DEPARTMENT OF MATHEMATICS

Scheme B. Sc. /B.A. (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^{th} 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 marks system. 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 evaluationsystem 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 workwould be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specificelective 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 versaand 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 leads 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. / B.A. (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

Semester I	MAT-CC-311	Real Analysis
	MAT-CC-312	Linear Algebra
Semester II	MAT-CC-321	Sequences & Series
	MAT-CC-322	Group Theory and Rings
Semester III	MAT-CC-331	Differential Calculus
	MAT-CC-332	Complex Analysis
	MAT-CC-333	Differential Equations
Semester IV	MAT-CC-341	Integral Calculus
	MAT-CC-342	Solid Geometry
	MAT-CC-343	Number Theory
Semester V	MAT-CC-351	Metric Space
	MAT-CC-352	Probability and Statistics
Semester VI	MAT-CC-361	Ring Theory and Linear algebra II
	MAT-CC-362	Vector Calculus

Semester V	MAT-DSE-001	Transformations
	MAT-DSE-002	Cryptography and Network security
	MAT-DSE-003	Discrete Mathematics
	MAT-DSE-004	Research Methodology
Semester VI	MAT-DSE-005	Linear Programming and applications
	MAT-DSE-006	Applications of differentiation and integration
	MAT-DSE-007	Mechanics
	MAT-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)

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

Generic Elective (GE) Courses (for other disciplines)

MAT-GE-001	Matrices and Polynomials
MAT-GE-002	Differentiation and Integration
MAT-GE-003	Numerical Analysis
MAT-GE-004	Descriptive Statistics and Probability Theory

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

Sl. No.	Details of Courses	Credits		
		Theory	Tutorials	TOTAL
I	**Core Courses** (6 Credits) (**14 Courses**)	14 X5 = 70	14 X 1 = 14	84
II	**Elective Courses** (6 Credits) (**8 Courses**)			
	(a) Discipline Specific Elective (DSE) Courses (**4 Courses**)	4 X 5 = 20	4 X 1 = 4	24
	(b) Generic Elective (GE) Courses (**4 Courses**)	4 X 5 = 20	4 X 1 = 4	24
III	**Ability Enhancement Courses**			
	(a) Ability Enhancement Compulsory Courses (AEC) (4 Credits) (**2 Courses**)	2 X 4 = 8		8
	(b) Skill Enhancement Courses (SEC) (2 Credits) (**2 Courses**)	2 X 2 = 8		4
Grand Total Credit				**144**

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
I	MAT-CC-311	Real Analysis	5:1:0	6
	MAT-CC-312	Linear Algebra	5:1:0	6
II	MAT-CC-321	Sequences & Series	5:1:0	6
	MAT-CC-322	Group Theory and Rings	5:1:0	6
III	MAT-CC-331	Differential Calculus	5:1:0	6
	MAT-CC-332	Complex Analysis	5:1:0	6
	MAT-CC-333	Differential Equations	5:1:0	6
IV	MAT-CC-341	Integral Calculus	5:1:0	6
	MAT-CC-342	Solid Geometry	5:1:0	6
	MAT-CC-343	Number Theory	5:1:0	6
V	MAT-CC-351	Metric Space	5:1:0	6
	MAT-CC-352	Probability and Statistics	5:1:0	6
VI	MAT-CC-361	Ring Theory and Linear algebra II	5:1:0	6
	MAT-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
V (Any two for DSE I and DSE II)	MAT-DSE-001	Transformations	5:1:0	6
	MAT-DSE-002	Cryptography and Network security	5:1:0	6
	MAT-DSE-003	Discrete Mathematics	5:1:0	6
	MAT-DSE-004	Research Methodology	5:1:0	6
VI (Any two for DSE III and DSE IV)	MAT-DSE-005	Linear Programming and applications	5:1:0	6
	MAT-DSE-006	Applications of differentiation and integration	5:1:0	6
	MAT-DSE-007	Mechanics	5:1:0	6
	MAT-DSE-008	Dissertation		6

(c) Generic Elective (GE) Courses

(i) Please refer to the syllabus of following departments/disciplines for GE 1 to GE 4

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
I	ENG-AE-011	Technical Writing and Communication in English	4:0:0	4
II	EVS-AE-021	Environmental Studies	4:0:0	4

(e) Skill Enhancement Courses (SEC)*

Semester		Course Title	Credit (L:T:P)	Credit
I & III	MAT-SEC-001	Basics Of MATLAB	1:0:1	2
	MAT-SEC-002	Logics and Sets	2:0:0	2
II & IV	MAT-SEC-003	Time Series Analysis	2:0:0	2
	MAT-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
Core Papers										
MAT-CC-311	**CC**	Real Analysis	60	-	40	100	5	1	0	6
MAT-CC-312	**CC**	Linear Algebra	60	-	40	100	5	1	0	6
Ability Enhancement Compulsory Course										
ENG-AE-011	**AECC**	Technical Writing and Communication in English	30	-	20	50	4	0	0	4
Skill Enhancement Course-NIL										
Elective: Discipline Specific -NIL										
Elective: Generic										
	GE-I	One Generic Elective Course paper is to be Opted by the students as offered by other departments of the School.								6
MAT-GE-001	**GE**	Matrices and Polynomials	60	-	40	100	5	1	0	6
TOTAL										**22**

SEMESTER-II

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

SEMESTER-III

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

SEMESTER-IV

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

SEMESTER-V

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

SEMESTER-VI

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

SEMESTER – I

MAT-CC- 311 (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.SomaSundremand V. Chowdhari: Course in Mathematical Analysis, Narosa Publishing House.
5. Shanti Narayan: A Course of Mathematical Analysis, S. Chand and Company, New Delhi.

SEMESTER – I

MAT-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

- Think about the 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, Eigen values 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 ENLISH)

L	T	P	Credit
4	0	0	4

Pre-requisite: Basic English grammar.

Course Objectives: This course is designed to help students became 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

MAT-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, Eigen values, 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

MAT-CC-321 (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

MAT-CC-322 (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 – 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-sports 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

MAT-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, By parts, Partial fractions, 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, Mascow.
3. Higher Engineering Mathematics, B.S. Grewal, Delhi, Khanna Publishers.
4. Introduction to Mathematical Physics, Charlie Harper, Prentice Hall of India.

SEMESTER – III

MAT-CC-331 (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(l+x), $(l+x)^m$.

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 – III

MAT-CC-332 (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 – III

MAT-CC-333 (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-III

MAT-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 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, logog 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

MAT-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

MAT-GE-003 (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 – IV

MAT-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, trigonometric substitution, integration by parts,Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their ombinations.

Module III

Double Integration

Double integrals along with all applications

Module IV

Triple Integrations

Triple integrals along with all applications.

Module V

Applications of the Integral

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Length of plane curve.

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.

SEMESTER – IV

MAT-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 and are parallel to a given line; 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

MAT-CC-343 (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 – IV
MAT-SEC-003 (TIME SERIES ANALYSIS)

L	T	P	Credit
2	0	0	2

Pre-requisite: Basic Time Series Analysis

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

- Think about 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
- fit trend by 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
MAT-SEC-004 (BOOLEAN ALGEBRA)

L	T	P	Credit
2	0	0	2

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-Mc Cluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Recommended Books:

1. BA.Davey and H.A.Priestley,IntroductiontoLatticesandOrder,CambridgeUniversityPress, Cambridge,1990.
2. Rudolf Lidl and Günter Pilz,AppliedAbstractAlgebra,2ndEd.,UndergraduateTextsinMathematics, Springer(SIE), Indianreprint,2004.

SEMESTER – IV

MAT-GE-004 (DESCRIPTIVE STATISTICS AND PROBABILITY THEORY)

L	T	P	Credit
5	1	0	6

Pre-requisite: Basics of probability and Statistics

Course Objectives: The main objective of this course is to make students aware basics of probability and statistics.

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

- Understand the basic concepts of probability and statistics.
- Calculate correlation and regression.
- Check skewness and bivariate data.

Module I

Population

Concepts of a statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Presentation of data by tables and by diagrams, frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Module II

Skewness and Bivariate Data

Measures of location (or central tendency) and dispersion, moments, measures of skewness and kurtosis, cumulants. Bivariate data: Scatter diagram, principle of least-square and fitting of polynomials and exponential curves.

Module III

Correlation and regression.

Correlation and regression. Karl Pearson coefficient of correlation, Lines of regression, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

Module IV

Basic Probability Theory

Random experiment, sample point and sample space, event, algebra of events, Definition of Probability - classical, relative frequency and axiomatic approaches to probability, merits and demerits of these approaches (only general ideas to be given).

Module V

Theorem on probability

Conditional probability, Independent events. Baye's theorem and its applications.

Recommended Books:

1. J.E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, 2009.
2. A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamentals of Statistics, Vol. I, 8th Ed., World Press, Kolkatta, 2005.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand and Sons, 2007.
4. R.V. Hogg, A.T. Craig and J.W. Mckean, Introduction to Mathematical Statistics, 6th Ed., Pearson Education, 2005.

SEMESTER – V

MAT-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:

i) Understand the basic concepts of metric spaces;

ii) Correlate these concepts to their counter parts in real analysis;

iii) 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

MAT-CC-352 (PROBABILITY & STATISTICS)

L	T	P	Credit
5	1	0	6

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

MAT-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

MAT-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 Feistal 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(2n). 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

MAT-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:
i) Lattices and their types;
ii) Boolean algebra, switching circuits and their applications;
iii) Graphs, their types and its applications in study of shortest path algorithms.

Module1

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, Prims 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

MAT-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

MAT-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 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

MAT-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.

Recommended Books:

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

SEMESTER – VI

MAT-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 solutionof 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

MAT-DSE-006 (APPLICATIONS OF DIFFERENTIATION AND INTEGRATION)

L	T	P	Credit
5	1	0	6

Pre-requisite: Basic Differentiation and Integration.

Course Objectives: The objective of this course is to be able the students to find applications differentiation and integration of the functions. This course is essential for science students.

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

- Know about partial derivatives in detail
- Calculate maximum and minimum value of the functions
- Find applications of double and triple integrals.
- Find line, surface and volume integrals.
- Solve the questions by Gauss divergence theorem, Stock theorem and Greens Theorem.

Module I

Differential Calculus

Partial derivatives, Homogeneous function, Euler's theorem, Chain rule, Total derivative. Change of variables, Partial differentiation of implicit function

Module II

Maximum and Minimum Values of Function

Taylor series of two variables, Maximum and minimum values of function of two variables, Jacobin, Error and increment, Lagrange's Approximations, Lagrange's Method of Undermined multiplier.

Module III

Tracing of Curves

Asymptotes, Tracing of Cartesian, Parametric , Polar curves (Standard Curves Only)

Module IV

Integral Calculus

Rectification, Quadrature, Order of integration, Change of variables, Area and volume by double and triple integral.

Module V

Vector Calculus

Differentiation of vector, Scalar and vector field, Gradient of scalar field, Directional derivatives, Divergence, Curl of vector field, Integration of vector, Line, surface and volume integral, Applications of Stokes theorem, Divergence theorem, Green's theorem (theorems without proof).

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 – VI

MAT-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

MAT-DSE- 008 (DISSERTATION)

Credit
6

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^{th} 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.