100	5	1	0	6
MATH-CC-322	<b>CC</b>	Sequences & Series	60	-	40	100	5	1	0	6
<b>Ability Enhancement Compulsory Course</b>										
ENV-AE-011	<b>AECC</b>	Environmental Studies	30	-	20	50	4	0	0	4
<b>Skill Enhancement Course-NIL</b>										
<b>Elective: Discipline Specific –NIL</b>										
<b>Elective: Generic</b>										
	<b>GE-II</b>	One Generic Elective Course paper is to be Opted by the students as offered by other departments of the School.								6
<b>TOTAL</b>										<b>22</b>
MATH-GE-002	<b>GE</b>	Differentiation & Integration	60	-	40	100	5	1	0	6

### SEMESTER-III

Paper Code	CC/AECC /SEC/DSE /GE	Name of Paper	Marks							Credits
			Theory	Practical	Assessm Internal	Total Marks	L	T	P	
<b>Core Papers</b>										
MATH-CC-331	CC	Real Analysis	60	-	40	100	5	1	0	6
MATH-CC-332	CC	Number Theory	60	-	40	100	5	1	0	6
MATH-CC-333	CC	Group Theory and Rings	60	-	40	100	5	1	0	6
<b>Ability Enhancement Compulsory Course- NIL</b>										
<b>Skill Enhancement Course</b>										
One Skill Enhancement Course paper is to be opted by the students out of the courses offered by the departments										
MATH-SEC-001	SEC	Basics of MATLAB	30	-	20	50	1	0	1	2
MATH-SEC-002	SEC	Logics and Sets	30	-	20	50	2	0	0	2
<b>Elective: Discipline Specific- NIL</b>										
<b>Elective: Generic</b>										
	GE-III	One Generic Elective Course paper is to be opted by the students as offered by other departments of the School.								6
<b>TOTAL</b>										<b>26</b>
MATH-GE-003	GE	Queueing and Reliability Theory	60	-	40	100	5	1	0	6

## SEMESTER-IV

Paper Code	CC/AECC /SEC/DSE /GE	Name of Paper	Marks							Credits
			Theory	Practical	Assessm Internal	Total Marks	L	T	P	
<b>Core Papers</b>										
MATH-CC-341	CC	Integral Calculus	60	-	40	100	5	1	0	6
MATH-CC-342	CC	Solid Geometry	60	-	40	100	5	1	0	6
MATH-CC-343	CC	Complex Analysis	60	-	40	100	5	1	0	6
<b>Ability Enhancement Compulsory Course- NIL</b>										
<b>Skill Enhancement Course</b>										
One Skill Enhancement Course paper is to be opted by the students out of the courses offered by the departments										
MATH-SEC-003	SEC	Time Series Analysis	30	-	20	50	2	0	0	2
MATH-SEC-004	SEC	Boolean Algebra	30	-	20	50	2	0	0	2
<b>Elective: Discipline Specific- NIL</b>										
<b>Elective: Generic</b>										
	GE-IV	One Generic Elective Course paper is to be opted by the students as offered by other departments of the School.								6
<b>TOTAL</b>										<b>26</b>
MATH-GE-004	GE	Sample Surveys and Design of Experiments	60	-	40	100	5	1	0	6

## SEMESTER-V

Paper Code	CC/AECC /SEC/DSE /GE	Name of Paper	Marks							Credits
			Theory	Practical	Assessm Internal	Total Marks	L	T	P	
										Total
<b>Core Papers</b>										
MATH-CC-351	<b>CC</b>	Metric Space	60	-	40	100	5	1	0	6
MATH-CC-352	<b>CC</b>	Probability & Statistics	60	-	40	100	5	1	0	6
<b>Ability Enhancement Compulsory Course- NIL</b>										
<b>Skill Enhancement Course- NIL</b>										
<b>Elective: Discipline Specific ( Student will choose two courses out of given courses)</b>										
MATH-DSE-001	<b>DSE</b>	Transformations	60	-	40	100	5	1	0	6
MATH-DSE-002	<b>DSE</b>	Cryptography and Network Security	60	-	40	100	5	1	0	6
MATH-DSE-003	<b>DSE</b>	Discrete Mathematics	60	-	40	100	5	1	0	6
MATH-DSE-004	<b>DSE</b>	Research Methodology	60	-	40	100	5	1	0	6
<b>Elective: Generic-NIL</b>										
<b>TOTAL</b>										<b>24</b>

## SEMESTER-VI

Paper Code	CC/AECC /SEC/DSE /GE	Name of Paper	Marks							Credits
			Theory	Practical	Assessm Internal	Total Marks	L	T	P	
<b>Core Papers</b>										
MATH-CC-361	CC	Ring Theory and Linear Algebra II.	60	-	40	100	5	1	0	6
MATH-CC-362	CC	Vector Calculus	60	-	40	100	5	1	0	6
<b>Ability Enhancement Compulsory Course- NIL</b>										
<b>Skill Enhancement Course- NIL</b>										
<b>Elective: Discipline Specific( Student will choose two courses out of given courses)</b>										
MATH-DSE-005	DSE	Linear Programming and applications	60	-	40	100	5	1	0	6
MATH-DSE-006	DSE	Numerical Analysis	60	-	40	100	5	1	0	6
MATH-DSE-007	DSE	Mechanics	60	-	40	100	5	1	0	6
MATH-DSE-008	DSE	Dissertation								6
<b>Elective: Generic-NIL</b>										
<b>TOTAL</b>									<b>24</b>	

**\* End-semester Examination (ESE) and Comprehensive Continuance Assessment (CCA)**

**Scheme of Three years Degree of B.Sc. with Mathematics**

**Scheme for Examination for each course**

- The medium of instructions and Examinations shall be English only.
- ESE Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by SSU, Palampur.
- Each course of 4/6 credits (theory + Tutorial) will carry 100 marks and will have following components:

(FOR COURSES WITHOUT PRACTICALS WHICH ARE OF 100 MARKS)

I) End-Semester Examination (ESE)= 60 marks

II). Comprehensive Continuous Assessment (CCA) = 40 marks

- a) Assignment/Class Test/Quiz/Seminar= 05 marks
- b) Mid-Term Examination + MCQ's = 30 marks
- c) Attendance =05 marks

## SEMESTER – I

### MATH-CC- 311 (DIFFERENTIAL CALCULUS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Knowledge of differentiation.

**Course Objectives:** The objective of this course is to be able the students to find successive derivatives of a function. They will also be able to solve questions based upon theorems like Rolle's Theorem and Mean Value Theorem. They will also be able to find the maximum and minimum value of a function.

**Course Outcomes:** After the completion of this course students will be able to

- Calculate the Differentiability of functions.
- Understand the Mean value theorems, Roll's Theorem
- Apply applications of differential calculus in curve sketching.
- Find maximum and minimum value of a function.

#### **Module I**

##### **Successive Differentiation**

Differentiability of functions, Chain rule, Successive differentiation, Leibnitz's theorem, Indeterminate forms.

#### **Module II**

##### **Applications of Differentiation**

Rolle's theorem, Lagrange's & Cauchy Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series. Maclaurin's series of  $\sin x$ ,  $\cos x$ ,  $e^x$ ,  $\log(1+x)$ ,  $(1+x)^m$ .

#### **Module III**

##### **Curve Tracing**

Concavity, Convexity & Points of Inflexion, Curvature, Asymptotes, Singular points, Parametric representation of curves and tracing of curves in parametric form, Polar coordinates and tracing of curves in polar coordinates.

#### **Module IV**

##### **Euler's Theorem**

Functions of several variables (upto three variables): Limit and Continuity of these functions, Partial differentiation, Euler's theorem on homogeneous functions.

#### **Module V**

##### **Maxima and Minima**

Maximum and minimum value of a function, Maxima and Minima with Lagrange Multipliers Method, Jacobian of a function.

##### **Recommended Books:**

1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

## SEMESTER – I

### MATH-CC-312 (LINEAR ALGEBRA)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Mathematical Operations.

**Course Objectives:** The main objective of this course is to demonstrate understanding of the concept of vector space and subspace along with homomorphism and isomorphism, linear independence, span and basis.

**Course Outcomes:** After completion of this course, the students will be able to

- Solve problems based upon vector space and subspace
- Use computational techniques and algebraic skills essential for the study of systems of Linear transformations
- Understand the concept of inner product spaces
- Check the orthogonality of the vectors.

#### **Module I**

##### **Vector Space**

Vector Space, Subspaces, Sum and direct sum of subspaces, Linear span, Linearly independent and linearly dependent subsets of a vector space, Finitely generated vector space, Existence theorem for basis of finitely generated vector space(statement only), Invariance of number of elements of basis sets, Dimension of vector space.

#### **Module II**

##### **Linear transformation I**

Homomorphism and isomorphism of vector spaces, linear transformation and their algebra, Representation of transformation by matrices, Linear functional, Null space and range space of a linear transformation, Rank and nullity theorem.

#### **Module III**

##### **Linear transformation II**

Algebra of linear transformations, Minimal polynomial of linear transformation, Singular and non- singular linear transformations, Matrix of linear transformation, Change of basis, Eigenvalues and eigenvectors of a linear transformation.

#### **Module IV**

##### **Inner product spaces**

Inner product spaces, Cauchy-Schwartz inequality, orthogonal vectors, orthogonal complements, Orthonormal sets and basis.

#### **Module V**

##### **Gram-Schmidt Orthogonalization process**

Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt orthogonalization process and problems based on it.

##### **Recommended Books:**

1. I.N. Herstein: Topics in Algebra, Wiley Eastern Company, New Delhi.
2. Hoffman and R. Kunze: Linear Algebra, 2nd Edition, Prentice Hall of India, Delhi.
3. VivekShahi and VikasBist: Algebra, Narosa Publishing House.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition).



## SEMESTER – I

### ENG-AE-011(TECHNICAL WRITING AND COMMUNICATION IN ENGLISH)

L	T	P	Credit
4	0	0	4

**Pre-requisite:** Basic English grammar.

**Course Objectives:** This course is designed to help students become proficient in listening, speaking, reading and writing skills, help students to become independent users of English language, develop vital communication skills, in students integral to their personal, social and professional interaction and teach them the appropriate language of professional communication.

**Course Outcomes:** After completion of this course, the students will be able to

- Acquire basic proficiency in reading, listening, writing and speaking skills
- Understand spoken and written English language, particularly the language of their chosen technical field.
- Converse fluently.
- Produce their own clear and coherent texts.
- Become proficient in professional communication such as interviews, group discussion, office environment, important reading skills as well as writing skills and thereby will have better job prospects

#### **Module I**

##### **Communication**

Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

#### **Module II**

##### **Writing skills**

Selection of topic, thesis statement, developing the thesis, introductory, developmental, transitional and concluding paragraphs, linguistic Moduley, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

#### **Module III**

##### **Technical writing**

Scientific and technical subjects, formal and informal writings, formal writings/reports, handbooks, manuals, letters, memoranda, notices, agenda, minutes, common errors to be avoided.

##### **Recommended Books:**

1. Frank, M Writing as thinking: A guided process approach. Englewood Cliffs, Prentice-Hall (1989).
2. Hamp-Lyons, L. &Heasely, B. Study writing. Cambridge University Press (1987).
3. Quirk, R., Greenbaum, S., Leech, G. &Svartvik, J. A comprehensive grammar of the English Language. Harlow: Longman: London (1985).
4. Riordan, D. G. & Pauley, S. A. Technical report writing today 8th Ed. (2004).
5. Allen, J. P. B. &Widdowson, H. G. English in focus: English in Physical Science. Oxford University Press (1974).
6. Rosa, A. &Eschholz, P. W. Writer's Brief Handbook 6th Ed. Longman (2007).

## SEMESTER – I

### MATH-GE-001 (MATRICES AND POLYNOMIALS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Mathematical operations.

**Course Objectives:** Know how to add and subtract matrices. Know how to multiply matrices by a scalar. Know when it is possible to multiply two matrices and how it is done. Know the terms identity matrix, determinant, transpose and inverse matrix.

**Course Outcomes:** After completion of this course, the students will be able to

- Understand different types of matrices and their basic operations along with applications.
- Explain the methodology for finding a determinant.
- Understand different methods to solve the polynomials.

#### **Module I**

##### **Matrices**

Definition of matrices, Symmetric and skew-symmetric matrices, Hermitian, Skew-Hermitian matrices, Elementary operations on matrices, Determinants, Properties of determinants, Dimensions of row and column spaces, Row-rank, Column-rank and rank of a matrix (Normal form).

#### **Module II**

##### **Cayley-Hamilton Theorem and**

Characteristic equation of a matrix, Eigenvalues, Eigen vectors, Cayley-Hamilton theorem and its use to find the inverse of a matrix.

#### **Module III**

##### **Consistency of system of linear equations**

Applications of matrices to system of linear homogenous and non-homogeneous equations, Consistency of system of linear equations.

#### **Module IV**

##### **Solution of polynomial equations**

Relation between roots and coefficients of general Polynomial equation of one variable, Transformation of equations, Horner's method. Descartes's rule of signs(without proof) to find the nature of the roots of an equation, Solution of cubic equations (Cardan's method) and biquadratic equations (Ferrari's and Descartes's Method).

#### **Module V**

##### **De-Moivre's theorem**

De-Moivre's theorem and its applications, Expansion of trigonometric functions (expansion of powers of  $\sin \theta$  and  $\cos \theta$  in terms of multiples of sines and cosines and vice-versa), Summation of sine and cosine series only.

##### **Books Recommended:**

1. H.S. Hall and S.R. Knight: Higher Algebra, H.M. Publications.
2. Shanti Narayan: A Text Book of Matrices, S. Chand and Co.
3. Chandrika Prasad: Text Book of Algebra and Theory of Equations, Pothishala Pvt. Ltd. Allahabad.

## SEMESTER – II

### MATH-CC-321 (DIFFERENTIAL EQUATIONS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Knowledge about differential equations.

**Course Objectives:** The aim of the course is to cover the basic of first and higher order differential equations. The main objective of the course is to develop in student an intuitive understanding of differential equations emphasizing on its applications.

**Course Outcomes:** After the completion of the course, Students will be able to

- Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
- Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
- Find the series solution of differential equations.

#### **Module I**

##### **Linear Differential Equations I**

Linear differential equations, Basic theory of linear differential equations with constant coefficients, Non homogeneous linear differential equations with constant coefficients, Method of variation of parameters to solve second degree equations.

#### **Module II**

##### **Linear Differential Equations II**

Cauchy-Euler equation, Legendre's differential equation, System of linear differential equations with constant coefficients, Differential operators and homogeneous linear system of differential equations (two equations in two unknown functions).

#### **Module III**

##### **Ordinary Differential Equations**

Differential equations of first order but not of first degree, Equations solvable for  $p$ ,  $y$  and  $x$ , Clairaut's equation, Equations reducible to Clairaut's equation, Singular solution of differential equations.

#### **Module IV**

##### **Partial Differential Equations**

Formulation of first order PDE, Solution of Linear first order PDE (Lagrange's method), Integral surfaces passing through a given curve, Solution of non-linear PDE of first order by Charpit's method, second order PDE equations, Classification of second order PDE, Solution of linear PDE with constant coefficients and Monge's method to solve the non-linear PDE ( $r + Ss + Tt = V$  only).

#### **Module V**

##### **Series solution of differential equations**

Power series solution of differential equations, Orthogonal functions, Solution of Bessel and Legendre's equations, Properties of Bessel's and Legendre's functions.

##### **Recommended Books:**

1. D.A. Murray: Introductory Course in Differential Equations, Orient Longman (India).
2. S.L. Ross: Differential Equations, John Wiley and Sons.
3. J.N. Sharma and Kehar Sing: Partial Differential Equations for Engineers and Scientists, Narosa Publishing House.
4. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and sons. New York.

## SEMESTER – II

### MATH-CC-322 (SEQUENCES AND SERIES)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic idea about convergence and divergence.

**Course Objectives:** After studying this course student will be able to work with infinite sequences and series. They will learn to check whether infinite sequence and infinite series are bounded, monotonic, convergent or divergent,

**Course Outcomes:** After the completion of the course, Students will be able to

- Determine if an infinite sequence is bounded, monotonic, convergent or divergent
- Find the sequence of partial sums of an infinite series is convergent or divergent using different tests.

#### **Module I**

##### **Sequences**

Real sequences and their convergence, Theorem on limits of the sequence, Bounded and monotonic sequence and theorems based on them, Cauchy's first and second theorem on the limit of the sequence, Cauchy's sequence and Cauchy's general principle of convergence.

#### **Module II**

##### **Series**

Convergence and divergence of infinite series, Positive term series, comparison test for positive term series and Cauchy's general principle of convergence of the series.

#### **Module III**

##### **Test of Convergence I**

Convergence and divergence of geometric series, Harmonic series and p-series, Cauchy's condensation test (Without Proof) and Cauchy's root test.

#### **Module IV**

##### **Test of Convergence II**

D'Alembert's Ratio test, Kummer's test, Raabe's test, De Morgan test, Bertrand test, Logarithmic test, Cauchy's integral test, Gauss test.

#### **Module V**

##### **Test of Convergence III**

Alternating series, Leibnitz's test, Absolute and conditional convergence, Series of arbitrary terms, Abel's lemma, Abel's test, Dirichlet's test, Multiplication of series, Abel's test for product of series.

##### **Recommended Books:**

1. R.R. Goldberg: Real Analysis, Oxford and I.B.H. Publishing co., New Delhi.
2. S.C. Malik: Mathematical Analysis, Wiley eastern Ltd. Allahabad.
3. Shanti Narayan: A Course in Mathematical Analysis, S. Chand and Co, New Delhi.

## SEMESTER – II

### ENV-AE-011 (ENVIRONMENTAL STUDIES)

L	T	P	Credit
4	0	0	4

**Pre-requisite:** Basic science.

**Course Objectives:** Understand how much environment is crucial for the sustenance of life on earth.

**Course Outcomes:** After completion of this course, the students will be able to

- Knowing the composition of atmosphere and different reaction pathways for environmentally relevant chemical processes.
- Learning the mitigation strategies for the pollution problems.
- Realizing the importance of green chemistry and sustainability.

#### **Module I**

##### **Basics of Environmental Studies**

Multidisciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness.

#### **Module II**

##### **Renewable and non-renewable resources**

Natural resources and associated problems- a) Forest resources : Use and over-exploitation, deforestation, case studies; timber extraction, mining, dams and their effects on forest and tribal people; b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems; c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies; d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. F) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources; equitable use of resources for sustainable lifestyles.

#### **Module III**

##### **Ecosystems**

Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers; Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a) Forest ecosystem; b) Grassland ecosystem; c) Desert ecosystem; d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

#### **Module IV**

##### **Biodiversity and its Conservation**

Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity - In-situ and Ex-situ conservation of biodiversity.

#### **Module V**

##### **Environmental Pollution**

Definition, cause, effects and control measures of: - Air pollution; Water pollution; soil pollution; Marine pollution; Noise pollution; Thermal pollution; nuclear hazards and solid waste management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

## Module VI

### Social issues and the environment

From unsustainable to sustainable development; urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns. Case Studies; Environmental ethics: Issues and possible solutions; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation. Consumerism and waste products. Environment protection act. Air (prevention and control of pollution) act, water (prevention and control of Pollution) act; Wildlife protection act, forest conservation act, issues involved in enforcement of environmental legislation, public awareness.

## Module VII

### Human population and the environment

Population growth, variation among nations; Population explosion – Family welfare programme. Environment and human health; Human rights. Value education; HIV/AIDS, Women and child welfare, Role of information technology in environment and human health.

## Module VIII

### Field Work

Visit to a local area to document environmental assets river/forest/ grassland/hill/ mountain; Visit to a local polluted site-urban/rural/industrial/agricultural; Study of common plants, insects, birds; Study of simple ecosystems-pond, river, hill slopes, etc.

### Recommended Books:

1. Mhaskar A.K., Matter Hazardous, Techno-Science Publication.
2. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. Clark R.S., Marine Pollution, Clanderson Press Oxford .
3. Trivedi R. K. And P.K. Goel, Introduction to air pollution, Techno-Science Publication
4. Agarwal, K.C. Environmental Biology, Nidi Publ. Ltd. Bikaner
5. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India,
6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. Environmental Encyclopedia, Jaico Publ. House, Mumabai,
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd.

## SEMESTER – II

### MATH-GE- 002 (DIFFERENTIATION AND INTEGRATION)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Mathematical Operations.

**Course Objectives:** The objective of this course is to be able the students to differentiate and integrate the functions. This course is essential for science students.

**Course Outcomes:** After the completion of this course students will be able to

- Know about sets, relations and functions
- Calculate limits of various functions
- Differentiate and integrate the functions.

#### **Module I**

##### **Set, Relation and Function**

Set, Product sets, Relations, Functions (Polynomials, Trigonometric, Exponential), Graphical representation of functions.

#### **Module II**

##### **Limits**

Limit at a point, Properties of limit, Computation of limits of various types of functions.

#### **Module III**

##### **Continuity**

Continuity at a point, Continuity over an interval, Intermediate value theorem, Type of discontinuities.

#### **Module IV**

##### **Differentiation**

Derivative, Derivatives of sum, differences, product & quotients rule, Chain rule, Derivatives of composite functions, Logarithmic differentiation, Differentiation of function of several independent variables, Change of variables, Relations between partial derivatives, Total differentials, Chain rules for partial differentiation, Euler's theorem.

#### **Module V**

##### **Integration**

Integral as limit of sum, Riemann sum, Fundamental theorem of calculus, Indefinite integrals, Methods of integration: substitution, Byparts, Partialfractions, Integration of algebraic and transcendental functions.

##### **Recommended Books:**

1. Integral Calculus, Shanti Narayan, Delhi, S. Chand and Co.
2. Mathematical Hand Book, M. Vygodsky, Mir, Moscow.
3. Higher Engineering Mathematics, B.S. Grewal, Delhi, Khanna Publishers.
4. Introduction to Mathematical Physics, Charlie Harper, Prentice Hall of India.

## SEMESTER – III

### MATH-CC-331 (REAL ANALYSIS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic knowledge of sequence and series.

**Course Objectives:** This course is designed to provide fundamental concepts of analysis, including Riemann integral, differentiation and integration of real functions, as well as some fundamental topics in general topology and metric space theory.

**Course Outcomes:** After completion of this course, the students will be able to

- Define open and closed set.
- Demonstrate some of the fundamental theorems of analysis
- Understand some important theorems.
- Check the convergence of improper integrals.

#### **Module I**

##### **Metric Space**

Definition and examples of metric spaces, Neighborhood limit points, Interior points, Open and close sets, Closure, Interior and boundary points in a metric space and theorem based on them.

#### **Module II**

##### **Riemann integral**

Definition and existence of Riemann integral, Refinement of partitions and theorems based on them, Darboux's theorem, Condition of integrality.

#### **Module III**

##### **Integrable functions**

The integrability of the sum and difference of integrable functions, The fundamental theorem of integral calculus. First and second mean value theorems of calculus.

#### **Module IV**

##### **Test of improper functions**

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's test of improper functions.

#### **Module V**

##### **Fourier series**

Fourier series, Fourier expansion of piecewise monotonic functions, Properties of Fourier coefficients Parseval's identity for Fourier series, Fourier series for even and odd functions, Half range series, Change of intervals.

#### **Recommended Books:**

1. Shanti Narayan: Theory of Functions of Complex Variables, S. Chand and Company New Delhi.
2. T.M.Apostel: Mathematical Analysis, Narosa Publishing House.
3. R.R.Goldberg: Mathematical Analysis, Oxford and IBH publishing House, New Delhi.
4. D.SomaSundrem and V. Chowdhari: Course in Mathematical Analysis, Narosa Publishing House.
5. Shanti Narayan: A Course of Mathematical Analysis, S. Chand and Company, New Delhi.



**SEMESTER – III**

**MATH-CC-332 (NUMBER THEORY)**

L	T	P	Credit
5	1	0	6

**Pre-requisite:** One Variable Calculus.

**Course Objectives:** The main objective of this course is to define and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization,

**Course Outcomes:** After the completion of the course, Students will be able to

- Demonstrate knowledge and understanding of topics including.
- Learn methods and techniques used in number theory.
- Write programs/functions to compute number theoretic functions and use mathematical induction and other types of proof writing techniques.

**Module I**

**The Integrals**

Division algorithm, Greatest common divisor, Euclidean algorithm, Unique factorization, Lame's theorem, linear Diophantine equations: Pythagoras, Fermat, Pell

**Module II**

**Fundamental theorem of arithmetic**

Fundamental theorem of arithmetic, prime counting function, Prime number theorem, Goldbach conjecture.

**Module III**

**Congruences**

Basic properties, Modular arithmetics, Binary and decimal representation of integers, linear congruences, complete set of residues, Fermat's Euler's and Wilson's theorem, Chinese remainder theorem.

**Module IV**

**Some More Functions**

Number theoretic functions, sum and number of divisors, totally multiplicative functions, Arithmetic functions, Mersenne primes, Prime number theorem.

**Module V**

**Mobius inversion formula**

Definition and properties of the Dirichlet product, Euler's phi-function, the greatest integer function, Mobius function, Möbius inversion formula, Arithmetic properties of Fibonacci number,

**Recommended Books:**

1. David M. Burton, Elementary Number Theory 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with Maple, CRC Press, Boca Raton, 2000.
3. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

## SEMESTER – III

### MATH-CC-333(GROUP THEORY AND RINGS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Algebra.

**Course Objectives:** The focus of the course will be the study of certain basic structures called groups and some related structures and application in ring theory and field theory. The objective of this course is to introduce the fundamental theory of rings, integral domain and field, and their corresponding homeomorphisms..

**Course Outcomes:** After completion of this course, the students will be able to

- Develop various algebraic structures, Recognize the mathematical objects called groups
- Explain the significance of the notions of cosets, normal subgroups, and factor groups
- Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains

#### **Module I**

##### **Groups and its Elementary Properties.**

Definition of group with examples and simple properties of groups, Semi groups and monoid, Subgroups and theorems based on subgroups, Centre of a group, Generation of groups, Cyclic groups., Congruence relations and quotient structures.

#### **Module II**

##### **Cosets and Quotient groups.**

Cosets, Left and right cosets, Normal subgroups and their properties, Quotients groups, Permutation of groups, Cauchy's theorem for finite abelian group.

#### **Module III**

##### **Group Homomorphism**

Homomorphism of groups, Isomorphism of groups, Automorphism of a group and inner automorphism of a group.

#### **Module IV**

##### **Permutation Groups and Lagrange's Theorem**

Introduction of binary operations, Permutation groups, Cyclic notation for permutations, Properties of permutation, Even and odd permutations, alternating groups, properties of cosets, Lagrange's theorem, Fermat's theorem.

#### **Module V**

##### **Ring Theory**

Introduction of rings, Sub-rings, Integral domain and fields, Characteristics of rings, Ring homomorphism, Ideals (Principal, Prime and maximal) and quotient rings, Field of quotients of an integral domain.

##### **Recommended Books:**

1. I.N. Herstein: Topics in Algebra, Wiley Eastern Company, New Delhi.
2. Vivek Shahi and Vikas Bist: Algebra, Narosa Publishing House.
3. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul; Basic Abstract Algebra (2nd Edition).

## SEMESTER-III

### MATH-SEC- 001(BASICS OF MATLAB)

L	T	P	Credit
1	0	1	2

**Pre-requisite:** Basic knowledge of Computer.

**Course Objectives:** This Course helps the students to understand the many of MATLAB commands . In this course we introduce the concepts of numerical computations and analysis. Student can also use blocks of data called matrices .MATLAB is probably the most commonly used scientific and numerical software for research and this help the students in higher study.

**Course Outcomes:** At the end of the course, the student will be able to

- Understand features of MATLAB as programming tool. They are fully familiar to this software and easily handle the software.
- Have working knowledge of scalars, variables, arrays, mathematical operations with arrays, built-in and user defined functions, graphics: two-dimensional and three-dimensional.
- Learn new teaching model which include theory and practical running simultaneously. This method is very effective and helped to develop programming skills, technique to solve mathematics problem.
- Work as MATLAB programmer in the industry because of the hands on practical session. This job Oriented course will helps students to get jobs in future.
- Understand MATLAB as simulation tool.
- Learned graphic feature and they are use this feature effectively in the various application.

### **Basic of MATLAB**

The MATLAB environment, scalars, variables, arrays, mathematical operations with arrays, built-in and user defined functions, graphics: two-dimensional and three-dimensional, m-files: script and function files, functions: input; disp and fprintf, relational and logical operators, symbolic math: symbolic objects and expressions; collect; expand; factor; simplify; simple; pretty; solve; diff and int commands, Programming: if-end structure; if-else-end structure; if-elseif-else-end structure; loops: for-end and while-end

1. Explain the main windows in MATLAB desktop.
2. To enter matrix using MATLAB, to find the matrix order, to find the matrix transpose.
3. Addition, subtraction and multiplication of two matrices
4. To find the diagonal of the matrix, Get the sum of each column in the matrix, Get the sum of each row in the matrix A, To find the sum of all elements in the matrix, add 2 to the element in the 2nd row and 3rd column.
5. Enter the complex number, To find the real and the imaginary parts of z, To find the magnitude and the phase angle of z, to add, subtract and multiply the complex numbers
6. To find the conjugate transpose, To find the point transpose.
7. If  $R = 10 \text{ Ohms}$  and the current is increased from 0 to 10 A with increments of 2 A, write a MATLAB m-file program to generate a table of current, voltage and power dissipation.
8. Define a matrix A with 5 rows and 6 columns, Define a column vector B from the elements in all of the rows of column 3 in matrix A, Define a row vector C from the elements in all of the columns of row 2 in matrix A, Define a matrix E from the elements in rows 2 through 4 and all the columns in matrix A, Create a matrix F from the elements in rows 1 through 3 and columns 2 through 4 in matrix A.

9. Write an m-file which shows use of plot, xlabel, ylabel, title, and axis commands.
10. Create a linearly spaced vector of 1000 samples and show the difference between plot, semilogy, semilogx, loglog commands.
11. Write an m-file to create bar plot(horizontal and vertical) and pie plot.
12. Use relational and logical operations in MATLAB
13. Solution of polynomial and its plot by using MATLAB
14. Calculation of polynomial by using its roots in MATLAB

**Books Recommended:**

1. Higham, D.J. and Higham, N.J., MATLAB Guide, 2nd Edition. Society for Industrial and Applied Mathematics (SIAM), 2005.
2. Gilat, A., MATLAB: An Introduction with Applications, 5th Edition. John Wiley & Sons, 2014.

## SEMESTER-III

### MATH-SEC- 002 (LOGICS AND SETS)

L	T	P	Credit
2	0	0	2

**Pre-requisite:** Knowledge of Set Theory

**Course Objectives:** The aim of the course is to cover the basic concepts of Set Theory and Relations. Students will also get idea about Logics, Equivalence and Quantifiers.

**Course Outcomes:** After the completion of the course, Students will be able to

- Learn truth tables and various Logic connectives. .
- Learn about Set theory and Relations.

#### **Module I**

##### **Basics of Logics**

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

#### **Module II**

##### **Logical Equivalences and Quantifiers**

Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

#### **Module III**

##### **Set Theory**

Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

#### **Module IV**

##### **Relations**

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

##### **Recommended Books:**

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

## SEMESTER-III

### MATH-GE-003 (QUEUEING AND RELIABILITY THEORY)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Knowledge of basic Mathematics.

**Course Objectives:** The main objective of this course is to make students aware about use of Different queueing models in their day to day life. They will be able to predict results of different daily life problems.

**Course Outcomes:** After completion of this course, the students will be able to

- Understand different single server and multiserver models
- Use applications of different queue models.
- Understand basics of Reliability.
- Understand different probability distributions in queueing systems.

#### Module I

##### **Basics of Queueing Theory;**

General concepts of queueing system, Queueing problem, Transient and steady states, Measures of performance, Arrival and Service Processes, Single server and Multi server models, channels in parallel with limited and unlimited queues- M/M/1/K, M/M/C.

#### **Module II**

##### **Models**

Queues with Unlimited service. Finite source queues. Application of simple queueing decision model's, Design and control models.

#### **Module III**

##### **Basics of Reliability**

Basics of reliability. Classes of life distributions. Series, Parallel, Configurations. Reliability models.

#### **Module IV**

##### **Distributions**

Reliability, Probability distributions in queueing systems, Mean Time before failure and Hazard rate of Exponential and Weibull distributions.

#### **Module V**

##### **Preventive and Corrective Maintenance**

Concepts and definitions of preventive maintenance, Corrective maintenance and age replacement.

##### **Recommended Books:**

1. R.B. Cooper, Introduction to Queueing Theory, 2nd Ed., North Holland, 1981.
2. D. Gross, C. M. Harris, Fundamentals of Queueing Theory, 3rd Ed., John Wiley and Sons Inc. P. Ltd., 2002.
3. U.N. Bhat, An Introduction to Queueing Theory: Modelling and Analysis in Applications (Statistics for Industry and Technology), Birkhauser Boston, 2008.
4. U.N. Prabhu, Foundations of Queueing Theory, International Series in Operations Research & Management Science, Kluwer Academic Publishers, 2nd Ed., 2002.
5. John G. Rau, Optimization and Probability in Systems Engineering, V.N. Reinhold Co., 1970.
6. Riccardo Manzini, Alberto Regattieri, Hoang Pham, Emilio Ferrai, Maintenance for Industrial Systems, Springer-Verlag, London Limited, 2010.
7. P.K. Kapur, R.B. Garg, S. Kumar, Contributions to Hardware and Software Reliability, World Scientific, Singapore, 1999.

## SEMESTER – IV

### MATH-CC-341(INTEGRAL CALCULUS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic knowledge of integration.

**Course Objectives:** The main objective of this course is to make students aware about use of Fundamental Theorem of Calculus to evaluate a definite integral, use a definite integral to find the area between two curves, set up an integral representing the volume of a solid of revolution about a coordinate axis, given the formulas for solids of revolution.

**Course Outcomes:** After completion of this course, the students will be able to

- Apply the concept and various principles of integral calculus to integrate the functions
- Evaluate definite integrals,
- Have Working knowledge of double integral and triple integrals
- Understand the applications : Rectification, Quadrature, volume and surface areas of solids formed by revolution of plane curve and areas problems only.

#### **Module I**

##### **Basic Integrations**

Integration of rational and irrational functions. Properties of definite integrals, The First and Second Fundamental Theorem of Calculus, The Mean Value Theorem for integrals.

#### **Module II**

##### **Techniques of Integrations**

Integration by substitution, Integration by parts, integration by Partial fractions. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

#### **Module III**

##### **Double Integration**

Evaluation of Double integrals, Change of variables in Double integrals,, Change of order of integration.

#### **Module IV**

##### **Triple Integrations**

Triple integrals in rectangular coordinates, Volume of region in  $R^3$ , Change of variables in triple integrals.

#### **Module V**

##### **Applications of the Integral**

Areas and Volume as a double Integrals, Volumes as a triple integral, Volume of solids of revolution, Calculation of Mass, Centre of Gravity. Gauss divergence theorem, Green,s theorem, Stock Theorem.

##### **Recommended Books:**

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd., 2002.
- 3.N.P. Bali, Dr.ManishGoyal, A text book of Engineering Mathematics, Laxmi Publications.

## SEMESTER – IV

### MATH-CC-342 (SOLID GEOMETRY)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic knowledge of trigonometry.

**Course Objectives:** To get basic knowledge about Circle, Cone, Parabola, Hyperbola, Ellipse etc., To understand the concepts & advance topics related to two & three dimensional geometry, To study the applications of conics, To study the application of Sphere, cone and cylinder and to study how to trace the curve.

**Course Outcomes:** After the completion of the course, Students will be able to

- Understand geometrical terminology for angles, triangles, quadrilaterals and circles.
- Measure angles using a protractor, use geometrical results to determine unknown angles.
- Recognize line and rotational symmetries and find the areas of triangles, quadrilaterals and circles and shapes based on these

#### **Module I**

##### **Conics**

General equation of second degree, Tangent and normal at any point of the conic, Chord of contact, Pole of a line to the conic, Director circle of conic, Polar equation of a conic, Tangent and normal to the conic in the polar form and their geometrical properties.

#### **Module II**

##### **Sphere**

Sphere, Plane section of a sphere, Sphere through a given circle, Intersection of two spheres, Radical plane, Radical line and radical point in spheres, Co-axial system of spheres.

#### **Module III**

##### **Cylinders**

Definition of a cylinder, Equation to the cylinder whose generators intersect a given conic, Enveloping cylinder of a sphere; The right circular cylinder, Equation of the right circular cylinder with a given axis and radius. The general equation of the second degree and the various surfaces represented by it.

#### **Module IV**

##### **Classification of Conicoids**

General equation of second degree, Central conicoids, Principal plane, Classification of conicoids, Equation of tangent plane, Director sphere of an ellipsoid, equation of a normal at a point, Normals from a given point to a paraboloid and an ellipsoid.

#### **Module V**

##### **Reduction of equation**

Finding centre and equation of the surface referred to the centre as origin, Reduction of equation to the standard form and nature of the surface represented by it.

##### **Recommended Books:**

1. Shanti Narayan: Analytic Solid Geometry, S. Chand and Company, New Delhi.



## SEMESTER – IV

### MATH-CC-343 (COMPLEX ANALYSIS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Knowledge of complex numbers and complex plane.

**Course Objectives:** The main objective of this course is to understand how complex numbers provide a satisfying extension of the real numbers. They learn the techniques of complex analysis that make practical problems easy (e.g. graphical rotation and scaling as an example of complex multiplication). They will also understand how mathematics is used in design.

**Course Outcomes:** After the completion of the course, Students will be able to

- Understand the concept of analytic functions and how to calculate conjugate functions.
- Find the transformations or coordinate in  $w$  plane.
- Have a working knowledge of differentiability for complex functions and be familiar with the Cauchy-Riemann equations
- Evaluate integrals along a path in the complex plane and understand the concept of Cauchy's theorem and Cauchy's formula.

#### **Module I**

##### **Basic Functions of Complex Plane.**

Function of complex variable, Trigonometric function, Exponential function, Euler's theorem, Direct and inverse hyperbolic functions, Relations between trigonometric and hyperbolic functions, Logarithm of a complex quantity.

#### **Module II**

##### **Analytic Function and Cauchy Riemann Equations**

Analytic function, Harmonic function, Determination of conjugate function, Milne-Thomson method, Cauchy Riemann equations (Cartesian and polar forms), Sufficient conditions for differentiability.

#### **Module III**

##### **Mappings and Transformations**

Conformal mappings, Necessary and sufficient conditions for a complex function to be a conformal mapping (Statement only), Some elementary transformation like translation, Rotation, Magnification and Magnification and rotation with examples, Mobius Transformations, Resultant of two bilinear transformations.

#### **Module IV**

##### **Complex Integrations**

Cross ratio, Fixed points, Inverse points with respect to a circle, Complex integration with examples. Definite integrals of a function, Contours, Contour integrals and its examples.

#### **Module V**

##### **Cauchy's Theorem and fundamental theorem of algebra.**

Cauchy Theorem, Cauchy's integral formula, An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.

##### **Recommended Books:**

1. Shanti Narayan: Theory of Functions of Complex Variables, S.Chand and Co., New Delhi.
2. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi.
3. R.R. Goldberg: Real Analysis, Oxford and IBH Publishing Co., New Delhi.

**SEMESTER – IV**  
**MATH-SEC-003 (TIME SERIES ANALYSIS)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**Pre-requisite:** Basic Mathematics

**Course Objectives:** The main objective of this course is to identifying the nature of the phenomenon represented by the sequence of observations, and forecasting (predicting future values of the time series variable).

**Course Outcomes:** After completion of this course, the students will be able to

- Calculate time series data, its applications to various fields and components of time series
- Plot various growth curves such as modified exponential, Gompertz and logistic curve
- Know about Moving Average method, measurement of Seasonal Indices by Ratio-to-Trend , Ratio-to-Moving Average and Link Relative methods
- Calculate of variance of random component by variate component method

**Module I**

**Introduction to times series data**

Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series.

**Module II**

**Trend**

Estimation of trend by free hand curve method, method of semi averages, fitting a various mathematical curve, and growth curves, Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series.

**Module III**

**Seasonal and Cyclic Component**

Estimation of seasonal component by Method of simple averages, Ratio to Trend, Ratio to Moving Averages and Link Relative method, Deseasonalization, Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

**Recommended Books:**

1. Kendall M.G. (1976): Time Series, Charles Griffin.
2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied

**SEMESTER – IV**  
**MATH-SEC-004 (BOOLEAN ALGEBRA)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**Pre-requisite:** Basic Set Theory

**Course Objectives:** The main objective of this course is to make students aware about Order Sets, Lattices, Boolean algebra and Switching Circuits.

**Course Outcomes:** After completion of this course, the students will be able to

- Define order sets along with duality principle.
- Discuss about Lattices.
- Define Boolean algebra.
- Define switching circuits.

**Module I**

**Order Set and Lattices**

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, Lattices as ordered sets, complete lattices, lattices as algebraic structures, sub lattices, products and homomorphisms.

**Module II.**

**Boolean Algebra**

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials.

**Module III**

**Switching Circuits**

Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

**Recommended Books:**

1. B.A.Davey and H.A.Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

**SEMESTER – IV**  
**MATH-GE-004 (SAMPLE SURVEYS AND DESIGN OF EXPERIMENTS)**

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basics Statistics.

**Course Objectives:** The main objective of this course is to make students aware about concept of Population, Sampling, Analysis of variance and covariance, Design of experiments and regression Analysis.

**Course Outcomes:** After completion of this course, the students will be able to

- Understand the basic concepts of sample survey.
- Calculate the problems based upon correlation and regression.
- Analysis the variance and covariance.
- Understand the concept of design of experiments.

### **Module I**

#### **Sample Surveys**

Concepts of population and sample. Complete enumeration vs. sampling. Need for sampling. Principal and organizational aspects in the conduct of a sample survey. Properties of a good estimator, Sampling and non-sampling errors. SRSWR & SRSWOR, determination of sample size. Stratified random sampling and different allocations. Systematic sampling, comparison of known sampling strategies under linear trend. Ratio and Regression estimators and their comparison with SRSWOR estimator.

### **Module II**

#### **Indian Official Statistics**

Present Official Statistical System in India relating to census of population, agriculture, industrial production, and prices; methods of collection of official statistics, their reliability and limitation and the principal publications containing such statistics. Also the various agencies responsible for the data collection- C.S.O., N.S.S.O., Office of Registrar General, their historical development, main functions and important publications.

### **Module III**

#### **Analysis of variance and covariance**

Analysis of variance and covariance (with one concomitant variable) in one-way and two-way classified data with equal number of observations per cell.

### **Module IV**

#### **Design of experiments**

Principles of experimentation, uniformity trails, completely randomized, Randomized block and Latin square designs. Missing plot technique, 22 and 23 Factorial experiments: construction and analysis.

### **Module V**

#### **Regression Analysis**

Two variable linear model – estimation, testing and problems of predication. Predication of the estimated regression equation, interval estimation, variance estimation.

#### **Books Recommended**

1. W.G. Cochran, Sampling Techniques, John Wiley and Sons, New York, 1997.
2. A.M. Goon, M.K. Gupta, and B. Dasgupta, Fundamentals of Statistics (Vol. II), 8th Ed., World Press, Kolkata, 2005.
3. A.M. Goon, M.K. Gupta and B. Dasgupta, An Outline of Statistical Theory (Vol. II), 3rd Ed., World Press, Kolkata, 2005.

## SEMESTER – V

### MATH-CC-351 (METRIC SPACE)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Vector Space.

**Course Objectives:** The course aims at providing the basic knowledge pertaining to metric spaces such as open and closed balls, neighborhood, interior, closure, subspace, continuity, compactness, connectedness etc.

**Course Learning Outcomes:** The course will enable the students to:

- Understand the basic concepts of metric spaces.
- Correlate these concepts to their counter parts in real analysis'
- Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.

#### **Module 1**

##### **Basic Concepts**

Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.

#### **Module II**

##### **Topology of Metric Spaces**

Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.

#### **Module III**

##### **Continuity & Uniform Continuity in Metric Spaces**

Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.

#### **Module IV**

##### **Connectedness**

Connectedness, Connected subsets, Connectedness and continuous mappings,

#### **Module V**

##### **Compactness**

Compactness, Compactness and boundedness, Continuous functions on compact spaces.

##### **Recommended Books:**

1. Shirali, Satish&Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
2. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
3. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis. Tata McGraw Hill. New Delhi.

**SEMESTER – V**  
**MATH-CC-352 (PROBABILITY & STATISTICS)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
<b>5</b>	<b>1</b>	<b>0</b>	<b>6</b>

**Pre-requisite:** Basic knowledge of Probability & Statistics

**Course Objectives:** Main objective of this course is to identify the types of data (qualitative, quantitative, discrete, and continuous) and types of sampling (random, stratified, systematic, cluster). Student will use appropriate statistical methods to collect, organize, display, and analyze relevant data.

**Course Outcomes:** After completion of this course, the students will be able to

- Understand basic elements of probability theory and apply them to solve real life problems
- Understand the basic concepts of Mathematical Expectation, Discrete and Continuous distributions.

### **Module I**

**Basic Probability:**

Experiment, definition of probability, conditional probability, independent events, Bayes' rule, Bernoulli trials, Random variables, discrete random variable, probability mass function, continuous random variable, probability density function, cumulative distribution function, properties of cumulative distribution function, Marginal probability function, Independent random variables. Two dimensional random variables and their distribution functions.

### **Module II**

**Some special Probability Distributions:**

Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Normal, Exponential and Gamma densities, Evaluation of statistical parameters for these distributions.

### **Module III**

**Mathematical expectation and moment generating function**

Mathematical expectation, moments, moment generating function, characteristic function.

### **Module IV**

**Basic Statistics**

Measure of central tendency: Moments, Expectation, dispersion, skewness, kurtosis, expected value of two dimensional random variable, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression, Bounds on probability, Chebyshev's Inequality

### **Module IV**

**Applied Statistics**

Formation of Hypothesis, Test of significance: Large sample test for single proportion, Difference of proportions, Single mean, Difference of means, and Difference of standard deviations.

Test of significance for Small samples: t- Test for single mean, difference of means, t-test for correlation coefficients, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attributes.

### **Module V**

**Curve Fitting**

Curve fitting by the numerical method: Curve fitting by of method of least squares, fitting of straight lines, second degree parabola and more general curves.

**Recommended Books:**

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Application, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Model, 9th Ed., Academic Press, Indian Reprint,

## SEMESTER – V

### MATH-DSE-001 (TRANSFORMATIONS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Differentiation and Integration.

**Course Objectives:** Main objective of this course is to make students aware about different type of transformations. To impart knowledge about Laplace Transformations, Inverse Laplace Transformations, periodicity, Fourier series, Fourier Transformations and Laplace Transformations etc.

**Course Outcomes:** After completion of this course, the students will be able to

- Apply Laplace and Inverse Laplace Transformations to solve differential equations.
- Solve half range expressions of Fourier Series.
- Solve Fourier Transformations and Z- Transformations.

#### **Module I**

##### **Laplace Transforms**

Definition of Laplace transform, Laplace transforms of various standard functions, Properties of Laplace transforms, Inverse Laplace transforms, Transform of derivatives and integrals, Laplace transform of unit step function, Impulse function, Periodic functions, Solution of ordinary linear differential equations with constant coefficients and simultaneous differential equations using Laplace transform.

#### **Module II**

##### **Fourier Series**

Periodic functions, Euler's formula, Even and odd functions, Half range expansions, Fourier series of different wave forms.

#### **Module III**

##### **Fourier Transform**

Definition of Fourier transform, Fourier Integral theorem, Fourier sine and cosine integral, Complex form of Fourier integrals, Fourier transforms, Inverse Fourier transform, Modulation theorem, Convolution theorem for Fourier transforms, Parseval's identity, Fourier transforms of derivative of functions, Relation between Fourier and Laplace transform.

#### **Module IV**

##### **Z –Transforms**

Definition of z-transform, Some standard z-transform, Properties of z-transforms, Modulation theorem, Convolution theorem for z-transforms, Evaluation of inverse z-transforms.

#### **Module V**

##### **Special Functions**

Power series solution of differential equations, Frobenius method, Legendre polynomial, Bessel's equation, Bessel functions of the first and second kind.

##### **Recommended Books:**

1. Advanced Engineering Mathematics, R.K. Jain and S.R.K. Iyengar, Narosa Publication.
2. Higher Engineering Mathematics, B.S. Grewal, Khanna Publication.
3. Higher Engineering Mathematics, N.P. Bali, Laxmi Publication.

## SEMESTER – V

### MATH-DSE-002 (CRYPTOGRAPHY AND NETWORK SECURITY)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Knowledge about coding-decoding.

**Course Objectives:** This course helps the students to develop skills and knowledge of standard concepts in cryptography and demonstrates how cryptography plays an important role in the present digital world by knowing encryption and decryption techniques and secure data in transit across data networks.

**Course Learning Outcomes:** After the course, the student will be able to:

- Understand the fundamentals of Cryptography and Network Security, including data and advanced encryption standard (DES & AES), RSA and elliptic curve cryptography.
- Encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms.
- Acquire knowledge of standard algorithms that can be used to provide confidentiality, integrity and authentication of data.

#### **Module I**

##### **Module 1: Cryptography and Data Encryption Standard**

Overview of Cryptography, Computer security concepts, Security attacks, Symmetric cipher model, Cryptanalysis and brute-force attack, Substitution techniques, Caesar cipher, Monoalphabetic ciphers, Playfair cipher, Hill cipher, Polyalphabetic ciphers, One-time pad, Transposition techniques, Binary and ASCII, Pseudo-random bit generation, Stream ciphers and Block ciphers, The Feistel cipher, The data encryption standard (DES), DES example.

#### **Module II**

##### **Algorithms**

Review of basic concepts in Number theory and Finite Fields: Divisibility, Polynomial and modular arithmetic, Fermat's and Euler's theorems, The Chinese remainder theorem,

#### **Module III**

##### **Advanced Encryption Standard**

Discrete logarithm, Finite fields of the form  $GF(p)$  and  $GF(2^n)$ . Advanced encryption standard (AES), AES transformation functions, AES key expansion, AES example.

#### **Module IV**

##### **Public-key Cryptography**

Principles of public-key cryptosystems, The RSA algorithm and security of RSA, Elliptic curve arithmetic, Elliptic curve cryptography, Cryptographic Hash functions, Secure Hash algorithm.

#### **Module V**

##### **Digital Signatures and Network Security**

Digital signatures, Elgamal and Schnorr digital signature schemes, Digital signature algorithm. Wireless network and mobile device security, Email architecture, formats, threats and security, Secure/Multipurpose Internet Mail Extension (S/MIME) and Pretty Good Privacy (PGP).

##### **Recommended Books:**

1. Stallings, William (2017). Cryptography and Network Security, Principles and Practice (7th ed.). Pearson Education Limited. England.



## SEMESTER – V

### MATH-DSE-003 (DISCRETE MATHEMATICS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Mathematics.

**Course Objectives:** This course aims at introducing the concepts of lattices, Boolean algebras, switching circuits and graph theory. The course discusses some important applications of Boolean algebra and graph theory in real life situations through switching circuits and shortest path algorithms.

**Course outcomes:** After the course, the student will be able to understand the concepts of

- Lattices and their types.
- Boolean algebra, switching circuits and their applications.
- Graphs, their types and its applications in study of shortest path algorithms.

#### **Module I**

##### **Ordered Sets**

Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.

#### **Module II**

##### **Lattices**

Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice.

#### **Module III**

##### **Boolean Algebras and Switching Circuits**

Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.

#### **Module IV**

##### **Graph Theory**

Introduction to graphs, Konigsberg Bridge problem, Instant insanity game; Definition, examples and basic properties of graphs, Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs.

#### **Module V**

##### **Circuits**

Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, Shortest path, Dijkstra's algorithm, Prim's algorithm, Kruskal algorithm

##### **Recommended Books:**

1. Davey, B. A., & Priestley, H. A. (2002). Introduction to lattices and order (2nd ed.). Cambridge University press, Cambridge. Department of Mathematics, University of Delhi

## SEMESTER – V

### MATH-DSE-004 (RESEARCH METHODOLOGY)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic idea about research paper.

**Course Objectives:** This course is introduced to impart knowledge about the basic concepts of research and to provide a road map for conducting research. Students are expected to identify, explain and apply basic concepts of research; acquire information, recognize various issues related to research and to learn instrumental methods required for research in Mathematics.

**Course outcomes:** After the course, the student will be able to understand the concepts of:

- Know about various print and e-resources, search engines needed for carrying out literature survey in a topic.
- Have some idea about writing literature survey report, review and scientific article.
- Learn about plagiarism and how to avoid it.
- Acquire basic understanding of data analyses.

#### **Module 1**

##### **Introduction to research.**

Meaning of research, role of research in important areas, process of research, types of research, Unit of analysis, characteristics of interest. Research problem as a hypothesis testing Sampling Techniques: Introduction to sampling, advantage of sampling over census, simple random sampling, sampling frame, probabilistic aspects of sampling, stratified random sampling, other methods of sampling, sampling design, non probability sampling methods

#### **Module II**

##### **Data**

Introduction, primary and secondary data, methods of collecting primary data, merits and demerits of different methods of collecting primary data, designing a questionnaire, pretesting a questionnaire, editing of primary data, technique of interview, collection of secondary data, scrutiny of secondary data, Data Processing: Introduction, editing of data, coding of data, classification of data, tables as data presentation devices, graphical presentation of data

#### **Module III**

##### **Data Analysis**

An overview on techniques in univariate, bivariate and multivariate data Models and Model Building: role of models, types of models, objectives of modeling, model building/ model development, model validation, simulation models

#### **Module IV**

##### **Literature Survey**

Print: Sources of information-Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, Wiki-Databases, Science Direct, SciFinder, Scopus.

## Module V

### Methods of Scientific Research and Writing Scientific Papers

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources. Finding and citing published information. Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

### Recommended Books

1. Kothari, C. K.; Garg, G. Research Methodology-Methods and Techniques, 3rd Ed., New Age International, New Delhi (2014).
2. Kumar, R. Research Methodology–A Step-By-Step Guide for Beginners; 2nd Ed., Pearson Education: New Delhi (2005).
3. Montgomery, D. C. Design & Analysis of Experiments; 8th Ed., Wiley India: Noida (2013).
4. Hibbert, D. B.; Gooding, J. J., Data Analysis for Chemistry. Oxford University Press (2006).
5. Topping, J., Errors of Observation and their Treatment, 4th Ed., Chapman Hall, London (1984).

## SEMESTER – VI

### MATH-CC-361 (RING THEORY AND LINEAR ALGEBRA II)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic knowledge of Group Theory

**Course Objectives:** This course introduces the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers, used in finite fields with applications in Cryptography. This course emphasizes the application of techniques using the adjoint of a linear operator and their properties to least squares approximation and minimal solutions to systems of linear equations.

**Courses Learning Outcomes:** On completion of this course, the student will be able to:

- Appreciate the significance of unique factorization in rings and integral domains.
- Compute with the characteristic polynomial, eigenvalues, eigenvectors, and eigen spaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.
- Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain orthonormal basis.

#### **Module 1**

##### **Polynomial Rings and Eisenstein criterion**

Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion.

#### **Module II**

##### **Unique Factorization Domain (UFD)**

Unique factorization in  $\mathbb{Z}[x]$ ; Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.

#### **Module III**

##### **Dual Spaces and Diagonalizable Operators**

Dual spaces, Double dual, Dual basis, Transpose of a linear transformation and its matrix in the dual basis, Annihilators; Eigenvalues, Eigenvectors, Eigenspaces and characteristic polynomial of a linear operator; Diagonalizability, Invariant subspaces and Cayley-Hamilton theorem; The minimal polynomial for a linear operator.

#### **Module IV**

##### **Inner Product Spaces**

Inner product spaces and norms, Orthonormal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality.

#### **Module V**

##### **Adjoint Operators and Their Properties**

The adjoint of a linear operator, Least squares approximation, Minimal solutions to systems of linear equations, Normal, Self-adjoint, Unitary and orthogonal operators and their properties.

##### **Recommended Books:**

1. Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). *Linear Algebra* (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.

## SEMESTER – VI

### MATH-CC-362 (VECTOR CALCULUS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Knowledge of scalars and vectors.

**Course Objectives:** Vector calculus plays an important role in differential geometry and in the study of partial differential equations. It is used extensively in physics and engineering, especially in the description of electromagnetic fields, gravitational fields, and fluid flow.

**Course Outcomes:** After completion of this course, the students will be able to

- Study of vector differentiation and integration in two and three dimensional spaces
- Understanding functions (both real & complex) non-Euclidean geometry and topology.

#### **Module I**

##### **Scalar and vector product**

Scalar and vector product of three vectors, Product of four vectors, Reciprocal vectors, Vector differentiation, Scalar valued point functions, vector valued point functions, Derivative along a curve, directional derivatives.

#### **Module II**

##### **Gradient, curl and Divergence**

Gradient of a scalar point function, Geometrical interpretation of gradient of a scalar point function, Divergence and curl of a vector point function, Character of divergence and curl of a vector point function, Gradient, Divergence and curl of sums and products and their related vector identities

#### **Module III**

##### **Orthogonality**

Laplacian operator, Orthogonal curvilinear coordinates, Conditions for orthogonality, Fundamental triads of mutually orthogonal unit vectors.

#### **Module IV**

##### **Operators**

Gradient, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinators (Cylindrical and spherical coordinates), Relation between cartesian and cylindrical and spherical coordinates.

#### **Module V**

##### **Theorem of Gauss, Green's theorem, Stokes's theorem**

Vector integration, Line integral, Surface integral, Volume integral, Theorem of Gauss, Green's theorem, Stokes's theorem, Problems based on these theorems.

##### **RecommendedBooks:**

1. Murray R. Spiegel: Theory and problems of Advanced calculus, Schaum Publishing company, New York.
2. Murray R. Spiegel: Vector Analysis, Schaum Publishing company, New York.
3. Shanti Narayan: A Text book of vector calculus: S Chand and Co. New Delhi.

## SEMESTER – VI

### MATH-DSE-005(LINEAR PROGRAMMING AND APPLICATIONS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic knowledge about LPP

**Course Objectives:** The objective of this course is to understand the theory of optimization methods and algorithms developed for solving various types of optimization problems. To provide students with the modeling skills necessary to describe and formulate optimization problems to solve and interpret optimization problems in engineering.

**Course Outcomes:** After completion of this course, the students will be able to

- Solve linear programming problems by different methods
- Find graphical solutions of linear programming problems with two variables
- Know about the relationships between the primal and dual problems
- Understand duality and dual simplex method
- Understand transportation model and concept of game theory.

#### **Module I**

##### **Introduction to Linear Programming**

Linear Programming Problems: Standard, Canonical and Matrix form, Graphical Approach for Solving some Linear Programs. Hyperplanes Convex Sets, Basic Feasible Solutions, Correspondence between basic feasible solutions and extreme points.

#### **Module II**

##### **Methods of Solving Linear Programming Problem**

Simplex method, Optimal Solution, Unique and optimal solutions, Unboundedness: Simplex Algorithm and its Tableau Format, Introduction to artificial variables, two-phase method, Big-M method and their comparison.

#### **Module III**

##### **Duality Theory of Linear Programming**

Duality, formulation of the dual problem, primal- dual relationships, Fundamental Theorem of duality.

#### **Module IV**

##### **Transportation Models**

Transportation Models (Minimizing and Maximizing cases), Balanced and unbalanced cases, Initial basic feasible solution by N-W Corner Rule, Least cost, Vogel's approximation methods, Check for optimality of transportation model: Solution by MODI / Stepping Stone method, Cases of degeneracy.

#### **Module V**

##### **Game Theory**

Basic concept, Formulation and solution of two- person zero-sum games, Games with mixed strategies, Linear programming method of solving a game.

##### **Recommended Books:**

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.

## SEMESTER – VI

### MATH-DSE-006 (NUMERICAL ANALYSIS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Basic Mathematical Operations.

**Course Objectives:** To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.

**Course Learning Outcomes:** The course will enable the students to learn the following:

- Some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
- Interpolation techniques to compute the values for a tabulated function at points not in the table.
- Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

#### **Module 1**

##### **Methods for Solving Algebraic and Transcendental Equations**

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method

#### **Module II**

##### **Techniques to Solve Linear Systems**

Partial and scaled partial pivoting, LU decomposition and its applications, Iterative methods: Gauss-Jacobi, Gauss-Seidel and SOR methods.

#### **Module III**

##### **Interpolation**

Lagrange and Newton interpolation, Piecewise linear interpolation.

#### **Module IV**

##### **Numerical Differentiation**

First order and higher order approximation for first derivative, Approximation for second derivative.

#### **Module V**

##### **Numerical Integration**

Numerical integration by closed Newton-Cotes formula: trapezoidal rule, Simpson's rule and its error analysis. Euler's method to solve ODE's.

##### **Recommended Books:**

1. Bradie, Brian. (2006). A Friendly Introduction to Numerical Analysis. Pearson Education, India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.
2. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). Numerical Methods for Scientific and Engineering Computation. (6th ed.). New Age International Publisher, India, 2016.
3. Gerald, C. F., & Wheatley, P. O. (2008). Applied Numerical Analysis (7th ed.). Pearson Education. India.

## SEMESTER – VI

### MATH-DSE-007(MECHANICS)

L	T	P	Credit
5	1	0	6

**Pre-requisite:** Knowledge of basic physics.

**Course Objectives:** The course aims at understanding the various concepts of physical quantities and the related effects on different bodies using mathematical techniques. It emphasizes knowledge building for applying mathematics in physical world.

**Course Learning Outcomes:** The course will enable the students to understand:

- The significance of mathematics involved in physical quantities and their uses;
- To study and to learn the cause-effect related to these; and
- The applications in observing and relating real situations/structures.

#### **Module 1**

##### **Forces in Equilibrium**

Coplanar force systems; Three-dimensional force systems; Moment of a force about a point and an axis, Principle of moments, Couple and couple moment, Moment of a couple about a line, Resultant of a force system, Distributed force system, Rigid-body equilibrium, Equilibrium of forces in two and three dimensions, Free-body diagrams, General equations of equilibrium, Constraints and statical determinacy.

#### **Module II**

##### **Friction, Center of Gravity and Moments of Inertia**

Equations of equilibrium and friction, Frictional forces on screws and flat belts; Center of gravity, Center of mass and Centroid of a body and composite bodies; Theorems of Pappus and Guldinus; Moments and products of inertia for areas, composite areas and rigid body, Parallel-axis theorem, Moment of inertia of a rigid body about an arbitrary axis, Principal moments and principal axes of inertia.

#### **Module III**

##### **Conservation of Energy and Applications**

Conservative force fields, Conservation of mechanical energy, Work-energy equations, Kinetic energy and work-kinetic energy expressions based on center of mass, Moment of momentum equation for a single particle and a system of particles.

#### **Module IV**

##### **Rigid Body Motion**

Translation and rotation of rigid bodies, Chasle's Theorem, General relationship between time derivatives of a vector for different references, Relationship between velocities of a particle for different references, Acceleration of particle for different references.

#### **Module V**

##### **Motions**

Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

##### **Recommended Books:**

1. Hibbeler, R. C. (2016). Engineering Mechanics: Statics & Dynamics (14th ed.). Pearson Prentice Hall (Pearson Education), New Jersey.
2. Shames, Irving H., & Rao, G. Krishna Mohan (2009). Engineering Mechanics: Statics and Dynamics (4th ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi.  
Department of Mathematics, University of Delhi



## SEMESTER – VI

### MATH-DSE-008(DISSERTATION)

<b>Credit</b>
<b>6</b>

**Pre-requisite:** Basic knowledge about Research Methodology

**Course Objectives:** This course is introduced to provide an opportunity to the UG final semester students to have some experience in research by taking small projects. Apart from the experimental works, students will also learn to write scientific reports on the project work carried out.

**Course Learning Outcomes:** On completion of this course the students will be able to:

- Understand the aims and objectives research and formulate a research work plan in a scientific manner.
- Generate good research hypothesis, design appropriate experiments, collect and interpret the data to validate their experiments.
- Process the data using computer software, analyze the data and critically examine the hypothesis and the conclusions.
- Obtain and evaluate information from a variety of databases.
- Communicate effectively in a variety of forms like research publications, patents, etc.

Students of 6<sup>th</sup> semester who opted dissertation as DSE course will have to work on minor project on different topics related to their project work which will be chosen by them in consultation with the teachers of the department. The project will be delivered before the students and faculty of the department. The following factors will be taken into consideration while evaluating the candidate.

- (i) Project Report
- (ii) Presentation
- (iii) Viva-voce.