HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

M. Sc. MATHEMATICS (Integrated)

(Duration: 4 Years)

CURRICULUM and SYLLABUS

(Applicable for Students admitted from Academic Year 2023-24)

DEPARTMENT OF MATHEMATICS

SCHOOL OF LIBERAL ARTS AND APPLIED SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

VISION AND MISSION

MOTTO:

To Make Every Man a Success and No Man a Failure

VISION:

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

MISSION:

- To create an ecosystem for learning and world class research.
- To nurture a sense of creativity and innovation.
- To instill highest ethical standards and values with a sense of professionalism.
- To take up activities for the development of Society.
- To develop national and international collaboration and strategic partnership with industry and institutes of excellence.
- To enable graduates to become future leaders and innovators.

VALUE STATEMENT

- Integrity, Innovation, Internationalization

DEPARTMENT OF MATHEMATICS

VISION AND MISSION

VISION

To be a worldwide Centre for Excellence in Mathematics and scientific computing for the growth of Science and Technology

MISSION

M1: Imparting of quality mathematics education and the inculcating of the spirit of research through innovative teaching and research methodologies.

M2: To achieve high standards of excellence in generating and propagating knowledge in Mathematics.

M3: To build a community that champions and promotes the mathematician in everyone.

M. Sc. MATHEMATICS (Integrated)

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The Program Educational Objectives (PEOs) for Mathematics describe accomplishments that students are expected to attain within four years after post-graduation.

PEO I: To provide students' knowledge and insight in Mathematics and hence they are able to work as a mathematical professional.

PEO II: To prepare them to pursue higher studies and conduct research.

PEO III: To provide students with knowledge and capability in formulating & analysis of mathematical models in real life application

PEO IV: To develop teaching skills, subject knowledge in the course of their study which will help them shine in various field including Education, IT etc.

PROGRAM OUTCOMES (ALIGNED WITH GRADUATE ATTRIBUTES) (PO)

At the end of this program, graduates will be able to:

PO1: Scholarship of Knowledge: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2: Critical Thinking: Analyze complex mathematical problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider, theoretical, practical and policy context.

PO3: Problem Solving: Think laterally and originally, conceptualize and solve mathematical problems, evaluate a wide range of potential solutions for those and arrive at feasible, optimal Solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4: Research Skill: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually / in group(s) to the development of scientific/ technological / programming knowledge in one or more domains of mathematics

PO5: Usage of Modern Tools: Create, select, learn, and apply appropriate techniques, resources, and IT tools, including prediction and modeling, to complex mathematical activities with an understanding of the limitations.

PO6: Collaborative and Multidisciplinary Work: Process knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborate-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision—making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7: Project Management and Finance: Demonstrate knowledge and understanding of mathematical and management principles and apply the same one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.

PO8: Communication: Communicate with mathematical community, and with society at large, regarding complex mathematical activities confidentially an effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9: Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10: Ethical Practices and Social Responsibility: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11: Independent and Reflective Learning: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

PO12: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Apply the knowledge of mathematical concepts in interdisciplinary fields.

PSO2: Appreciate the nature of abstract mathematics and explore the concepts in further details.

PSO3: Recognize the need to engage in lifelong learning through continuing education and research.

M.Sc. Mathematics (Integrated)
(160 CREDIT STRUCTURE)

SEMESTER – I									
S. No.	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1.	HS	GLS51008	Tamil	2	0	0	2	2	2
		GLS51009	Hindi						
		GLS51010	Telugu						
		GLS51011	French						
		GLS51012	German						
		GLS51013	Spanish						
		GLS51014	Korean						
		GLS51015	Mandarin						
		GLS51016	Japanese						
2.	HS	ALS02001	Communication Skills	2	0	1	2	1	3
3.	PC	AIM02001	Classical Algebra	3	1	0	4	1	4
4.	PC	AIM02002	Differential and Integral Calculus	3	0	2	4	1	5
5.	BS	APH02001	Applied Physics	3	1	0	4	0	4
6	SE	ACA02001	Python Programming and MATLAB	2	1	2	4	0	5
			Total	17	1	4	20	4	22
L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours									

SEMESTER – II									
S. No.	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**

1.	PC	AIM02003	Vector Calculus and Fourier Series	3	0	2	4	1	5
2.	PC	AIM02004	Differential Equations and Transforms	3	0	2	4	1	5
3.	SE	AIM02005	Mathematical Statistics with R	3	1	0	4	1	4
4	PC	AIM02006	Mathematical Social Science	3	1	0	4	1	4
5	PC	AIM02007	Financial Mathematics	3	1	0	4	0	4
			Total	15	3	4	20	4	22
L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours									

SEMESTER – III									
S. No.	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1.	PC	AIM02008	Modern Algebra	3	1	0	4	1	4
2.	PC	AIM02009	Mathematical Analysis	3	1	0	4	1	4
3.	PC	AIM02010	Complex Functions	3	1	0	4	1	4
4.	PC	AIM02011	Probability and Statistics	3	0	2	4	1	5
5.	SE	ACA02002	Object Oriented Programming Using C++	3	0	2	4	0	5
			Total	15	3	4	20	4	22
L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours									

SEMESTER – IV

S. No.	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1.	PC	AIM02012	Linear Algebra	3	0	2	4	1	5
2.	PC	AIM02013	Real Analysis	3	1	0	4	1	4
3.	PC	AIM02014	Complex Analysis	3	1	0	4	1	4
4.	AE	AIM02015	Advanced Statistics	3	1	0	4	1	4
5.	HS	ACA02003	Basics of Data Science	3	1	0	4	0	4
			Total	15	4	2	20	4	21
L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours									

SEMESTER – V									
S. No.	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1.	PC	AIM02016	Discrete Mathematics	3	1	0	4	1	4
2.	PC	AIM02017	Three-Dimensional Analytical Solid Geometry	3	1	0	4	1	4
3.	PC	AIM02018	Numerical Analysis	3	1	0	4	1	4
4.	DE	AIM025**	Elective – I	3	1	0	4	0	4
5.	DE	AIM025**	Elective – II	3	1	0	4	0	4
			Total	15	5	0	20	3	20
L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours									

SEMESTER – VI

S. No.	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1.	PC	AIM02019	Operations Research	3	1	0	4	1	4
2.	PC	AIM02020	Number Theory	3	1	0	4	1	4
3.	AE	AIM02021	Advanced Numerical Analysis	3	0	2	4	1	5
4.	DE	AIM025**	Elective – III	3	1	0	4	0	4
5.	DE	AIM025**	Elective – IV	3	1	0	4	0	4
			Total	15	4	2	20	3	21

L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH –Total Contact Hours

SEMESTER – VII									
S. No.	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1.	PC	AIM02022	Real integral using Complex Analysis	3	1	0	4	1	4
2.	PC	AIM02023	Advanced Operations Research	3	1	0	4	1	4
3.	PC	AIM02024	Classical Mechanics	3	1	0	4	1	4
4.	DE	AIM025**	Elective – V	3	1	0	4	0	4
5.	DE	AIM025**	Elective – VI	3	1	0	4	0	4
			Total	15	5	0	20	3	20

L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH –Total Contact Hours

SEMESTER – VIII									
S. No.	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1.	PC	AIM02025	Topology and Advanced Functional Analysis	3	1	0	4	1	4
2.	PC	AIM02026	Commutative Algebra	3	1	0	4	1	4
3.	PJ	AIM02800	Project	0	0	24	12	0	24
			Total	6	2	24	20	2	32
L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours									

TOTAL CREDITS – 160

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE

Elective I									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
5	DE	AIM02500	Numerical Solution of Partial Differential Equations	3	1	0	4	0	4
5	DE	AIM02501	Stochastic Processes	3	1	0	4	0	4
5	DE	AIM02502	Fourier Analysis	3	1	0	4	0	4
Elective II									
5	DE	AIM02503	Mathematical Physics	3	1	0	4	0	4
5	DE	AIM02504	Basics of Graph Theory	3	1	0	4	0	4
5	DE	AIM02505	Representation Theory of Finite Groups	3	1	0	4	0	4
Elective III									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
6	DE	AIM02506	Special Theory of Relativity and Analytical Mechanics	3	1	0	4	0	4
6	DE	AIM02507	Theory of Fuzzy Subsets and its Models	3	1	0	4	0	4
6	DE	AIM02508	Neural Networks	3	1	0	4	0	4
Elective IV									
6	DE	AIM02509	Functional Analysis	3	1	0	4	0	4
6	DE	AIM02510	Fluid Mechanics	3	1	0	4	0	4
6	DE	AIM02511	Control Theory	3	1	0	4	0	4
Elective V									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
7	DE	AIM02512	Advanced Number Theory	3	1	0	4	0	4
7	DE	AIM02513	Electromagnetic theory	3	1	0	4	0	4
7	DE	AIM02514	Number Theory and Crptography	3	1	0	4	0	4
Elective VI									
7	DE	AIM02515	Genetic Algorithm	3	1	0	4	0	4
7	DE	AIM02516	Applications of Graph Theory	3	1	0	4	0	4
7	DE	AIM02517	Financial Calculus	3	1	0	4	0	4

SEMESTER I

COURSE TITLE	CLASSICAL ALGEBRA			CREDIT	4
COURSE CODE	AIM02001	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to the theory of equations and series
Course Objective	1. To enable the students to learn Binomial, Exponential, Logarithmic series and their application to summation of series. 2. To study intensively the convergence and divergence of different types of series. 3. To demonstrate the standard methods to solve both polynomial and transcendental type equations.
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the concept of Binomial, Exponential, Logarithmic series and their application to summation of series. 2. Find the convergence or divergence of an infinite series. 3. Obtain the absolute convergence series using Cauchy's and Raabe's Test. 4. Calculate the approximate roots of the equation. 5. Identify multiple roots using Horner's method

Prerequisites: Knowledge of Limits and Sequences

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	-	3	-	-	3	-	-	-	-	-	-	-
CO2	-	2	3	-	3	-	-	3	3	-	-	-	-	-	3
CO3	-	2	3	-	3	-	-	3	-	-	-	-	-	-	-
CO4	-	2	3	-	3	-	-	3	-	-	-	-	-	-	-
CO5	-	2	3	-	3	-	-	3	2	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Summation of Series using Binomial and Exponential Theorem (9L+3T=12)	
Binomial, exponential theorems-their statements only- their immediate application to summation and approximation only. **Self-Study:** Proof of Binomial and Exponential Theorems	**CO-1** **BTL-3**
MODULE 2: Logarithmic Series, Convergence and Divergence of Series (9L+3T=12)	
Logarithmic series theorem-statement and proof-immediate application to summation and approximation only. Convergency and Divergency of series – definitions, elementary results comparison tests-De-Alembert's and Cauchy's tests. **Self-Study:** Divergence of series	**CO-2** **BTL-3**
MODULE 3: Absolute Convergence of Series (9L+3T=12)	
Absolute convergence-series of positive terms-Cauchy's condensation test-Raabe's test. **Self-Study:** Series of positive terms	**CO-3** **BTL-3**
MODULE 4: Theory of Equations (9L+3T=12)	
Roots of an equation- Relations connecting the roots and coefficients-transformations of equations-character and position of roots- Descartes's rule of signs-symmetric function of roots-Reciprocal equations. **Self-Study:** Reciprocal equations	**CO-4** **BTL-3**
MODULE 5: Multiple Roots (9L+3T=12)	
Multiple roots-Rolle's theorem - position of real roots of f(x) =0 – Newton's method of approximation to a root – Horner's method.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	T. K. ManikavasagamPillai, T. Natarajan and K.S Ganapathy (2013), *Algebra*, Viswanathan Printers and Publishers Private Ltd, Chennai.
REFERENCE BOOKS	
1	P. Kandasamy and K. Thilagavathy (2014), *Mathematics forB.Sc.Branch* I -Vol. I, S. Chand and Company Ltd, New Delhi.
E BOOKS	
1	N. P. Bali (2010), *Algebra*, Laxmi Publications-New Delhi Edition.

MOOC	
1.	https://www.brainkart.com/article/Introduction-to-Binomial,-Exponential-and-Logarithmicseries_35107/2
2.	http://www.jjernigan.com/172/ConvergenceDivergenceNotes.pdf
3.	http://home.iitk.ac.in/~psraj/mth101/lecture_notes/Lecture11-13.pdf
4.	https://maths4uem.files.wordpress.com/2015/09/1028-infinite-series.pdf
5.	https://ocw.mit.edu/high-school/mathematics/exam-prep/concept-of-series/series-convergencedivergence/

COURSE TITLE	DIFFERENTIAL AND INTEGRAL CALCULUS			CREDITS	4	
COURSE CODE	AIM02002	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1	
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3	
ASSESSMENT SCHEME						
CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	15%	10%	5%	5%	25%	25%
Course Description	To expose the students to the basics of real analysis.					
Course Objective	1. To characterize constants and functions with limitations. 2. To find the derivative using first principle, chain rule and Leibnitz's Theorem 3. To perform partial differentiation of a function of two variables 4. To classify definite and indefinite integrals 5. To perceive the knowledge on multiple integrals					
Course Outcome	Upon completion of this course, the students will be able to 1. Apply limit on functions and derive the theorems on limit. 2. Calculate the rate of change and successive derivatives of a function. 3. Obtain partial derivatives and apply Euler's theorem 4. Evaluate definite and indefinite integrals 5. Determine the area and volume using multiple integrals and evaluate beta and gamma functions.					
Prerequisites: Basic of sets and functions						

CO, PO AND PSO MAPPING															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	1	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	1	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	3	-	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:FUNCTION AND LIMITS	**(9L+6P)**
Constants and variables – Function- Absolute value or modulus – Neighborhood of a Number – Limit of a Function - Theorems on limit – List of important results – Continuous Function. **Self Study:** Limit of a Function **Lab:** Basic Representation of MATLAB	**CO-1** **BTL-3**
MODULE 2:DIFFERENTIATION	**(9L+6P)**
Slope and Rate of Change – Derivative [First Principle] – Method for Evaluating the Differential Coefficient using the First Principle and Standard Results – Derivative of Logarithmic function and Exponential Function – Chain rule – Differentiation of an Implicit Function – Logarithmic Differentiation – Successive Differentiation – Definition and Notations – Leibnitz's Theorem on Successive Differentiation. **Self Study:** Chain rule **Lab:** Differentiation of single variable	**CO-2** **BTL-3**
MODULE 3:PARTIAL DIFFERENTIATION	**(9L+6P)**
Derivation of partial derivation – Successive partial derivation – Homogeneous function- Euler's theorem – Partial derivatives of a function of two functions. (Note: Simple Problem only) **Self Study:** Homogeneous function **Lab:** Partial Differentiation of multi variable	**CO-3** **BTL-3**
MODULE 4:INTEGRATION TECHNIQUES	**(9L+6P)**
Integration – Methods of integration – Substitution method – Integration by parts – Integration using partial fraction – Bernoulli's formula. **Self Study:** Definite integral **Lab**: Integration of single variable	**CO-4** **BTL-3**
MODULE 5: MULTIPLE INTEGRAL	**(9L+6P)**
Double integral – Triple integral- Change of order of integration - Improper Integral – Gamma function – Beta function. **Self Study:** Improper Integral **Lab**: Integration of multi variable	**CO-5** **BTL-3**

TEXT BOOKS

1.	S. Narayanan and T. K. ManickavasagamPillay (2014), *Calculus Volume I,* S. ViswanathanPvt. Ltd, India.
2.	Bhupander Singh, S.K.Pundir (2021), *Differential Calculus and Integral Calculus*, Pragathi Publications, India.

REFERENCE BOOKS	
1.	Dr P. Mariappan (2015), *Business Mathematics*, Pearson Indian Education Service Pvt. Ltd, India.
2.	Dr.P.R. Vittal&Dr.V.Malini (2014) *Calculus*,Margham Publication, India.
E BOOKS	
1.	http://www.themathpage.com
2.	http://mathworld.wolfram.com
3.	http://www.analyzemath.com/calculus
MOOC	
1.	https://itemspro.eu/2020/12/15/mooc-differential-and-integral-calculus-2021/
2.	https://openlearning.aalto.fi/course/view.php?id=168

COURSE TITLE	**APPLIED PHYSICS**			**CREDITS**	**4**
COURSE CODE	**APH02001**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-1-0-0**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To expose the students to the basics of Applied Physics.				
Course Objective	1. To enable the students to about the mechanics of science, electricity and elasticity. 2. To study intensively on gravitational forces and sound. 3. To demonstrate the standard methods adopted in geometrical optics.				
Course Outcome	Upon completion of this course, the students will be able to 1. Develop an understanding on the concept of Simple Harmonic Motion, Angular Momentum, Moment of Inertia, Kinetic Energy. 2. Acquire a clear knowledge on law of gravitation, Kepler's law and Poisson's ratio. 3. Apply the concepts of transverse waves in Melde's experiment, production of ultrasonic waves and its applications. 4. Apply Newton's rings in determination of wave length and refractive index of liquid. 5. Understand the basic laws in electrostatics and its significance in capacitors.				
Prerequisites: Knowledge of Physical Science.					

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	3	-	1	-	2	-	-	-	-	-	2	-	1
CO2	2	-	1	-	2	-	-	-	-	-	-	-	1	2	-

CO3	**1**	**2**	**-**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**3**
CO4	**2**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
CO5	**-**	**1**	**2**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Mechanics	**(9L)**
Simple harmonic motion, phase-equations of wave motion-compound pendulum- center of suspension-interchangeability center of oscillation and suspension.Moment of Inertia – Radius of gyration – Angular Momentum – torque – Theorems of M.I - M.I. of uniform rod, disc, circular ring, solid sphere.	**CO-1** **BTL-3**

	MODULE 2: Gravitation and Elasticity (9L)	
	Law of gravitation–constant G - Kepler's laws-relation between G and g – earth's mass and density -variation of the acceleration due to gravity - orbital velocity - escape velocity. Types of module - Hooke's law - Stress-strain relation - Poisson's ratio relation between Y, η and K.	**CO-2 BTL-3**
	MODULE 3: Sound (9L)	
	Transverse waves – velocity along a stretched string-laws of transverse vibration of strings -verification of laws - Melde's experiment. Ultrasonics-generation - piezo-electric effect - Detection of ultrasonics-applications (SONAR & NDT).	**CO-3 BTL-3**
	MODULE 4: Optics (9L)	
	Geometrical Optics: Spherical aberration of a thin lens – Methods of reducing spherical aberration – Coma – Aplanatic surface – Astigmatism – Curvature of the field – Distortion. Interference: Introduction – Air wedge – Newton's rings – Colors of thin films. Diffraction : Plane diffraction Grating – Theory of plane transmission Grating	**CO-4 BTL-3**
	MODULE 5: Electrostatics (9L)	
	Coulomb's inverse square law – Gauss theorem and its applications (Intensity at a point due to a charged sphere & cylinder), Principle of a capacitor – Capacity of a spherical and cylindrical capacitors – Energy stored in a capacitor – Loss of energy due to sharing of charges - Capacitors in series and parallel – Types of capacitors**.** **Self-Study:** Gauss Theorem	**CO-5 BTL-3**
	TEXT BOOKS	
	1. V. K. Mehta (2014), *Principles of Electrostatics*, S. Chand and Company Ltd, New Delhi.	
REFERENCE BOOKS		
1.	A. S. Vasudeva (2013), *Modern Engineering Physics*, S. Chand and Company Ltd, New Delhi.	
E BOOKS		
1.	Allied Physics (Paper I and II), 1/e | S Chand Publishing	
MOOC		
1.	https://nptel.ac.in/courses/115103108/	

COURSE TITLE	PYTHON PROGRAMMING AND MATLAB			CREDITS	4
COURSE CODE	ACA02001	COURSE CATEGORY	SE	L-T-P-S	2-1-2-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA				ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)
15%	15%	10%	5%	5%	25%

Course Description	It is a discipline that helps to make better decisions in complex scenarios by the application of a set of advanced analytical methods.
Course Objective	1. To understand the Python Programming environment 2. Able to do simple calculations using MATLAB 3. Able to carry out simple numerical computations and analyses using MATLAB
Course Outcome	Upon completion of this course, the student should be able to: 1. Demonstrate an understanding on Basic principles of computers and File systems 2. Design Control Structures using Python programming 3. Define classes and functions 4. Acquire the knowledge of basis in MATLAB and find vectors and matrices in MATLAB. 5. Design simple algorithms to solve problem.

Prerequisites: Knowledge of matrices and vectors

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO3
CO1	-	3	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	3	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	3	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	3	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	3	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE1: Introduction to Python Programming	**(6L+3P=9)**
Relationship between computers and programs -- Basic principles of computers -- File systems -- Using the Python interpreter -- Introduction to binary computation -- Input / Output	**CO-1** **BTL-3**
MODULE 2: Data types and Control Structures	**(6L+3P=9)**
Operators (unary, arithmetic, etc.) -- Data types, variables, expressions, and statements -- Assignment statements -- Strings and string operations -- Control Structures: loops and decision	**CO-2** **BTL-3**
MODULE 3: Modularization and Classes	**(6L+3P=9)**
Standard modules -- Packages -- Defining Classes -- Defining functions -- Functions and arguments (signature)	**CO-3** **BTL-3**
MODULE 4: MATLAB Basics, Matrices and vectors in MATLAB	**(6L+3P=9)**
The MATLAB environment- Basic computer programming- Variables and constants, operators and simple calculations - Formulas and functions- MATLAB toolboxes. Matrix and linear algebra review- Vectors and matrices in MATLAB- Matrix operations and functions in MATLAB.	**CO-4** **BTL-3**
MODULE 5: MATLAB programming	**(6L+3P=9)**
Algorithms and structures- MATLAB scripts and functions (m-files) - Simple sequential algorithms - Control structures (if…then, loops) Reading and writing data, file handling - Personalized functions- Toolbox structure - MATLAB graphic functions	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Stephen J. Chapman (2001),*MATLAB Programming for Engineers*, Nelson Education Limited, USA.
2	Wesley Chun (2001), *Core Python Programming*, Prentice Hall.
REFERENCE BOOKS	
1.	RudraPratap (2016), *Getting Started with MATLAB*, Oxford University Press.
2.	R NageshwaraRaoda (2016), *Core Python Programming*, Dreamtech Press.
E BOOKS	
1.	Learn Python, Break Python: A Beginner's Guide to Programming, by Breaking Stuff Books (learnpythonbreakpython.com)
MOOC	
1.	Python 3.4.3 - Course (swayam2.ac.in)
2	Training - Courses in MATLAB, Simulink, and Stateflow - MATLAB & Simulink (mathworks.com)

SEMESTER II

COURSE TITLE	VECTOR CALCULUS AND FOURIER SERIES			CREDITS	4
COURSE CODE	AIM02003	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA				ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)
15%	15%	10%	5%	5%	25%

Course Description	Designed to develop an understanding of topics which are fundamental to the Study of calculus, Fourier series and multiple integrals.
Course Objective	To enable the students to learn about the expansion of trigonometric, hyperbolic functions, vector calculus and the expansions of Fourier series.
Course Outcome	Upon completion of this course, the students will be able to 1. Evaluate the expansion of trigonometric functions and hyperbolic functions. 2. Acquire the basic knowledge of logarithm of complex quantities. 3. Determine and apply the important quantities associated with vector fields such as the divergence, curl and scalar potential. 4. Examine line integral, surface integral, volume integral and inter-relations among them. 5. Find Fourier series of a given periodic function

Prerequisites: Knowledge in Vector Algebra, Differentiation and Integration

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	-	2	3	-	3	-	-	2	-	-	-	-	-	-	-
CO2	-	2	3	-	3	-	-	2	3	-	-	-	-	-	-
CO3	-	2	3	-	3	-	-	2	-	-	-	-	-	-	-
CO4	-	2	3	-	3	-	-	2	-	-	-	-	-	-	-
CO5	-	2	3	-	3	-	-	2	2	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Expansion in Series	**(9L+3T=12)**
Expansion in Series – Expansion of cosnθ, sinnθ in a series of cosines and sines of multiples of θ –Expansions of cosnθ, sinnθ and tannθ in powers of sines, cosines and tangents – Expansion of sinθ, cosθ and tanθ in powers of θ – hyperbolic functions and inverse hyperbolic functions. **Self-Study**: Inverse hyperbolic functions. **Mat Lab**: Expansion of cosnθ, sinnθ.	**CO-1** **BTL-3**
MODULE 2: Logarithm of Complex Quantities and Summation of Series	**(9L+3T=12)**
Logarithm of complex quantities - summation of series – when angles are in arithmetic progression, method of summation – method of differences. **Mat Lab**: Summation of Series	**CO-2** **BTL-3**
MODULE 3: Vector Differentiation	**(9L+3T=12)**
Scalar and vector fields – Differentiation of vectors – Gradient, Divergence and Curl- Solenoidal and irrotationalvectors-Laplacian Operator. **Self-Study**: Laplacian Operator. **Mat Lab**: Gradient, Divergence, Curl, Irrotational, and Solenoidal.	**CO-3** **BTL-3**
MODULE 4: Vector Integration	**(9L+3T=12)**
Integration of vectors – line integral – surface integral – Green's theorem in the plane – Gauss divergence theorem – Stake's theorem - verification of the above said theorems. **Self-Study:** Surface Integral **Mat Lab:**Solutions of Problems on Gauss Divergence Theorem, Stoke's theorem, Green's theorem	**CO-4** **BTL-3**
MODULE 5: Fourier Series	**(9L+3T=12)**
Periodic functions – Fourier series of periodicity 2π – half range series, Change of Interval and Harmonic Analysis. **Self-Study:** Periodic Functions **Mat Lab:** Solution of Fourier Series.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P. Kandasamy and K. Thilagavathi (2004), *Mathematics for B.Sc. Branch I, Volume I, II and IV*, S. Chand and Company Ltd, New Delhi.
REFERENCE BOOKS	
1.	P. Duraipandian and Laxmi durai pandian (2005), *Vector Analysis*, Emerald Publishers. India.
2.	K. Manichavasagam Pillai and S.Narayanan (2009), *Trigonometry*, Viswanathan Publishers and Printers Pvt. Ltd. New Delhi
E BOOKS	
1.	http://www.freebookcentre.net/maths-books-download/Calculus,-Applications-and-Theory.html
2.	vhttp://www.freebookcentre.net/maths-books-download/Fourier-Analysis-by-Gustaf-Gripenberg.html
MOOC	
1.	http://www.nptelvideos.in/2012/11/mathematics-iii.html
2.	http://www-math.mit.edu/~djk/18_01/chapter20/section03.html
3.	https://www.whitman.edu/mathematics/calculus_online/chapter16.html
4.	http://www.mecmath.net/calc3book.pdf

COURSE TITLE	DIFFERENTIAL EQUATIONS AND TRANSFORMS			CREDITS	4
COURSE CODE	AIM02004	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME						
CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	15%	10%	5%	5%	25%	25%

Course Description	To impart knowledge on the method of solving Partial differential equations, and ordinary differential Equations using Laplace Transforms.
Course Objective	This course includes the study of first order differential equations, higher order linear differential equations, Laplace transforms, numerical methods, boundary value and initial value problems, qualitative analysis of solutions, and applications of differential equations.
Course Outcome	Upon completion of this course, the students will be able to 1. Solve higher order linear differential equations. 2. Demonstrate the solution of higher order using Euler's homogeneous 3. Demonstrate competency to solve linear PDE by Lagrange's method. 4. Analyze the concepts of Laplace transforms and inverse Laplace transforms. 5. Identify the inverse Laplace transform.

Prerequisites: Knowledge of ordinary and Partial Derivatives

CO, PO AND PSO MAPPING															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-
1: Weakly related, 2: Moderately related and 3: Strongly related															

MODULE 1: Linear First Order Differential Equation	**(9L+3T=12)**
Ordinary Differential Equations: Equations of First Order and of Degree Higher than one –Solvable for p, x, y– Clairaut's Equation – Simultaneous Differential Equations with constant coefficients of the form (i) $f_1(D)x + g_1(D)y = \emptyset_1(t)$(ii) $f_2(D)x + g_2(D)y = \emptyset_2(t)$where f_1, g_1, f_2 and g_2 are rational functions D=d/dt with constant coefficients and $\emptyset_1$, $\emptyset_2$ explicit functions of t. **Self-Study:** Clairaut's Equation **LAB:** Solution of first order differential equations	**CO-1** **BTL-3**
MODULE 2: Higher Order Linear Differential Equation	**(9L+3T=12)**
Finding the solution of Second and Higher Order with constant coefficients with Right Hand Side is of the form where V is a function of x – Euler's Homogeneous Linear Differential Equation. **LAB:** Solution of first second differential equations	**CO-2** **BTL-3**
MODULE 3: Partial Differential Equations	**(9L+3T=12)**
Partial Differential Equations: Formation of equations by eliminating arbitrary constants and arbitrary functions –Solutions of P.D Equations – Solutions of Partial Differential Equations by direct integration – Methods to solve the first order P.D. Equations in the standard forms –Lagrange's Linear Equations. **Self-Study:** Solutions of Partial Differential Equations by direct integration **LAB:** Solution of Lagrange's and Standard PDE differential equations	**CO-3** **BTL-3**
MODULE 4: Laplace Transforms	**(9L+3T=12)**
Laplace Transforms: Definition – Laplace Transforms of standard functions – Linearity property –First Shifting Theorem – Transform of tf(t), f (t)/t, f'(t), f''(t), Inverse Laplace Transforms – Applications to solutions of First Order and Second Order Differential Equations with constant coefficients. **Self-Study:** First Shifting Theorem **LAB:** To find Laplace and Inverse Laplace of elementary function	**CO-4** **BTL-3**
MODULE 5: Fourier Transforms	**(9L+3T=12)**
Fourier Integral Theorem (without proof) - Fourier transform pair - Sine and Cosine transforms - Properties - Transforms of Simple functions - Convolution theorem - Parseval's identity. **LAB:**To find Fourier Transform of elementary function	**CO-5** **BTL-3**

TEXT BOOKS

1.	P. Kandasamy and K. Thilagavathi (2004), Mathematics *for B.Sc – Branch* – I *Volume*III , S. Chand and Company Ltd, New Delhi.
2.	Dr. J. K. Goyal and K.P. Gupta (2004), *Laplace and Fourier Transforms*, PragatiPrakash Publishers, Meerut.

REFERENCE BOOKS

1.	S. Narayanan and T. K. ManickavasagamPillai (2009), *Calculus Vol III*, S. Viswanathan Printers and Publishers Pvt. Ltd, Chennai.
2.	N. P. Bali. (2004), *Differential Equations*, Laxmi Publication Ltd, New Delhi.

E BOOKS	
1.	https://www.math.hkust.edu.hk/~machas/differential-equations.pdf
2.	http://www.mmcmodinagar.ac.in/econtent/physics/DifferentialEquationsAndTheirApplications.pdf
MOOC	
1.	https://nptel.ac.in/courses/111105035/
2.	http://www.nptelvideos.in/2012/11/mathematics-iii.html
3.	https://www.digimat.in/nptel/courses/video/111108081/L02.html
4.	https://www.math.ust.hk/~machas/differential_equations.pdf.
5.	https://www.ijsr.net/archive/v2i1/ijsron2013331.pdf
6.	https://www.whitman.edu/mathematics/calculus_online/chapter17.html

COURSE TITLE	MATHEMATICAL STATISTICS WITH R			CREDITS	4
COURSE CODE	AIM02005	COURSE CATEGORY	SE	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course discusses the basic Mathematical statistics which provides students with decision theory, estimation, confidence intervals, and hypothesis testing.
Course Objective	1. To study and to develop learning mindsets to analyze statistical data through R. 2. To learn and to develop learning mindsets to analyze statistical inference through R.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on concepts of probability 2. Apply the test of hypothesis for sampling 3. Analyze simple and multiple regression 4. Acquire the knowledge on time series, forecasting and decision theory 5. Demonstrate the knowledge of data visualization using r.

Prerequisites: Basic definitions and concepts of statistics, programming knowledge

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO-1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO-2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO-3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO-4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO-5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DESCRIPTIVE STATISTICS	**(9L+3T=12)**
Grouping and displaying data – Measures of central tendency and dispersion in frequency distribution – Introduction to probability – Probability distribution.	**CO-1** **BTL-3**

MODULE 2: INFERENTIAL STATISTICS	**(9L+3T=12)**
Sampling and Sampling distribution – estimation – test of hypothesis – one sample – 2 sample test – quality and quality control- chi square and analysis of variance.	**CO-2** **BTL-3**
MODULE 3: CORRELATION AND REGRESSION	**(9L+3T=12)**
Correlation and partial correlation – simple & multiple and partial correlation analysis – simple and multiple regression analysis.	**CO-3** **BTL-3**
MODULE 4: TIME SERIES, FORECASTING AND DECISION THEORY	**(9L+3T=12)**
Non parametric test – time series and forecasting – decision theory	**CO-4** **BTL-3**
MODULE5: DATA VISUALIZATION	**(9L+3T=12)**
Introduction to GGPlot2 – Factors – Aesthetics – Plotting with Layers – Overriding Aesthetics – Mapping vs Setting – Histograms – Density Charts – Statistical Transformation – Facets – Coordinates – Themes.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Gupta, S. C. and Kapoor, V. K. (2020). *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi, 11th Edition.
2.	Mark Gardener. (2013). *Beginning R – The Statistical Programming Language*, Wiley.
3.	Ross, S. M. (2014). *Introduction to Probability and Statistics*, Academic Foundation.
REFERENCE BOOKS	
1.	Papoulis, A. and Pillai, S. U. (2010). *Probability, Random Variables and Stochastic Processes*, TMH.
2.	Hastie, Trevor, et al. (2017). *The elements of Statistical Learning*, Springer.
3.	Robert Knell. (2013). *Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R*, Amazon Digital South Asia Services Inc.
E BOOKS	
1.	https://www.e-booksdirectory.com/details.php?ebook=12097
2.	https://www.e-booksdirectory.com/details.php?ebook=9332
MOOC	
1.	https://www.edx.org/course/statistics-and-r
2.	https://ocw.mit.edu/courses/mathematics/18-655-mathematical-statistics-spring-2016/#
3.	https://www.coursera.org/browse/data-science/probability-and-statistics

COURSE TITLE	MATHEMATICAL SOCIAL SCIENCES			CREDITS	4
COURSE CODE	AIM02006	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	First Periodical Assessment	Second Periodical Assessment
15%	15%	10%	5%	15%	15%

Course Description	To make the student understand the basic concepts of Mathematical social science and its application
Course Objective	1. To equip the students with a sample of available tools/techniques in Mathematics to study and analyze the social issues and to give a first-hand experience in using / experimenting with the techniques.
Course Outcome	Upon completion of this course, the students will be able to 1. Recognize fuzzy logic membership function and fuzzy Inference systems 2. Determine the graph theoretic tools / techniques 3. Apply statistical techniques in real time problems 4. Apply the optimization techniques in networks 5. Derive statistical approach using fuzzy models

Prerequisites: Basics of statistics

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO 2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO 3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO 4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO 5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO SOCIAL SCIENCE	**(9L+3T=12)**
Some fundamental concepts in social science – Research- survey- investigation and experiment- Hypothesis in social research Questionnaire- Experimental design in social research- Examples from case studies.	**CO-1 BTL-3**
MODULE 2: GRAPH THEORETIC TOOLS / TECHNIQUES	**(9L+3T=12)**

Conversion of issues to graphs- weighted graphs- popular models- Examples from case studies-Techniques used in Numerical Methods- Examples from case studies.	**CO-2** **BTL-3**

MODULE 3: STATISTICAL TOOLS / TECHNIQUES	**(9L+3T=12)**
Sampling and types of sampling-Standard measures in statistics Examples from case studies.	**CO-3 BTL-3**
MODULE 4: OPERATIONS RESEARCH TOOLS / TECHNIQUE	**(9L+3T=12)**
Formulating the Linear Programming Problem-Simplex method Transportation Problem-Assignment Problem -Necessity for maintaining inventory-E.O.Q Problems with Deterministic and Probabilistic Demand-Networks-Graphs-Spanning Tree problem Shortest Route Problem-Maximal Flow problem - Examples from case studies.	**CO-4 BTL-3**
MODULE 5: FUZZY TOOLS / TECHNIQUES	**(9L+3T=12)**
Fuzzy models –fuzzy cognitive maps –combined overlap fuzzy cognitive maps-Neutrosophic cognitive maps- combine overlap Neutrosophic cognitive maps- Neutrosophic relational maps-Statistical approach using fuzzy models and Neutrosophic models.	**CO-5 BTL-3**

TEXT BOOKS

1.	Mojumdar, P. K. (2011). *Research Methods in Social Sciences*, Viva Books Pvt. Ltd., chapters: 2.1– 2.3 and 3 (full), 4.5 and 8.1, 8.2, 8.8, 17.4-17.7and 8.11 General outlook from Chapters 9, 10, 11, 12 and 13.
2.	Bart Kosko, (2003). *Neural Networks and Fuzzy systems*, Prentice Hall of India, New Delhi, Chapters: 3, 4 and 8
3.	Bondy and Murthy, (2013) Graph Theory with Applications, Chapters 14,15

REFERENCE BOOKS

1.	KanthiSwaroop, et.al., (2014). *Operations Research*, Sultan Chand & Sons, Reprint
2.	VasanthaKandasamy,W. B., FlorentinSmarandache, K. and Ilanthenral. (2007).*Elementary fuzzy matrix theory and fuzzy models for social scientists*, Published by Automaton, Los Angeles, USA.
3.	GopalLal Jain. (2010). *Research methodology*,Mangal Deep Publications.
4.	Kapoor, J. N. (2010). *Statistical methods*,S Chand & Co Ltd.

E BOOKS

1.	Jonathan - Kropko - Mathematics - Social-Scientists -eBook/dp/B016ILJ5WI

MOOC

1.	https://online-learning.harvard.edu/subject/social-sciences

COURSE TITLE	FINANCIAL MATHEMATICS			CREDITS	4
COURSE CODE	AIM02007	COURSE CATEGORY	PC	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to the basics of Financial Mathematics
Course Objective	1. To understand the concepts of Financial Mathematics 2. To have a clear idea of stocks, Futures forward and swaps 3. To understand Markowitz theory of portfolio 4. To understand about Future options 5. To perceive the concept of Martingales
Course Outcome	Upon completion of this course, the students will be able to 1. Identify the need for financial mathematics 2. Analyze present and future value of cash flow 3. Apply the concept of minimum variance portfolio 4. Classify the future options and put call parity 5. Apply brownian motion

Prerequisites: Basics of Probability

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FINANCIAL MARKETS, BONDS AND STOCKS	(9L+3T=12)
Introduction to the Financial Mathematics –Need - Introduction to financial markets and bonds – Introduction to stocks- Examples and discussion.	**CO-1** **BTL-3**

MODULE 2: FUTURES FORWARD, SWAPS AND OPTIONS	**(9L+3T=12)**
Introduction to Futures forward and swaps- Examples and discussion- Introduction to options – Interest rates- Examples and discussion – Present and future value of cash flow – Bond yield – Price yield curve.	**CO-2 BTL-3**
MODULE 3: PORTFOLIO THEORY	**(9L+3T=12)**
Markowitz theory of portfolio - Return and risk of portfolio - Examples and discussion-Minimum variance portfolio – Efficient frontier – Minimum variance line.	**CO-3 BTL-3**
MODULE 4: FUTURE OPTIONS	**(9L+3T=12)**
No arbitrage principle and pricing of forward contracts – Future options and put call parity – Bounds on options – Examples and discussion.	**CO-4 BTL-3**
MODULE 5: MARTINGALES, ITO INTEGRAL	**(9L+3T=12)**
Single period binomial model – Multi period binomial model – Martingales – Markov process – Brownian motion – Discussion – Integral and its properties – Ito process – Ito formula.	**CO-5 BTL-3**

TEXT BOOKS	
1.	Capinski, M. and Zastawniak, T. (2011). *Mathematics for Finance: An Introduction to Financial Engineering,* Springer, Second Edition.
3.	Cvitanic, J. and Zapatero, F. (2004). *Introduction to the Economics and Mathematics of Financial Markets,* The MIT Press.
REFERENCE BOOKS	
1.	Steven Shreve. (2015). *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model,*Springer Finance.
2.	Steven Shreve. (2010). *Stochastic Calculus for Finance II: Continuous-Time Models,* Springer Finance.
E BOOKS	
1.	Robert Buchanan. (2012). *An undergraduate introduction to Financial Mathematics,* Millersville University, USA, Third Edition, https://doi.org/10.1142/8495.
2.	Richardson, Clarence, H., Leslie Miller Isaiah. (2005). *Financial Mathematics,* D. Van Nostrand Company Inc.

MOOC	
1.	https://www.classcentral.com/course/swayam-financial-mathematics-13024
2.	https://www.openlearning.com/courses/introduction-to-financial-mathematics/?cl=1
3.	https://onlinecourses.nptel.ac.in/noc19_ma26/preview
4.	https://www.coursera.org/courses?query=mathematical%20finance

SEMESTER III

COURSE TITLE	MODERN ALGEBRA			CREDITS	4
COURSE CODE	AIM02008	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course discusses how algebra allows us to abstract out the geometric objects and numbers.
Course Objective	Focuses on the concepts of algebraic structures which is one of the pillars of modern Mathematics and emphasis on their properties and applications.
Course Outcome	Upon completion of this course, the students will be able to 1. Compare the properties and extend group structure to finite permutation groups. 2. Evaluate subgroups an its types. 3. Evaluate the concepts of homomorphism, isomorphism and automorphism. 4. Demonstrate ring from groups. 5. Obtain ideals and quotients from rings

Prerequisites: Knowledge of basic Algebra**.**

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO-9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Groups and its Basic Properties	**(9L+3T=12)**
Sets – mappings – Relations and binary operations – Groups: Abelian group, Symmetric group -Definitions and Examples – Basic properties. **Self-Study:**Sets	**CO-1** **BTL-3**

MODULE 2: Subgroups and Normal Subgroups	(9L+3T=12)
Subgroups – Cyclic subgroup - Index of a group – Order of an element – Fermat theorem – A, Counting Principle - Normal Subgroups and Quotient Groups. **Self-Study:** Quotient Groups	**CO-2** **BTL-3**
MODULE 3: Automorphisms	**(9L+3T=12)**
Homomorphisms (Applications 1 and 2 are omitted) –Automorphisms – Inner automorphism – Cayley's theorem, permutation groups. **Self-Study:** Permutation Group	**CO-3** **BTL-3**
MODULE 4: Rings	**(9L+3T=12)**
Definition and Examples –Some Special Classes of Rings– Commutative ring – Field – Integral domain - Homomorphisms of Rings.	**CO-4** **BTL-3**
MODULE 5: Ideals and Quotient Rings	**(9L+3T=12)**
Ideals and Quotient Rings – More Ideals and Quotient Rings – Maximal ideal - The field of Quotients of an Integral Domain.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	I.N. Herstein (2006), *Topics in Algebra*, John Wiley and Sons, New York.
REFERENCE BOOKS	
1.	Surjeet Singh and QaziZameeruddin (2013), *Modern Algebra*, Vikas Publishing house, Ahmedabed.
2.	A. R. Vasishtha (2019), *Modern Algebra*, Krishna PrakashanMandir, Meerut, India.
E BOOKS	
1.	https://www.dymocks.com.au/book/advanced-modern-algebra-by-joseph-j-rotman-9781470411763
MOOC	
1.	https://www.classcentral.com/course/swayam-modern-algebra-14201
2.	https://nptel.ac.in/courses/111/106/111106113/
3.	https://nptel.ac.in/courses/106/104/106104149/

COURSE TITLE	MATHEMATICAL ANALYSIS			CREDITS	4
COURSE CODE	AIM02009	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course covers the fundamentals of mathematical analysis.
Course Objective	1. To present a deeper and rigorous understanding of fundamental concepts like continuity, 2. Connectivity, derivative, monotonic functions with properties and Riemann - integral.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the understanding of continuity, uniform continuity, compactness, and connectedness. 2. Determine monotonic functions. 3. Evaluate algebra of derivatives using some methods. 4. Obtain properties of monotonic functions. 5. Determine the Riemann integrability and the Riemann-Stieltjes integrability of abounded function.

Prerequisites: Knowledge in Mappings and Properties of Real Numbers

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Topological Mappings	(9L+3T=12)
Examples of continuous functions –continuity and inverse images of open or closed sets –functions continuous on compact sets –Topological mappings –Bolzano's theorem. **Self-Study:** Topological mappings	**CO-1** **BTL-3**

MODULE 2: Monotonic Functions	(9L+3T=12)
Connectedness –components of a metric space – Uniform continuity - Uniform continuity and compact sets –fixed point theorem for contractions –monotonic functions. **Self-Study:** Uniform continuity	**CO-2** **BTL-3**
MODULE 2: Monotonic Functions	**(9L+3T=12)**
Connectedness –components of a metric space – Uniform continuity - Uniform continuity and compact sets –fixed point theorem for contractions –monotonic functions. **Self-Study:** Uniform continuity	**CO-2** **BTL-3**
MODULE 3: Derivatives	**(9L+3T=12)**
Definition of derivative –Derivative and continuity –Algebra of derivatives – the chain rule–one sided derivatives and infinite derivatives –functions with non-zero derivatives –zero derivatives and local extrema –Rolle's theorem –The mean value theorem for derivatives – Taylor's formula with remainder. **Self-Study:** Rolle's theorem	**CO-3** **BTL-3**
MODULE 4: Functions of bounded variation	**(9L+3T=12)**
Properties of monotonic functions –functions of bounded variation –total Variation –additive properties of total variation on (a, x) as a function of x – functions of bounded variation expressed as the difference of increasing functions –continuous functions of bounded variation. **Self-Study:** Monotonic functions	**CO-4** **BTL-3**
MODULE 5: The Riemann- Stieltjes integral	**(9L+3T=12)**
Introduction –Notation –The definition of Riemann –Stieltjes integral –linear properties –Integration by parts –change of variable in a Riemann –Stieltjes integral –Reduction to a Riemann integral.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	M. Apostol (2005), *Mathematical Analysis*, Narosa Publishing Company, Chennai
REFERENCE BOOKS	
1.	R.R.Goldberg (2009), *Methods of Real Analysis*, NY, John Wiley, New York.
2.	G.F.Simmons (2011), *Introduction to Topology and Modern Analysis*, McGraw – Hill, New York
3.	G. Birkhoff and MacLane (2017*), A survey of Modern Algebra*, Macmillian, 3rdEdition, NewYork.
4.	J.N.Sharma and A.R.Vasistha (2017), *Real Analysis*, Krishna Prakashan Media (Ltd), Uttar Pradesh.
E BOOKS	
1.	Mathematical Analysis, Second Edition (ru.ac.bd)
MOOC	
1.	https://www.whitman.edu/Documents/Academics/Mathematics/grady.pdf
2.	https://nptel.ac.in/courses/122/101/122101003/
3.	https://www.math.ucdavis.edu/~emsilvia/math127/chapter7.pdf
4.	https://nptel.ac.in/courses/111/106/111106053/

COURSE TITLE	COMPLEX FUNCTIONS			CREDITS	4
COURSE CODE	AIM02010	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students about Complex analysis
Course Objective	To equip the students with the understanding of the fundamental concepts of complex functions, analyticity, power series and complex integration.
Course Outcome	Upon completion of this course, the students will be able to 1. Obtain the cross ratio using bilinear transformation. 2. Calculate a function for its analyticity and find it series development. 3. Determine power series and elementary functions. 4. Obtain the relationship between conformal mapping and harmonic functions. 5. Compute contour integrals directly and by the fundamental theorem.

Prerequisites: Knowledge of Calculus and its types

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Complex Plane	**(9L+3T=12)**
Complex number –Field of Complex numbers – Conjugation – Absolute value - Argument –Elementary Transformations i) w=z +α ii) w =az iii) w =1/z. Fixed points -cross-ratio-invariance of cross-ratio under bilinear transformation – Definition of extended complex plane– Stereographic projection. **Self-Study:** Bilinear Transformation	**CO-1** **BTL-3**

MODULE 2: Analytic Functions	**(9L+3T=12)**
Complex Functions- Limit of a function –continuity –differentiability – Analytical function defined in a region –necessary conditions for differentiability –sufficient conditions for differentiability –Cauchy-Riemann equation in polar coordinates – Definition of entire function. **Self-Study:** Entire Function	**CO-2** **BTL-3**
MODULE 3: Power Series and Elementary Functions	**(9L+3T=12)**
Absolute convergence –circle of convergence –Analyticity of the sum of power series in the Circle of convergence (term by term differentiation of a series) Elementary functions: Exponential, Logarithmic, Trigonometric and Hyperbolic functions. **Self-Study:** Trigonometric Functions	**CO-3** **BTL-3**
MODULE 4: Harmonic Functions and Conformal Mapping	**(9L+3T=12)**
Definition and determination. Conformal Mapping: Isogonal mapping – Conformal Mapping-Mapping z⍰f(z), where f is analytic, particularly the mappings, $w= e^{z}$, $w= z^{2}$, w=sin z , w = cosz , w=z+ 1/z .	**CO-4** **BTL-3**
MODULE 4: Harmonic Functions and Conformal Mapping	**(9L+3T=12)**
Definition and determination. Conformal Mapping: Isogonal mapping – Conformal Mapping-Mapping z⍰f(z), where f is analytic, particularly the mappings, $w= e^{z}$, $w= z^{2}$, w=sin z , w = cosz , w=z+ 1/z .	**CO-4** **BTL-3**
MODULE 5: Complex Integration	**(9L+3T=12)**
Simply and multiply connected regions in the complex plane. Integration of f(z) from definition along a curve joining z_1 and z_2. Proof of Cauchy's Theorem (using Goursat's lemma for a simply connected region). Statement of Cauchy's integral formula for higher derivatives -Morera's theorem.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P. Duraipandian and LaxmiDuraipandian (2006), *Complex Analysis*, Emerald Publishers, Chennai.
REFERENCE BOOKS	
1.	Churchill (2008), *Complex Variable and Applications*, Tata McGraw Hill Publishing Company Ltd. New Delhi.
2.	Swaminarayan (2005), *Theory of functions of Complex Variable*, S. Chand and Company, Meerut, India.
3.	Tyagi B.S (2004), *Functions of Complex Variable*, 17th Edition, PragatiPrakasham Publishing Company Ltd, Meerut, New Delhi.
E BOOKS	
1.	UG_B.Sc._Mathematics_113 63 COMPLEX ANALYSIS_8718.pdf
MOOC	
1.	https://nptel.ac.in/courses/111/103/111103070/
2.	https://nptel.ac.in/courses/111/107/111107056/
3.	https://nptel.ac.in/courses/122/103/122103012/

COURSE TITLE	PROBABILITY AND STATISTICS			CREDITS	4	
COURSE CODE	AIM02011	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1	
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3	
ASSESSMENT SCHEME						
CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	15%	10%	5%	5%	25%	25%
Course Description	To expose the students about Complex analysis					
Course Objective	1. To understand basic theoretical and applied principles of statistics. 2. Analyze statistical data using measures of central tendency, dispersion and location. 3. Analyze statistical data graphically using frequency distributions and cumulative frequency distributions.					
Course Outcome	Upon completion of this course, the students will be able to 1. Develop an understanding of the concept of population and samples. 2. Apply the basic probability for simple problems in real time. 3. Prove Baye's theorem and compute the conditional probabilities. 4. Derive the mean, variance and moment generating function for probability distributions. 5. Apply the methods of sampling					
Prerequisites: Knowledge of Calculus and its types						

CO, PO AND PSO MAPPING															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	3	2	2	-	-	-	-	-	-	2	-	3
CO2	-	3	-	3	-	2	-	-	-	-	-	-	1	2	-
CO3	3	2	3	3	3	2	2	-	-	-	-	-	3	2	-
CO4	3	-	3	3	2	2	2	-	-	-	-	-	-	3	2
CO5	3	2	-	3	-	2	2	-	-	-	-	-	3	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:Measures of Central Tendency	**(9L+6P=12)**
Introduction and Overview – Distinction between population and sample, and between population parameters and sample statistics –Frequency Distribution – Graphical and Tabular Representation of Data – Measures of Central Tendency (Arithmetic Mean, Geometric Mean, Harmonic Mean, Median, Mode, and their properties, Percentiles, Quartiles, Deciles) **Self-Study**: Measures of Central Tendency **Lab:**Mean, Median, Mode	**CO** **BTL-3**
MODULE 2: Measures of Dispersion	**(9L+6P=12)**
Measures of Dispersion (Range, Quartile Deviation, Mean Deviation, Standard Deviation, Coefficient of Variation, Coefficient of Mean Deviation, Coefficient of Quartile Deviation, Lorenz Curve, and Gini Coefficient) – Population moments and their sample counterparts – Skewness and Kurtosis – Correlation and Regression. **Self-Study**: Skewness and Kurtosis **Lab:**Quartile Deviation, Standard Deviation	**CO-2** **BTL-3**
MODULE 3: Probability Theory	**(9L+6P=12)**
Elementary Probability Theory – Sample spaces and events –Probability axioms and properties - Counting techniques –Conditional probability – Theorem of Compound Probability – Bayes Theorem and Applications – Random Variable (Discrete and Continuous) **Self-Study**: Random variables **Lab:**Conditional probability	**CO-3** **BTL-3**
MODULE 4: Probability Distributions	**(9L+6P=12)**
Probability Distributions – Expected values of Random Variables – Properties of commonly used discrete and continuous distributions – Binomial, Poisson, and Normal distributions (derivation of pmf/pdf, mean, variance, moments, moment generating functions, problems) – Joint distribution functions of random variable. **Self-Study:** Joint distribution functions of random variable. **Lab:** Binomial, Poisson, and Normal distribution	**CO-4** **BTL-3**
MODULE 5: Sampling (9L+6P=12)	
Principal steps in sample survey – Methods of sampling – SRSWR – SRSWOR – Stratified Sampling – Multistage Sampling – Sampling distribution of sample mean and sample proportion – Mean and standard error – Standard normal, chi-square, Student's t and F distributions- Definitions and important properties (mean and variance). **Self-Study:** Methods of sampling **Lab:**Mean and standard error, chi-square test and t – test	**CO-5** **BTL-3**
TEXT BOOKS	
1.	David C. M A.M.Gun, M.K. Gupta, and B. Dasgupta (2016), *Fundamentals of Statistics*, Volume I, World Press.
REFERENCE BOOKS	
1.	Derek Rowntree (2018), Statistics Without Tears: An Introduction for Non-Mathematicians, Penguin.
E BOOKS	
1.	https://onlinestatbook.com/Online_Statistics_Education.pdf
MOOC	
1.	https://www.coursera.org/specializations/business-statistics-analysis

2.	https://nptel.ac.in/courses/110/107/110107114/

COURSE TITLE	**OBJECT ORIENTED PROGRAMMING USING C++**			**CREDITS**	**4**	
COURSE CODE	**ACA02002**	**COURSE CATEGORY**	**SE**	**L-T-P-S**	**3-0-2-0**	
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**	
ASSESSMENT SCHEME						
CIA					**ESE**	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	**15%**	**10%**	**5%**	**5%**	**25%**	**25%**
Course Description	To develop applications for a range of problems using object-oriented programming techniques.					
Course Objective	1. To study the principles of data abstraction, inheritance and polymorphism. 2. To enable the students to understand the principles of virtual functions and polymorphism. 3. To demonstrate exception handling mechanisms.					
Course Outcome	Upon successful completion of this course, the student should be able to 1. Identify and implement the simple Object-Oriented programming concepts using classes. 2. Develop applications using friend functions, constructors and overloading mechanisms. 3. Build re-usable code using Inheritance and Runtime Polymorphism. 4. Implement exception handling, streaming and file handling mechanisms. 5. Solve real time problem using templates and Standard Template Library (STL).					
Prerequisites: Knowledge of C program						

CO, PO AND PSO MAPPING															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	2	3	3	3	-	-	2		-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-

CO5	-	**2**	**3**	**3**	**3**	-	-	**2**	**2**	-	-	-	**3**	-	-
1: Weakly related, 2: Moderately related and 3: Strongly related															

MODULE 1: Introduction to C++ and OOP	**(6L+6P=12)**
Object-Oriented Paradigm – Features of Object-Oriented Programming – C++ Fundamentals – Variables - Data types – Operators - Arrays - Strings – Default arguments -Inline Functions, Reference Variables and Pointers, Dynamic Memory Management. Introduction to C++ classes –Class Objects- Access Specifiers – Accessing Class Members- Defining Member functions–Arrays of Objects - Objects as Arguments. **LAB:** (i) Search a given number in an array. (ii) Perform various string manipulation functions. (iii) Swap two numbers using call by value and call by reference (Using pointers and reference variables). (iv) Create a class to read and display student/account/employee details. (v) Handle multiple student/account/employee records using array of objects.	**CO-1** **BTL-3**
MODULE 2: Functions and Compile-Time Polymorphism	**(6L+6P=12)**
Working with Friend functions and Friend Classes – Static Data and Member Functions -Constructors - Parameterized Constructors - Constructors with Default Arguments- Copy Constructors- Constructor overloading- Destructors. Polymorphism- Types of Polymorphism – Compile time and Runtime - Function Overloading - Rules of Operator Overloading- Overloading of Unary and Binary Operators as Member function/Friend function. **LAB:** (i) Add two complex numbers using friend function. (ii) Calculate the area of different shapes using various constructor types. (iii) Find average of variables with different types using function overloading. (iv) Overload unary arithmetic operators using member and friend function. (v) Overload binary arithmetic operators using member and friend function.	**CO-2** **BTL-3**
MODULE 3: Inheritance and Run Time Polymorphism	**(6L+6P=12)**
Inheritance- Types of Inheritance – Single, Multilevel, Hierarchical, Multiple, Hybrid, Multipath and Virtual base class - Accessing Overridden Function - Constructors and Destructors in derived classes. Understanding Runtime polymorphism - Memory Management operators, Pointers to objects, Virtual Functions (concept of VTABLE), pure virtual functions, Abstract Class. **LAB**: (i) Manipulate employee/account/student information using various Inheritance types. (ii) Implement constructors and destructors in derived classes. (iii) Read and display book details using pointers to objects. (iv) Implement the concept of virtual and pure virtual functions.	**CO-3** **BTL-3**
MODULE 4: Exception Handling, Streams and Files	**(6L+6P=12)**
C++ streamUnderstanding of working and implementation of Exception Handling. Streams- Unformatted and formatted console I/O operations – Manipulators, User-Defined Manipulators - Implementation of Files, Writing and Reading Objects. Practical C **LAB:** (i) Handle arithmetic and array index out of bounds exceptions. (ii) Read and display the given text using unformatted I/O operations. Create a user-defined manipulator function.	**CO-4** **BTL-3**

(iii) Write details of n number of books to a file, then read and display the same. **(iv)** Handle two files simultaneously to copy/append the content of one file to another	
MODULE 5: Templates and Standard Template Library	**(6L+6P=12)**
Generic Programming with Templates - Function Templates- Function Templates with Multiple Arguments - Overloaded Function Templates - Class Templates - Class Templates with Multiple Arguments. Standard Template Library (STL) – Components of Standard Template Library - Containers, Algorithms and Iterators -Implementation of Sequence and Associative containers for different Algorithms using Iterator. **LAB:** (i) Sort n numbers using function template. (ii) Perform stack operations using class template. (iii) Perform queue operations using containers in STL. (iv) Perform searching and sorting using algorithms in STL.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	K. R. Venugopal and RajkumarBuyya (2017), *Mastering C++*, McGraw Hill Education, 2nd Edition.
2.	Herbert Schildt (2017), *C++: The Complete Reference*, McGraw Hill Education, 4th Edition.
REFERENCE BOOKS	
1.	BjarneStroustrup (2013), *The C++ Programming Language*, Addison-Wesley Professional, 4th Edition.
2.	Nell Dale and Chips Weems (2015), *Programming and Problem Solving with C++*, Jones and Bartlett Learning, 5th Edition.
3	Nicolai M. Josuttis (2012), *The C++ Standard Library: A Tutorial and Reference*, Addison Wesley, 2nd Edition.
E BOOKS	
1.	http://fac.ksu.edu.sa/sites/default/files/ObjectOrientedProgramminginC4thEdition.pd
MOOC	
1.	https://www.edx.org/course/introduction-c-microsoft-dev210x-5
2.	https://www.coursera.org/learn/c-plus-plus-a#syllabu

SEMESTER IV

COURSE TITLE	LINEAR ALGEBRA			CREDITS	4
COURSE CODE	AIM02012	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	15%	10%	5%	5%	25%	25%

Course Description	To make the student understand the basic concepts of functional analysis
Course Objective	To develop understanding in the domain of matrix theory, vector spaces, linear transformations as well as the principles underlying the subject.
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the basic concepts of matrices. 2. Evaluate the types of matrices. 3. Learn the concepts of base and dimension of vector space 4. Apply the Gram-Schmidt process to construct an orthonormal set of vectors in an inner product space. 5. Demonstrate competence with the basic ideas of Matrix theory and linear transformation linear transformation.

Prerequisites: Basics Knowledge of matrices

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Matrices	**(9L+6P=12)**
Introduction – Addition and Scalar Multiplication of Matrices – Product of Matrices –Transpose of a Matrix – Matrix Inverse – Symmetric and Skew - Symmetric Matrices. **Self-Study:** Inverse of Matrices **Lab:** Addition and Scalar Multiplication of Matrices, Transpose of a Matrix, Matrix Inverse	**CO-1** **BTL-3**
MODULE 2: Conjugate and Rank of Matrices	**(9L+6P=12)**
Hermitian and Skew-Hermitian Matrices – Orthogonal and Unitary Matrices – Rank of a Matrix – Characteristic Roots and Characteristic Vectors of a Square Matrix. **Self-Study:** Characteristics Roots **Lab:** Orthogonal, Unitary Matrices, Rank of a Matrix, Characteristic Roots	**CO-2** **BTL-3**
MODULE 3: Vector Spaces	**(9L+6P=12)**
Elementary Basic Concepts – Subspace of a Vector space - Homomorphism – Isomorphism -Internal and External direct sums - Linear span - Linear Independence and Bases. **Self-Study:** Homomorphism **Lab:**Internal and External direct sums	**CO-3** **BTL-3**
MODULE 4: Dual Spaces	**(9L+6P=12)**
Dual Spaces – Annihilator of a subspace - Inner Product Spaces – Norm of a Vector –Orthogonal Vectors - Orthogonal Complement of a subspace – Orthonormal set. **Self-Study:**Orthogonal set **Lab:**Orthogonal Complement	**CO-4** **BTL-3**
MODULE 5: Linear Transformations	**(9L+6P=12)**
Algebra of Linear Transformations – Regular, Singular Transformations – Range of T – Rank of T - Characteristic Roots – Characteristic Vectors – Matrices. **Self-Study:**Orthogonal set **Lab:**Characteristic Roots and Characteristic Vectors	**CO-5** **BTL-3**

TEXT BOOKS	
1.	R.Balakrishnan and M. Ramabadran (2005), *Modern Algebra*, Vikas Publishing House Pvt. Ltd, New Delhi.
2.	I.N. Herstein (2006), *Topics in Algebra*, John Wiley and Sons, New York.
REFERENCE BOOKS	
1.	Surjeet Singh and QaziZameeruddin (2004), *Modern Algebra*, Vikas Publishing house Hill, New Delhi.
2.	A.R.Vasishtha (2015), *Modern Algebra*, Krishna PrakashanMandir, Meerut.
E BOOKS	
1.	https://bookauthority.org/books/best-abstract-algebra-ebooks
MOOC	
1.	https://nptel.ac.in/courses/111/106/111106135/
2.	https://nptel.ac.in/courses/111/101/111101115/
3.	https://nptel.ac.in/courses/111/108/111108066/
4.	https://nptel.ac.in/courses/115/105/115105097/

COURSE TITLE	REAL ANALYSIS			CREDITS	4
COURSE CODE	AIM02013	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course covers the fundamentals of mathematical analysis.
Course Objective	Aimed at exposing there a number systems that underpin the development of real analysis and in understanding various physical phenomena.
Course Outcome	Upon completion of this course, the students will be able to 1. Evaluate real and complex number systems. 2. Derive set theory. 3. Obtain elements of points set topology. 4. Demonstrate covering and compactness. 5. Apply skills in finding the limits and continuity in metric spaces.

Prerequisites: Basics of real and complex numbers

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: The Real and Complex Number Systems	**(9L+3T=12)**
Introduction -the field axioms, the order axioms –integers –the unique Factorization theorem for integers –Rational numbers –Irrational numbers –Upper bounds, maximum Elements, least upper bound –the completeness axiom –some properties of the supremum –properties of the integers deduced from the completeness axiom- The Archimedean property of the real number system –Rational numbers with finite decimal representation of real numbers –absolute values and the triangle inequality – the Cauchy-Schwarz inequality –plus and minus infinity and the extended real number system. **Self-Study:** –Rational numbers –Irrational numbers	**CO-1 BTL-3**

MODULE 2: Basic Notions of a Set Theory	**(9L+3T=12)**
Notations –ordered pairs –Cartesian product of two sets – Relations and functions – further terminology concerning functions –one–one functions and inverse –composite functions –sequences –similar sets-finite and infinite sets –countable and uncountable sets –uncountability of the real number system –set algebra –countable collection of countable sets. **Self-Study:** Composite functions	**CO-2** **BTL-3**
MODULE 3: Elements of Point Set Topology	**(9L+3T=12)**
Elements of point set topology: Euclidean space R^n–open balls and open sets in R^n. The structure of open sets in R^n–closed sets and adherent points–The Bolzano – Weierstrass theorem –the Cantor intersection Theorem.	**CO-3** **BTL-3**
MODULE 4: Covering and Compactness	**(9L+3T=12)**
Covering –Lindal of covering theorem –the Heine Borel covering theorem – Compactness in R^n–Metric Spaces –point set topology in metric spaces –compact subsets of a metric space –Boundary of a set. **Self-Study:** Boundary of a set.	**CO-4** **BTL-3**
MODULE 5: Limits and Continuity in Metric Spaces	**(9L+3T=12)**
Convergent sequences in a metric space –Cauchy sequences –Completeness sequences –complete metric Spaces. Limit of a function –Continuous functions –continuity of composite functions. Continuous complex valued and vector valued functions.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	T.M.Apostol (2011), *Mathematical Analysis*, Narosa Publishing Company,2nd Edition, Chennai.
REFERENCE BOOKS	
1	R.R. Goldberg (2010), *Methods of Real Analysis*, John Wiley, New York.
2.	G.F.Simmons (2017) *Introduction to Topology and Modern Analysis*, McGraw – Hill, New York.
3	J.N.Sharma and A.R.Vasistha (2019), *Real Analysis*, Krishna PrakashanMedia Ltd. New Delhi.
E BOOKS	
1.	http://www.uop.edu.pk/ocontents/G.%20Bartle%20,%20R.%20Sherbert,%20%E2%80%9CIntroduction%20to%20Real%20Analysis.pdf
2.	http://bayanbox.ir/view/6039605503262807876/Problems-In-Real-Analysis-A-Workbook-With-Solutions-Aliprantis.pdf
MOOC	
1.	https://nptel.ac.in/courses/111/105/111105069/#
2	https://nptel.ac.in/courses/111/106/111106053/
3.	https://www.digimat.in/nptel/courses/video/111105098/
4.	https://nptel.ac.in/courses/111/101/111101134/

COURSE TITLE	COMPLEX ANALYSIS			CREDITS	4
COURSE CODE	AIM02014	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course covers the fundamentals of complex analysis.
Course Objective	To familiarize the students with fundamental theorems, singularity, residues in complex functions, integrations of complex functions, meromorphic functions and their applications.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the integral value using Cauchy's theorem. 2. Compute Taylor's series and Laurent's series. 3. Apply residue theorem to compute integrals. 4. Find the calculus of residues. 5. Determine meromorphic functions.

Prerequisites: Knowledge in Calculus and its types

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Integral Theorems	**(9L+3T=12)**
Results based on Cauchy's theorem (I)-Zeros-Cauchy's Inequality – Liouville's theorem –Fundamental theorem of algebra –Maximum modulus theorem –Gauss mean value theorem –Gauss mean value theorem for a harmonic function on a circle. **Self-Study:** Gauss mean value theorem	**CO-1** **BTL-3**
MODULE 2: Taylor's Series & Laurent's Series	**(9L+3T=12)**
Results based on Cauchy's theorem (II)-Taylor's series –Laurent's series. **Self-Study:** Taylor's series	**CO-2** **BTL-3**

MODULE 3: Singularities and Residues	**(9L+3T=12)**
Isolated singularities (Removable Singularity, pole and essential singularity) – Residues –Residue theorem.	**CO-3** **BTL-3**
MODULE 4: Real Definite Integrals	**(9L+3T=12)**
Evaluation using the calculus of residues – Integration on the unit circle – Integral with -∞ and +∞ as lower and upper limits with the following integrals: i) P(x) /Q(x) where the degree of Q(x) exceeds that of P(x) at least 2. ii) (sin ax).f(x), (cos ax).f(x), where a>0 and f(z) →0 as z→∞ and f(z) does not have a pole on the real axis. iii) f(x) where f(z) has a finite number of poles on the real axis. **Self-Study:** Definite Integrals	**CO-4** **BTL-3**
MODULE 5: Meromorphic Functions	**(9L+3T=12)**
Theorem on number of zeros minus number of poles –Principle of argument-Rouche's theorem– Theorem that a function which is meromorphic in the extended plane is a rational function.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	David C. P.Durai Pandian and Laxmi Durai Pandian (2016), *Complex analysis*, Emerald Publishers.
REFERENCE BOOKS	
1.	Churchill (2016), *Complex Variable and Applications*, Tata Mc-Graw Hill Publishing Company Ltd, New Delhi.
2.	Swaminarayan (2008), *Theory of functions of Complex Variable*, S.Chand and Company. New Delhi.
3.	Tyagi B. S. (2009), *Functions of Complex Variable*, PragatiPrakasham Publishing Company Ltd, Meerut.
E BOOKS	
1.	Mathematical Analysis, Second Edition (ru.ac.bd)
MOOC	
1.	https://nptel.ac.in/courses/111/103/111103070/
2	https://nptel.ac.in/courses/111/106/111106094/
3	https://nptel.ac.in/courses/122/103/122103012/

COURSE TITLE	ADVANCED STATISTICS			CREDITS	4
COURSE CODE	AIM02015	COURSE CATEGORY	AE	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	1. Identify areas where ethical issues may arise in statistics. 2. Demonstrate preparedness to provide guidance in statistical design and analysis.
Course Objective	1. Understand basic theoretical and applied principles of statistics needed to enter the job force. 2. Communicate key statistical concepts to non-statisticians. 3. Gain proficiency in using statistical software for data analysis
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the basics of statistical inference 2. Constructed index numbers 3. Analyze the forecasting 4. Apply the basics of non-parametric tests in real time problems design sample frameworks and carry out surveys

Prerequisites: Knowledge in Calculus and its types

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE1: Statistical Inference	**(9L+3T=12)**
Point Estimation – Properties of a good estimator – Basic principles of Ordinary Least Square, Maximum Likelihood Method, Method of Moments – Interval estimation – Confidence level and Confidence interval – Testing of hypothesis – Null and Alternative hypotheses – Type I and Type II errors – Power of a test – p-Value **Self-Study:** Testing of Hypotheses	**CO-1** **BTL-3**

MODULE 2: Index Numbers	**(9L+3T=12)**
Statistics in Practice –Economic Statistics in India – Role of Central Statistics Office – Price Indices – Consumer Price Index – Price Indices in India – Deflating a Series – Selection of Items – Selection of a Base Period – Quality Changes – Quantity Indexes **Self-Study:** Price Indices	**CO-2** **BTL-3**
MODULE 3: Forecasting	**(9L+3T=12)**
Components of a Time Series: Trend Component – Cyclical Component – Seasonal Component – Irregular Component – Smoothing Methods: Moving Averages – Weighted Moving Averages – Exponential Smoothing Averages – Trend Projection – Trend and Seasonal Components: Multiplicative Model – Calculating Seasonal Indexes – Deseasonalising the Time Series – Using Depersonalized Time Series to Identify Trend – Seasonal Adjustments – Models Based on Monthly Data – Cyclical Component.	**CO-3** **BTL-3**
MODULE 4: Non-Parametric Methods	**(9L+3T=12)**
Sign Test: Small-Sample Case – Large-Sample Case – Hypothesis Test About a Median – Mann Whitney-Wilcoxon Test – Kruskal-Wallis Test – Rank Correlation.	**CO-4** **BTL-3**
MODULE 5: Sample Survey	**(9L+3T=12)**
Terminology used in Sample Surveys – Types of Surveys and Sampling Methods – Survey Errors: Non-sampling Error – Sampling Error – Simple Random Sampling: Population Mean – Population Total – Population Proportion – Determine Sample Size – Stratified Random Sampling: Population Mean – Population Total – Population Proportion – Determining Sample Size – Cluster Sampling: Population Mean – Population Total – Population Proportion – Determining Sample Size – Systematic Sampling. **Self-Study:** Sample Survey	**CO-5** **BTL-3**

TEXT BOOKS	
1.	David C. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, and James J. Cochran (2019), *Statistics for Business and Economics*, Cengage, 13th Edition.
2.	A.M. Gun, M.K. Gupta and B. Dasgupta (2016), *Fundamentals of Statistics*, Volume I, World Press.
3.	A.M. Gun A.M. Gun, M.K. Gupta, and B. Dasgupta (2016), *Fundamentals of Statistics*, Volume II, World Press.
REFERENCE BOOKS	
1	Lind, Marchal, and Wathen (2017), *Basic Statistics for Business and Economics*, 7th Edition, McGraw Hill Education.
E BOOKS	
1.	https://www.coursera.org/specializations/business-statistics-analysis
2.	https://www.coursera.org/specializations/social-science
3.	https://nptel.ac.in/courses/110/107/110107114/
MOOC	
1.	https://www.coursera.org/courses?query=statistics
2	https://www.edx.org/learn/statistics
3	https://www.udemy.com/topic/statistics/

COURSE TITLE	BASICS OF DATA SCIENCE			CREDITS	4
COURSE CODE	ACA02003	COURSE CATEGORY	HS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Fundamental coursework on the standards and practices for collecting, organizing, managing, exploring, and using data.
Course Objective	1. To use applied statistical knowledge to analyze data, derive data summaries, build predictive models, and make scientific inference. 2. To interpret modeling results and communicate their findings to both a general and a technical audience.
Course Outcome	Upon completion of this course, the students will be able to 1. Develop relevant programming abilities 2. Demonstrate skill in data management. 3. Execute statistical analyses with professional statistical software 4. Develop the ability to build and assess data-based models. 5. Apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively

Prerequisites: Basics of forces

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Introduction to Data Science	(9L+3T=12)
Introduction to Data Science – Evolution of Data Science – Data Science Roles – Stages in a Data Science Project – Applications of Data Science in various fields – Data Security Issues	CO-1 BTL-3

MODULE 2: Data Collection and Data Pre-Processing	**(9L+3T=12)**
Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization	**CO-2** **BTL-3**
MODULE 3: Exploratory Data Analytics	**(9L+3T=12)**
Descriptive Statistics – Mean, Standard Deviation, Skewness and Kurtosis – Box Plots – Pivot Table – Heat Map – Correlation Statistics – ANOVA.	**CO-3** **BTL-3**
MODULE 4: Model Development	**(9L+3T=12)**
Simple and Multiple Regression – Model Evaluation using Visualization – Residual Plot – Distribution Plot – Polynomial Regression and Pipelines – Measures for In -sample Evaluation – Prediction and Decision Making.	**CO-4** **BTL-3**
MODULE 5: Model Evaluation	**(9L+3T=12)**
Generalization Error – Out-of-Sample Evaluation Metrics – Cross Validation – Overfitting – Under Fitting and Model Selection – Prediction by using Ridge Regression – Testing Multiple Parameters by using Grid Search.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	David Dietrich, Barry Heller and Beibei Yang (2013), *Data Science and Big data Analytics*: *Discovering, Analyzing, Visualizing and Presenting Data*, Indianapolis, IN: Wiley
2.	JojoMoolayil (2016), *Smarter Decisions: The Intersection of IoT and Data Science*, PACKT.
REFERENCE BOOKS	
1.	Cathy O'Neil and Rachel Schutt (2013), *Doing Data Science*, O'Reilly Media.
2.	Pethuru Raj and Ganesh Chandra Deka (2014), *Handbook of Research on Cloud Infrastructures for Big Data Analytics*, IGI Global, United States.
E BOOKS	
1.	(PDF) The Field Guide to Data Science (researchgate.net)
MOOC	
1.	Introduction to Data Science | Coursera
2.	A Crash Course in Data Science | Coursera

SEMESTER V

COURSE TITLE	DISCRETE MATHEMATICS			CREDITS	4
COURSE CODE	AIM02016	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of Insurance
Course Objective	Prepare students to develop mathematical foundations to understand, create mathematical arguments and focuses on the Formal languages, Automata, Lattices, Boolean Algebra and Graphs
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the mathematical logical operations. 2. Demonstrate an understanding of relations and functions. 3. Determine formal languages and automata. 4. Analyze about partially ordered sets, Boolean algebra, lattices and their types. 5. Acquire the knowledge of basis in graphs

Prerequisites: Knowledge of functions and relations

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE1: Mathematical logic (9L+3T=12)

Connectives, well-formed formulas, Tautology, Equivalence of formulas, Tautological-implications, Duality law, Normal forms, Predicates, Variables, Quantifiers, Free and bound Variables. Theory of inference for predicate calculus. **Self-Study:** Tautology.	**CO-1** **BTL-3**

MODULE 2: Relations and Functions	**(9L+3T=12)**
Composition of relations, Composition of functions, Inverse functions, one-to-one, onto, one-to-one& onto functions, Hashing functions, Permutation function, Growth of functions. Algebra -structures: Semi groups, Free semi groups, Monoids. **Self-Study:** Functions.	**CO-2** **BTL-3**
MODULE 3: Formal Languages and Automata	**(9L+3T=12)**
Regular expressions, Types of grammar, Regular grammar and finite state automata, Context free and sensitive grammars. **Self-Study:** Formal Languages.	**CO-3** **BTL-3**
MODULE 4: Lattices and Boolean Algebra	**(9L+3T=12)**
Partial ordering, Poset, Lattices, Boolean algebra, Boolean functions, Theorems, Minimization of Boolean functions (Karnaugh Method only). **Self-Study:** Boolean Algebra	**CO-4** **BTL-3**
MODULE 5: Graphs	**(9L+3T=12)**
Directed and undirected graphs, Paths, Reachability, Connectedness, Matrix representation, -Euler paths, Hamiltonian paths, Trees, Binary trees - theorems, and applications.	**CO-5** **BTL-3**
TEXT BOOKS	
1.	J. P Tremblay and R.P Manohar (2000), *Discrete Mathematical Structures with Applications to Computer Science*, Mc. Graw Hill.
REFERENCE BOOKS	
1.	Oscar Levin (2016), *Discrete Mathematics*, Northern Colorado.
E BOOKS	
1.	mth202.pdf (iitk.ac.in)
MOOC	
1.	Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.] https://nptel.ac.in/courses/106/106/106106094/
2.	https://nptel.ac.in/courses/111/107/111107058/

COURSE TITLE	THREE-DIMENSIONAL ANALYTICAL SOLID GEOMETRY			CREDITS	4
COURSE CODE	AIM02017	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To enable students to deepen the knowledge in various concepts of Analytical Solid Geometry.
Course Objective	1. To understand the basic concepts of three-dimensional object like Plane 2. To understand the concepts of three-dimensional object like Straight lines 3. To understand the concepts of three-dimensional object like Sphere 4. To understand concepts of three-dimensional object like Cone 5. To perceive the concept of three-dimensional object like Cylinder
Course Outcome	Upon completion of this course, the students will be able to 1. Obtain equation of Plane 2. Determine the shortest distance between straight lines 3. Find equation of Sphere 4. Derive a condition for the general equation of the second degree to represent a cone 5. Classifying the right circular cylinder and enveloping cylinder

Prerequisites: Basics of Analytical Solid Geometry

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PLANE	**(9L+3T=12)**
General equation of a plane – Equation of a plane in the normal form – Angle between planes – Plane through three given points – Equation of a plane through the line of intersection of two planes. **Self-Study:** Angle between of a plane.	**CO-1** **BTL-3**

MODULE 2: STRAIGHT LINE	**(9L+3T=12)**
Symmetrical form of a straight line – Image of a point with respect to a plane – Image of a line with respect to a plane – Length and equation of the shortest distance between two skew lines - Coplanar lines. **Self-Study:** Coplanar lines.	**CO-2** **BTL-3**
MODULE 3: SPHERE	**(9L+3T=12)**
Equation of the sphere – Length of the tangent – Tangent plane – Section of a sphere by a plane – Orthogonal spheres – Equation of a sphere through a given circle.	**CO-3** **BTL-3**
MODULE 4: CONE	**(9L+3T=12)**
Equation of a cone with a given vertex and a given guiding curve - Equation of a cone with its vertex at the origin - Condition for the general equation of the second degree to represent a cone - Right circular cone – Enveloping cone - Tangency of a plane to a cone. **Self-Study:** Right circular cone.	**CO-4** **BTL-3**
MODULE5: CYLINDER	**(9L+3T=12)**
Equation of a cylinder with a given generator and a given guiding curve - Right circular cylinder - Enveloping cylinder – Enveloping cylinder as a limiting form of an enveloping cone.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	T. K. Manicka Vachagom Pillay (2011), *Analytical Geometry (Three Dimensions)*, S. Viswanathan Printers and Publishers Pvt. Ltd. Chennai.
REFERENCE BOOKS	
1.	P. R. Vittal (2014), *Coordinate Geometry.* Margham Publishers, Chennai, Reprint
2.	P. Duraipandian and Lakshmi Duraipandian (2011), *Analytical Geometry – 3D*, Emerald Publishers, Chennai.
EBOOKS	
1.	https://www.amazon.in/Textbook-Analytical-Geometry-Three-Dimensions/dp/812240300X
2.	https://ebook.mediadata.website/a-textbook-of-analytical-geometry-of-three-dimensions-2nd.pdf
MOOC	
1.	https://www.doubtnut.com/iit-solutions/chapter-three-dimensional-geometry--topic-plane-1
2.	https://edurev.in/studytube/Introduction-to-Three-Dimensional-Geometry--Class-/e4532cc8-3146-40cd-8e56-d79c03d3c7f7_v

COURSE TITLE	NUMERICAL ANALYSIS			CREDITS	4
COURSE CODE	AIM02018	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of numerical analysis
Course Objective	1. To find different numerical techniques 2. To relate algebraic and differential equations 3. To recall skills in solving problem using numerical techniques 4. To explain the forward difference problems 5. To find predictor corrector problems.
Course Outcome	Upon completion of this course, the students will be able to 1. Compute the solutions of algebraic and transcendental equations numerically 2. Determine the solutions of system of equations using direct and indirect methods 3. Apply the linear interpolation methods for equal and unequal intervals. 4. Evaluate differentiation and integration numerically 5. Compute the solutions of ordinary differential equations numerically numerical solution of ordinary differential equations.

Prerequisites: Basics of Mathematics

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO NUMERICAL ANALYSIS	**(9L+3T=12)**
Introduction to numerical analysis – The solution of algebraic and transcendental equations – Bisection method – Iteration method – Regula-False method- Newton- Raphson method. **Self-Study:** Transcendental equations.	**CO-1** **BTL-3**
MODULE 2: LINEAR SYSTEM OF EQUATIONS	**(9L+3T=12)**
Linear System of Equations– Gauss elimination method – Gauss-Jordan method– Iterative methods – Jacobi method – Gauss-Seidel method. **Self-Study:** Linear system of equations.	**CO-2** **BTL-3**
MODULE 3: FINITE DIFFERENCES	**(9L+3T=12)**
Finite differences –Interpolation - Introduction – Gregory-Newton interpolation formulae – Interpolation with unequal intervals – Lagrange's interpolation formula. **Self-Study:** Interpolation	**CO-3** **BTL-3**
MODULE 4: NUMERICAL DIFFERENTIATION AND INTEGRATION	**(9L+3T=12)**
Numerical differentiation and integration – Newton's formulae to compute the derivative – Numerical integration – A general quadrature formula – Trapezoidal rule -Simpson's one third rule – Simpson's three-eighth rule.	**CO-4** **BTL-3**
MODULE 5: NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION	**(9L+3T=12)**
Numerical solution of ordinary differential equation – Taylor series method –Euler's method – Runge-Kutta methods – Adam's Moulton Method – Milne's Predictor corrector method. **Self-Study:** Ordinary Differential Equations.	**CO-5** **BTL-3**

TEXT BOOKS

1.	P. Kandasamy, K.Thilagavathy, K. Gunavathy (2003), *Numerical Methods*, S. Chand & company limited, 2nd Revised Edition New Delhi.
2.	S.S Sastry (2012), *Introductory Methods of Numerical Analysis*, PHI Learning Private Limited, New Delhi.

SEMESTER VI

COURSE TITLE	OPERATIONS RESEARCH			CREDITS	4
COURSE CODE	AIM02019	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to the basics of descriptive statistics.
Course Objective	To familiarize students with the basic concepts, models and techniques for effective decision making, model formulation and applications
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic concepts and application of operations research in various fields. 2. Obtain the solution of LPP by simplex method. 3. Find the solution of LPP using Big M Two phase method. 4. Determine an understanding of duality in LPP. 5. Calculate the optimum solution of transportation problems.

Prerequisites: Knowledge of algebra

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Basics of Operations Research & Formulation Of L.P.P	**(9L+3T=12)**
Basics of O.R – Definition of O.R – Characteristics of O.R – Scientific methods in O.R –Necessary of O.R in Industry – O.R and Decision Making – Scope of O.R in Modern Management–Uses and limitations of O.R. Linear Programming Problem – Formulation of L.P.P. **Self-Study:** Basics of O.R	**CO-1** **BTL-3**
MODULE 2: Linear Programming Problem -Simplex method	**(9L+3T=12)**
Graphical solutions of L.P.P – Problems. Simplex Method – Problems. **Self-Study:** Linear Programming Problem	**CO-2** **BTL-3**
MODULE 3: Big-M & Two-Phase Method	**(9L+3T=12)**
Charne's Penality Method (or) Big – M Method – Two Phase Simplex method – Problems.	**CO-3** **BTL-3**
MODULE 4: Duality In L.P.P	**(9L+3T=12)**
Duality in L.P.P – Concept of duality – Duality and Simplex Method – Problems.	**CO-4** **BTL-3**
MODULE 5: Transportation Model	**(9L+3T=12)**
The transportation Problems – Basic feasible solution by L.C.M – NWC-VAM- optimum solutions – unbalanced Transportation problems. **Self-Study:** Optimum solutions.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Kantiswarup, P. K. Gupta and Man Mohan (2003), *Operations Research*, S. Chand and Sons Education Publications, New Delhi.
2.	S. DharaniVenkata Krishnan. (2014), *Operations Research Principles and Problems*, Keerthi publishing house PVT Ltd. Chennai.
REFERENCE BOOKS	
1.	Prem Kumar Gupta and D. S. Hira (2014) *Operations Research*, S. Chand & Company Ltd. New Delhi.
E BOOKS	
1.	https://nptel.ac.in
2.	http://ebooks.lpude.in.operation research
MOOC	
1.	https://nptel.ac.in/courses/111/102/111102012/
2.	https://nptel.ac.in/courses/111/104/111104027/

COURSE TITLE	NUMBER THEORY			CREDITS	4
COURSE CODE	AIM02020	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To study of the integers, their additive and multiplicative structures and their properties that set them apart from other rings.
Course Objective	To enhance the knowledge in the basic concepts of number theory, fundamental definitions, theorems
Course Outcome	Upon completion of this course, the students will be able to 1. Acquire the knowledge of basis in number theory. 2. Analyze and apply the concepts of divisibility and primes 3. Describe the fundamental theorem of Arithmetic. 4. Demonstrate an understanding on the theory of congruence. 5. Prove fermatas theorem.

Prerequisites: Knowledge of elements number theory

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Early Number Theory	(9L+3T=12)
Peano's Axiom - Mathematical Induction - The Binomial Theorem - Early Number Theory. **Self-Study:** Introduction to Number Theory.	**CO-1** **BTL-3**

MODULE 2: Divisibility Theory in Integers	**(9L+3T=12)**
Divisibility Theory in Integers - The Division Algorithm - The G.C.D. - Euclidean Algorithm - Extended Euclidean Algorithm - The Diophantine Equation ax + by = c. **Self-Study:** The Division Algorithm.	**CO-2** **BTL-3**
MODULE 3: Primes and their Distributions	**(9L+3T=12)**
Primes and their Distributions - The fundamental Theorem of Arithmetic - The sieve of Eratosthenes - The Gull Conjecture. **Self-Study:** Primes.	**CO-3** **BTL-3**
MODULE 4: The Theory of Congruence	**(9L+3T=12)**
The Theory of Congruence - Basic Properties of Congruence - Special Divisibility test – Linear Congruence- Chinese Reminder Theorem-Prime modulus- Power residues.	**CO-4** **BTL-3**
MODULE 5: Fermat's Theorem	**(9L+3T=12)**
Fermat's Theorem - Fermat's factorization method - The Little theorem - Wilson's theorem.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	David M. Burton (2000), *Elementary Number theory* - Brown Publishers, Dubuque, Lawa.
2.	Neville Robbins,(2007), *Beginning Number Theory*, Narosa Publication House Pvt. Ltd, 2nd Edition, Delhi.
REFERENCE BOOKS	
1.	Ivan Nivan and H (2001), *An Introduction to theory of Numbers*, Zuckerman, Wiley.
2.	S.Kumaravelu and SusheelaKumaravelu(2002), *Elements of Number Theory* , Raja Sankar offset Printers.
E BOOKS	
1.	https://www.e-booksdirectory.com/listing.php?category=138
2.	https://www.kobo.com/us/en/ebooks/number-theory
MOOC	
1.	https://nptel.ac.in/courses/111/103/111103020/
2.	https://nptel.ac.in/courses/111/101/111101137/

COURSE TITLE	ADVANCED NUMERICAL ANALYSIS			CREDITS	4
COURSE CODE	AIM02021	COURSE CATEGORY	AE	L-T-P-S	3-0-2-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME						
CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	15%	10%	5%	5%	25%	25%

Course Description	To make the student understand the basic concepts of Advanced Numerical Analysis
Course Objective	1. To expose the students to use numerical differentiation in solving numerical problems. 2. To expose the students to use numerical integration in solving numerical problems. 3. To enable the students to apply ordinary differential equations in solving numerical problems. 4. To empower the students to apply system of linear equations in solving numerical problems. 5. To enable the students to apply the methods in a computer and social environment.
Course Outcome	Upon completion of this course, the students will be able to 1. Compute the linear system of equations using direct and indirect method 2. Interpolate the solutions, differentiate and integrate numerically 3. Evaluate the polynomial approximations 4. Compute the ordinary differential equations numerically 5. Determine the solution of partial differential equations numerically
Prerequisites: Basics of numerical methods	

CO, PO AND PSO MAPPING															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3
1: Weakly related, 2: Moderately related and 3: Strongly related															

MODULE 1: SYSTEMS OF LINEAR EQUATIONS AND ALGEBRAIC EIGENVALUE PROBLEMS	**(9L+3T=12)**
Direct Method: Gauss elimination method - Error Analysis - Iterative methods: Gauss Jacobi and Gauss-Seidel - Convergence considerations - Eigenvalue Problem: Power method. **Self-Study:** Error Analysis	**CO-1** **BTL-3**
MODULE 2: INTERPOLATION, DIFFERENTIATION AND INTEGRATION	**(9L+3T=12)**
Interpolation: Lagrange's and Newton's interpolation - Errors in interpolation - Optimal points for interpolation - Numerical differentiation by finite differences - Numerical Integration: Trapezoidal, Simpson's and Gaussian quadrature - Error in quadrature. **Self-Study:** Error in quadrature.	**CO-2** **BTL-3**
MODULE 3: APPROXIMATION OF FUNCTIONS	**(9L+3T=12)**
Norms of functions - Best Approximations: Least squares polynomial approximation - Approximation with Chebyshev polynomials - Piecewise Linear & Cubic Spline approximation.	**CO-3** **BTL-3**
MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS	**(9L+3T=12)**
Single-Step methods: Euler's method - Taylor series method - Runge-Kutta method of fourth order - Multistep methods: Adams-Bashforth and Milne's methods - Stability considerations - Linear Two-point BVPs: Finite Difference method.	**CO-4** **BTL-3**
MODULE 5: PARTIAL DIFFERENTIAL EQUATIONS	**(9L+3T=12)**
Elliptic equations: Five-point finite difference formula in rectangular region - Truncation error; One-dimensional Parabolic equation: Explicit and Crank-Nicholson schemes; Stability of the above schemes - One-dimensional Hyperbolic equation: Explicit scheme. **Self-Study:** Stability of partial differential equations.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Jain, M. K. Iyengar, S. R. K and Jain, R. K. (2019). *Numerical Methods for Scientific and Engineering Computation* (Multi Colour Edition), New Age International Private Limited, New Delhi, Fifth Edition.
2.	Gupta, D. Gupta, S. (2017).*Numerical Methods,* McGraw Hill Education**.**
REFERENCE BOOKS	
1.	Pundir, S. K. (2017). *Numerical Methods in Science and Engineering*, CBS.
2.	Froberg, C. E. (2016). *Introduction to Numerical Analysis,* Addison-Wesley Publishing Company, Second Edition.
E BOOKS	
1.	Nita-Shah - Numerical-Methods-Programming- eBook /dp/B01FHAZOUI
MOOC	
1.	https://www.mooc-list.com/tags/numerical-methods

SEMESTER VII

COURSE TITLE	REAL INTEGRAL USING COMPLEX ANALYSIS			CREDITS	4
COURSE CODE	AIM02022	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to the basics of complex Analysis.
Course Objective	1. To introduce analytic functions. 2. To introduce the basic analogous of complex line integral,Cauchy theorem. 3. To get introduced to integration via residues. 4. To introduce and emphasize on Riemann mapping theorem and Hadamard's theorem. 5. To introduce the fundamental concepts of entire and meromorphic functions
Course Outcome	Upon completion of this course, the students will be able to 1. Construct the analytic functions 2. Evaluate the contour integrals for complex valued functions 3. Expand the function using Taylor and Laurent series 4. Evaluate the definite integrals using residue theorem 5. Derive mapping theorems

Prerequisites: Basics of analytic functions

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE1: ANALYTIC FUNCTIONS	**(9L+3T=12)**
Functions of Complex variables- mappings- limits- continuity- derivatives- C-R equations- Analytic functions.	**CO-1 BTL-4**

MODULE 2: COMPLEX INTEGRATION	**(9L+3T=12)**
Complex valued functions- contours- contour integrals- Cauchy- Goursat theorem, Cauchy integral formula- Morea's theorem- Liouville's theorem- fundamental theorem of algebra. **Self-Study:** Contours	**CO-2** **BTL-3**
MODULE 3: POWER SERIES	**(9L+3T=12)**
Convergence of sequences and series- power series and analytic functions- Taylor series- Laurent's series- absolute and uniform convergence- integration and differentiation of power series- uniqueness of series representation- zeros of an analytic function classification of singularities- behavior of analytic function at an essential singular point. **Self-Study**: Zeros of an analytic function	**CO-3** **BTL-3**
MODULE 4: RESIDUES AND POLES	**(9L+3T=12)**
Residues, Cauchy – Residue theorem, residues at poles- evaluation of improper integrals- evaluation of definite integrals- the argument principle- Roche's theorem- Schwarz lemma- maximum modules principle.	**CO-4** **BTL-3**
MODULE5: SPACES OF ANALYTIC FUNCTIONS	**(9L+3T=12)**
Spaces of analytic functions-spaces of meromorphic functions, Riemann mapping theorem-Weiresstrass factorization theorem-Schwarz reflection principle-Hadamard's product representation-Jensen's theorem- Phragment Lindel of theorem- Hadamard's three circle theorem	**CO-5** **BTL-3**

TEXT BOOKS	
1.	R. V. Churchill and J. W. Brown (2017). *Complex Variables and Applications,* McGraw Hill Series, 8th edition.
2.	S. Kumaresan (2021). *A Pathway to Complex Analysis,* Techno World Publication.
REFERENCE BOOKS	
1.	L. V. Alfors (2017). *Complex Analysis,* McGraw Hill, Third Edition.
2.	Ian Stewart and David Tall. (2018). *Complex Analysis*, Cambridge University Press, Second edition.
3.	Sobhakar, G. (2020).*Elements of Complex Analysis*, Academic Publishers, 3rd Edition**.**
E BOOKS	
1.	https://www.springer.com/gp/book/9781441972873
2.	https://www.oulu.fi/sites/default/files/151/complex_book.pdf
MOOC	
1.	https://www.coursera.org/learn/complex-analysis
2.	https://nptel.ac.in/courses/111/103/111103070/

COURSE TITLE	ADVANCED OPERATIONS RESEARCH			CREDITS	4
COURSE CODE	AIM02023	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of Operation research and its application
Course Objective	1. To provide the students mathematical techniques to model and analyze decision problems, with effective application to real life in optimization of objectives. 2. To impart knowledge in concepts and tools of Operations Research 3. To understand mathematical models used in Operations Research 4. To apply these techniques constructively to make effective business decisions
Course Outcome	Upon completion of this course, the students will be able to 1. Identify and develop operational research models using integer linear programming. 2. Compute the solution of dynamic programming in optimization problems. 3. Determine the inventory concepts in the various probabilistic models. 4. Apply various models in linear and nonlinear programming. 5. Analyze the decision-making processes in project management.

Prerequisites: Basics of Linear Programming

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	1	2	3	3	3	-	-	2	2	-	-	-	3	3	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTEGER LINEAR PROGRAMMING AND GAME THEORY (9L+3T=12)	
Pure and mixed integer programming problems and applications – Cutting plane algorithm – The branch and bound algorithm – Maximin –Minimax principle –saddle point and value of the game –Arithmetic method-Graphical method for 2xn or mx2 games. **Self-Study:** Saddle point.	**CO-1** **BTL-3**
MODULE 2: DYNAMIC PROGRAMMING AND REPLACEMENT MODELS (9L+3T=12)	
Dynamic Programming- Characteristics of dynamic programming – models in dynamic programming – Capital budgeting problem – reliability problem – shortest route problem - suboptimal problem. Replacement – individual replacement-group replacement. **Self-Study:** Characteristics of dynamic programming.	**CO-2** **BTL-3**
MODULE 3: INVENTORY MODELS (9L+3T=12)	
Inventory models-Purchasing model –manufacturing model- with and without shortage -– probabilistic models-– A continuous review single period models – multiple period models-ABC analysis of inventory.	**CO-3** **BTL-3**
MODULE 4: ADVANCED TOPICS IN LINEAR PROGRAMMING, NON LINEAR PROGRAMMING (9L+3T=12)	
Goal programming – Stochastic programming – Lagrangian multiplier method- Quadratic Programming by Wolfe's Method.	**CO-4** **BTL-3**
MODULE5: PROJECT MANAGEMENT AND DECISION THEORY (9L+3T=12)	
Introduction to PERT and CPM- Terms used in network analysis- Concept of float- PERT- Project cost analysis: Crashing of network- Decision making under certainty-under risk-under uncertainty-under conflict. **Self-Study:** Terms used in network analysis.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Hamdy A. Taha, (2016). *Operations Research*, Tenth Edition, Pearson Education Asia Editions, 8th Edition.
3.	Taha, H.A. (2017). *Operations Research: An Introduction, Prentice Hall of India*, 10th Edition.
REFERENCE BOOKS	
1.	Srinivasan, G. (2017).*Operations Research: Principles and Applications,* PHI Learning.
2.	Richard, B and Govindasami, N. (2017).Schaum's Outline of Operations Research**,** McGraw Hill Education.
E- BOOKS	
1.	https://www.eolss.net/ebooklib/bookinfo/optimization-operations-research.aspx
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc19_ma29/preview
2.	https://digitaldefynd.com/best-operational-research-courses/

COURSE TITLE	CLASSICAL MECHANICS			CREDITS	4
COURSE CODE	AIM02024	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of AI and its application
Course Objective	1. Relative motion. Inertial and non-inertial reference frames. 2. Parameters defining the motion of mechanical systems and their degrees of freedom. 3. Study of the interaction of forces between solids in mechanical systems. 4. Centre of mass and inertia tensor of mechanical systems
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the concept of mechanics in D'Alembert's principle and Lagrange's equations. 2. Apply the Hamilton's principle to systems with constraints 3. Analyze the equations of motion in reduction to the equivalent one body problem. 4. Determine Euler angles using Euler's theorem on the motion of a rigid body 5. Compute the solutions of rigid body problems using the Euler equations of motion.

Prerequisites: Basics of dynamic system

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	2
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	2
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	2
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	2
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: MECHANICS OF A PARTICLE	**(9L+3T=12)**
Mechanics of a particle, Mechanics of a system of particles- Constraints- D'Alembert's principle and Lagrange's equations- Velocity dependent potentials and the dissipation function- Simple applications of the Lagrangian formulation. (Chapter 1 of text) **Self-Study:** Velocity dependent potentials.	**CO-1** **BTL-3**
MODULE 2: HAMILTON'S PRINCIPLE	**(9L+3T=12)**
Hamilton's principle- some techniques of the calculus of variations- derivation of Lagrange's equation from Hamilton's principle- Extending Hamilton's principle to systems with constraints- Conservation theorems and symmetry properties. (Sections 2.1, 2.2, 2.3, 2.4 and 2.6)	**CO-2** **BTL-3**
MODULE 3: EQUATIONS OF MOTION	**(9L+3T=12)**
Reduction to the equivalent one body problem- the equations of motion and first integrals- the equivalent one-dimensional problem and classification of orbits- the Virial theorem- the differential equation for the orbits and integrable power law potentials- the Kepler problem: Inverse square law of force. (Sections 3.1, 3.2, 3.3, 3.4, 3.5 and 3.7) **Self-Study:** Differential equation for the orbits.	**CO-3** **BTL-3**
MODULE 4: ORTHOGONAL TRANSFORMATION	**(9L+3T=12)**
The independent coordinates of a rigid body- orthogonal transformation- the Euler angles- the Cayley – Klein parameters and related quantities- Euler's theorem on the motion of a rigid body- the Coriolis effect. (Sections 4.1, 4.2, 4.4, 4.5, 4.6, 4.10)	**CO-4** **BTL-3**
MODULE 5: ANGULAR MOMENTUM	**(9L+3T=12)**
Angular momentum and kinetic energy of motion about a point- tensors- the inertial tensor and the moment of inertia- Eigen values of the inertial tensor and the principal axis transformation- solving rigid body problems and the Euler equations of motion. (Sections 5.1 to 5.5) **Self-Study:** Eigen values of the inertial tensor.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P. C. Deshmukh. (2022). *Foundations of Classical Mechanics*, Cambridge University Press.
2.	Goldstein, H. (2018). *Classical Mechanics,* Narosa Publishing House, New Delhi, Second Edition.
REFERENCE BOOKS	
1.	Greenwood, D. (2012). *Classical Dynamics*, Prentice Hall of India, New Delhi, Revised ed. Edition, Kindle Edition
2.	Rane, N. C. and Joag, P. S. (2015). *Classical Mechanics*, Tata McGraw Hill.
E BOOKS	
1.	Classical Mechanics - Book – IOP science
MOOC	
1.	NPTEL :: Mechanical Engineering – Engineering Mechanics

SEMESTER VIII

COURSE TITLE	TOPOLOGY AND ADVANCED FUNCTIONAL ANALYSIS			CREDITS	4
COURSE CODE	AIM02025	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student tostudy certain topological-algebraical structures, functional analysis and the methods by which the knowledge of these methods can be applied to analytic problems
Course Objective	The objective of this course is to equip the student with basics of topology and functional analysis so that the student is capable of higher learning.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding of the concept of topological spaces 2. Derive the properties of connected spaces and compact spaces 3. Analyze the structure of topological spaces 4. Recognize the fundamental properties of normed spaces and their transformations 5. Apply the standard theorems on bounded linear functionals

Prerequisites: Basics of sets and spaces

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: TOPOLOGICAL SPACES	**(9L+3T=12)**
Definition and Examples of Topological spaces**:** open sets- closed sets- neighborhoods- bases- sub bases- limit points- closures- interiors- continuous functions- homeomorphisms and properties-Subspaces- Relative Topology-Product topology- Quotient topology. **Self-Study:** Subspaces.	**CO-1** **BTL-3**
MODULE 2: CONNECTEDNESS AND COMPACTNESS	**(9L+3T=12)**
Connected spaces, Connected subspaces of the real line- Components and local connectedness. Compactness and finite intersection property-Heine-Borel Theorem-Bolzano-Weierstrass property- Local –compactness- One-point Compactification. **Self-Study:** One-point Compactification.	**CO-2** **BTL-3**
MODULE 3: HOMEOMORPHISM AND SEPARATION AXIOMS	**(9L+3T=12)**
Continuous functions and homeomorphism- first and second countable space- Lindel of spaces- separable space-Separation axioms: Hausdorff spaces- Regularity- Complete Regularity- Normality- Urysohn Lemma and Urysohn Metrization Theorem.	**CO-3** **BTL-3**
MODULE 4: NORMED AND BANACH SPACES	**(9L+3T=12)**
Normed spaces- Banach spaces- Subspaces- Metric spaces with examples- Dual spaces and transposes- Hahn-Banach Extension and Separation Theorems- Spaces of bounded linear operators.	**CO-4** **BTL-3**
MODULE5: BOUNDED LINEAR FUNCTIONALS	**(9L+3T=12)**
Open Mapping Theorem-Closed Graph Theorem and their applications- Uniform Boundedness Principle and its applications- Inner product spaces- Hilbert spaces- Orthonormal basis- Projection theorem and Riesz Representation Theorem. **Self-Study:** Inner product spaces.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Walter Rudin. (2017). *Functional Analysis*, McGraw-Hill, In.
2.	Munkres, J. R. (2015). *Topology*, Pearson Education, India.
REFERENCE BOOKS	
1.	Limayee, B. V. (2014). *Functional Analysis*, First Edition.
2.	Conway, J.B. (2007). *A Course in Functional Analysis*, Springer, Berlin.
3.	Armstrong, M. A. (2004). *Basic Topology*, Springer, India.
E BOOKS	
1.	https://nptel.ac.in/courses/111/106/111106054/ https://www.youtube.com/watch?v=kOFtfmCpNg0 http://jde27.uk/tg/topsp02.html
MOOC	
1.	https://www.classcentral.com/course/swayam-functional-analysis-22982
2.	https://onlinecourses.nptel.ac.in/noc21_ma25/preview
3.	https://nptel.ac.in/courses/111/106/111106054/

COURSE TITLE	COMMUTATIVE ALGEBRA			CREDITS	4
COURSE CODE	AIM02026	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To expose the students to variables, algebraic expressions, inequalities, functions, and all their multiple representations.
Course Objective	To understand the concepts groups, rings, polynomial rings and field.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on basic concept of groups 2. Analyze the group of symmetries in Cayley's and Sylow's theorem 3. Apply the concept of rings in various domains 4. Apply Eisenstein's criterion for reducibility and irreducibility of polynomial rings over a field 5. Able to derive separable and inseparable extensions.

Prerequisites: Basics of Vector Space

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC CONCEPTS OF GROUPS	(9L+3T=12)
A brief review of groups, their elementary properties and examples, subgroups, cyclic groups, homomorphism of groups and Lagrange's theorem; permutation groups, permutations as products of cycles, even and odd permutations, normal subgroups, quotient groups; isomorphism theorems, correspondence theorem. **Self-Study:** Normal subgroups.	**CO-1** **BTL-3**

MODULE 2: SYLOW'S THEOREM	(9L+3T=12)
Group action, Cayley's theorem, group of symmetries, dihedral groups and their elementary properties; orbit decomposition; counting formula; class equation, consequences for p-groups; Sylow's theorems (proofs using group actions). Applications of Sylow's theorems, conjugacy classes in Sn and An, simplicity of An. Direct product; structure theorem for finite abelian groups; invariants of a finite abelian group (Statements only) **Self-Study:**Consequences for p-groups.	**CO-2** **BTL-3**
MODULE 3: RINGS	**(9L+3T=12)**
Basic properties and examples of ring, domain, division ring and field; direct products of rings; characteristic of a domain; field of fractions of an integral domain; ring homomorphisms (always unitary); ideals; factor rings; prime and maximal ideals, principal ideal domain; Euclidean domain; unique factorization domain.	**CO-3** **BTL-3**
MODULE 4: POLYNOMIAL RINGS	**(9L+3T=12)**
A brief review of polynomial rings over a field; reducible and irreducible polynomials, Gauss' theorem for reducibility of f(x) Z x ; Eisenstein's criterion for irreducibility of f(x) Z x over Q, roots of polynomials; finite fields of orders 4, 8, 9 and 27 using irreducible polynomials over Z2 and Z3 .	**CO-4** **BTL-3**
MODULE 5: FIELD THEORY	**(9L+3T=12)**
Characteristic of a field, extensions, degree of an extension, primitive elements for an extension - Algebraic extensions, finitely generated field extensions, compositum of two fields - Splitting fields and algebraic closure – Separability - Separable and Inseparable extensions - Fields of characteristic p > 0 - Finite fields.- Perfect fields - Separable and inseparable degrees. **Self-Study:** Separable and inseparable degrees.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Vijay, K. K and Bhambri, S. K. (2017). *Basic A Course In Abstract Algebra*, Vikas Publishing, Fifth Edition.
2.	Musili, C. (2018). *Rings and Modules*, Narosa Publishing House, Second Revised Edition.

REFERENCE BOOKS	
1.	Fraleigh, J. B. (2013). *A First Course in Abstract Algebra*, Narosa Publishing House, New Delhi, 7th edition.
2.	Jacobson, N. (2009). *Basic Algebra I,* Dover Publications Inc.; 2nd edition..
3.	Herstein, I. N. (1995). *Topics in Algebra*, John Wiley and Sons, New York, Second Edition.
E BOOKS	
1.	http://math.uga.edu/~pete/integral2015.pdf
2.	http://www.jmilne.org/math/xnotes/CA.pdf
MOOC	
1.	https://nptel.ac.in/content/storage2/111/106/111106113/MP4/mod08lec44.mp4
2.	https://nptel.ac.in/content/storage2/111/106/111106113/MP4/mod08lec45.mp4
3.	https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec39.mp4
4.	https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec42.mp4

COURSE TITLE	PROJECT			CREDITS	12
COURSE CODE	AIM02800	COURSE CATEGORY	PC	L-T-P-S	0-0-24-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
CIA	80%		ESE		20%
Course Outcome	Upon completion of the project, the students will be able to 1. Identify the problem and work for the real life needs of the society 2. Derive practical solutions to the societal problem 3. Apply the importance of Engineering concepts and its relevant application				

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	2	-	3	3	3	3	3	-	3	3	-
CO2	3	2	-	-	2	-	3	3	3	3	3	-	3	3	-
CO3	3	-	-	2	-	1	3	3	3	3	3	-	3	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

PROJECT

In this project, each individual is expected to design and develop practical solutions to real life problems related to Industry and Information Technology research. Software usage should be followed during the development. The theoretical knowledge gained from the subject in the current and previous semesters should be applied to develop effective solutions to various applications. At the end of the project the individual should submit a complete report of the project work carried out.

Assessment is made as follows

Assessment Model: LE

Review / Exam	Weightage
First Review	20%
Second Review	20%
Third Review	10%
Project Report & Viva- Voce	50%
TOTAL	**100%**

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE

COURSE TITLE	NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS			CREDITS	4
COURSE CODE	AIM02500	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of partial differential equations.
Course Objective	1. To understand the concepts of numerical solutions of partial differential equations. 2. To perceive the concept of iterative methods to linear system of equations. 3. To understand the concept of parabolic equation 4. To understand the concept of elliptic equation 5. To understand the concept of hyperbolic equation
Course Outcome	Upon completion of this course, the students will be able to 1. Solve the linear system of equations by indirect methods 2. Obtain the finite difference approximations to derivatives 3. Solve the parabolic equations explicit and implicit methods 4. Solve the elliptic equations numerically 5. Apply finite difference methods in solving hyperbolic equations

Prerequisites: Basics of partial differential equations

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	2
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	2
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	2
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	2
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INITIAL & BOUNDARY VALUE PROBLEMS	**(9L+3T=12)**
Review of iterative methods to linear system of equations: Jacobi- Gauss-seidel-SOR-Matrix form of indirect methods and their convergence-Initial value problems-Initial boundary value problems and their analysis of convergence-consistency and stability- Lax theorem- Von Neumann criterion for stability.	**CO-1 BTL-3**
MODULE 2: DIRICHLET & NEUMANN PROBLEMS	**(9L+3T=12)**
Classification of PDEs- finite difference approximations to derivates- truncation errors- boundary conditions: Dirichlet- Neumann and Robin type boundary conditions.	**CO-2 BTL-3**
MODULE 3: SOLUTION OF PARABOLIC EQUATIONS	**(9L+3T=12)**
Parabolic equations: explicit and implicit methods for one- and two-dimensional parabolic equations- Crank-Nicolson method- numerical examples- weighted average approximation- consistency- convergence and stability.	**CO-3 BTL-3**
MODULE 4: SOLUTION OF ELLIPTIC EQUATIONS	**(9L+3T=12)**
Elliptic equations: Numerical examples: a torsion problem- a heat conduction problem with derivative boundary conditions. Finite differences in polar co-ordinates- techniques near a curved boundary- improvement of the accuracy of the solutions. Analysis of the discretization error of the five-point approximation to Poisson's equation.	**CO-4 BTL-3**
MODULE 5: SOLUTION OF HYPERBOLIC EQUATIONS	**(9L+3T=12)**
Hyperbolic equations: Finite difference methods for first and second order wave equation- Lax- Wendorff explicit method- CFL condition for one and two dimensions- ADI schemes for two dimensional hyperbolic equations- Lax-Wendorff method for a system of hyperbolic equations- Wendorff's implicit approximation- reduction of a first order equation to a system of ordinary differential equations - numerical examples.	**CO-5 BTL-3**

TEXT BOOKS	
1.	Zhilin, L. Zhonghua, Q. Tao, T. (2017). *Numerical solution of partial differential equations, introduction to finite difference methods and finite element method*, Cambridge University Press.
2.	Thomas, J. W. (2010). *Numerical partial differential equations: Finite difference methods*, Springer.
REFERENCE BOOKS	
1.	Morton, K. W. and Mayers, D. F. (2011). *Numerical solution of partial differential equations*, Cambridge, Second Edition.
2.	Smith, G. D. (2010). *Numerical solution of partial differential equations, finite difference methods*, Ox ford, Third Edition.
E BOOKS	
1.	https://www.springer.com/gp/book/9783764389390
MOOC	
1.	https://nptel.ac.in/courses/111/107/111107063/

COURSE TITLE	STOCHASTIC PROCESSES			CREDITS	4
COURSE CODE	AIM02501	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The goal is to introduce the stochastic processes which is used in solving hard problems that have wide variability in their characteristics.
Course Objective	This course aims at providing the necessary basic concepts in stochastic processes. Knowledge of fundamentals and applications of random phenomena will greatly help in the understanding of topics such as signals and systems, pattern recognition, voice and image processing and filtering theory.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the concept of Markov and Stationary Processes 2. Demonstrate an understanding of the concept of Renewal processes in discrete and continuous time 3. Apply the concept of Markov Renewal and Semi – Markov Processes 4. Generalize the concept of classical Galton and Watson process 5. Analyze diffusion equations and Kolmogorov equations

Prerequisites: Some background in probability and random variables.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2		-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2		-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2		-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: ARKOV AND STATIONARY PROCESSES	**(9L+3T=12)**
Specification of Stochastic Processes - Stationary Processes - Poisson Process -Generalizations - Birth and Death Processes - Martingales - Erlang Process.	**CO-1 BTL-3**
MODUL2: RENEWAL PROCESSES	**(9L+3T=12)**
Renewal processes in discrete and continuous time - Renewal equation - Stopping time - Wald's equation - Renewal theorems - Delayed and Equilibrium renewal processes - Residual and excess life times - Renewal reward process - Alternating renewal process - Regenerative stochastic process.	**CO-2 BTL-3**
MODULE 3: MARKOV RENEWAL AND SEMI – MARKOV PROCESSES	**(9L+3T=12)**
Definition and preliminary results - Markov renewal equation - Limiting behaviour - First passage time.	**CO-3 BTL-3**
MODULE 4: BRANCHING PROCESSES	**(9L+3T=12)**
Generating functions of branching processes - Probability of extinction - Distribution of the total number of progeny - Generalization of classical Galton - Watson process - Continuous time Markov branching process - Age dependent branching process.	**CO-4 BTL-3**
MODULE 5: MARKOV PROCESSES WITH CONTINUOUS STATE SPACE	**(9L+3T= 12)**
Brownian motion - Wiener process - Diffusion and Kolmogorov equations -First passage time distribution for Wiener process - Ornstein - Uhlenbeck process.	**CO-5 BTL-3**

TEXT BOOKS	
1.	Medhi, J. (2017). *Stochastic Processes*, New Age International (P) Ltd., New Delhi, Third Edition.
2.	Ionuthttps://www.amazon.in/s/ref=dp_byline_sr_book_1?ie=UTF8&field-author=Ionut+Florescu&search-alias=stripbooksFlorescu. (2014). *Probability and Stochastic Processes*, Wiley, 1st edition.
REFERENCE BOOKS	
1.	Peter Watts Jones, Peter Smith. (2020). *An introduction Stochastic Processes*, Chapman and Hall/CRC.
2.	Robert G. Gallager. (2013). *The Theory of Stochastic Pro* Stochastic Processes: Theory for Applications. Cambridge University Press, 1st edition
E BOOKS	
1.	https://www.amazon.in/Stochastic-Processes-Dover-Books-Mathematics-ebook/dp/B00Y3Q8RIO
2.	https://www.amazon.in/Introduction-Stochastic-Processes-Dover-Mathematics-ebook/dp/B00GEA9OO8
MOOC	
1.	https://nptel.ac.in/courses/111/102/111102098/
2.	https://www.elsevier.com/books/stochastic-processes/najim/978-1-903996-55-3

COURSE TITLE	FOURIER ANALYSIS			CREDITS	4
COURSE CODE	AIM02502	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	It is a discipline that helps to make better decisions in Fourier Analysis.
Course Objective	The course will help the Learner to: 1. Study the concept of Banach spaces. 2. Understand the concept of seperability. 3.Analyse the concept of Hahn Banach space. 4.Study the concept of Hilbert's space. 5. Understand the concept of adjoint of an operator, dual, double dual convergence.
Course Outcome	Upon completion of the course students will be able to: 1. Apply the concept of Banach spaces. 2.Solve problems in seperability. 3. Use the concept of Hahn Banach Space. 4. Perform the concept of Hilbert's space. 5. Relate the concept of adjoint of operator and dual, double dual convergence.
Prerequisites: Differential equation, linear algebra and real analysis.	

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	-	-	2	-	-	-	-	3	1	-
CO2	2	3	1	3	1	-	-	2	3	-	1	2	3	2	2
CO3	3	2	2	1	2	-	1	2	-	-	-	-	2	-	3
CO4	2	3	2	2	3	-	1	2	-	-	-	1	3	2	-
CO5	3	2	3	3	3	-	-	2	2	-	-	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: LINEAR SPACES	**(9L+3T=12)**
Normed linear spaces, Banach spaces; Classical examples: C([0,1]), l_p, c, c_0, c_{00}, $L_p[0,1]$; Continuity and boundedness of linear operator; Quotient spaces.	**CO-1** **BTL-3**
MODULE 2: FINITE DIMENSONAL NORMED SPACES	**(9L+3T=12)**
Finite dimensional Normed spaces; Riesz lemma, (non)compactness of unit ball; Seperability with examples.	**CO-2** **BTL-3**
MODULE 3: EXTENDED SPACES	**(9L+3T=12)**
Hahn Banach extension theorem, Open mapping theorem, Closed graph theorem, Uniform boundedness principle**.**	**CO-3** **BTL-3**
MODULE 4: HILBERT SPACE	**(9L+3T=12)**
Hilbert spaces, Projection theorem; Orthonormal basis, Bessel inequality, Parseval equality; Dual, Duals of classical spaces-c_0, l_p, $L_p[0,1]$;	**CO-4** **BTL-3**
MODULE 5: ADJOINT OPERATOR	**(9L+3T=12)**
Riesz representation theorem, Adjoint of an operator; Double dual, Weak and weak* convergence.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	M. Fabian, P. Habala, P. Hajek, V. M. Santalucia, J. Pelant and V. Zizler, Functional analysis and infinite-dimensional geometry. (Canadian Math. Soc, Springer 2001).
2.	M. T. Nair, Functional analysis. (PHI-Learning, New Delhi, Fourth Print 2014).
REFERENCE BOOKS	
1.	B. Bollobas, Linear analysis (Cambridge Univ. Press 1999).
2.	Conway, A course in functional analysis. (Springer 2007).
3.	P. D. Lax, Functional analysis (Willey interscience 2002).
E BOOKS	
1.	http://www.freebookcentre.net/maths-books-download/Fourier-Analysis-by-Gustaf-Gripenberg.html
MOOC	
1.	https://ocw.mit.edu/courses/18-103-fourier-analysis-fall-2013/
2.	https://onlinecourses.nptel.ac.in/noc23_ma22/preview

COURSE TITLE	MATHEMATICAL PHYSICS			CREDITS	4
COURSE CODE	AIM02503	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of Mathematical Physics and its application
Course Objective	1. To equip the students with a sample of available tools/techniques in Mathematics to study and analyze the math and to give a first-hand experience in using / experimenting with the techniques. 2. To expose the students to areas of mathematics having applications in physics
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the behavior of series solutions 2. Derive recurrence relations for special functions 3. Expand the Fourier series for periodic functions 4. Find the Laplace transform for periodic and non-periodic functions 5. Find Fourier transform for simple function

Prerequisites: Basics of physics

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DIFFERENTIAL EQUATIONS	**(9L+3T=12)**
Ordinary differential equations-Series solutions and behaviour of series solutions-Singularity – Frobenius method - Hypergeometric Functions.	**CO-1** **BTL-3**
MODULE 2: SPECIAL FUNCTIONS	**(9L+3T=12)**
Bessel-Legendre- Hermite and Laguerre equations - Properties of their solutions-Recurrence Relations-Orthogonal properties.	**CO-2** **BTL-3**
MODULE 3: FOURIER SERIES	**(9L+3T=12)**
Fourier series for periodic functions- Dirichlet conditions- Half range series-Complex form of Fourier series	**CO-3** **BTL-3**
MODULE 4: LAPLACE TRANSFORMS	**(9L+3T=12)**
Laplace transform – Conditions of existence – Transform of elementary functions – properties – Transforms of derivatives – Initial and final value theorems – Transform of periodic functions.	**CO-4** **BTL-3**
MODULE 5: FOURIER TRANSFORMS	**(9L+3T=12)**
Fourier Integral Theorem (without proof) - Fourier transform pair - Sine and Cosine transforms - Properties - Transforms of Simple functions - Convolution theorem - Parseval's identity.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Pipes and Harvill. (2014). *Applied Mathematics for Engineers and Physicists*, McGraw Hill International Book Company, Third Edition.
2.	Erwin Krysigz. (2011). *Advanced Engineering Mathematics*, John Wiley& Sons, New York, Tenth edition.
REFERENCE BOOKS	
1.	Suresh Chandra, Mohit Kumar Sharma. (2013). *Introduction to Mathematical Physics*.
2.	Zill. (2016). *Advanced Engineering Mathematics*, Jones & Bartlett Learning, Six Edition.
E BOOKS	
1.	Mathematical-Physics-H-K-Dass - ebook/dp/B00QUYKS34
MOOC	
1.	https://www.coursera.org/specializations/social-science

COURSE TITLE	BASICS OF GRAPH THEORY			CREDITS	4
COURSE CODE	AIM02504	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of Graph Theory
Course Objective	1. To introduce students with the fundamental concepts in Graph Theory. 2. To translate real life situations to diagrammatic representations.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on basics concepts of graph theory. 2. Develop problem solving skills and thereby solve real life problems. 3. Analyze the nature of acyclic connected graphs. 4. Determine a minimal spanning tree for a given weighted graph. 5. Develop an understanding on planar graphs and coloring.

Prerequisites: Knowledge of mathematical proof technique and basic linear algebra.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS9	PS10	PS11	PS12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Basic Concepts	**(9L+3T=12)**
Definition of graph and examples – incidence and degree – subgraphs – complement of a graph – intersection graphs and line graphs – isomorphism – operation on graphs. **Self Study:** Graphs	**CO-1** **BTL-3**

MODULE 2: Connectivity of a Graph	**(9L+3T=12)**
Paths and cycles – connectedness and connectivity – components of a graph – cut points and bridges – blocks – Menger's theorem – matrices related to a graph. **Self Study:** Paths & Cycles	**CO-2** **BTL-3**
MODULE 3: Trees and Properties	**(9L+3T=12)**
Trees – characteristics of trees – center of a tree – spanning tree in graph – minimum spanning tree algorithm – diameter of graph – average distance of graph. **Self Study:** Trees	**CO-3** **BTL-3**
MODULE 4: Various Graphs	**(9L+3T=12)**
Eulerian graphs – Konigsberg bridge problem – Hamiltonian graphs – chordal graph – weighted graph – Cayley graph, hypercube network and their properties.	**CO-4** **BTL-3**
MODULE 5: Planarity and Colourability	**(9L+3T=12)**
Planarity – colourability – chromatic number – five colour theorem – four colour problem – matching – independent sets and coverings – perfect graphs. **Self Study:** Planarity	**CO-5** **BTL-3**

TEXT BOOKS	
1.	JunmingXu (2001), *Topological Structure and Analysis of Interconnection Networks*, Kluwer Academic Publishers, The Netherlands.
2.	Douglas B. West (2002), *Introduction to Graph Theory*, Prentice Hall of India, Second Edition.
REFERENCE BOOKS	
1.	Arumugam and Ramachandran (1994), *Invitation to Graph Theory*, New gamma publishing house, Palayamkottai.
2.	NarsinghDeo (2016), *Graph Theory with Applications to Engineering & Computer Science*, Dover publications, New York.
E BOOKS	
1.	https://b-ok.asia/book/3289235/25da6f
MOOC	
1.	https://www.coursera.org/learn/graphs
2.	https://www.coursera.org/specializations/data-structures-algorithms

COURSE TITLE	REPRESENTATION THEORY OF FINITE GROUPS			CREDITS	4
COURSE CODE	AIM02505	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	It is a discipline that helps in understanding the theory of finite groups. .
Course Objective	The course will help the learner to: 1. The concept of linear groups. 2. Impart knowledge on group representation. 3. Enable the students to analyze the concept of group algebra. 4. Understand Orthogonal relation of characters. 5. Make the students to understand the concept of finite abelian group.
Course Outcome	Upon completion of the course students will be able to: 1.Solve linear groups problems. 2.Solve concepts under group representation. 3. Apply the concept of group algebra. 4.Learn about Orthogonal relation of Characters. 5. Apply the concept of finite abelian group.

Prerequisites: Algebra I and II

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	-	-	2	-	-	1	-	3	2	1
CO2	3	3	3	3	3	-	1	2	3	-	-	1	3	2	2
CO3	3	3	2	3	2	-	-	3	-	2	-	2	2	-	3
CO4	3	3	3	2	3	1	-	3	-	-	1	-	3	2	-
CO5	3	2	3	3	3	-	-	2	2	-	-	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CLASSICAL GROUPS	**(9L+3T=12)**
Classical groups: General linear group , Orthogonal group, Symplectic group, Unitary group.	**CO-1** **BTL-3**
MODULE 2: GROUP REPRESENTATION	**(9L+3T=12)**
Group representation, conjugate representation, G-invariant spaces - irreducible representations - Schur's lemma.	**CO-2** **BTL-3**
MODULE 3: GROUP ALGEBRA	**(9L+3T=12)**
The Group Algebra - Maschke's theorem - characters. Orthogonality relations for characters – Number of irreducible representations.	**CO-3** **BTL-3**
MODULE 4: PERMUTATION REPRESENTATION	**(9L+3T=12)**
Permutation representation-Regular representation. Representation-symmetric groups.	**CO-4** **BTL-3**
MODULE 5: REPRESENTATION OF FINITE ABELIAN GROUPS	**(9L+3T=12)**
Representation of Finite Abelian groups - Dihedral groups.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	C.W. Curtis and I. Reiner., "Representation theory of finite groups and associative algebras", AMS Chelsea Publishing, Providence, Rhode Island, 2006.
2.	Bruce E. Sagan., "The symmetric group. Representations, combinatorial algorithms, and symmetric functions", The Wadsworth & Brooks/Cole Mathematics Series. Wadsworth & Brooks/Cole Advanced Books & Software, Pacific Grove, CA, 1991.
3.	Eting of Pavel, Golberg Oleg, Hensel Sebastian, Liu Tiankai, Schwendner Alex, Vaintrob Dmitry, Yudovina Elena,, *Introduction to representation theory. With historical interludes by Slava Gerovitch*, Student Mathematical Library 59. American Mathematical Society. 2011.
REFERENCE BOOKS	
1.	William Fulton, "Young tableaux, with applications to representation theory and geometry", London Mathematical Society Student Texts, 35, Cambridge University Press, Cambridge, 1997. 4.
2.	G. James and A. Kerber., "The Representation theory of the symmetric group", Encyclopedia of Mathematics and its Applications, 16. Addison-Wesley Publishing Co., Reading, Mass., Boston,1981.
3.	J. P. Serre, *Linear representations of finite groups*, Graduate Texts in Mathematics. Vol. 42. Springer-Verlag. New York-Heidelberg. 1977.
E BOOKS	
1.	https://link.springer.com/book/10.1007/978-3-030-21792-1
MOOC	
1.	https://faculty.math.illinois.edu/~rezk/Finite%20Group%20Reps/short-course-finite-group-representations.html
2.	http://math.iisc.ac.in/all-courses/ma220.html

COURSE TITLE	SPECIAL THEORY OF RELATIVITY AND ANALYTICAL MECHANICS			CREDITS	4
COURSE CODE	AIM02506	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	1. This course is conceptual and exploratory, a course that describes the relative motion of different bodies in different frame of references. 2. It compares different theories and establishes the most reliable one, identified through valid and consequential experimental investigations.
Course Objective	The objectives of this course are to: introduce students to the concept of special relativity and its applications to Physical Sciences; and provide students with knowledge and proof of the validity of Physical Laws and nonexistence of the hypothetical stationary anther.
Course Outcome	Upon completion of this course, the students will be able to 1. Derive Einstein's formulation of special relativity 2. Analyze the Lorentz transformations in three dimensions 3. Demonstrate an understand on the concept of the four-vector formulation of special relativity 4. Derive the Doppler shift in special relativity 5. Derive Maxwell's equations and formulate the four vector Maxwell's equations

Prerequisites: Basics of relativity theory

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	-	1	-	-	3	-	-	-	-	3	3	-
CO2	1	1	-	1	-	-	-	3	-	-	-	-	3	3	-
CO3	3	2	2	-	-	2	-	3	-	-	-	-	3	3	-
CO4	2	-	2	-	2	-	-	3	-	-	-	-	3	3	-
CO5	3	-	2	-	-	-	-	3	-	-	-	-	3	3	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DERIVATION OF SPECIAL RELATIVITY	**(9L+3T=12)**
Fundamental concepts - Einstein's formulation of special relativity - The Lorentz transformations.	**CO-1** **BTL-3**
MODULE 2: DERIVATION OF SPECIAL RELATIVITY	**(9L+3T=12)**
Length contraction, Time dilation and simultaneity - The velocity addition formulae - Three dimensional Lorentz transformations.	**CO-2** **BTL-3**
MODULE 3: THE FOUR-VECTOR FORMULATION OF SPECIAL RELATIVITY	**(9L+3T=12)**
The four-vector formalism - The Lorentz transformations in 4-vectors - The Lorentz and Poincare groups - The null cone structure - Proper time.	**CO-3** **BTL-3**
MODULE 4: APPLICATIONS OF SPECIAL RELATIVITY	**(9L+3T=12)**
Relativistic kinematics - The Doppler shift in relativity - The Compton effect - Particle scattering - Binding energy- Particle production and particle decay.	**CO-4** **BTL-3**
MODULE 5: ELECTROMAGNETISM IN SPECIAL RELATIVITY	**(9L+3T=12)**
Review of electromagnetism - The electric and magnetic field intensities - The electric current - Maxwell's equations and electromagnetic waves - The four-vector formulation of Maxwell's equations.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Einstein, A. (2017). *Relativity: The Special and the General Theory***,** Fingerprint Publishing.
2.	Goldstein, H., Poole, C. P. and Safko, J. L. (2003). Classical Mechanics, Addison-Wesley Publishing Co.
REFERENCE BOOKS	
1.	Freund, J. (2008). *Special Relativity for Beginners*, World Scientific.
2.	Ringler, W. (2006). *Introduction to Special Relativity*, Oxford University Press.
E BOOKS	
1.	https://b-ok.asia/book/837243/1f3a69.
MOOC	
1.	https://www.coursera.org/learn/engineering-mechanics-statics
2.	https://www.coursera.org/learn/physics-101-forces-kinematics

COURSE TITLE	THEORY OF FUZZY SUBSETS AND ITS MODEL			CREDITS	4
COURSE CODE	AIM02507	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of Fuzzy logic and its application
Course Objective	1. The theory of fuzzy subsets is a step forward a rapprochement between the precision of classical mathematics and the pervasive imprecision of the real world a rapprochement born of the incessant human quest for a better understanding of mental processes and cognition. 2. To impart knowledge in concepts and tools of Fuzzy models 3. To understand mathematical models used in fuzzy logic 4. To apply these techniques constructively to make effective business decisions
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on the concept of fuzzy sets 2. Apply the concepts of fuzzy graphs and fuzzy relations 3. Determine crips and fuzzy sets 4. Formulate fuzzy cognitive models and its applications 5. Apply statistical approach using Neutrosophic models

Prerequisites: Basics of fuzzy logic

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO FUZZY SUBSETS	**(9L+3T=12)**
Introduction- Review of the notion of membership-The concept of a fuzzy subset-Dominance relations-Simple operations on fuzzy subsets-Set of fuzzy subsets for E and M finite-Properties of the set of the fuzzy subsets-Product and algebraic sum of two fuzzy subsets.	**CO-1** **BTL-3**
MODULE 2: FUZZY GRAPHS AND FUZZY RELATIONS	**(9L+3T=12)**
Fuzzy graphs-Fuzzy relations-Composition of fuzzy relations -Fuzzy subsets induced by a mapping -Conditioned fuzzy subsets -Properties of fuzzy binary relation -Transitive closure of a fuzzy binary relation-Paths in a finite fuzzy graph.	**CO-2** **BTL-3**
MODULE 3: FUZZY PREORDER RELATIONS	**(9L+3T=12)**
Fuzzy preorder relations -Similitude sub relations in a fuzzy preorder-Antisymmetry - Fuzzy order relations-Ant symmetric relations without loops - Ordinal relations- Ordinal functions in a fuzzy order relation-Dissimilitude relations -Resemblance relations -Various properties of similitude and resemblance Various properties of fuzzy perfect order relations-Ordinary membership functions.	**CO-3** **BTL-3**
MODULE 4: FUZZY COGNITIVE MODELS AND FUZZY RELATIONAL MODELS	**(9L+3T=12)**
Fuzzy cognitive maps-combined fuzzy cognitive maps-combined overlap fuzzy cognitive maps-Fuzzy relation maps-combined fuzzy relational maps.	**CO-3** **BTL-3**
MODULE 5: NEUTROSOPHIC COGNITIVE MODELS AND NEUTROSOPHIC RELATIONAL MODELS	**(9L+3T=12)**
Neutrosophic cognitive maps- combine overlap Neutrosophic cognitive maps- Neutrosophic relational maps- Stasticial approach using fuzzy models and Neutrosophic models.	**CO-4** **BTL-3**

TEXT BOOKS	
1.	Kaufmann, A. (2017). *Introduction to the Theory of Fuzzy Subsets,* Academic Press, New York.
2.	Hans, J. Z. (2020). *Fuzzy Set Theory—And Its Applications,* , Springer Nature (Sie).
REFERENCE BOOKS	
1.	VasanthaKandasamy, W. B., FlorentinSmarandache, Ilanthenral, K. (2013). *Fuzzy Neutrosophic Models for Social Scientists*.
2.	VasanthaKandasamy,W.B., FlorentinSmarandache, Ilanthenral, K. (2020). *Elementary fuzzy matrix theory and fuzzy models for social scientists***,** Indo American Books, Kindle edition.
E BOOKS	
1.	https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf
MOOC	
1.	https://www.classcentral.com/course/swayam-introduction-to-fuzzy-set-theory-arithmetic-and-logic-14149
2.	https://nptel.ac.in/courses/111/102/111102130/

COURSE TITLE	NEURAL NETWORKS			CREDITS	4
COURSE CODE	AIM02508	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course aims at introducing the fundamentals of Neural Networks. To expose the students to basics of Neural Networks
Course Objective	The course will help the learner to: 1. To know them an in fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications. 2. Acquire in-depth knowledge in Non-linear dynamics 3. Apply neural network to classification and generalization problems. 4. To acquire knowledge about Back Propagation Algorithm. 5. To know the fundamental principles of directional derivatives
Course Outcome	On successful completion of the course, the students should be able to 1. Understand and analyze different neutron network models 2. Understand the basic ideas behind most common learning algorithms for multilayer perceptions, radial-basis function networks. 3. Describe Hebbrule and analyze back propagation Algorithm with examples. 4. Study convergence and generalization and implement common learning algorithm. 5. Study directional derivatives and necessary conditions for optimality and to evaluate quadratic functions.

Prerequisites: Statistics and basic mathematics.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	-	-	2	-	-	-	1	3	2	-
CO2	3	2	2	3	1	-	-	2	3	-	1	-	3	2	2
CO3	3	3	2	2	2	-	2	2	-	2	-	-	3	-	3
CO4	3	2	3	2	3	-	-	2	-	-	1	-	3	2	-
CO5	3	2	3	3	3	-	-	2	2	-	-	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: NEURON MODEL AND NETWORKARCHITECTURES	**(9L+3T=12)**
MathematicalNeuronModel-NetworkArchitectures-Perceptron-HammingNetwork-HopfieldNetwork-LearningRules.	**CO-1 BTL-3**
MODULE 2: PERCEPTRON ARCHITECTURES	**(9L+3T=12)**
PerceptronArchitecturesandLearningRulewithProofofConvergence.SupervisedHebbianLearning-Linear Associator.	**CO-2 BTL-3**
MODULE 3: SUPERVISED HEBBIANLEARNING	**(9L+3T=12)**
TheHebbRule-PseudoinverseRule-VariationsofHebbianLearning-BackPropagation-MultilayerPerceptrons.	**CO-3 BTL-3**
MODULE 4: BACK PROPAGATION	**(9L+3T=12)**
BackpropagationAlgorithm-ConvergenceandGeneralization-PerformancesSurfacesandOptimumPoints-Taylor series.	**CO-4 BTL-3**
MODULE 5: PERFORMANCE SURFACES AND PERFORMANCE OPTIMIZATIONS	**(9L+3T=12)**
DirectionalDerivatives-Minima-NecessaryConditionsforOptimality-QuadraticFunctions-PerformanceOptimizations-SteepestDescent-Newton'sMethod-ConjugateGradient.	**CO-5 BTL-3**
TEXT BOOKS	
1.	Introduction to Artificial Neural systems – Jacek M. Zurada, 1994, Jaico Publ. House
2.	Laurene Fausett, "Fundamentals of Neural Networks" , Pearson Education, 2006
REFERENCE BOOKS	
1.	Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2003.
2.	S.N.Sivanandam, S.Sumathi,S. N. Deepa "Introduction to Neural Networks using MATLAB 6.0", TATA Mc Graw Hill, 2006.
3.	S. Rajasekharan and G. A. Vijayalakshmipai, "Neural Networks, Fuzzy logic,
E BOOKS	
1.	https://www.inf.ed.ac.uk/teaching/courses/nlu/assets/reading/Gurney_et_al.pdf
MOOC	
1.	https://in.coursera.org/courses?query=neural%20networks
2.	https://www.coursera.org/learn/neural-networks-deep-learning

COURSE TITLE	FUNCTIONAL ANALYSIS			CREDITS	4
COURSE CODE	AIM02509	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course is intended both for mathematics students continuing to do advanced work and for other students using mathematics at a high level in theoretical physics, engineering and information technology, and mathematical economics.
Course Objective	The course gives an introduction to spectral theory, compact linear operators and approximation theory which is one of the main branches of modern functional analysis. After successfully completion of course, the student will able to explore subject into their respective dimensions
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on the concept of operators and its convergence of sequence 2. Determine the inner product spaces and check their orthogonality 3. Analyze spectral theory in finite dimensional normed spaces 4. Acquire knowledge on concept of compact linear operator on normed spaces 5. Describe spectral representation of bounded self-adjoint linear operators

Prerequisites: Basics of real and complex analysis

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: OPERATORS AND CONVERGENCE	**(9L+3T=12)**
Definitions-examples and basic properties of bounded Linear Functionals-embedding and Reflexivity of normed spaces- Unitary and normal operators-adjoint of bounded linear operations- strong and weak convergence-convergence of sequence of operators and functional.	**CO-1 BTL-3**
MODULE 2: INNER PRODUCT SPACES AND ORTHOGONALITY	**(9L+3T=12)**
Definitions and basic properties of inner product spaces and Hilbert space-completion of inner product spaces- orthogonality of vectors- orthogonal compliment and projection theorem- orthonormal sets and Fourier analysis-complete orthonormal sets.	**CO-2 BTL-3**
MODULE 3: SPECTRAL THEORY OF LINEAR OPERATORS IN NORMED SPACES	**(9L+3T=12)**
Spectral Theory in Finite Dimensional Normed Spaces- Basic Concepts-Spectral Properties of Bounded Linear Operators- Use of Spaces Complex Analysis in Spectral Theory- Banach Algebra.	**CO-3 BTL-3**
MODULE 4: COMPACT LINEAR OPERATORS ON NORMED SPACES	**(9L+3T=12)**
Compact Linear Operator on Normed Spaces- Properties of Compact Linear Operator- Spectral Properties of Compact Linear Operators on Normed Spaces-Operator Equations Involving Compact Linear Operators- Further Theorem of Fredholm Type.	**CO-4 BTL-3**
MODULE 5: BOUNDED SELF - ADJOINT LINEAR OPERATORS	**(9L+3T=12)**
Spectral Properties of Bounded Self - Adjoint Linear Operators- Positive Operators- Square Roots of a Positive Operator- Projection Operators- Further Properties of Projections- Spectral Family of a Bounded Self - Adjoint Linear Operators- Spectral Representation of Bounded Self- Adjoint Linear Operators.	**CO-5 BTL-3**

TEXT BOOKS	
1.	Siddiqui, A. H., Khalil Ahmad and Manchanda, P. (2015). *Introduction to Functional Analysis with Applications*, Real World Education Publishers, New Delhi.
2.	Siddiqui, A. H. (2015). *Applied Functional Analysis*, Real World Education Publishers, New Delhi.
REFERENCE BOOKS	
1.	Limaye B. V. (2016). Functional Analysis, New Age International Ltd., Publishers, Third Edition.
2.	Walter Rudin. (2017). *Functional Analysis*, McGraw Hill Education.
E BOOKS	
1.	https://www.youtube.com/watch?v=ZCq9zynbY_Y
2.	https://cosmolearning.org/video-lectures/spectral-theory/
3.	https://cosmolearning.org/video-lectures/approximation-theory/
MOOC	
1.	https://nptel.ac.in/courses/111/106/111106147/

COURSE TITLE	FLUID MECHANICS			CREDITS	4
COURSE CODE	AIM02510	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course aims at introducing the fundamentals of fluid mechanics. This course aims at imparting the knowledge on tensors, kinematics of fluid, incompressible flow, boundary layer flows and classification of non-Newtonian fluids.
Course Objective	This course will help the learner to 1. Understand the basic concept of tensors and their representative 2. Physics and mathematics behind the basics of fluid mechanics 3. Familiar with two- or three-dimensional incompressible flows 4. Classifications of non-Newtonian fluids
Course Outcome	On successful completion of the course, the students should be able to 1. Apply the tensor formalism 2. Apply general stresses and deformations in continuous 3. Derive the equation of motion in cartesian coordinates 4. Analyze the inviscid incompressible flow in all three dimensions 5. Analyze two dimensional viscous flows

Prerequisites: Calculus and Differential equations.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CARTESIAN TENSORS AND CONTINUUM HYPOTHESIS (9L+3T=12)	
Cartesian tensors: Cartesian tensors- basic properties- transpose- symmetric and skew symmetric tensors- gradient- divergence and curl in tensor calculus- integral theorems-Continuum hypothesis: deformation gradient- strain tensors- infinitesimal strain- compatibility relations- principal strains- material and local time derivatives- transport formulas- stream lines- path lines. **Self Study:** Path lines.	**CO-1** **BTL-3**
MODULE 2: STRESS, STRAIN AND BASIC PHYSICAL LAWS (9L+3T=12)	
Stress and Strain: stress components and stress tensor- normal and shear stresses- principal stresses- transformation of the rate of strain and stress- relation between stress and rate of strain. **Self-Study:** Relation between stress and rate of strain.	**CO-2** **BTL-3**
MODULE 3: FUNDAMENTAL BASIC PHYSICAL LAWS (9L+3T=12)	
The equation of continuity- conservation of mass- equation of motion (Navier-Stokes equations in Cartesian coordinates)- conservation of momentum- the energy -equation, conservation of energy.	**CO-3** **BTL-3**
MODULE 4: ONE, TWO AND THREE DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW (9L+3T=12)	
Bernoulli equation- derivation of Bernoulli's equation and its applications- circulation theorems- circulation concept- Kelvin's theorem- constancy of circulation- Laplace equations- stream functions in two- and three-dimensional motion- Two-dimensional flow: rectilinear flow- source and sink- the theorem of Blasius. **Self Study:** Laplace equations.	**CO-4** **BTL-3**
MODULE 5: TWO DIMENSIONAL FLOWS OF VISCOUS FLUID (9L+3T=12)	
Flow between parallel flat plates- Couette flow- plane Poiseuille flow- the Hagen-Poiseuille flow- flow between two concentric rotating cylinders.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Bruce, R. M. Alric, P. R. Theodore, H.O and Wade, W. H. (2017). *Foundations of fluid mechanics*, Wiley.
2.	Raisinghania, M. D. (2014). *Fluid Dynamics*, S. Chand and Company Ltd.
REFERENCE BOOKS	
1.	Chandrasekharaiah, D. S. and Debnath, L. (2014), *Continuum mechanics*, Academic Press, Reprint.
2.	Kundu, P. K. Ira M. Cohen and David R. Dowling, (2010). *Fluid Mechanics*, Fifth Edition.
3.	Batchelor, G. K. (2000). *An introduction to fluid mechanics*, Cambridge University Press.
E BOOKS	
1.	White, F. M. (2011). *Fluid Mechanics*, Tata McGraw Hill.
MOOC	
1.	NPTEL :: Mechanical Engineering - Fluid Mechanics
2.	NPTEL :: Mechanical Engineering - NOC:Introduction to Fluid Mechanics

COURSE TITLE	CONTROL THEORY			CREDITS	4
COURSE CODE	AIM02511	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Designed to develop an understanding of Observability, Controllability, Stability, Stabilizability.
Course Objective	The course will help the Learner to: 1. Understand the concepts ofObservability, ControllabilityandStability. 2. Gainknowledge about linear timevaryingsystems. 3. Developtheabilityofsolvinglinearfeedbackcontrol. 4. Acquire knowledge about stabilization using feedback and Bass method. 5. Understand stabilization linear feedback control.
Course Outcome	Upon completion of the course students will be able to: 1. Explain observability and estimate the observability of constant coefficient System,linear,nonlinear system, anddiscuss reconstruction kernel. 2. Apply controllability criteria to constant coefficient system, linear, Nonlinear system, and explain steering function. 3. Analyze the stabilityoflinearsystem,lineartime varyingsystem,perturbed Linearsystemand nonlinear system. 4. Evaluatestabilizationvialinearfeedbackcontrol,Bass method. 5. Analyzecontrollablesubspace,andstabilizationwithrestrictedfeedback.

Prerequisites: Linear Algebra, complex analysis and multi variate calculus and ordinary differential equation.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	-	2	-	-	-	-	3	2	-
CO2	3	2	2	3	3	-	1	2	3	-	2	-	3	2	2
CO3	3	3	2	2	2	-	-	3		-	-	-	3	-	3
CO4	3	2	3	2	3	1	-	1		-	1	-	3	2	-
CO5	3	3	3	3	3	-	-	2	2	-	-	-	3	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:OBSERVABILITY	**(9L+3T=12)**
LinearSystems–ObservabilityGrammian–Constantcoefficientsystems–Reconstructionkernel–Nonlinear Systems.	**CO-1 BTL-3**

MODULE 2: CONTROLLABILITY	**(9L+3T=12)**
Linearsystems–ControllabilityGrammian–Adjointsystems–Constantcoefficientsystems–steeringfunction – Nonlinear systems.	**CO-2** **BTL-3**
MODULE 3: STABILITY	**(9L+3T=12)**
Stability–Uniform Stability –Asymptotic Stability of Linear Systems.	**CO-3** **BTL-3**
MODULE 4: PERTURBED LINEAR SYSTEMS	**(9L+3T=12)**
Linear time varying systems–Perturbed linear systems – Non linear systems.	**CO-4** **BTL-3**
MODULE 5: STABILIZABILITY	**(9L+3T=12)**
Stabilization via linear feedback control–Bass method Controllable subspace – Stabilization with restricted feedback.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	M.Gopal, ―Control System – Principles and Design‖, Tata McGraw Hill, 4th Edition, 2012.
2.	J.Nagrath and M.Gopal, ―Control System Engineering‖, New Age International Publishers, 5th Edition, 2007.
REFERENCE BOOKS	
1.	Brigitte d'Andréa-Novel, Michel De Lara, Control Theory for Engineers-A Primer Springer Berlin Heidelberg, USA, Edition 3, 2015
2.	Eduardo D. Sontag, Mathematical Control Theory Deterministic Finite Dimensional Systems, 2nd, Springer Publication, USA, Edition, 2013.
E BOOKS	
1.	https://library.oapen.org/bitstream/id/ca08ee4d-3639-43d0-81b7-f53ebdfd1e03/1002170.pdf
MOOC	
1.	https://www.classcentral.com/course/youtube-control-systems-48209/classroom
2.	https://in.coursera.org/specializations/modernrobotics

COURSE TITLE	ADVANCED NUMBER THEORY			CREDITS	4
COURSE CODE	AIM02512	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To develop problem solving skills and to acquire knowledge on basic concepts of Arithmetical Functions, Dirichlet Multiplication, Averages of Arithmetical Functions and Congruence's.
Course Objective	1. Understand the study of integers and their properties. 2. Present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs. 3. Provides students an opportunity to develop an appreciation of pure mathematics while engaged in the study of basic number theoretic results. 4. Provide students an opportunity to work with conjectures, proofs, and analyzing mathematics.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on the concepts of divisibility and congruence 2. Compute the solution of problems involving divisibility 3. Determine various types of congruence problems 4. Prove mathematical theorems on existence of primitive roots modulo m 5. Compute the solution of linear Diophantine equations

Prerequisites: Basics of congruence theory

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: ARITHMETICAL FUNCTIONS AND DIRICHLET MULTIPLICATION	**(9L+3T=12)**
Introduction- The Mobius function μ(n) – The Euler totient function ϕ (n)- A relation connecting ϕ and μ - A product formula for ϕ (n)- The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function Λ(n) - multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function λ (n) - The divisor functions, Generalized convolutions.	**CO-1 BTL-3**
MODULE 2: CONGRUENCES	**(9L+3T=12)**
Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p. Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem- Polynomial congruences with prime power module.	**CO-2 BTL-3**
MODULE 3: QUADRATIC RESIDUES AND THE QUADRATIC RECIPROCITY LAW	**(9L+3T=12)**
Quadratic residues- Legendre's symbol and its properties- Evaluation of (-1/p) and (2/p)- Gauss Lemma-The quadratic reciprocity law-Applications of the reciprocity law- The Jacobi symbol-Applications to Diophantine equations- Gauss sums and the quadratic reciprocity law.	**CO-3 BTL-3**
MODULE 4: PRIMITIVE ROOTS	**(9L+3T=12)**
The exponent of a number mod *m*. Primitive roots- Primitive roots and reduced residue systems-The nonexistence of primitive roots mod 2^a for $a \geq 3$ – The existence of primitive roots and p for odd primes p. Primitive roots and quadratic residues- The existence of primitive roots mod p^a - The existence of primitive roots mod 2 p^a - The nonexistence of primitive roots in the remaining cases- The number of primitive roots mod *m*.	**CO-4 BTL-3**
MODULE 5: DIRICHLET SERIES AND EULER PRODUCTS	**(9L+3T=12)**
Chapter- 11:- Articles 11.1 to 11.7. The halfplane of absolute convergence of a Dirichlet series- The function defined by Dirichlet series, Multiplication of Dirichlet series- Euler Products- The half-plane of convergence of a Dirichlet series- Analytic properties of Dirichlet series- Dirichlet series with non-negative coefficients.	**CO-5 BTL-3**

TEXT BOOKS

1.	APOSTOL, T. M. (2010). *Introduction to Analytic Number Theory*, Springer Verlag, New York, Heidelberg, Berlin.
2.	Ivan Niven, Herbert S. Zuckerman, Hugh L. Montgomery (2008). *An Introduction to the Theory of Numbers*, 5ed, Wiley.

REFERENCE BOOKS

1.	Hardy, G. H., Wright, E. M., Heath-Brown, D. R., Silverman, J. H. *An Introduction to the Theory of Numbers*, Oxford University Press, Sixth Edition (2008).

2.	H. Davenport. (2013). The Higher Arithmetic: An Introduction to the Theory of Numbers. Cambridge University Press
E BOOKS	
1.	https://b-ok.asia/book/2369279/3a9676
MOOC	
1.	https://www.coursera.org/learn/number-theory
2.	https://www.coursera.org/specializations/discrete-mathematics

TITLE	ELECTROMAGNETIC THEORY			CREDITS	4
COURSE CODE	AIM02513	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To enables students to handle electromagnetic theory using mathematical concepts
Course Objective	1. To understand the basic concepts of electromagnetic theory 2. To understand different types of waves 3. To understand the standard results on electromagnetic theory 4. To understand about wage propagation 5. To perceive the concept antennas
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on the basic concepts of electromagnetic theory 2. Compute the solution of helmholtz equation 3. Derive the huygen and babinet principles 4. Classify guided waves 5. Calculate and apply fundamental antenna parameters

Prerequisites: Basics of physics

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	-
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	-
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNDAMENTAL CONCEPTS OF ELECTROMAGNETICS (9L+3T=12)	
Fundamental concepts of electromagnetics: Maxwell equations- Lorentz force relation- electric and magnetic polarizations- constitutive relations- boundary conditions- Poynting theorem in real and complex forms- energy relations.	**CO-1 BTL-3**

MODULE 2: SOLUTION OF HELMHOLTZ EQUATION	**(9L+3T=12)**
Plane- cylindrical- and spherical waves- dispersion- phase and group velocities- attenuation- wave propagation in anisotropic media.	**CO-2** **BTL-3**
MODULE 3: ELECTROMAGNETIC THEOREMS	**(9L+3T=12)**
Uniqueness- duality- reciprocity- equivalence- and induction theorems- Huygen and Babinet principles.	**CO-3** **BTL-3**
MODULE 4: GUIDED AND WAVE PROPAGATION	**(9L+3T=12)**
Mode expansions- metallic and dielectric waveguides- resonant cavities.	**CO-4** **BTL-3**
MODULE5: ANTENNAS	**(9L+3T=12)**
Potentials- radiation- elementary antennas.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Lonngren, E., Savor, S. V. (2017). *Fundamentals of Electromagnetics with Matlab*, PHI, Second Edition.
2.	Hayt (Jr), W. H., Buck, J. A. (2020). *Engineering Electromagnetics*, TMH, Nineth Edition.
REFERENCE BOOKS	
1.	Balanis, C. A. (2012). *Advanced Engineering Electromagnetics*. Second Edition.
2.	Jordan, E. C. and Balmain, K. G. *Electromagnetic Waves & Radiating System*, PHI. Second Edition, (2020).
E BOOKS	
1.	https://www.electronicsforu.com/resources/9-free-ebook-on-elecromagnetics
2.	https://bookauthority.org/books/beginner-electromagnetism-books

MOOC	
1.	https://www.mitmuzaffarpur.org/wp-content/uploads/2018/08/COURSE-FILE-EMFT-_2018-19.pdf
2.	https://nptel.ac.in/courses/115/101/115101005/
3.	https://onlinecourses.nptel.ac.in/noc21_ee83/preview

COURSE TITLE	NUMBER THEORY AND CRYPTOGRAPHY			CREDITS	4
COURSE CODE	AIM02514	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	It is a discipline that helps to make better decisions in Number Theory and Crptography .
Course Objective	The course will help the Learner to 1. Have a knowledge on divisibility. 2. Learn congruence and solving congruence. 3. Know about quadratic residues 4. Describe discrete laws in finite fields. 5. Classify the concept of pseudoprimes.
Course Outcome	Upon completion of the course students will be able to: 1. Have learnt to solve divisibility problems using binomial theorem. 2. Determine congruence and compute power residues. 3. Apply quadratic reciprocity law in cryptography. 4. Perform discrete laws in finite field. 5. Use Pseudoprimes and strong Pseudoprimes.

Prerequisites: Calculus and linear algebra

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	-	-	2	-	1	2	-	3	3	-
CO2	3	3	1	3	3	-	-	2	3	-	--	-	2	2	1
CO3	3	2	2	1	2	1	-	1	-	-	1	-	3	-	2
CO4	3	2	3	2	3	-	-	2	-	-	-	-	3	2	-
CO5	3	2	3	3	3	-	-	2	2	-	1	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:ELEMENTARY NUMBER THEORY **(9L+3T=12)**

Divisibility and the Euclidean Algorithm, Congruences, Finite fields and Quadratic residues, Cryposystems, Enciphering matrices, Public key Cryptography, RSA, Discrete Log, Knapsack, Primality and	**CO-1 BTL-3**

Factoring.	
MODULE 2: INTRODUCTION TO CRYPTOSYSTEMS	**(9L+3T=12)**
Some simple crypto systems , enciphering matrices, DES	**CO-2** **BTL-3**
MODULE 3: FINITE FIELDS AND QUADRATIC RESIDUES	**(9L+3T=12)**
Finite fields, quadratic residues and reciprocity.	**CO-3** **BTL-3**
MODULE 4: PUBLIC KEY CRYPTOGRAPHY	**(9L+3T=12)**
The idea of a public key Cryptography, RSA, Discrete Log, Algorithms to find discrete logs in finite Fields: Shank's giant – step - baby -step algorithm, Silver-Pohlig – Hellman's algorithm, Diffie - Hellman key - exchange system, ElGamal, zero – knowledge protocols.	**CO-4** **BTL-3**
MODULE 5: PRIMALITY FACTORING AND ELLIPTIC CURVES	**(9L+3T=12)**
Pseudo primes and strong Pseudo primes, some methods to factor a composite integer: Pollard's rho method, Fermat factorization and factor bases, the quadratic Sieve method, elliptic curves-basic facts, elliptic curve cryptosystems	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Behrouz A. Forouzan, "Cryptography & Network Security", Tata McGraw Hill, Special Indian Edition, Third Edition, New Delhi, 2015
2.	Kenneth Ireland & Michael Rosen, "A Classical Introduction to Modern Number Theory",Springer International Edition, Second Edition, New York, 2010
REFERENCE BOOKS	
1.	Koblitz, N., "A course in number theory and Cryptography", Springer Verlag , New York, 1994
2.	Niven.I, Herbert S.Zuckermann, Hugh L. Montgomery, "An Introduction to the Theory of Numbers", John Wiley, Fifth Edition, New York, 2013.
3.	Stinson D.R., "Cryptography: Theory and Practice", CRC Press, Fourth Edition, New York, 2018
E BOOKS	
1.	https://link.springer.com/book/10.1007/978-1-4419-8592-7
MOOC	
1.	https://in.coursera.org/learn/number-theory-cryptography
2.	https://www.classcentral.com/course/number-theory-cryptography-9210

COURSE TITLE	GENETIC ALGORITHM			CREDITS	4
COURSE CODE	AIM02515	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The goal is to introduce the Evolutionary Computation (EC) which is used in solving hard problems that have wide variability in their characteristics.
Course Objective	1. To solve hard problems without using complex mathematical formulations 2. To design algorithms that are robust yet easy to program
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on the basic concepts of Optimization problems 2. Develop population-based algorithms and its genetic representations 3. Apply the concept of operators on real valued representations 4. Compute the solution of evolution strategies 5. Apply the optimization algorithms in real life application problems

Prerequisites: Some background in Bridge Sequence.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF OPTIMIZATION	(9L+3T=12)
Basics of Optimization, Optimization Problems, Point to Point Algorithms, Simulated Annealing.	CO-1 BTL-3

MODULE 2: POPULATION BASED ALGORITHMS	**(9L+3T=12)**
Population Based Algorithms, Brief Overview of Evolutionary Computation, Genetic Algorithms (Theory and Advanced Operators), Genetic Representation, search operators, selection schemes and selection pressure.	**CO-2** **BTL-3**
MODULE 3: REAL VALUED REPRESENTATION OPERATORS	**(9L+3T=12)**
Operators on Real valued Representations, Niche and fitness sharing, Particle Swarm Optimization, Mimetic Algorithms.	**CO-3** **BTL-3**
MODULE 4: GENETIC PROGRAMMING	**(9L+3T=12)**
Evolution Strategies, Genetic Programming, Evolutionary Programming, Differential Evolution.	**CO-4** **BTL-3**
MODULE 5: OPTIMIZATION PROBLEMS	**(9L+3T=12)**
Constraint handling in optimization problems, Real Life application of optimization Algorithms, Introduction of Multi-objective Evolutionary Algorithms.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	D. E. Goldberg, (2008). *Genetic Algorithm in search, optimization & Machine learning,* Addison – Pearson Education India.
2.	S.N. Sivanandam, S. N. Deepa ,(2007). *Introduction to Genetic Algorithms.* Springer publication.
REFERENCE BOOKS	
1.	Lance Chambers, (2000). *The Practical Handbook* of genetic algorithms applications, Second edition, CRC Press.
2.	Kenneth A. DeJong, (2006). *Evolutionary Computation, A Unified Approach,* MIT Press, ISBN: 0262041944
E BOOKS	
1.	https://freecomputerbooks.com/Genetic-Algorithms-in-Applications.html
2.	https://books.google.co.in/books/about/Introduction_to_Genetic_Algorithms.html?id=wonrLjj2GagC&redir_esc=y

MOOC	
1.	https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_8/M8L5_LN.pdf
2.	https://www.coursera.org/lecture/functional-mri-2/module-9-advanced-experimental-design-iii-optimizing-experimental-designs-with-O96gd
3.	https://www.udemy.com/course/geneticalgorithm/

COURSE TITLE	APPLICATIONS OF GRAPH THEORY			CREDITS	3
COURSE CODE	AIM02516	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course makes students to learn directed and undirected graphs, paths, cycles, trees, colorings and matchings, with applications to sciences and engineering.
Course Objective	The objective of the course is to introduce students with the fundamental concepts in graph Theory, with applications to sciences and engineering.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding on basics concepts of graph theory 2. Determine a minimal spanning tree for a given weighted graph 3. Develop the relation between domination and minus domination in graphs 4. Develop an understanding on planar graphs and coloring 5. Compute the solution of matching of graphs

Prerequisites: Basics of graphs

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO2	-	2	3	3	3	-	-	2	3	-	-	-	3	-	3
CO3	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO4	-	2	3	3	3	-	-	2	-	-	-	-	3	-	3
CO5	-	2	3	3	3	-	-	2	2	-	-	-	3	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC CONCEPTS OF GRAPHS (9L+3T=12)

Fundamental Concepts – The incidence and adjacency matrix – Subgraphs – Vertex degree – Degree sequence – Path and cycles – Shortest path problem – Dijkstra's algorithm. **Self-Study:** Path and cycles.	**CO-1** **BTL-3**

MODULE 2: TREES AND NETWORKS	**(9L+3T=12)**
Trees – Cut edges and bridges – Cut vertices – Cayley's formula – Connectivity – Blocks – Euler tours – Hamiltonian cycles – Menger's Theorem – The Chinese Postman Problem – Fleury's algorithm – Network flow problem.	**CO-2** **BTL-3**
MODULE 3: DOMINATION	**(9L+3T=12)**
Introduction to Domination function – Minus Domination in graphs – Relation between Domination and minus domination – Extremal results – Upper minus Domination – Minus Domination in cubic graphs. **Self-Study:** Relation between Domination and minus domination.	**CO-3** **BTL-3**
MODULE 4: PLANAR GRAPHS AND COLORING	**(9L+3T=12)**
Planar graphs – Euler formula – Dual graphs – Planarity testing – Kuratowski's Theorem – Coloring – Crossing number – Surfaces of higher genus – Four and Five Colour Theorem.	**CO-4** **BTL-3**
MODULE 5: MATCHINGS	**(9L+3T=12)**
Matchings – Matchings and coverings in bipartite graphs – Perfect matchings – Edge colorings – Edge chromatic number – Independent sets – Vertex colorings – Chromatic number – Brook's Theorem. **Self-Study:** Edge colorings.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Vadim, Z. (2021). *Modern Applications of Graph Theory* ,Oxford University Press.
2.	Richard, J.T. (2017). *Introduction to Graph Theory*, Zaccheus Entertainment.
REFERENCE BOOKS	
1.	NarsinghDeo. (2016). *Graph Theory with Applications to Engineering & Computer Science*, Dover publications, New York.
2.	G. A. V. Pai.(2017). *Data Structures and Algorithms: Concepts - Techniques and Applications***,** McGraw Hill Education**.**
E BOOKS	
1.	https://b-ok.asia/book/3289235/25da6f.
MOOC	
1.	https://www.coursera.org/learn/graphs
2.	https://www.coursera.org/specializations/data-structures-algorithms

COURSE TITLE	FINANCIAL CALCULUS			CREDITS	4
COURSE CODE	AIM02517	COURSE CATEGORY	DE	L-T-P-S	3-1-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	It is a discipline that helps to make better decisions in Financial calculus.
Course Objective	The course will help the Learner to: 1. Understand the basic probability concepts in association with random variables and significance of the Central Limit theorem with respect to the Brownian motion. 2. Understand the basic concepts of present value and accumulated value and apply these concepts toward solving more complicated financial problems and complex annuity problems. 3. Appreciate the Arbitrage theorem in the context of the Black–Scholes formula. 4. Obtain practical knowledge on the Portfolio selection problem. 5. Understand option pricing with respect to various options via multi-period binomial models.
Course Outcome	Upon completion of the course students will be able to: 1. Demonstrate a comprehensive understanding of the probability concepts. 2. Locate and use information to solve problems in interest theory and Finance. 3. Know the main features of models commonly drawn from industry and Financial firms in order to explore arbitrage strategy. 4. Understand and appraise utility and effectiveness in option pricing. 5. Simulate appropriate models treating Exotic options.

Prerequisites: Single and multivariable calculus, linear algebra, differential equation, probability and statistics.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	-	-	2	-	-	-	-	3	2	1
CO2	3	3	2	3	3	-	1	2	3	-	1	-	3	2	2
CO3	3	3	2	2	2	2	-	3	-	-	-	-	3	-	3
CO4	3	2	3	2	3	-	-	2	-	-	1	-	3	3	-
CO5	3	2	3	3	3	1	-	2	2	-	-	-	3	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROBABILITYAND RANDOMVARIABLES	**(9L+3T=12)**
ProbabilityandEvents-Conditionalprobability-RandomVariablesandExpectedvalues-Covariance and Correlation - Normal Random Variables - Properties of Normal Random Variables - Central Limittheorem – Geometric Brownian Motion as a limit of simpler models- Brownian motion.	**CO-1** **BTL-3**
MODULE 2: PRESENTVALUEANALYSISANDARBITRAGE	**(9L+3T=12)**
Interest rates - Present value analysis - Rate of return - Continuously varying interest rates – Pricingcontracts viaArbitrage-Anexampleinoptionspricing.	**CO-2** **BTL-3**
MODULE 3: ARBITRAGETHEOREMAND BLACK-SCHOLESFORMULA	**(9L+3T=12)**
The Arbitrage theorem–Multi-period binomial model- Black Scholes formula-Properties of Black-Scholes option cost-Delta Hedging Arbitrage Strategy-Pricing American put options**.**	**CO-3** **BTL-3**
MODULE 4: EXPECTED UTILITY	**(9L+3T=12)**
Limitationsofarbitragepricing-Valuinginvestmentsbyexpectedutility-Theportfoliosectionproblem - Capital assets pricing model - Rates of return - Single period and geometric Brownian motion.	**CO-4** **BTL-3**
MODULE 5: EXOTIC OPTIONS	**(9L+3T=12)**
Barrier options - Asian and look back options - Monte Carlo Simulation - Pricing exotic option bysimulation-Moreefficientsimulationestimators-Optionswithnon-linearpayoffs-pricingapproximationsviamulti-periodbinomialmodels.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Martin Baxter, Andrew Rennie, Financial Calculus: An Introduction to Derivative Pricing 1st Edition, Cambridge University Press, USA, Kindle Edition, 2014.
2.	Mark S. Joshi , The Concepts and Practice of Mathematical Finance: 8 (Mathematics, Finance and Risk), 2nd Edition, Cambridge University Press, USA, 2008
REFERENCE BOOKS	
1.	SheldonM.Ross,“AnElementaryIntroductiontoMathematicalFinance”,Cambridge UniversityPress,3rdEdition,Cambridge,2011.
2.	StevenRoman,“IntroductiontotheMathematicsoffinance”,Springer-VerlagNewYork,2ndEdition,2012.
3.	Williams,R.J.,“IntroductiontotheMathematicsoffinance”,AMS,UniversitiesPress Pvt.Ltd,India,2006.
E BOOKS	
1.	https://www.kobo.com/ww/en/ebook/financial-calculus
MOOC	
1.	https://www.classcentral.com/course/swayam-financial-mathematics-13024
2.	https://www.edx.org/course/mathematical-methods-for-quantitative-finance