INDUCTION PROGRAMME

S no	Course Name	Category	L-T-P-C
1	Physical activities--sports, yoga and meditation, plantation	MC	0-0-6-0
2	Career counselling	MC	2-0-2-0
3	Orientation to all branches –career options, tools, etc.	MC	3-0-0-0
4	Orientation on admitted branch—corresponding labs, tools and platforms	EC	2-0-3-0
5	Proficiency modules & productivity tools	ES	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	MC	2-0-3-0
7	Remedial training in foundation courses	MC	2-1-2-0
8	Human values & professional ethics	MC	3-0-0-0
9	Communication skills –focus on listening, speaking, reading, writing skills	BS	2-1-2-0
10	Concepts of programming	ES	2-0-2-0

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AK23 - REGULATIONS
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B.Tech. – I Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P	C			
1	BS	23ABS9903	Engineering Physics	2	1	0	3	30	70	100
2	BS	23ABS9904	Linear Algebra & Calculus	2	1	0	3	30	70	100
3	ES	23AES0201	Basic Electrical & Electronics Engineering	2	1	0	3	30	70	100
4	ES	23AES0301	Engineering Graphics	1	0	4	3	30	70	100
5	ES	23AES0501	Introduction to Programming	2	1	0	3	30	70	100
6	ES	23AES0503	IT Workshop	0	0	2	1	30	70	100
7	BS	23ABS9908	Engineering Physics Lab	0	0	2	1	30	70	100
8	ES	23AES0202	Electrical & Electronics Engineering Workshop	0	0	3	1.5	30	70	100
9	ES	23AES0502	Computer Programming Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9904	NSS/NCC/Scouts & Guides/Community Service	0	0	1	O.5	50	–	50
			Total	9	4	15	20.5	320	630	950

B.Tech.– I Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P	C			
1	HM	23AHM9901	Communicative English	2	0	0	2	30	70	100
2	BS	23ABS9901	Chemistry	2	1	0	3	30	70	100
3	BS	23ABS9905	Differential Equations &Vector Calculus	2	1	0	3	30	70	100
4	ES	23AES0101	Basic Civil& MechanicalEngineering	2	1	0	3	30	70	100
5	PC	23APC0501	Data Structures	2	1	0	3	30	70	100
6	HM	23AHM9902	Communicative English Lab	0	0	2	1	30	70	100
7	BS	23ABS9906	Chemistry Lab	0	0	2	1	30	70	100
8	ES	23AES0302	Engineering Workshop	0	0	3	1.5	30	70	100
9	PC	23APC0502	Data Structures Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9903	Health and wellness, Yoga and Sports	0	0	1	O.5	50	–	50
			Total	**10**	**4**	**11**	**19.5**	**320**	**630**	**950**

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B.Tech.–II Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T /CLC	P	C			
1	BS	23ABS9913	Discrete Mathematics & Graph Theory	2	1	0	3	30	70	100
2	HM	23AHM9905	Universal Human Values	2	1	0	3	30	70	100
3	PC	23APC0508	Database Management Systems	2	1	0	3	30	70	100
4	PC	23APC0504	Advanced-Data Structures and Algorithms Analysis	2	1	0	3	30	70	100
5	PC	23APC0506	Object-Oriented Programming Through JAVA	2	1	0	3	30	70	100
6	PC	23APC0505	Advanced-Data Structures and Algorithms Analysis Lab	0	0	3	1.5	30	70	100
7	PC	23APC0507	Object-Oriented Programming Through JAVA Lab	0	0	3	1.5	30	70	100
8	SC	23ASC0501	Python Programming	1	0	2	2	30	70	100
			Total	**11**	**5**	**8**	**20**	**240**	**560**	**800**

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P	C			
1	HM	23AHMMB01	Managerial economics and financial analysis	2	0	0	2	30	70	100
2	BS	23ABS9915	Statistical Methods for Data Science	2	1	0	3	30	70	100
3	PC	23APC3001	Artificial Intelligence	2	1	0	3	30	70	100
4	PC	23APC3201	Introduction to Data Science	2	1	0	3	30	70	100
5	PC	23APC0503	Digital Logic & Computer Organization	2	1	0	3	30	70	100
6	PC	23APC3002	Artificial Intelligence Lab	0	0	3	1.5	30	70	100
7	PC	23APC0509	Data Science using Python Lab	0	0	3	1.5	30	70	100
8	SC	23ASC0503	Full Stack Development-1	1	0	2	2	30	70	100
9	ES	23AES0304	Design Thinking & Innovation	2	0	0	2	30	70	100
10	MC	23AMC9901	Environmental Science	2	0	0	–	30	–	30
			Total	**15**	**4**	**8**	**21**	**300**	**630**	**930**
			Mandatory Community Service Project Internship of 08 weeks duration during summer vacation							

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B.Tech.– III Year I Semester

S. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/CLC	P	C			
1	PC	23APC3003	Data warehousing and data mining	2	1	0	3	30	70	100
2	PC	23APC3005	introduction to Machine Learning	2	1	0	3	30	70	100
3	PC	23APC3007	Multi Agent Systems	2	1	0	3	30	70	100
4	PE-I	23APE3001 23APE3002 23APE3003 23APE3004	1. Data Visualization 2. Soft computing 3. IoT for AI Applications 4. Exploratory Data Analysis with Python	2	1	0	3	30	70	100
5	ES	23AES0504	Introduction to Quantum Technologies and Applications	2	1	0	3	30	70	100
6	OE-1	23AOE9915	English for Competitive Examinations	2	1	0	3	25	75	100
7	PC	23APC3004	Data warehousing and data mining Lab	0	0	3	1.5	30	70	100
8	PC	23APC3006	Machine Learning Lab	0	0	3	1.5	30	70	100
9	SC	23ASC9901	Soft Skills	1	0	2	2	30	70	100
10	ES	23AES0404	Tinkering Lab	0	0	2	1	30	70	100
11	PR	23APR3001	Community Service Internship	-	-	-	2	100	-	100
			Total	**13**	**6**	**10**	**26**	**395**	**705**	**1100**

Open Elective – I

S. NO	Course Code	Course Name	Offered by the Dept.
1	23AOE0101	Green Buildings	CIVIL
2	23AOE0102	Construction Technology and Management	
3	23AOE0201	Electrical Safety Practices and Standards	EEE
4	23AOE0301	Sustainable Energy Technologies	ME
5	23AOE0401	Electronic Circuits	ECE
6	23AOE9901	Mathematics for Machine Learning and AI	Mathematics
7	23AOE9906	Materials Characterization Techniques	Physics
8	23AOE9911	Chemistry of Energy Systems	Chemistry
9	23AOE9915	English for Competitive Examinations	Humanities
10	23AOEMB01	Entrepreneurship and New Venture Creation	

S.No.	Category	Course code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P				
1	PC	23APC3008	Big Data Analytics	2	1	0	3	30	70	100
2	PC	23APC3010	Deep learning	2	1	0	3	30	70	100
3	PC	23APC3012	Natural Language Processing	2	1	0	3	30	70	100
4	PE-II	**23APE3005** **23APE3006** **23APE3007** **23APE3008**	1. Reinforcement learning 2. Recommender Systems 3. Predictive Analytics 4. AI for Finance	2	1	0	3	30	70	100
5	PE-III	**23APE3009** **23APE3010** **23APE3011** **23APE3012**	1. Quantum Computing 2. Computer Vision 3. Cloud Computing for AI 4. Social Network Analysis	2	1	0	3	30	70	100
6	OE-II	23AOE0402	**Open Elective – II**	2	1	0	3	25	75	100
7	PC	23APC3009	Deep learning Lab	0	0	3	1.5	30	70	100
8	PC	23APC3011	Big data analytics & Data Visualization Lab	0	0	3	1.5	30	70	100
9	SC	23ASC3001	Full Stack Development - II	1	0	2	2	30	70	100
10	AC	23AMC9902	Technical Paper Writing & IPR	2	0	0	-	30	-	30
11	SC	23ASC3002	Workshop	-	-	-	-	-	-	-
			TOTAL	15	6	8	23	295	635	930

NOTE: Workshop can be conducted either in III-I or III-II and the participation certificate with 90% and above attendance on it shall be submitted to the Department /Exam section before III-II Regular exam notification released

Open Elective – II

S NO	Course Code	Course Name	Offered by the Dept.
1	23AOE0103	Disaster management	CIVIL
2	23AOE0104	Sustainability in engineering practices	
3	23AOE0202	Renewable Energy Sources	EEE
4	23AOE0302	Automation and Robotics	ME
5	23AOE0402	Digital Electronics	ECE
6	23AOE9902	Optimization Techniques	Mathematics
7	23AOE9907	Physics Of Electronic Materials And Devices	Physics
8	23AOE9912	Chemistry Of Polymers And Applications	Chemistry
9	23AOE9916	Academic Writing and Public Speaking	Humanities
10	23AOE9903	Mathematical Foundation of Quantum Technologies	Mathematics

S. No.	Category	Course code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CL C	P				
1	**PC**	23APC3013	Generative AI	2	1	0	3	30	70	100
2	**MC-II**	23AHMMB02 23AHMMB03 23AHMMB04	1. Business Ethics and Corporate Governance 2. E-Business 3.Management Science	2	0	0	2	30	70	100
3	**PE-IV**	23APE3013 23APE3014 23APE3015 23APE3016	1. Edge AI 2. Human Computer Interaction 3. Machine learning Operations 4. NoSQL databases	2	1	0	3	30	70	100
4	**PE-V**	23APE3017 23APE3018 23APE3019 23APE3020	1. Data Wrangling 2. Drone Technology 3. Robotics 4. Mining Massive Data Sets	2	1	0	3	30	70	100
5	**OE-III**		**Open Elective-III**	2	1	0	3	30	70	100
6	**OE-IV**		**Open Elective-IV**	2	1	0	3	30	70	100
7	**SC**	23ASC3002	Prompt Engineering	1	0	2	2	30	70	100
8	AC	23AMC9903	Gender Sensitization	2	0	0	-	30	-	30
9	PR	**23APR3002**	Industry Internship [SHORT TERM]	-	-	-	2	100		100
			TOTAL	15	5	02	21	340	490	830

Open Elective – III

S NO	Course Code	Course Name	Offered by the Dept.
1	23AOE0105	Building materials and services	CIVIL
2	23APE0106	Environmental impact assessment	
3	23AOE0203	Smart Grid Technologies	EEE
4	23AOE0303	3D Printing Technologies	ME
5	23APC0412	Microprocessors and Microcontrollers	ECE
6	23AOE9904	Wavelet transforms and its Applications	Mathematics
7	23AOE9908	Smart Materials And Devices	Physics
8	23AOE9913	Green Chemistry And Catalysis For Sustainable Environment	Chemistry
9	23AOE9917	Employability Skills	Humanities
10	23AOE9909	Introduction to Quantum Mechanics	Physics

Open Elective – IV

S NO	Course Code	Course Name	Offered by the Dept.
1	23AOE0106	Geo-Spatial Technologies	CIVIL
2	23AOE0107	Solid Waste Management	
3	23AOE0204	Electric Vehicles	EEE
4	23AOE0304	Total Quality Management	ME
5	23AOE0403	Transducers and Sensors	ECE
6	23AOE9905	Financial Mathematics	Mathematics
7	23AOE9910	Sensors And Actuators For Engineering Applications	Physics
8	23AOE9914	Chemistry Of Nanomaterial's and Applications	Chemistry
9	23AOE9918	Literary Vibes	Humanities
10	23AOE0510	Quantum Computing	CSE

S.No.	Category	Course code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/CLC	P				
1	PR	23APR3003	Long term Internship	-	-	-	4	100	-	100
2	PR	23APR3004	Project Work	-	-	-	8	40	160	200
			Total	-	-	-	12	140	160	300

LIST OF COURSES FOR HONOURS DEGREE in B. Tech-AI&DS

Note: students must choose courses from the list (S.No 1 to 9) and earn a minimum of 18 credits, based on availability on SWAYAM-NPTEL Portal. A total no of 18 creditsare required to obtain an Honours degree in B.Tech-AIDS

S.No.	Subjects codes	Courses	Weeks	Credits
1	23AHN3001	AI: Knowledge Representation and Reasoning	12 weeks	3
2	23AHN3002	Applied Accelerated AI	12 weeks	3
3	23AHN3003	Affective Computing	12 weeks	3
4	23AHN3004	Introduction to Large Language Models	12 weeks	3
5	23AHN3005	Deep Learning for Computer Vision	12 weeks	3
6	23AHN3006	Distributed Optimization and Machine Learning	12 weeks	3
7	23AHN3007	AI: Search Methods for Problem Solving	12 weeks	3
8	23AHN3008	Responsible and safe AI Systems	12 weeks	3
9	23AHN3009	Games and Information	12 weeks	3
			Total	**18**

MINOR DEGREE in Artificial Intelligence for CSE,CSD,CSIT,CIC,ECE,EEE,ME and CE

Note: students of CSE,CSD,CSIT,CIC,ECE,EEE,ME and CE Programs to get a minor in artificial intelligence must complete SWAYAM-NPTEL courses listed below (S. No1 to 13) and obtain a total of 15 credits.in addition,Students must complete a **Minor Discipline Project** in **Artificial Intelligence**, which carries 3 credits altogether,a total of 18 credits are required to obtain the minor degree in **Artificial Intelligence**

S.No	SUB CODE	Course Name	Weeks	Credits
1	23AMN3001	Discrete Mathematics	12 Weeks	3
2	23AMN3002	Design and Analysis of Algorithms	12 Weeks	3
3	23AMN3003	Introduction to algorithms and analysis	12 Weeks	3
4	23AMN3004	Introduction to Machine Learning	12 Weeks	3
5	23AMN3005	Introduction to Artificial Intelligence	12 Weeks	3
6	23AMN3006	Artificial Intelligence: Concepts and Techniques	12 Weeks	3
7	23AMN3007	Human Computer Interaction	12 Weeks	3
8	23AMN3008	Foundations of Computing	12 Weeks	3
9	23AMN3009	ML and DL: Fundamentals and Applications	12 Weeks	3
10	23AMN3010	Reinforcement Learning	12 Weeks	3
11	23AMN3011	Computer Vision	12 Weeks	3
12	23AMN3012	Natural Language Processing	12 Weeks	3
13	23AMN3013	Minor Project in AI Domain (Mandatory)	12 Weeks	3
		Total		**18**

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Semester I (First year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P	C			
1	BS	23ABS9903	Engineering Physics	2	1	0	3	30	70	100
2	BS	23ABS9904	Linear Algebra & Calculus	2	1	0	3	30	70	100
3	ES	23AES0201	Basic Electrical & Electronics Engineering	2	1	0	3	30	70	100
4	ES	23AES0301	Engineering Graphics	1	0	4	3	30	70	100
5	ES	23AES0501	Introduction to Programming	2	1	0	3	30	70	100
6	ES	23AES0503	IT Workshop	0	0	2	1	30	70	100
7	BS	23ABS9908	Engineering Physics Lab	0	0	2	1	30	70	100
8	ES	23AES0202	Electrical & Electronics Engineering Workshop	0	0	3	1.5	30	70	100
9	ES	23AES0502	Computer Programming Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9904	NSS/NCC/Scouts & Guides/Community Service	0	0	1	0.5	50	-	50
			Total	**9**	**4**	**15**	**20.5**	**320**	**630**	**950**

Course Code		ENGINEERING PHYSICS		L	T/CLC	P	C
23ABS9903				2	1	**0**	**3**
Regulation: **AK23**		Common to I B.Tech ECE, AI&DS, AI&ML, ME, CE (Sem-1) & CSE, CIC, EEE, &CSD (Sem-2)					

Course Outcomes (CO): At the end of the course students will be able to

CO1:**Understand** the intensity variation of light due to interference, diffraction, and polarization. CO2:**Analyze** the fundamentals of crystallography and X-ray diffraction.
CO3:**Apply** the basic concepts of dielectric and magnetic materials for engineering applications.
CO4:**Analyze** the fundamentals of Quantum mechanics and interpret the nanomaterials for engineering problems. CO5:**Analyze** the charge carrier dynamics in semiconductors by implementing the equations of state.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	The intensity variation of light due to interference, diffraction, and polarization.			L2
2	**Analyze**	The fundamentals of crystallography and X-ray diffraction.			L4
3	**Apply**	The basic concepts of dielectric and magnetic materials		for engineering applications.	L3
4	**Analyze**	The fundamentals of Quantum mechanics and interpret the nanomaterials		for engineering problems.	L4
5	**Analyze**	The charge carrier dynamics in semiconductors.	By implementing the equations of state.		L4

UNIT I   Wave Optics   10 Hrs

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Newton's Rings, Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit, double slit (Qualitative) – Diffraction Grating.

Polarization: Introduction -Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism -Half wave and Quarter wave plates.

UNIT II Crystallography and X-ray diffraction   8 Hrs

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattices – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC - Miller indices – separation between successive (hkl) planes.

X-ray diffraction: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue's and powder methods.

UNIT III Dielectric and Magnetic Materials   8 Hrs

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector – Relation between the electric vectors - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius-Mossotti equation - Frequency dependence of polarization-Applications of Dielectric materials.

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability – Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials - Applications of magnetic materials.

UNIT IV Quantum Mechanics and Nanomaterials   12 Hrs

Quantum Mechanics: Dual nature of matter – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent and dependent wave equations– Particle in a one-dimensional infinite potential well.

Nanomaterials: Introduction to Nanomaterials–Significance of nanoscale - Physical, Mechanical, Magnetic, and optical properties of nanomaterials –Synthesis of nanomaterials: Ball Milling, Applications of Nanomaterials.

UNIT V Semiconductors   10 Hrs

Semiconductors: Formation of energy bands – classification of crystalline solids - Intrinsic semiconductors: Density of charge carriers – Electrical conductivity – Fermi level – Extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein's equation – Hall effectand its applications – Applications of semiconductors.

Textbooks:
1. A Text book of Engineering Physics, M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. K.Thyagarajan ―Engineering Physics‖,-Mc Graw Hill Publishing Company Ltd, 2016.
3. Engineering Physics - D.K.Bhattacharya and Poonam Tandon, Oxford press (2015)

Reference Books:
1. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning 2021.
2. Engineering Physics - Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018.
3. Engineering Physics‖ - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.2010
4. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

Web Resources: https://www.loc.gov/rr/scitech/selected-internet/physics.html

Mapping of COs to POs and PSOs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	15	22.3	3	**Understand**	**L2**	PO1	PO1: Apply (L3)	2
2	11	16.4	2	**Analyze**	**L4**	PO1	PO1: Apply (L3)	3
3	12	17.9	2	**Apply**	**L3**	PO1, PO4	PO1, PO4: Apply (L3)	3
4	13	19.4	2	**Analyze**	**L4**	PO1	PO1: Apply (L3)	3
5	16	23.8	3	**Analyze**	**L4**	PO1, PO4	PO1, PO4: Apply (L3)	3
	67							

CO1: The intensity variation of light due to interference, diffraction, and polarization.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO1 Action Verb is lesser than PO1 verb by one level; Therefore, correlation is moderate (2).
CO2: The fundamentals of crystallography.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO2 Action Verb is greater than PO1 verb; Therefore correlation is high (3).
CO3: Apply the basic concepts of dielectric and magnetic materials for engineering applications.
Action Verb: Apply (L3)
PO1 and PO4 Verbs: Apply (L3)
CO3 Action Verb level is equal to PO1 and PO4 verb; Therefore correlation is high (3).
CO4: The fundamentals of Quantum mechanics and interpret the nanomaterials for engineering problems.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).
CO5: The charge carrier dynamics in semiconductors by implementing the equations of state.
Action Verb: Analyze (L4)
PO1 and PO4 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb; therefore, the correlation is high (3).

Year : I **Semester** : I				**Branch of Study :** Common to All			

Subject Code: 23ABS9904	**Subject Name: Linear Algebra & Calculus**	**L** 2	**T/CLC** 1	**P** 0	**Credits** 3	

Course Outcomes (CO):
Student will be able to
CO1. **Analyze** the matrix algebraic techniques for engineering applications.
CO2. **Understand** the concept of Eigen values, Eigen vectors and quadratic forms.
CO3. **Analyze** the mean value theorems for real time applications.
CO4. **Apply** the concepts of partial differentiation to functions of several variables.
 CO5. **Apply** the multivariable integral calculus for computation of Area and Volume.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Analyze**	the matrix algebraic techniques	for engineering applications.		**L4**
2	**Understand**	the concept of eigen values, eigen vectors and quadratic forms.	-		**L2**
3	**Analyze**	the mean value theorems	for real time applications.		**L4**
4	**Apply**	the concept of Maxima and Minima	to functions of several variables.		**L3**
5	**Apply**	the multivariable integral calculus	for computation of Area and volume.		**L3**

Unit I: Matrices **12hrs**
Rank of a matrix by Echelon form, Normal form, Cauchy-Binet formula (without proof).Inverse of Non-singular matrices by Gauss-Jordan method, system of linear equations: solving system of Homogeneous and Non-homogeneous equations by Gauss Elimination method, Jacobi and Gauss Seidel Iteration methods.

Unit II: Eigen values, Eigen vectors and Orthogonal Transformation **9hrs**
Eigen values, Eigen vectors and their properties, Diagonalization of a matrix, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, Quadratic forms and Nature of the Quadratic forms, Reduction of quadratic form to canonical forms by Orthogonal Transformation.

Unit III: Calculus **9hrs**
Mean Value Theorems: Rolle's theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders (without proof), problems and applications on the above theorems.

Unit IV: Partial differentiation and Applications(Multi Variable Calculus) **10hrs**
Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Directional derivative, Taylor's and Maclaurin's series expansion of functions of two variables, Jacobians, Functional dependence, Maxima and Minima of functions of two variables, method of Lagrange multipliers.

Unit V: Multiple Integrals **10hrs**
Double integrals, triple integrals change of order of integration, change of Variables to polar, Cylindrical and Spherical coordinates, Finding areas(by double integrals) and volumes (by double integrals and triple integrals).

Textbooks:
1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.

References:
1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass,Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar,Alpha Science International Ltd., 25th Edition(9th reprint).
3. Advanced Modern Engineering Mathematics, Glyn James, Pearsonpublishers, 2018, 5 th Edition.
4. Advanced Engineering Mathematics, Micheael Greenberg, , Pearsonpublishers, 9 th edition.
5. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications,2014, Third Edition

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1		3									
2		2									
3		3									
4	3										
5	3										

mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10	14	2	**Analyze**	**L4**	PO2	**Analyze**	3
2	15	21.4	3	**Understand**	**L2**	PO2	**Apply**	2
3	15	21.4	**3**	**Analyze**	**L4**	PO2	**Analyze**	3
4	16	22.8	**3**	**Apply**	**L3**	PO1	**Apply**	3
5	14	20	**3**	**Apply**	**L3**	PO1	**Apply**	3

CO1: Analyze the matrix algebraic techniques that are needed for engineering applications.
Action Verb: Analyze(L4)
PO2 Verbs: Analyze (L4)
CO1 Action Verb is equal toPO2 verb ; Therefore correlation is high (3).

CO2: Understand the concept of eigen values, eigen vectors and quadratic forms.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO2 Action Verb is low level to PO1 verb by one level; Therefore correlation is moderate (2).

CO3: Analyze the mean value theorems for real life problems.
Action Verb: Analyze **(L4)**
PO1 Verb: Analyze (L4)
CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Apply the concept of Maxima and Minima of functions of several variables.
Action Verb: Apply (L3)
PO2 Verb: Apply (L3)
CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO5: Apply the multivariable integral calculus for computation of area and volume.
Action Verb: Apply(L3)
PO1 Verb: Apply (L3)
CO5 Action verb is high level to PO1 verb; therefore the correlation is high (3)

Course Code	Year & Sem	Basic Electrical & Electronics Engineering	L	T/CLC	P	C
23AES0201	I-I		2	1	0	3

Course Outcomes:

After studying the course, student will be able to

CO1: **Understand** the fundamental laws of A. C circuits and D. C circuits.

CO2: **Understand** operating principles of motors, generators and measuring instruments.

CO3: **Understand** the fundamentals of power generation, costing and safety measures.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
1	Understand	The fundamentals laws of A. C circuits and D. C circuits.		A. C circuits and D. C circuits	L2
2	Understand	Operating principles of motors, generators and measuring instruments.			L2
3	Understand	The fundamentals of Power generation, costing and safety measures.			L2

PART-A
BASIC ELECTRICAL ENGINEERING

UNIT I: DC & AC Circuits

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems).

UNIT II: Machines and Measuring Instruments

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone Bridge.

UNIT III: Energy Resources, Electricity Bill & Safety Measures

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

TEXTBOOKS:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition 2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013.
2. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

REFERENCE BOOKS:

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019, Fourth Edition.
2. Principles of Power Systems, V.K. Mehtha, S. Chand Technical Publishers, 2020.
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press, 2017.
4. Basic Electrical and Electronics Engineering, S. K. Bhatacharya, Person Publications, 2018, Second Edition.

WEB RESOURCES:

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108108076

COURSE OUTCOMES:

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

CO4: **Understand** the fundamental concepts of diodes, transistors and its applications.

CO5: **Analyze** the concepts of rectifiers, power supplies and amplifiers in electronics.

CO6: **Analyze** the concepts of Number Systems, Boolean Functions, Logic Gates and Digital Circuits.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO4	Understand	fundamental concepts of diodes, transistors and its applications			L2
CO5	Analyze	concepts of rectifiers, power supplies and amplifiers in electronics			L4
CO6	Analyze	concepts of Number Systems, Boolean Functions, Logic Gates and Digital Circuits			L4

UNIT I: SEMICONDUCTOR DEVICES

Introduction - Evolution of electronics – Vacuum tubes to nano electronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier.

UNIT II   : BASIC ELECTRONIC CIRCUITS AND INSTRUMENTTAION

Rectifiers and power supplies: Block diagram description of a DC power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response. Electronic Instrumentation: Block diagram of an electronic instrumentation system.

UNIT III: DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adder, Introduction to sequential circuits, Flip flops, Registers and counters (Elementary Treatment only)

Textbooks:
1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

Reference Books:
1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India, 2002.
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	2	2				1						2	
CO2	2	1				1						1	
CO3	2	1				2						1	2
CO4	2	3											
CO5	3	3											
CO6	3	3											

Justification Table:

CO	CO					Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	08	30	3	**Understand**	**L2**	PO1, PO2, PO6	PO1: Apply (L3) PO2: Identify (L3) PO6: Thumb Rule	2 2 1
2	08	30	3	**Understand**	**L2**	PO1, PO2, PO6	PO1: Apply (L3) PO2: Analyze(L4) PO6: Thumb Rule	2 1 1
3	10	38	3	**Understand**	**L2**	PO1, PO2, PO6	PO1: Apply (L3) PO2: Analyze(L4) PO6: Thumb Rule	2 1 2
4	08	30	3	Understand	**L2**	PO1, PO2	PO1: Apply (L3) PO2: Review (L2)	2 3
5	08	30	3	Analyze	**L4**	PO1, PO2	PO1: Apply (L3) PO2: Review (L2)	3 3
6	10	38	3	Analyze	**L4**	PO1, PO2	PO1:Apply(L3) PO2:Review (L2)	3 3

CO1: Understand the fundamental laws of AC and DC circuits.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO1 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Identify (L3)
CO1 Action Verb is Less than PO2 verb by one level; Therefore, correlation is moderate (2).
PO6: Using thumb rule, CO1 correlates PO6 as low (1).

CO2: Understand operating principles of motors, generators, MC and MI instruments.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO2 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO2 Action Verb is Less than PO2 verb by two level; Therefore, correlation is low (1).
PO6: Using thumb rule, CO2 correlates PO6 as low (1).

CO3: Understand the fundamentals of power generation, costing and safety measures.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO3 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO3 Action Verb is Less than PO2 verb by two level; Therefore, correlation is low (1).
PO6: Using thumb rule, CO3 correlates PO6 as medium (2).

CO4: Understand the fundamental concepts of diodes, transistors and its applications
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO4 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
PO2 Verbs: Review (L2)
CO4 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO5: Analyze the concepts of rectifiers, power supplies and amplifiers in electronics.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO5 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO5 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO6: Analyze the concepts of Number Systems, Boolean Functions, Logic Gates and Digital Circuits.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO6 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO6 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Engineering Graphics	L	T/CLC	P	C
23AES0301	I-I		1	0	4	3

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

CO: 1 **Apply** the concepts of engineering curves and scales for technical drawing.

CO: 2 **Understand** the quadrant system to locate the position of points, lines and planes.

CO: 3 **Analyze** the projection of solids located in quadrant system.

CO: 4 **Analyze** the sectional views and development of surfaces of regular solids.

CO: 5 **Apply** orthographic and isometric projections concepts to construct the given object

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the concepts of engineering curves and scales	for technical drawing		L3
CO2	Understand	the quadrant system to locate the position of points, lines and planes			L2
CO3	Analyze	the projection of solids	located in quadrant system		L4
CO4	Analyze	the sectional views and development of surfaces	of regular solids		L4
CO5	Apply	orthographic and isometric projections concepts to construct the given object			L3

Unit I: Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.
Curves: construction of ellipse, parabola and hyperbola by general, Cycloids, Involutes, Normal and tangent to Curves.
Scales: Plain scales, diagonal scales and vernier scales.

Unit II
Orthographic Projections: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.
Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes
Projections of Planes: regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

Unit III
Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

Unit IV
Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids in simple position only.
Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

Unit V
Conversion of Views: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views. **Computer graphics**: Creating 2D&3D drawings of objects including PCB and Transformations using Auto CAD (*Not for end examination*).
Text Books:
1. K. L. Narayana & P. Kannaiah, Engineering Drawing, 3/e, Scitech Publishers
2. N. D. Bhatt, Engineering Drawing, 53/e, Charotar Publishers

Reference Books:
1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2013.
2. Engineering Drawing, M.B. Shah and B.C. Rana, Pearson Education Inc,2009.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, TataMcGraw Hill, 2017.

Mapping of course outcomes with program outcomes

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Engineering Graphics	CO1	3		3							3		2	2
	CO2	2		2							3		2	2
	CO3	2		2							3		2	2
	CO4	3		3							3		2	2
	CO5	3		3							3		2	2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	24	3	Apply	L3	PO1 PO2 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 3
2	15	20	2	Understand	L2	PO1 PO2 PO10	Apply (L3) Develop (L3) Thumb Rule	2 2 3
3	15	20	2	Analyze	L4	PO1 PO2 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 3
4	15	20	2	Analyze	L4	PO1 PO2 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 3
5	12	16	2	Apply	L3	PO1 PO2 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 3

Justification Statements:
CO1: Apply the concepts of engineering curves and scales for technical drawing.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Develop (L3)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO10 Verb: Thumb Rule (TR)
CO1: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)
CO2: Understand the quadrant system to locate the position of points, lines and planes.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO2: Action verb is less than PO1 verb by one level. Therefore, the correlation is medium
(2) PO2 Verb: **Develop (L3)**
CO2: Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)
PO10 Verb: Thumb Rule (TR)
CO2: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)
CO3: Analyze the projection of solids located in quadrant system.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Develop (L3)**
CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO3: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO4: Analyze the sectional views and development of surfaces of regular solids

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO4: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO5: Apply orthographic and isometric projections concepts to construct the given object.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO5: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

Course Code	Year & Sem	INTRODUCTION TO PROGRAMMING	L	T / CLC	P	C
23AES0501	I-I	(Common to All branches of Engineering)	2	1	0	3

Course Outcomes:

After studying the course, student will be able to

CO 1: **Understand** the computer Programming concepts and Algorithms.

CO 2: **Analyze** the control structures to implement basic programs.

CO 3: **Understand** the concept of Arrays and string to manipulate the stored data.

CO 4: **Create** the dynamic memory allocation using pointers and structures.

CO 5: **Create** the user defined functions and files for modifying stored data.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the computer Programming concepts and Algorithms.			L2
CO2	Analyze	the control structures		to implement basic programs.	L4
CO3	Understand	the concept of Arrays and string		to manipulate the stored data	L2
CO4	Create	the dynamic memory allocation	using pointers and structures.		L6
CO5	Create	user defined functions and files		for modifying stored data.	L6

UNIT – I	Introduction to Programming and Problem Solving	10 Hrs

History of Computers, Basic organization of a computer: ALU, input-output units, memory, program counter, Introduction to Programming Languages, Basics of a Computer Program- Algorithms, flowcharts (Using Dia Tool), pseudo code. Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, Operations, Type Conversion, and Casting.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

UNIT – II	Control Structures	9 Hrs

Simple sequential programs Conditional Statements (if, if-else, switch), Loops (for, while, do- while) Break and Continue.

UNIT – III	Arrays and Strings	9 Hrs

Arrays indexing, memory model, programs with array of integers, two dimensional arrays, Introduction to Strings.

UNIT – IV	Pointers & User Defined Data types	9 Hrs

Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, User-defined data types-Structures and Unions.

UNIT – V	Functions & File Handling	9 Hrs

Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, modifying parameters inside functions using pointers, arrays as parameters. Scope and Lifetime of Variables, Basics of File Handling

Textbooks:

1. "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice- Hall, 1988
2. Schaum's Outline of Programming with C, Byron S Gottfried, McGraw-Hill Education, 1996.

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008.
2. Programming in C, Rema Theraja, Oxford, 2016, 2nd edition
3. C Programming, A Problem Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE, 3rd edition

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	19	25%	3	CO1: Understand	L2	PO1 PO2 PO3	PO1: Apply(L3) PO2: Review(L2) PO3:Develop(L3)	2 3 2
2	10	14%	2	CO2: Analyze	L4	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop (L3) PO11: Thumb rule	3 3 3 2
3	19	25%	3	CO3: Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Review (L2) PO11: Thumb rule	2 3 2
4	15	20%	2	CO4: Create	L6	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Review (L2) PO3: Develop (L3) PO11: Thumb rule	3 3 3 2
5	12	16%	2	CO5: Create	L6	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO11: Thumb rule	3 3 3 3
	75	100 %						

Justification Statements :

CO1: Understand the computer Programming concepts and Algorithms.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Review (L2)
CO1 Action verb is same as than as PO2 verb by two level. Therefore, the correlation is High (3)
PO3 Verb: Develop (L3)
CO1 Action verb is less than as PO2 verb by one level. Therefore, the correlation is moderate (2)
CO2: Analyze the control structures to implement basic programs**.**
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO2 Action verb is equal to PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO2 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
Some of the flow of control statements knowledge are used to solve various problems. Therefore, the correlation is moderate (2)
CO3: Understand the concept of Arrays and string to manipulate the stored data.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2: Review (L2)
CO3 Action verb is Same as PO2 verb. Therefore, the correlation is High (3)
PO11: Thumb rule
For some matrix operations array and string concepts were used Therefore, the correlation is moderate (2)
CO4: Create the dynamic memory allocation using pointers and structures.
Action Verb: Create (L6)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)
PO2: Review (L2)
CO4 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)

CO4 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some mathematical operations Pointers and structures are used to manipulate the memory references. Therefore, the correlation is moderate (2)

CO5: Create the user defined functions and files for modifying stored data.

Action Verb: Create (L6)

PO1: Apply (L3)

CO5 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)

PO2: Review (L2)

CO5 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO5 Action verb is greater than as PO3 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

In today's world file handling techniques were used in most of the areas. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	IT workshop	L	T/CLC	P	C
23AES0503	I-I	**(Common to AIDS&AIML)**	0	0	2	1

Course Outcomes:

After studying the course, student will be able to

CO1: Understand The Process of Software Installation & Hardware troubleshooting.

CO2: Analyze the network configurations for customizing web pages and search engines.

CO3: Apply the basic editing function, formatting text & objects on a required content.

CO4: Apply the formulas, functions and visualizations to manage the data.

CO5: Understand the libraries and models of chatGPT to generate information.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	The Process of Software Installation & Hardware troubleshooting.			L2
CO2	**Analyze**	the network configurations		for customizing web pages and search engines	L4
CO3	**Apply**	The basic editing function, formatting text & objects		on a required content	L3
CO4	**Apply**	the formulas, functions and visualizations		to manage the data	L3
CO5	**Understand**	The libraries and models of chatGPT		to generate information	L2

List of Experiments

PC Hardware & Software Installation

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the block diagram of the CPU along with the configuration of each peripheral and submit to your instructor.[CO1]

Task 2: Every student should disassemble and assemble the PC back to working condition. Lab instructors should verify the work and follow it up with a Viva. Also students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.[CO1]

Task 3: Every student should individually install MS windows on the personal computer. Lab instructor should verify the installation and follow it up with a Viva.[CO1]

Task 4: Every student should install Linux on the computer. This computer should have windows installed. The system should be configured as dual boot (VMWare) with both Windows and Linux. Lab instructors should verify the installation and follow it up with a Viva.[CO1]

Task 5: Every student should install BOSS on the computer. The system should be configured as dual boot (VMWare) with both Windows and BOSS. Lab instructors should verify the installation and follow it up with a Viva.[CO1]

Internet & World Wide Web

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally students should demonstrate, to the instructor, how to access the websites and email. If there is
no internet connectivity preparations need to be made by the instructors to simulate the WWW on the LAN.[CO2] **Task 2:** Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.[CO2]

Task 3: Search Engines & Netiquette: Students should know what search engines are and how to use the search engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student. [CO2]

Task 4: Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They need to customize their browsers to block pop ups, block active x downloads to avoid viruses and/or worms. [CO2]

LaTeX and WORD

Task 1 – Word Orientation: The mentor needs to give an overview of La TeX and Microsoft (MS) office or equivalent (FOSS) tool word: Importance of La TeX and MS office or equivalent (FOSS) tool Word as word Processors, Details of the four tasks and features that would be covered in each, Using La TeXand word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter in word. [CO3]

Task 2: Using La TeX and Word to create a project certificate. Features to be covered:- Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colors, Inserting Header and Footer,

Using Date and Time option in both La TeX and Word. [CO3]

Task 3: Creating project abstract Features to be covered:-Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes. [CO3]

Task 4: Creating a Newsletter: Features to be covered:- Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word. [CO3]

EXCEL

Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS) tool Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered in each. Using Excel – Accessing, overview of toolbars, saving excel files, Using help and resources. [CO4]

Task 1: Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text[CO4]

Task 2: Calculating GPA -. Features to be covered:- Cell Referencing, Formulae in excel – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function, [CO4]

LOOKUP/VLOOKUP

Task 3: Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting[CO4]

POWER POINT

Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint. [CO4]

Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts. [CO4]

Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides. [CO4]

AI TOOLS – ChatGPT

Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model responds. Try asking questions, starting conversations, or even providing incomplete sentences to see how the model completes them. [CO5]

• Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: What is the capital of France?"

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to brainstorm creative ideas[CO5]

• Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Task 3: Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output to see how accurate and fluent the translations are. [CO5]

• Ex:Prompt: "Translate the following English sentence to French: 'Hello, how are you doing today?'"

Reference Books:
1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide, David Anfins on and Ken Quamme. – CISCO Press, Pearson Education, 3rd edition
7. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan– CISCO Press, Pearson Education, 3rd edition

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)

			PO1	PO1: Apply(L3)	2
1	CO1: Understand	L2	PO2	PO2: Review(L2)	3
2	CO2: Analyze	L4	PO1	PO1: Apply(L3)	3
			PO2	PO2: Identify (L3)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	3
			PO5	PO5: Apply (L3)	3
3	CO3: Apply	L3	PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L2)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	2
			PO5	PO5: Apply (L3)	3
			PO11	PO11: Thumb rule	3
4	CO4: Apply	L3	PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L2)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	2
			PO5	PO5: Apply (L3)	3
			PO11	PO11: Thumb rule	3
5	CO5: Understand	L2	PO1	PO1: Apply(L3)	2
			PO2	PO2: Identify (L3)	2

Justification Statements :
CO1: Understand The Process of Software Installation & Hardware troubleshooting
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Review(L2)
CO1 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
CO2: Analyze the network configurations for customizing web pages and search engines
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: idetify(L3)
CO2 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO2 Action verb is greater than as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO2 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)
CO 3: Apply The basic editing function, formatting text & objects on a required content.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Review(L2)
CO3 Action verb is less than as PO2 verb. Therefore, the correlation is high(3)
PO3: Develop(L3)
CO3 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is less than as PO4 verb. Therefore, the correlation is moderate (2)
PO5: Apply (L3)
CO3 Action verb is same as PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
Documentation and presentation is learning process to find the solution better manner the correlation is high (3)
CO 4: Apply the formulas, functions and visualizations to manage the data.

Action Verb: Apply (L3)
PO1: Apply (L3)
CO4 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: idetify(L3)
CO4 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO4 Action verb is less than as PO4 verb by one level. Therefore, the correlation is moderate (2)
PO5: Apply (L3)
CO4 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
Spread sheets in Excel is the trending approach in the current days Therefore, the correlation is high (3)
CO 5: Understand the libraries and models of chatGPT to generate information.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Identify(L3)
CO1 Action verb is same as PO2 verb. Therefore, the correlation is moderate (2)

Subject Code: 23ABS9908	Subject Name: **Engineering Physics Lab**	L 0	T/CLC P 0 2	Credits: 1

Course Outcomes

CO1: **Analyze** the properties of light for engineering problems.
CO2: **Evaluate** the crystallite size using X-ray diffraction.
CO3: **Analyze** the basic properties of dielectric and magnetic behavior of the given material.
CO4: **Determine** the mechanical behavior of a given material.
CO5: **Evaluate** the basic parameters of a given semiconductor material.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Analyze	The properties of light		for engineering problems.	L4
2	Evaluate	The crystallite size using X-ray diffraction.			L5
3	Analyze	The basic properties of dielectric and magnetic behavior of the given material.			L4
4	Determine	The mechanical behavior of a given material.			L5
5	Evaluate	The basic parameters of a given semiconductor material.			L5

List of Experiments:

1. Determination of radius of curvature of a given Plano-convex lens by Newton's rings – CO1.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration – CO1.
3. Study the variation of B versus H by magnetizing the magnetic material (B-H curve) – CO3.
4. Determination of wavelength of Laser light using diffraction grating – CO1.
5. Magnetic field along the axis of a current carrying circular coil by Stewart Gee's Method – CO3.
6. Determination of energy gap of a semiconductor using p-n junction diode – CO5.
7. Determination of the resistivity of semiconductors by four probe methods – CO5.
8. Determination of the crystallite size using X-Ray Diffraction spectra – CO2.
9. Determination of the numerical aperture of a given optical fiber and angle of acceptance – CO1.
10. Verification of Brewster's law – CO1.
11. Determination of acceleration due to gravity and radius of Gyration by using a compound pendulum – CO4.
12. Determination of rigidity modulus of the material of the given wire using Torsional   pendulum   – CO4.
13. Determination of temperature coefficients of a thermistor – CO5.
14. Determination of dielectric constant using charging and discharging method – CO3.
15. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall Effect – CO5.
16. Sonometer: Verification of laws of stretched string – CO4.
17. Determination of magnetic susceptibility by Kundt's tube method – CO3.
18. Determination of Frequency of electrically maintained tuning fork by Melde's experiment – CO4.

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO

Experiments may be conducted in virtual mode.
References: A Textbook of Practical Physics - S. Balasubramanian, M. N. Srinivasan, S. Chand Publishers, 2017.
URL: www.vlab.co.in

Mapping of COs to POs and PSOs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	25	3	**Analyze**	**L4**	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3 3
2	6	16	2	**Evaluate**	**L5**	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3 3
3	9	25	3	**Analyze**	**L4**	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3 3
4	6	16	2	**Determine**	**L5**	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3 3
5	6	16	2	**Evaluate**	**L5**	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3 3
	36							

CO1: Analyze the properties of light for solving engineering problems.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
PO4 Verb: Analyze (L4)
CO1 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3). CO1
Action Verb is equal to PO4 verb; Therefore, correlation is high (3).

CO2: Evaluate the crystallite size using X-ray diffraction.
Action Verb: Evaluate (L5)
PO1 Verbs: Apply (L3) PO4 Verb: Analyze (L4)CO2 Action Verb is greater than PO1 verb by two levels; Therefore
correlation is high (3). CO2 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).

CO3: Analyze the basic properties of dielectric and magnetic behavior of the given material.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
PO4 Verb: Analyze (L4)
CO3 Action Verb level is greater than PO1 action verb by one level; Therefore correlation is high (3).
CO3 Action Verb level is equal to PO4 action verb; Therefore correlation is high (3).

CO4: Determine the mechanical behavior of a given material using dynamic methods.
Action Verb: Determine (L5)
PO1 Verbs: Apply (L3)
PO4 Verb: Analyze (L4)
CO4 Action Verb is greater than PO1 verb by two levels; Therefore correlation is high (3). CO4
Action Verb is greater than PO4 verb by one level; Therefore correlation is high (3).

CO5: Evaluate the basic parameters of a given semiconductor material.
Action Verb: Evaluate (L5)
PO1 and PO4 Verb: Apply (L3)
CO5 Action Verb is greater than PO1 verb by two levels; Therefore correlation is high (3). CO5
Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).

Course Code	Year & Sem	Electrical & Electronics Engineering Workshop	L	T/CLC	P	C
23AES0202	I-I		0	0	3	1.5

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

CO1: **Understand** the Electrical circuit design, measurement of resistance, power, and power factor.

CO2: **Apply** suitable methods to measure Resistance, power, energy and power factor.

CO3: **Design** suitable methods for magnetization characteristics of D. C shunt generator.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Understand	Electrical circuit design; measurement of resistance, power, power factor			L2
CO2	Apply	Suitable methods to measure Resistance, power, energy and power factor.			L3
CO3	Design	Suitable methods for magnetization characteristics of D. C shunt generator.			L6

SYLLABUS:

PART A
ELECTRICAL ENGINEERING LAB

List of experiments:
1. Verification of Kirchhoff's current law and Voltage law-(CO1).
2. Verification of Superposition theorem-(CO1).
3. Measurement of Resistance using Wheat stone bridge-(CO1).
4. Measurement of Power and Power factor using Single-phase watt-meter-(CO2).
5. Measurement of Earth Resistance using Megger-(CO2).
6. Calculation of Electrical Energy for Domestic Premises-(CO2).
7. Magnetization Characteristics of DC shunt Generator-(CO3).

Reference Books:
1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Note: Minimum Six Experiments to be performed.

PART B
ELECTRONICS ENGINEERING LAB

COURSE OUTCOMES:
After completion of the course, students will be able to:

CO4: **Understand** the V-I Characteristics of diodes and its applications.

CO5: **Analyze** the input and output characteristics of BJT and its applications.

CO6: **Analyze** the truth tables of all logic gates and f/f's using IC's.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO4	Understand	V-I Characteristics of diodes and its applications.			L2
CO5	Analyze	input and output characteristics of BJT and its applications			L4
CO6	Analyze	Truth tables of all logic gates and f/f's using IC's.			L4

List of Experiments:
1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias. (CO4)
2. Plot VI characteristics of Zener Diode and its application as voltage Regulator. (CO4)
3. Implementation of half wave and full wave rectifiers (CO4)
4. Plot Input & Output characteristics of BJT in CE and CB configurations (CO5)
5. Frequency response of CE amplifier. (CO5)
6. Simulation of RC coupled amplifier with the design supplied. (CO5)
7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs. (CO6)

8. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs. (CO6)

Tools Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROS, and all the required active devices.

References:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.

2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

3. R. T. Paynter, Introductory Electronic Devices & Circuits - Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using both Hardware and Software.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1		1					1			2	
CO2	3	2		2					1			2	
CO3		3		3					1			2	1
CO4	2	3											
CO5	3	3											
CO6	3	3											
Levels of correlation,viz.,1.Low,2.Moderate,3.High													

Table title (inside table): Mapping of Course outcomes with Program outcomes

Justification Table:

CO	COs		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Verb	BTL			
1	**Understand**	**L2**	PO1 PO2 PO4 PO9	PO1: Apply (L3) PO2: Analyze (L4) PO4: Analyze (L4) PO9: Thumb Rule	2 1 1 1
2	**Apply**	**L3**	PO1 PO2 PO4 PO9	PO1: Apply (L3) PO2: Analyze(L4) PO4: Analyze(L4) PO9: Thumb Rule	3 2 2 1
3	**Design**	**L6**	PO2 PO4 PO9	PO2: Analyze(L4) PO4: Design(L6) PO9: Thumb Rule	3 3 1
4	Understand	**L2**	PO1 PO2	PO1: Apply (L3) PO2: Review (L2)	2 3
5	Analyze	**L4**	PO1 PO2	PO1: Apply (L3) PO2: Review (L2)	3 3
6	Analyze	**L4**	PO1 PO2	PO1:Apply(L3) PO2:Review (L2)	3 3

CO1: Understand the Electrical circuit design, measurement of resistance, power, and power factor.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO1 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2: Analyze (L4)

CO1 Action Verb is Less than PO2 verb by two level; Therefore, correlation is low (1).

PO4: Analyze (L4)

CO1 Action Verb is Less than PO4 verb by two level; Therefore, correlation is low (1).

PO9: Using Thumb Rule, CO1 correlates to PO9 as low (1).

CO2: Apply suitable methods to measure Resistance, power, energy and power factor.

Action Verb: Apply (L3)

PO1: Apply (L3)

CO2 Action Verb is same as PO1 verb; Therefore, correlation is high (3).

PO2: Analyze (L4)

CO2 Action Verb is Less than PO2 verb by one level; Therefore, correlation is moderate (2).
PO4: Analyze (L4)
CO2 Action Verb is Less than PO4 verb by one level; Therefore, correlation is moderate (2).
PO9: Using Thumb Rule, CO2 correlates to PO9 as low (1).

CO3: Design suitable methods for magnetization characteristics of D. C shunt generator.
Action Verb: Design (L6)
PO2: Analyze (L4)
CO3 Action Verb is greater than PO2 verb by two level; Therefore, correlation is high (3).
PO4: Design (L6)
CO3 Action Verb is same as PO4 verb; Therefore, correlation is high (3).
PO9: Using Thumb Rule, CO3 correlates to PO9 as low (1).

CO4: Understand the V-I Characteristics of diodes and its applications.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO4 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2)
PO2 Verbs: Review (L2)
CO4 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO5: Analyze the input and output characteristics of BJT and its applications.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO5 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO5 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO6: Analyze the truth tables of all logic gates and f/f's using IC's.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO6 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO6 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

Course Code	Year & Sem	COMPUTER PROGRAMMING LAB	L	T/CLC	P	C
23AES0502	I-I	(Common to All Branches of Engineering)	0	0	3	1.5

Course Outcomes:

After studying the course, student will be able to

CO1: Understand the basic syntax of C program to build applications.

CO2: Create the control structure for solving complex problems.

CO3: Apply the concepts of arrays, functions, basic concepts of pointers to organize the data.

CO4: Apply the concepts of structures, unions and linked list to manage heterogeneous data .

CO5: Create the file applications for storing and accessing data.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the basic syntax of C program		to build applications	L2
CO2	Create	the control structure		for solving complex problems	L6
CO3	Apply	the concepts of arrays, functions, basic concepts of pointers		to organize the data	L3
CO4	Apply	the concepts of structures, unions and linked list		to manage heterogeneous data	L3
CO5	Create	the file applications		for storing and accessing data	L6

List of Experiments:

Exercise 1: Problem-solving using Computers[CO1]
- i)   Basic Linux environment and its editors like Vi, Vim & Emacs etc.
- ii) Exposure to Turbo C, gcc
- iii) Writing simple programs using printf(), scanf()

Exercise 2: Problem-solving using Algorithms and Flow charts.[CO1]
- i)   Sum and average of 3 numbers
- ii) Conversion of Fahrenheit to Celsius and vice versa
- iii) Simple interest calculation

Exercise 3: Variable types and type conversions[CO2]
- i)   Finding the square root of a given number
- ii)   Finding compound interest
- iii) Area of a triangle using heron's formulae
- iv)   Distance travelled by an object

Exercise 4: Operators and the precedence and as associativity[CO2]
- i)   Evaluate the following expressions.
- a.   A+B*C+(D*E) + F*G
- b.   A/B*C-B+A*D/3
- c.   A+++B---A
- d.   J= (i++) + (++i)
- ii)   Find the maximum of three numbers using conditional operator
- iii) Take marks of 5 subjects in integers, and find the total, average

in float list and perform insertion, deletion, and traversal.

Exercise 5: Branching and logical expressions[CO2]
- i)   Write a C program to find the max and min of four numbers using if-else.
- ii)   Write a C program to generate electricity bill.
- iii) Find the roots of the quadratic equation.
- iv)   Write a C program to simulate a calculator using switch case.
- v)   Write a C program to find the given year is a leap year or not.

Exercise 6: Loops, while and for loops[CO2]
- i)   Find the factorial of given number using any loop.
- ii)   Find the given number is a prime or not.
- iii) Compute sine and cos series

iv)   Checking a number palindrome
    iv) Construct a pyramid of
            numbers.
    Exercise 7: 1 D Arrays:
            searching[CO3]
i)   Find the min and max of a 1-D integer array.
ii)   Perform linear search on1D array.
iii)   The reverse of a 1D integer array
iv)   Find 2's complement of the given binary number.
v)   Eliminate duplicate elements in an array.
Exercise 8: 2 D arrays, sorting and Strings[CO3]
i)   Addition of two matrices
ii)   Multiplication two matrices
iii)   Sort array elements using bubble sort
iv)   Concatenate two strings without built-in functions
v)   Reverse a string using built-in and without built-in string functions
Exercise 9: Pointers, structures and dynamic memory allocation[CO3]
  i.   Write a C program to find the sum of a 1D array using malloc()
  ii.   Write a C program to find the total, average of n students using structures
  iii. Enter n students data using calloc() and display failed students list
  iv.   Read student name and marks from the command line and display the student details along with the total.
  v.   Write a C program to implement realloc()
Exercise 10: Bitfields, Self-Referential Structures, Linked lists[CO4]
i)   Create and display a singly linked list using self-referential structure.
ii)   Demonstrate the differences between structures and unions using a C program.
iii)   Write a C program to shift/rotate using bitfields.
iv)   Write a C program to copy one structure variable to another structure of the same type.
Exercise 11: Functions, call by value, scope and extent[CO2]
i)   Write a C function to calculate NCR value.
ii)   Write a C function to find the length of a string.
iii)   Write a C function to transpose of a matrix.
iv)   Write a C function to demonstrate numerical integration of differential equations using Euler's method
Exercise 12: Recursion, the structure of recursive calls[CO4]
i)   Write a recursive function to generate Fibonacci series.
ii)   Write a recursive function to find the lcm of two numbers.
iii)   Write a recursive function to find the factorial of a number.
iv)   Write a C Program to implement Ackermann function using recursion.
v)   Write a recursive function to find the sum of series.
Exercise 13: Call by reference, dangling pointers[CO4]
i)   Write a C program to swap two numbers using call by reference.
ii)   Demonstrate Dangling pointer problem using a C program.
iii)   Write a C program to copy one string into another using pointer.
v)   Write a C program to find no of lowercase, uppercase, digits and other characters using pointers.
Exercise 14: File handling[CO5]
i)   Write a C program to write and read text into a file.
ii)   Write a C program to write and read text into a binary file using fread() and fwrite()
iii)   Copy the contents of one file to another file.
iv)   Write a C program to merge two files into the third file using command-line arguments.
v)   Find no. of lines, words and characters in a file
vi)   Write a C program to print last n characters of a given file.

Textbooks:
  1. Ajay Mittal, Programming in C: A practical approach, Pearson.
  2. Byron Gottfried, Schaum' s Outline of Programming with C, McGraw Hill
Reference Books:
1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice- Hall of India
2. C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE

 Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2	2								2	

CO2	3	3		3								2	2	
CO3	3	3		2	3							3	2	
CO4	3	3	3	2								2	2	
CO5	3	3	3	3								3	2	

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	understand	L2	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Review(L2) PO3: Develop(L3) PO4: Analyze(L4)	2 3 2 2
2	Create	L6	PO1 PO2 PO4 PO5 PO11	PO1: Apply(L3) PO2: Review (L3) PO4: Analyze (L4) PO5: Apply(L3) PO11: Thumb rule	3 3 3 3 2
3	Apply	L3	PO1 PO2 PO4 PO5 PO11	PO1: Apply(L3) PO2: Review (L3) PO4: Analyze (L4) PO5: Apply(L3) PO11: Thumb rule	3 3 2 3 3
4	Apply	L3	PO1 PO2 PO3 PO4 PO11	PO1: Apply(L3) PO2: Review (L2) PO3: Develop(L3) PO4: Analyze (L4) PO11: Thumb rule	3 3 3 2 2
5	Create	L6	PO1 PO2 PO3 PO4 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop(L3) PO4: Analyze (L4) PO11: Thumb rule	3 3 3 3 3

Justification Statements :
CO1: Understand the basic syntax of C program to build applications.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Review(L2)
CO1 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop(L3)
CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is moderate (2)
PO4: Analyze(L4)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate is (2)

CO2: Create the control structure for solving complex problems.
Action Verb: Create (L6)
PO1: Apply (L3)
CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Review (L3)
CO2 Action verb is same level PO2 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply(L3)

CO2 Action verb is same as PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (2)

CO3: Apply the concepts of arrays, functions, basic concepts of pointers to organize the data.Action Verb: Apply (L3)

PO1: Apply (L3)

CO3 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)

CO3 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)

PO5: Apply(L3)

CO3 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (3)

CO4: Apply the concepts of structures, unions and linked list to manage heterogeneous data.

Action Verb: Apply (L3)

PO1: Apply (L3)

CO4 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)

CO4 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO4 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)

PO5: Apply(L3)

CO4 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (2)

CO5: Create the file applications for storing and accessing data.

Action Verb: Create (L6)

PO1: Apply (L3)

CO5 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)

CO5 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO5 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

PO5: Apply(L3)

CO5 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (3)

Course Code	Year & Sem	NSS/NCC/Scouts & Guides/Community Service	L	T/CLC	P	C
23AHM9904	I-I		0	0	1	0.5

Course Outcomes: After studying the course, students will be able to

CO1: **Understand** the importance of discipline, character and service motto of community.
CO2: **Analyze** the activities need to be done for nature protection
CO3: **Analyze** the social issues in a community and address it through the base camps.

Course Outcomes	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the importance of discipline, character and service motto		of community	L1
CO2	Analyze	the activities need to be done for nature protection			L4
CO3	Analyze	the social issues in a community and address it through the base camps			L4

UNIT-I

Orientation
General Orientation on NSS/NCC/ Scouts & Guides/Community Service activities, careerguidance.
Activities:
  i) Conducting –ice breaking sessions-expectations from the course-knowing personaltalents and skills
  ii) Conducting orientations programs for the students –future plans-activities-releasingroad map etc.
  iii) Displaying success stories-motivational biopics- award winning movies on societalissues etc.
  iv) Conducting talent show in singing patriotic songs-paintings- any other contribution

UNIT-II

Nature & Care
Activities:
  i) Best out of waste competition.
  ii) Poster and signs making competition to spread environmental awareness.
  iii) Recycling and environmental pollution article writing competition.
  iv) Organizing Zero-waste day.
  v) Digital Environmental awareness activity via various social media platforms.
  vi) Virtual demonstration of different eco-friendly approaches for sustainable living.
  vii) Write a summary on any book related to environmental issues.

UNIT-III

Community Service
Activities:
  i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities- experts-etc.
  ii) Mental health, Spiritual Health, HIV/AIDS,
  iii) Conducting consumer Awareness. Explaining various legal provisions etc.
  iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and PopulationEducation.
  v) Any other programmes in collaboration with local charities, NGOs etc.
  vi) Conducting awareness programs on Health-related issues such as General Health,

CORRELATION OF COS WITH THE POS & PSOS:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2								2			2
CO2	3	3								3			2
CO3	3	3								3			2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-POMAPPING JUSTIFICATION:

Unit No	Course Outcomes		Program Outcome (PO)	PO(s):Action Verb and BTL(forPO1 to PO11)	Level of Correlation (0-3)
	CO's Action Verb	BTL			
1	Understand	L2	PO1 PO2 PO10	Apply(L3) Analyze(L4) Thumb Rule	2 2 2
2	Analyze	L4	PO1 PO2 PO10	Apply(L3) Analyze(L4) Thumb Rule	2 3 3
3	Analyze	L4	PO1 PO2 PO10	Apply(L3) Analyze(L4) Thumb Rule	2 3 3

Justification Statements:

CO1: Understand the importance of discipline, character and service motto of community.
Action Verb: Understand (L2)
    CO1 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
    CO1 Action Verb is less than PO2 verb by one level; Therefore correlation is moderate (2).
    CO1 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO10 as moderate (2).

CO2: Analyze the activities need to be done for nature
protection Action Verb: Analyze (L4)
CO2 Action Verb is greater than PO1 verb by one level; Therefore correlation is moderate
(2). CO2 Action Verb is same as PO2 verb, Therefore correlation is High (3)
CO2 Action Verb is of BTL 4. Using Thumb rule, L4 correlates PO10 as moderate (4).

CO3: Analyze the social issues in a community and address it through the base camps
Action Verb: Analyze (L4)
CO3 Action Verb is greater than PO1 verb by one level; Therefore correlation is moderate
(2). CO3 Action Verb is same as PO2 verb, Therefore correlation is High (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)
(Effective for the batches admitted in 2023-24)

Semester II (First year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P	C			
1	HM	23AHM9901	Communicative English	2	0	0	2	30	70	100
2	BS	23ABS9901	Chemistry	2	1	0	3	30	70	100
3	BS	23ABS9905	Differential Equations &Vector Calculus	2	1	0	3	30	70	100
4	ES	23AES0101	Basic Civil& Mechanical Engineering	2	1	0	3	30	70	100
5	PC	23APC0501	Data Structures	2	1	0	3	30	70	100
6	HM	23AHM9902	Communicative English Lab	0	0	2	1	30	70	100
7	BS	23ABS9906	Chemistry Lab	0	0	2	1	30	70	100
8	ES	23AES0302	Engineering Workshop	0	0	3	1.5	30	70	100
9	PC	23APC0502	Data Structures Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9903	Health and wellness, Yoga and Sports	0	0	1	0.5	50	-	50
			Total	**10**	**4**	**11**	**19.5**	**320**	**630**	**950**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)
(Effective for the batches admitted from 2023-24)

Year: I B.Tech   **(Common to all branches)**   Semester: II

Subject Code 23AHM9901	Subject Name **COMMUNICATIVE ENGLISH**	L/CLC T P 2 0 0	Credit: 2	CLC: 2

Pre-Requisites	Communicative English	Semester	**II**

Course Outcomes (CO): Student will be able to

CO1: Understand reading / listening texts and to write summaries based on global comprehension of these texts.**(Listening & Reading)**

CO2: Apply grammatical structures to formulate sentences and correct word forms.**(Grammar)**

CO3: Analyze discourse markers to speak clearly on a specific topic in formal and informal conversations.**(Speaking)**

CO4: Analyze a coherent paragraph interpreting graphic elements,figure/graph/chart/table**(Read & Write)**

CO5: Create a coherent essay, letter writing, report writing and design a resume.**(Writing)**

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	reading / listening texts and to write summaries based on global comprehension of these texts.			L2
2	Apply	grammatical structures to formulate sentences and correct word forms			L3
3	Analyze	Analyze discourse markers to speak clearly on a specific topic in formal and informal conversations...			L4
4	Analyze	coherent paragraph interpreting a graphic elements.			L4
5	Create	coherent essay, letter writing, report writing and design a resume			L6

UNIT I

Lesson: HUMAN VALUES: Gift of Magi**(Short Story)**

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words.

UNIT II

Lesson: NATURE: The Brook by Alfred Tennyson (Poem)

Listening: Answering a series of questions about main ideas and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Structure of a paragraph - Paragraph writing (specific topics) **Grammar:** Cohesive devices - linkers, use of articles and zero article; prepositions.

Vocabulary: Homonyms, Homophones, Homographs.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing, Note-making, paraphrasing

Grammar: Verbs - tenses; subject-verb agreement.
Vocabulary: Compound words, Collocations

UNIT IV
Lesson: INSPIRATION: The Toys of Peace by Saki
Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
Writing: Letter Writing: Official Letters, Resumes, Cover letters
Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice
Vocabulary: Words often confused, Jargons

UNIT V
Lesson: MOTIVATION: The Power of Intrapersonal Communication (An Essay)
Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.
Speaking: Formal oral presentations on topics from academic contexts
Reading: Reading comprehension.
Writing: Writing structured essays on specific topics.
Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Vocabulary: Idiom and phrases & Phrasal verbs

Textbooks:
1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition, Orient Black Swan, 2023 (Units 1,2 & 3)
2. Empowering with Language by Cengage Publications, 2023 (Units 4 & 5)

Reference Books:
1. Dubey, Sham Ji& Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

WEB RESOURCES:
GRAMMAR:
1. www.bbc.co.uk/learningenglish
2. https://dictionary.cambridge.org/grammar/british-grammar/
3. www.eslpod.com/index.html
4. https://www.learngrammar.net/
5. https://english4today.com/english-grammar-online-with-quizzes/
6. https://www.talkenglish.com/grammar/grammar.aspx
VOCABULARY
1. https://www.youtube.com/c/DailyVideoVocabulary/videos
2. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

Correlation of COs with the POs & PSOs for B.Tech

Course Outcomes COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1									2		
CO2								2	2		
CO3									3		
CO4									3		

											3		
CO5											3		

(*3: Highly Correlated, 2: Moderately Correlated, 1: Weakly Correlated)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	12	22	3	**Understand**	**L2**	PO9	Thumb Rule	2
2	12	22	3	**Apply**	**L3**	PO8,PO9	Thumb Rule	2,2
3	10	18	**2**	**Analyze**	**L4**	PO9	Thumb Rule	3
4	10	18	**2**	**Analyze**	**L4**	PO9	Thumb Rule	3
5	10	18	**2**	**Create**	**L6**	PO9	Thumb Rule	3

CO1: Understand reading / listening text and to write summaries based on global comprehension of these texts.
Action Verb: Understand (L2)
CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Apply grammatical structures to formulate sentences and correct word forms.
Action Verb: Apply (L3)
CO2 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2) & (2)
CO3: Analyze discourse markers to speak clearly on a specific topic in Formal and informal Conversations.
Action Verb: Analyze (L4)
CO3 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).
CO4: Analyze a coherent paragraph interpreting graphic elements, figure/graph/chart/table
(Read & Write)
Action Verb: Analyze (L4)
CO4 Action Verb Analyze is of BTL 4. Using Thumb rule, L6 correlates PO6 to PO11 as high (3). **CO5: Create a coherent essay, letter writing, report writing and design a resume.(Writing) Action Verb: Create(L6)**
CO5 Action Verb Create is of BTL 6. Using Thumb rule, L5 correlates PO6 to PO1 as high (3).

Year: I B.Tech	(Semester: I **CSE, CIC, CSD& EEE**)	(Semester: II **ECE, AI&DS & AI&ML**)

Subject Code: 23ABS9901	Subject Name: Chemistry	L	T/CLC	P	Credits:3
		2	1	0	

Course Outcomes (CO): At the end of the course students will be able to
1. **Understand** the interaction of energy levels between atoms and molecules
2. **Apply** the principle of Band diagrams in the conductors and semiconductors
3. **Apply** the electrochemical principles to the construction of batteries, fuel cells and sensors
4. **Analyze** the preparation and mechanism of plastics, Elastomers and conducting polymers
5. **Analyze** the separation of liquid mixtures using instrumental methods.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the interaction of energy levels		between atoms and molecules	L2
2	**Apply**	principle of Band diagrams	conductors and semiconductors		L3
3	**Apply**	electrochemical principles to the construction of batteries, fuel cells and sensors			L3
4	**Analyze**	preparation and mechanism of plastics, Elastomers and conducting polymers			L4
5	**Analyze**	the separation of liquid mixtures	using instrumental methods		L4

UNIT I: Structure and Bonding Models
Fundamentals of Quantum mechanics, Schrodinger Wave equation, significance of Ψ and Ψ^2, particle in one dimensional box, molecular orbital theory – bonding in homo- and heteronuclear diatomic molecules – energy level diagrams of O_2 and CO, etc. π-molecular orbitals of butadiene and benzene, calculation of bond order.

UNIT II: Modern Engineering materials Semiconductors:
Introduction, basic concept, application **Super conductors**:
Introduction basic concept, applications.
Super capacitors: Introduction, Basic Concept-Classification – Applications.
Nano materials: Introduction, classification, properties and applications of Fullerenes, carbon Nano tubes and Graphines nanoparticles.

NIT III   Electrochemistry and Applications
Electrochemical cell, Nernst equation, cell potential calculations and numerical problems, potentiometry-potentiometric titrations (redox titrations), concept of conductivity, conductivity cell, conductometric titrations (acid-base titrations).
Electrochemical sensors – potentiometric sensors with examples, amperometric sensors with examples.
Primary cells – Zinc-air battery, Secondary cells –lithium-ion batteries- working of the batteries including cell reactions; Fuel cells, hydrogen-oxygenfuel cell– working of the cells. Polymer Electrolyte Membrane Fuel cells (PEMFC).

UNIT IV   Polymer Chemistry
Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, with specific examples and mechanisms of polymer formation.
Plastics –Thermo and Thermosetting plastics, Preparation, properties and applications of – PVC, Teflon, Bakelite, Nylon-6,6, carbon fibres.
Elastomers–Buna-S, Buna-N–preparation, properties and applications.
Conducting polymers – polyacetylene, polyaniline, – mechanism of conduction and applications. Bio-Degradable polymers - Poly Glycolic Acid (PGA), Polyl Lactic Acid (PLA).

UNIT V   Instrumental Methods and Applications
Electromagnetic spectrum. Absorption of radiation: Beer-Lambert's law. UV-Visible Spectroscopy, electronic

transition, Instrumentation, IR spectroscopies, fundamental modes and selection rules, Instrumentation. Chromatography-Basic Principle, Classification-HPLC: Principle, Instrumentation and Applications.

Textbooks:
1. Jain and Jain, Engineering Chemistry, 16/e, DhanpatRai, 2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e,Oxford University Press, 2010.

Reference Books:
1. Skoog and West, Principles of Instrumental Analysis, 6/e, Thomson, 2007.
2. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, Wiley Publications, Feb.2008
3. Textbook of Polymer Science, Fred W. Billmayer Jr, 3rd Edition

Mapping of COs to POs and PSOs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours				CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Register (Hrs)	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	10	10	15.6	2	Understand	L2	PO1	PO1: Apply (L3)	2
2	10	17	26.5	3	Apply	L3	PO1	PO1: Apply (L3)	3
3	10	12	18.7	3	Apply	L3	PO2	PO1: Apply (L3)	3
4	10	13	20.3	3	Analyze	L4	PO2	PO2: Analyze (L4)	3
5	10	12	18.7	3	Analyze	L4	PO1	PO2: Analyze (L4)	3

CO1: Understand the fundamentals of Atoms and Molecules
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO1 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
CO2: Apply electrochemical principles to construct batteries Action
Verb: Apply (L3)
PO1 Verbs: Apply (L3)
CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).
CO3: Apply electrochemical principles to the construction of batteries, fuel cells and electrochemical sensors
Action Verb: Apply (L3)
PO2 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).
CO4: Analyze the preparation and mechanism of polymers
Action Verb: Analyze (L4)
PO2 Verb: Analyze (L4)
CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).
CO5: Analyze the identification of individual components
Action Verb: Analyze (L4)
PO1 Verb: Analyze (L4)
CO5 Action Verb level is equal to PO2 verb; Therefore correlation is high

Year : I	Semester : II	Branch of Study : Common to all				

Subject Code: 23ABS9905	Subject Name: Differential Equations & Vector Calculus	L 2	T/CLC 1	P 0	Credits 3

Course Outcomes (CO): Student will be able to

CO1. **Apply** the concepts of ordinary differential equations of first order and first degree.
CO2. **Apply** the methods of linear differential equations related to various engineering problems.
CO3. **Analyze** the solutions of partial differential equations using Lagrange's method.
CO4. **Understand** the different operators and identities in the vector calculus.
CO5. **Evaluate** the surface integral and volume integral in the vector calculus using various theorems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	The concepts of ordinary differential equations.		of first order and first degree	L3
2	Apply	The methods of linear differential equations related to various engineering problems.			L3
3	Analyze	The solutions of partial differential equations.	Using Lagrange's method		L4
4	Understand	different operators and identities in the vector calculus.			L2
5	Evaluate	the surface integral and volume integral in the vector calculus.	Using various theorems		L5

UNIT I: Linear Differential Equations of first Order and first Degree   9hrs
Linear differential equations-Bernoulli's equations-Exat equations and equations reducible to exact form. Applications: Newton's Law of cooling-Law of natural growth and decay-Electrical circuits.

UNIT II: Equations Reducible to Linear Differential Equations and Applications   9 hrs
Definitions, homogeneous and non-homogeneous , complimentary function, general solution, particular integral, Wronskian, Method of variation of parameters. Simultaneous linear equations, Applications to L-C-R Circuit problems and simple Harmonic motion.

UNIT III: Partial Differential Equations   9 hrs
Introduction and formation of partial differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method. Homogeneous Linear Partial differential equations with constant coefficients.

UNIT IV: Vector differentiation   9 hrs
Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, Directional derivative, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT V: Vector integration   9 hrs
Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

Text Books :
1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2011.

References:
1. Dr.T.K.V.Iyengar, Engineering Mathematics-I,S.Chand publishers
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics,Laxmipublication,2008
4. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education.

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3										
2	3										
3		3									
4	2										
5		3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	20.8	3	Apply	L4	PO1	Apply	3
2	15	22.3	3	Apply	L3	PO1	Apply	3
3	14	20.8	3	Analyze	L4	PO2	Analyze	3
4	9	13.4	2	Understand	L2	PO1	Apply	2
5	15	22.3	3	Evaluate	L5	PO2	Analyze	3

CO1: Apply the concepts of ordinary differential equations of first order and first degree.
Action Verb: Apply(L3)
PO1 Verbs: Apply(L3)
CO1 Action Verb is equal to PO1 verb Therefore correlation is high (3).

CO2: Apply the methods of linear differential equations related to various engineering problems.
Action Verb: Apply (L3)
PO1 Verbs: Apply (L3)
CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO3: Analyze the solutions of partial differential equations.
Action Verb: Analyze(L4)
PO2 Verb: Analyze (L4)
CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Understand the different operators and identities in the vector calculus.
Action Verb: Understand(L2)
PO1 Verb: Apply(L3)
CO4 Action Verb is low level to PO1 to one level; Therefore correlation is moderate (2).

CO5: Evaluate the surface integral and volume integral in the vector calculus.
Action Verb: Evaluate(L5)
PO2 Verb: Analyze (L4)
CO5 Action verb is high level to PO2 verb; therefore the correlation is high (3).

Course Code	Year & Sem	Basic Civil & Mechanical Engineering	L	T/CLC	P	C
23AES0101	I-II		2	1	**0**	**3**

Course Outcomes:

After studying the course, student will be able to

CO1: Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society

CO2: Apply the methods of surveying in finding the measurements on Earth surface

CO3: Understand the importance of transportation, water resources and environmental engineering

CO4: Understand the applications and role of various materials in Mechanical Engineering.

CO5: Understand the different manufacturing processes and the basics of thermal engineering with its applications.

CO6: Understand the working of different mechanical power transmission systems, power plants and applications of robotics.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	Various sub-divisions of Civil Engineering		Role in ensuring better society	L2
CO2	Apply	Methods of surveying	Finding the measurements	On Earth surface	L3
CO3	Understand	Importance of transportation, water resources and environmental engineering			L2
CO4	Understand	applications and role of various materials in Mechanical Engineering			L2
CO5	Understand	different manufacturing processes and the basics of thermal engineering with its applications			L2
CO6	Understand	working of different mechanical power transmission systems, power plants and applications of robotics			L2

BASICS OF CIVIL ENGINEERING (PART-A)

UNIT I

Basics of Civil Engineering:

Role of Civil Engineers in Society- Various Disciplines of Civil Engineering- Structural Engineering- Geo-technical Engineering- Transportation Engineering Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each discipline - Building Construction and Planning- Construction Materials-Cement - Aggregate - Bricks- Cement concrete- Steel. Introduction to Prefabricated construction Techniques.

UNIT II

Surveying: Objectives of Surveying- Horizontal Measurements- Angular Measurements- Introduction to Bearings Levelling instruments used for levelling -Simple problems on levelling and bearings-Contour mapping.

UNIT III

Transportation Engineering: Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering.

Water Resources and Environmental Engineering:

Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology–Rainwater Harvesting-Water Storage andConveyance Structures (Simple introduction to Dams and Reservoirs).

Textbooks:

1. Basic Civil Engineering, M.S.Palanisamy, , Tata Mcgraw Hill publications (India) Pvt.Ltd. Fourth Edition.
2. Introduction to Civil Engineering, S.S. Bhavikatti, New Age International Publishers.2022. First Edition.
3. Basic Civil Engineering, Satheesh Gopi, Pearson Publications, 2009, First Edition

Reference Books:

1. Surveying, Vol- I and Vol-II, S.K. Duggal, Tata McGraw Hill Publishers 2019. FifthEdition
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, KhannaPublishers, Delhi. 2016
3. Irrigation Engineering and Hydraulic Structures - Santosh Kumar Garg, Khanna Publishers, Delhi 2023. 38th Edition
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10th Edition

5. Indian Standard DRINKING WATER — SPECIFICATION IS 10500-2012

PART-B
BASICS OF MECHANICAL ENGINEERING

UNIT I

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society- Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Engineering Materials - Metals-Ferrous and Non-ferrous, Ceramics, Composites, Smart materials.

UNIT II

Manufacturing Processes: Principles of Casting, Forming, joining processes, Machining, Introduction to CNC machines, 3D printing, and Smart manufacturing.

Thermal Engineering – working principle of Boilers, Otto cycle, Diesel cycle, Refrigeration and air-conditioning cycles, IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines, Components of Electric and Hybrid Vehicles.

UNIT III

Power plants – working principle of Steam, Diesel, Hydro, Nuclear power plants.

Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and their applications.

Introduction to Robotics - Joints & links, configurations, and applications of robotics.

Textbooks:

1. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India)Pvt. Ltd.
2. A Tear book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications,(India) Pvt. Ltd.
3. An introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, Cengage learning India Pvt. Ltd.

Reference Books:

1. Appuu Kuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I
2. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak MPandey, Springer publications
3. Thermal Engineering by Mahesh M Rathore Tata McGraw Hill publications (India) Pvt.Ltd.
4. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, TataMcGraw Hill publications (India) Pvt. Ltd.

Mapping of COs to POs

COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2					2						
CO2	3	2				2							
CO3	2	2					2						
CO4	2					2							
CO5	2						2						
CO6	2				2		2						

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	11/33	33	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L3) Thumb Rule	2 2 2
2	12/33	34	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
3	11/33	33	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L3) Thumb Rule	2 2 2
4	9/30	30	3	Understand	L2	PO1 PO6	Identify-L3 Thumb Rule	2 2
5	12/30	40	3	Understand	L2	PO1 PO7	Identify-L3 Thumb Rule	2 2
6	9/30	30	3	Understand	L2	PO1 PO5 PO7	Apply(Identify)-L3 Apply-L3 Thumb Rule	2 2 2

Justification Statements:

CO1: Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)
PO2 Verb: **Analyze(L4)**
CO1 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO7 Verb: **Thumb Rule**
CO1 correlates medium with PO7. Therefore, the correlation is medium (2)

CO2: Apply the methods of surveying in finding the measurements on Earth surface.
Action Verb: **Apply (L3)**
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Analyze(L4)**
CO2 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO6 Verb: **Thumb Rule**
CO2 correlates medium with PO6. Therefore, the correlation is medium (2)
CO3: Understand the importance of transportation, water resources and environmental engineering.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO3 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)
PO2 Verb: **Analyze(L4)**
CO3 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO7 Verb: **Thumb Rule**
CO3 correlates medium with PO7. Therefore, the correlation is medium (2)

CO4: Understand the applications and role of various materials in Mechanical Engineering.
Action Verb: **Understand (L2)**
PO1 Verb: **Apply (L3)**
CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO3 Verb: **Review-L2**
CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO4 correlates moderately with PO6. Therefore, the correlation is medium (2).

CO5: Understand the different manufacturing processes and the basics of thermal engineering with its applications.

Action Verb: **Understand (L2)**

PO1 Verb: **Apply (L3)**

CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Review-L2**

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO7 Verb: **Thumb Rule**

CO5 correlates moderately with PO6. Therefore, the correlation is medium (2).

CO6: Understand the working of different mechanical power transmission systems, power plants and applications of robotics.

Action Verb: **Understand (L2)**

PO1 Verb: **Apply (L3)**

CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Review-L2**

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO7 Verb: **Thumb Rule**

CO5 correlates moderately with PO6. Therefore, the correlation is medium (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Data Structures	L	T/CLC	P	C
23APC0501	I-II	**(Common to CSE, CIC, CSE(DS), AIML & AIDS)**	2	1	**0**	**3**

Course Outcomes:

After studying the course, student will be able to

CO 1: Understand the concepts of Linear Data Structures to sort the data

CO 2: Apply the Linked list concepts to perform operations on data.

CO 3: Apply the stacks features to manage the memory

CO 4: Analyse various operations of queues, dequeues and their applications.

CO 5: Understand binary search trees and hash tables to facilitate indexed search

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the concepts of Linear Data Structures		to sort the data	L2
CO2	**Apply**	The Linked list concepts		to perform operations on data.	L3
CO3	**Apply**	The stacks features		to manage the memory	L3
CO4	**Analyse**	various operations of queues, dequeues and their applications.			L4
CO5	**Understand**	The Binary Search Trees and hash tables		to facilitate indexed search	L2

UNIT – I		9 Hrs

Introduction to Linear Data Structures: Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures. Searching Techniques: Linear & Binary Search, Sorting Techniques: Bubble sort, Selection sort, Insertion Sort

UNIT – II		9 Hrs

Linked Lists: Singly linked lists: representation and operations, doubly linked lists and circular linked lists, Comparing arrays and linked lists, Applications of linked lists

UNIT – III		9 Hrs

Stacks: Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, Applications of stacks in expression evaluation, backtracking, reversing list etc.

UNIT – IV		9 Hrs

Queues: Introduction to queues: properties and operations, implementing queues using arrays and linked lists, Applications of queues in breadth-first search, scheduling, etc. Deques: Introduction to deques (double-ended queues), Operations on deques and their applications**.**

UNIT – V		9 Hrs

Trees: Introduction to Trees, Binary Search Tree – Insertion, Deletion & Traversal

Hashing: Brief introduction to hashing and hash functions, Collision resolution techniques: chaining and open addressing, Hash tables: basic implementation and operations, Applications of hashing in unique identifier generation, caching, etc

Textbooks:

1. Data Structures and algorithm analysis in C, Mark Allen Weiss, Pearson, 2nd Edition.
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson- Freed, Silicon Press, 2008

Reference Books:

1. Algorithms and Data Structures: The Basic Toolbox by Kurt Mehlhorn and Peter Sanders
2. C Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, and John E. Hopcroft
3. Problem Solving with Algorithms and Data Structures" by Brad Miller and David Ranum
4. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
5. Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms" by Robert Sedgewick

Online Learning Resources:

www.nptel.ac.in

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	18	24%	3	CO1: Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Review(L2)	2 3
2	14	19%	2	CO2: Apply	L3	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Develop (L3) PO4: Analysis (L4) PO11: Thumb rule	3 3 2 1
3	15	20%	2	CO3: Apply	L3	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Develop (L3) PO4: Analysis (L4) PO11: Thumb rule	3 3 2 2
4	13	18%	2	CO4: Analyse	L4	PO1 PO2 PO3 PO4 PO11	PO1: Apply(L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analysis(L4) PO11: Thumb rule	3 3 3 3 2
5	14	19%	2	CO5: Understand	L2	PO1 PO2 PO3 PO4 PO11	PO1: Apply(L3) PO2: review(L2) PO3: develop(L3) PO4: Interpret(L2) PO11: Thumb rule	2 3 2 3 2
	74	100 %						

Justification Statements :

CO1: Understand the concepts of Linear Data Structures to sort the data
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Review (L2)
CO1 Action verb is same level as PO2. Therefore, the correlation is high (3)
CO2: Apply the Linked list concepts to perform operations on data.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Develop (L3)
CO2 Action verb is same level PO2 verb. Therefore, the correlation is high (3)
PO4: Analysis (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)
PO11: Thumb rule
For some of Linear Data Structure applications, array and structure concepts are used to write programs store the data. Therefore, the correlation is low (1)

CO3: Apply the stacks features to manage the memory
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Develop (L3)
CO3 Action verb is same level PO2 verb. Therefore, the correlation is high (3)
PO4: Analysis (L4)
CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)
PO11: Thumb rule
For some of Data Structure applications, stacks concepts are used to write programs to manage programs.
Therefore, the correlation is low (1)
CO4: Analyse various operations of queues, dequeues and their applications.
Action Verb: Analyse (L4)
PO1: Apply(L3)
CO4 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)
PO2: Review (L2)
CO4 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)
PO4: Analysis (L4)
CO4 Action verb is greater than PO4 verb by one level. Therefore, the correlation is high (3)
PO11: Thumb rule
For some of Real Time problems Data Structure applications, queues concepts are used to write programs and
evaluation the memory operations. Therefore, the correlation is moderate (2)
CO5: Understand binary search trees and hash tables to facilitate indexed search
Action Verb: Create (L6)
PO1: Apply(L3)
CO5 Action verb is greater than PO1 verb by three levels. Therefore, the correlation is high (3)
PO2: Review (L6)
CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4: Interpret (L2)
CO5 Action verb is greater than PO4 verb by two levels. Therefore, the correlation is high (3)
PO11S: Thumb rule
For some of data manipulations Sorting and File Organization methods are used to solve storage problems.
Therefore, the correlation is low (3)

Year: I B.Tech	**(Commonto all branches)**	Semester: I & II

Subject Code **23AHM9902**	Subject Name **COMMUNICATIVE ENGLISH LAB**	L 0	T/CLC 0	P 2	Credit: 1

Course Outcomes (CO): Student will be able to

CO1: **Understand**-the different aspects of the English language proficiency with emphasis On LSRW skills.
CO2: **Apply** communication skills through various language learning activities.
CO3: **Analyze** the English speech sounds, for better listening and speaking.
CO4: **Evaluate** and exhibit professional is min participating in debates and group discussions.
CO5: **Analyze** the mselves to face interviews in future.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the different aspects of the English language proficiency with emphasis on LSRW skills			L2
2	**Apply**	communication skills through various language learning activities			L3
3	**Analyze**	the English speech sounds, for better listening and speaking.			L4
4	**Evaluate**	and exhibit professionalism in participating in debates and group discussions			L5
5	**Analyze**	themselves to face interviews in future			L4

List of Topics:
1. Vowels & Consonants (CO3)
2. Non Verbal Communication (CO2)
3. Communication Skills(CO2)
4. Role Playor Conversational Practice (CO1,CO2)
5. E-mail Writing (CO1)
6. Just A Minute (CO1,CO2)
7. Group Discussions-methods&practice (CO4)
8. Debates-Methods &Practice (CO4)
9. PPT Presentations/Poster Presentation (CO2)
10. Interviews Skills (CO5)

Suggested Software:
- Walden Infotech
- Young India Films

Reference Books:
1. RamanMeenakshi,Sangeeta-Sharma.*TechnicalCommunication*.OxfordPress.2018.
2. TaylorGrant:*EnglishConversationPractice*,TataMcGraw-HillEducationIndia,2016
3. Hewing's, Martin. Cambridge *AcademicEnglish*(B2).CUP,2012.
4. J.Sethi & P.V.Dhamija. *ACourse in Phonetics and Spoken English*,(2ndEd),Kindle,2013.

Spoken English:

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com/
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. https://www.youtube.com/c/ArnelsEverydayEnglish/featured
8. https://www.youtube.com/c/engvidAdam/featured
9. https://www.youtube.com/c/EnglishClass101/featured
10. https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw

Voice & Accent:

1. https://www.youtube.com/user/letstalkaccent/videos
2. https://www.youtube.com/c/EngLanguageClub/featured
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

Mapping of COs to POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1										2	
2									2	2	
3										3	
4									3	3	
5										3	

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1				Understand	L2	10	Thumb Rule	2
2				Apply	L3	9,10	Thumb Rule	2,2
3				Analyze	L4	10	Thumb Rule	3
4				Evaluate	L5	9,10	Thumb Rule	3,3
5				Analyze	L4	10	Thumb Rule	3

CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills

Action Verb: Understand (L2)

CO1 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Apply communication skills through various language learning activities.

Action Verb: Apply (L3)

CO2 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate(2).

CO3: Analyze the English speech sounds, for better listening and speaking.

Action Verb: Analyze (L4)

CO3 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).

CO4: Evaluate and exhibit professionalism in participating in debates and group discussions.

Action Verb: Evaluate (L5)

CO4 Action Verb is Evaluate of BTL 5. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).

CO5: Analyze themselves to face interviews in future.

Action Verb: Develop (L4)

CO5 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).

Year: I B.Tech   (Common to EEE, ECE, CSE & allied branches) Semester: I &II

Subject Code: 23ABS9906	Subject Name: Chemistry Lab	L 0	T/CLC 0	P 2	Credits:1

Course Objectives: Students are expected to
  Verify the fundamental concepts with experiments.
Course Outcomes: At the end of the course, the students will be able to
  CO1: Determine the cell constant and conductance of solutions.
  CO2: Prepare advanced polymer Bakelite materials.
  CO3: Measure the strength of an acid present in secondary batteries.
  CO4: Analyze the UV-Visible spectra of some organic compounds.
  CO5: Estimate the unknown solution by volumetric analysis

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Determine**	Cell constant and conductance of solutions.			**L4**
2	**Prepare**	advanced polymer Bakelite materials			**L4**
3	**Measure**	Strength of an acid present in secondary batteries.			**L4**
4	**Analyze**	UV-Visible spectra of some organic compounds.			**L4**
5	**Estimate**	Unknown solution by volumetric analysis.			**L5**

List of Experiments:
  1. Measurement of 10Dq by spectrophotometric method(CO1)
  2. Conductometric titration of strong acid vs. strong base (CO1)
  3. Conductometric titration of weak acid vs. strong base (CO1)
  4. Determination of cell constant and conductance of solutions (CO1)
  5. Potentiometry - determination of redox potentials and emfs (CO5)
  6. Determination of Strength of an acid in Pb-Acid battery (CO3)
  7. Preparation of a Bakelite (CO2)
  8. Verify Lambert-Beer's law (CO4)
  9. Estimation of copper by Iodometry (CO5)
  10. Wavelength measurement of sample through UV-Visible Spectroscopy (CO1)
  11. Preparation of nanomaterials by precipitation method (CO1)
  12. Estimation of Ferrous Iron by Dichrometry (CO5)

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO Experiments may be conducted in virtual mode.
Reference:
  - "Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publicationsby J. Mendham, R.C.Denney, J.D.Barnes and B. Sivasankar

Mapping of COs to POs and PSOs

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

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Determine	L4	PO4	PO4: Analyze (L4)	3
2				Prepare	L4	PO4	PO4: Analyze (L4)	3
3				Measure	L4	PO4	PO4: Analyze (L4)	3
4				Analyze	L4	PO4	PO4: Analyze (L4)	3
5				Estimate	L5	PO4	PO4: Analyze (L5)	3

Justification Statements

CO1: Determine the cell constant and conductance of solutions.
Action Verb: Determine **(L4)**
PO4 Verb: Analyze (L4)
CO1 Action Verb is equal to PO4 verb; Therefore, correlation is high (3).
CO2: Prepare advanced polymer Bakelite materials.
Action Verb: Prepare **(L4)**
PO4 Verb: Analyze (L4)
CO2 Action Verb is equal to PO4 verb; Therefore, correlation is high (3).
CO3: Measure the strength of an acid present in secondary batteries.
Action Verb: Measure **(L4)**
PO4 Verb: Analyze (L4)
CO3 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)
CO4: Analyze the UV-Visible spectra of some organic compounds.
Action Verb: Analyze **(L4)**
PO4 Verb: Analyze (L4)
 CO4 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)
CO5: Estimate the unknown solution by volumetric analysis.
Action Verb: Estimate **(L5)**
 PO4 Verb: Analyze (L4)
CO5 Action Verb is greater than PO4; Therefore correlation is high (3).

Course Code	Year & Sem	Engineering Workshop	L	T/CLC	P	C
23AES0302	I-II		0	0	3	1.5

Course Outcomes:

After studying the course, student will be able to

   CO1: Apply the wood working skills to prepare different joints.
   CO2: Analyze the sheet metal and fitting operations to prepare various components
   CO3: Apply the basic electrical engineering knowledge for house wiring practice.
   CO4: Apply the Welding process for Lap and Butt Joints.
   CO5: Understand the various plumbing pipe joints

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Apply	the wood working skills to prepare different joints			L3
CO2	Analyze	the sheet metal and fitting operations to prepare various components			L4
CO3	Apply	the basic electrical engineering knowledge for house wiring practice			L3
CO4	Apply	the Welding process for Lap and Butt joints			L3
CO5	Understand	the various plumbing pipe joints			L2

SYLLABUS

1. **Demonstration**: Safety practices and precautions to be observed in workshop.
2. **Wood Working:** Familiarity with different types of woods and tools used in woodworking and make following joints.
   a) Half – Lap joint   b) Mortise and Tenon joint   c) Corner Dovetail joint or Bridlejoint
3. **Sheet Metal Working**: Familiarity with different types of tools used in sheet metalworking, Developments of following sheet metal job from GI sheets.
   a) Tapered tray   b) Conical funnel   c) Elbow pipe   d) Brazing
4. **Fitting:** Familiarity with different types of tools used in fitting and do the followingfitting exercises.
   a) V-fit   b) Dovetail fit   c) Semi-circular fit   d) Bicycle tire punctureand change of two-wheeler tyre
5. **Electrical Wiring**: Familiarity with different types of basic electrical circuits and makethe following connections.
   a) Parallel and series   b) Two-way switch   c) Godown lighting
   d) Tube light   e) Three phase motor   f) Soldering of wires
6. **Foundry Trade:** Demonstration and practice on Moulding tools and processes,Preparation of Green Sand Moulds for given Patterns.
7. **Welding Shop**: Demonstration and practice on Arc Welding and Gas welding.Preparation of Lap joint and Butt joint.
8. **Plumbing:** Demonstration and practice of Plumbing tools, Preparation of Pipe jointswith coupling for same diameter and with reducer for different diameters.

Textbooks:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published,2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, MediaPromoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.

Mapping of COs to POs and PSOs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	CO Lesson Plan (Hrs)	%	Correlation	Verb	BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	-	-	3	Apply	L3	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
2	-	-	3	Analyze	L4	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
3	-	-	1	Apply	L3	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
4	-	-	2	Apply	L3	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
5	-	-	2	Understand	L2	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	2 2 2 2

Justification Statements:

CO1: Apply the wood working skills to prepare different joints

Action Verb: **Apply** (L3)

PO1 Verb: **Apply** (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review (L2)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb Rule**

CO1 Action verb is same level as PO9 verb. Therefore, the correlation is high (3)

CO2: Analyze the sheet metal and fitting operations to prepare various components

Action Verb: **Analyse** (L4)

PO1 Verb: **Apply** (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review (L2)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb Rule**

CO2 Action verb is same level (greater) as PO9 verb. Therefore, the correlation is high (3)

CO3: Apply the basic electrical engineering knowledge for house wiring practice

Action Verb: **Apply** (L3)
PO1 Verb: **Apply** (L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO3 Action verb is same level as PO9 verb. Therefore, the correlation is high (3)

CO4: Apply the Welding process for Lap and Butt Joints

Action Verb: **Apply** (L3)
PO1 Verb: **Apply** (L3)
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO4 Action verb is same level as PO9 verb. Therefore, the correlation is high (3)

CO5: Understand the various plumbing pipe joints.

Action Verb: **Understand (L2)**
PO1 Verb: **Apply** (L2)
CO5 Action verb is less than as PO1 verb. Therefore, the correlation is high (2)
PO2 Verb: **Review (L2)**
CO5 Action verb is less than as PO2 verb. Therefore, the correlation is high (2)
PO3 Verb: **Develop (L3)**
CO5 Action verb is less than as PO3 verb. Therefore, the correlation is high (2)
PO9 Verb: **Thumb Rule**
CO5 Action verb is less than as PO9 verb. Therefore, the correlation is high (2)

Course Code	Year & Sem	Data Structures Lab	L	T/CLC	P	C
23APC0502	I-II	**(Common to CSE, CIC, CSE(DS), AIML & AIDS)**	0	0	3	1.5

Course Outcomes:

After studying the course, student will be able to

CO 1: Apply the sorting and searching techniques using Arrays

CO 2: Develop linked list operations for efficient access to data.

CO 3: Develop stacks and queues to solve real time applications.

CO 4: Develop binary search tree operations using linked list

CO 5: Apply the hashing techniques to organise the data in hash table.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Apply**	sorting and searching algorithm	using arrays		L3
CO2	**Develop**	linked list operations		for efficient access to data.	L6
CO3	**Develop**	stacks and queues		to solve real time applications.	L6
CO4	**Develop**	binary search tree operations	using linked list		L6
CO5	**Apply**	the hashing techniques		to organise the data in hash table.	L3

List of Experiments:

Exercise 1: Array Manipulation[CO1]

i)   Write a program to reverse an array.

ii)   C Programs to implement the Searching Techniques – Linear & Binary Search

iii)   C Programs to implement Sorting Techniques – Bubble, Selection and Insertion Sort

Exercise 2: Linked List Implementation[CO2]

i)   Implement a singly linked list and perform insertion and deletion operations.

ii)   Develop a program to reverse a linked list iteratively and recursively.

iii)   Solve problems involving linked list traversal and manipulation.

Exercise 3: Linked List Applications[CO2]

i)   Create a program to detect and remove duplicates from a linked list.

ii)   Implement a linked list to represent polynomials and perform addition.

iii)   Implement a double-ended queue (deque) with essential operations.

Exercise 4: Double Linked List Implementation[CO2]

i)   Implement a doubly linked list and perform various operations to understand its properties and applications.

ii)   Implement a circular linked list and perform insertion, deletion, and traversal.

Exercise 5: Stack Operations[CO3]

i)   Implement a stack using arrays and linked lists.

ii)   Write a program to evaluate a postfix expression using a stack.

iii)   Implement a program to check for balanced parentheses using a stack.

Exercise 6: Queue Operations[CO3]

i)   Implement a queue using arrays and linked lists.

ii)   Develop a program to simulate a simple printer queue system.

iii)   Solve problems involving circular queues.

Exercise 7: Stack and Queue Applications[CO3]

i)   Use a stack to evaluate an infix expression and convert it to postfix.

ii)   Create a program to determine whether a given string is a palindrome or not.
iii)   Implement a stack or queue to perform comparison and check for symmetry.
Exercise 8: Binary Search Tree CO4]
i)   Implementing a BST using Linked List.
ii)   Traversing of BST.
Exercise 9: Hashing [CO5]
i)   Implement a hash table with collision resolution techniques.
ii)   Write a program to implement a simple cache using hashing.

Textbooks:
1. Data Structures and algorithm analysis in C, Mark Allen Weiss, Pearson, 2nd Edition.
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson- Freed, Silicon Press, 2008

Reference Books:
1. Algorithms and Data Structures: The Basic Toolbox by Kurt Mehlhorn and Peter Sanders
2. C Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, and John E. Hopcroft
3. Problem Solving with Algorithms and Data Structures" by Brad Miller and David Ranum
4. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
5. Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms by Robert Sedgewick.

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Apply	L3	PO1 PO2	PO1: Apply(L3) PO2: Review(L2)	3 3
2	CO2: Develop	L6	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Develop (L3) PO4: Design (L6) PO11: Thumb rule	3 3 3 3
3	CO3: Develop	L6	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Develop (L3) PO4: Design (L6) PO11: Thumb rule	3 3 3 3
4	CO4: Develop	L6	PO1 PO2 PO3 PO4 PO11	PO1: Apply(L3) PO2: Review (L2) PO3: Design (L6) PO4: Analysis(L4) PO11: Thumb rule	3 3 3 3 3
5	CO5: Apply	L3	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Review(L2) PO4: Analysis(L4) PO11: Thumb rule	3 3 2 3

Justification Statements :
CO1: Apply the sorting and searching techniques using Arrays
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review(L2)

CO1 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

CO2: Develop linked list operations for efficient access to data.

Action Verb: Develop (L6)

PO1: Apply (L3)

CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Develop (L6)

CO2 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Design (L6)

CO2 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (3)

CO3: Develop stacks and queues to solve real time applications

Action Verb: Develop (L6)

PO1: Apply (L3)

CO3 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Develop (L3)

CO3 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Design (L6)

CO3 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Data Structure applications, stacks concepts are used to manage data in the memory. Therefore, the correlation is high (3)

CO4: Develop binary search tree operations using linked list

Action Verb: Develop (L6)

PO1: Apply(L3)

CO4 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)

PO2: Review (L2)

CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO3: Design (L6)

CO4 Action verb is same as PO3 verb. Therefore, the correlation is high (3)

PO4: Analysis (L4)

CO4 Action verb is greater than PO4 verb by one level. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Real Time problems Data Structure applications, queues concepts are used to write programs and evaluation the memory operations. Therefore, the correlation is high (3)

CO5:Apply the hashing techniques to organise the data in hash table.

Action Verb: Apply (L3)

PO1: Apply(L3)

CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L2)

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO4: Analysis (L4)

CO5 Action verb less than PO4 verb by one level. Therefore, the correlation is moderate (2)

PO11: Thumb rule

For some of data manipulations tree and graphs concepts are used to solve data storage problems. Therefore, the correlation is high (3)

Common to I SEM CSE/CIC/SCD/EEE   &   II SEM   ECE/AI&DS/AI&ML/CE/ME

Course Code: 23AHM9903	HEALTH AND WELLNESS, YOGA AND SPORTS	L 0	T/CLC 0	P 1	C 0.5

Course Objectives:

The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits required for the development of the personality.

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

CO1. **Understand** the health & fitness by diet

CO2. **Understand** the importance of yoga.

CO3. **Apply** The yoga practices including Surya Namaskar

CO4. **Understand** the importance of sports.

CO5. **Analyze** various activities that help enhance their health & Positive Personality

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	Health & fitness by diet			L2
2	**Understand**	Importance of yoga.			L2
3	**Apply**	yoga practices including Surya Namaskar			L3
4	**Understand**	Importance of sports			L2
5	**Analyze**	Various activities that help enhance their health & Positive Personality			L4

UNIT I

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.

Activities:

i) Organizing health awareness programmes in community

ii) Preparation of health profile

iii) Preparation of chart for balance diet for all age groups

UNIT II

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities:

Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

i) Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.
Practicing general and specific warm up, aerobics

ii) Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping and running.

Reference Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning,2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. HumanKinetics, Inc.2014

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many as Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalingto 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva in the subject

Mapping of COs to POs and PSOs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	Level of Correlation (0-3)
	Register (Hrs)	Lesson Plan (Hrs)	% corr	Verb	BTL		
1				**Understand**	**L2**	P06,P07	2
2				**Understand**	**L2**	P06,P07	2
3				**Apply**	**L3**	P06,P07	2
4				**Understand**	**L2**	P06,P07	2
5				**Analyze**	**L4**	P06,P07	3

CO-PO mapping justification:

CO1: Understand the health & fitness by diet

Action Verb: Understand (L2)

CO1 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO2: Understand the Importance of yoga

Action Verb: Understand (L2)

CO2 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO3: APPLY

 yoga practices including Surya Namaskar

Action Verb: APPLY (L3)

CO3 Action Verb is APPLY of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO4: .Understand Importance of sports

Action Verb: Understand (L2)

CO4 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

Action Verb: APPLY (L3)

CO5: Analyze the Various activities that help enhance their health & Positive Personality

Action Verb: Analyze (L4)

CO5 Action Verb is Analyze of BTL 2.Using Thumb rule; L4 correlates PO6 and PO7 as a moderate (2)

Semester III (Second year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CLC	P	C			
1	BS	23ABS9913	Discrete Mathematics & Graph Theory	2	1	0	3	30	70	100
2	HM	23AHM9905	Universal Human Values	2	1	0	3	30	70	100
3	PC	23APC0508	Database Management Systems	2	1	0	3	30	70	100
4	PC	23APC0504	Advanced Data Structures and Algorithms Analysis	2	1	0	3	30	70	100
5	PC	23APC0506	Object-Oriented Programming Through JAVA	2	1	0	3	30	70	100
6	PC	23APC0505	Advanced Data Structures and Algorithms Analysis Lab	0	0	3	1.5	30	70	100
7	PC	23APC0507	Object-Oriented Programming Through JAVA Lab	0	0	3	1.5	30	70	100
8	SC	23ASC0501	Python Programming	1	0	2	2	30	70	100
			Total	**11**	**5**	**8**	**20**	**240**	**560**	**800**

Course Code	Year & Sem	Discrete Mathematics & Graph Theory	L	T/ CLC	P	C
23ABS9913	II-I	(Common to CSE,CIC,CSD,AI&DS, AI&ML)	2	1	0	3

Course Outcomes:

After studying the course, student will be able to

CO1: **Apply** the concepts of mathematical logic in various engineering fields.

CO2: **Understand** the concepts related to set theory and algebraic structures.

CO3: **Analyze** the theory of elementary combinatorics by using binomial and multinomial theorems.

CO4: **Evaluate** the solutions of homogeneous and inhomogeneous recurrence relations.

CO5: **Apply** the graph theory in solving computer science problems and finite difference approximation**.**

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the concepts of mathematical logic	in various engineering fields		L3
CO2	Understand	the concepts related to set theory and algebraic structures.			L2
CO3	Analyze	the theory of elementary combinatorics	by using binomial and multinomial theorems		L4
CO4	Evaluate	The solutions of homogeneous and inhomogeneous recurrence relations.			L5
CO5	Apply	The graph theory solving computer science problems.		and finite difference approximation.	L3

UNIT – I: Mathematical Logic	9Hrs

Introduction, Statements and Notation, Connectives, Well-formed formulas, Tautology, Duality law, Equivalence, Implication, Normal Forms, Functionally complete set of connectives, Inference Theory of Statement Calculus, Predicate Calculus, Inference theory of Predicate Calculus

UNIT – II: Set theory	9Hrs

The Principle of Inclusion-Exclusion, Pigeon hole principle and its application, Functions : composition of functions, Inverse Functions, Recursive Functions, Lattices and its properties.
Algebraic structures: Algebraic systems-Examples and General Properties, Semi groups , Monoids, groups, sub groups, homomorphism, Isomorphism.

UNIT – III: Elementary Combinatorics	9Hrs

Combinations and Permutations, Enumeration of Combinations and Permutations, Enumerating Combinations and Permutations with Repetitions, Enumerating Permutations with Constrained Repetitions, Binomial Coefficients, The Binomial and Multinomial Theorems.

UNIT – IV: Recurrence Relations	9Hrs

Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence relations, Solving Recurrence Relations by Substitution and Generating functions, The Method of Characteristic roots, Solutions of Inhomogeneous Recurrence Relations.

UNIT – V: Graphs	9Hrs

Basic Concepts, Isomorphism and Sub graphs, Trees and their Properties, Spanning Trees, Directed Trees, Binary Trees, Planar Graphs, Euler"s Formula, Multi graphs and Euler Circuits, Hamiltonian Graphs.

Textbooks

1.J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 2002.

2.Kenneth H. Rosen, Discrete Mathematics and its Applications with Combinatorics and Graph Theory, 7th Edition, McGraw Hill Education (India) Private Limited

Reference Books

1. Joe L. Mott, Abraham Kandel and Theodore P. Baker, Discrete Mathematics for Computer Scientists & Mathematicians, 2nd Edition, Pearson Education.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science.
3. Dr.J.Rajendra Prasad,T.Rama Rao and A.Madana Mohan Rao, Mathematical Foundation of Computer Science

Online Learning Resources:

http://www.cs.yale.edu/homes/aspnes/classes/202/notes.pdf

Mapping of COs to POs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Apply	L3	PO1	Apply (L3)	3
2				Understand	L2	PO1	Apply (L3)	2
3				Analyze	L4	PO2	Analyze (L4)	3
4				Evaluate	L5	PO2	Analyze (L4)	3
5				Apply	L3	PO1	Apply (L3)	3

CO1: .Apply the concepts of mathematical logic in various engineering fields
Action Verb: Apply (L3)
PO1 Verbs: **Apply** (L3)
CO1 Action Verb is equal to PO1 verb . Therefore correlation is high (3).

CO2: Understand the concepts related to set theory and algebraic structures
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO2 Action Verb is one level below to PO1 verb; Therefore correlation is moderate (2).

CO3: .Analyze the theory of elementary combinatorics by using binomial and multinomial theorems.
Action Verb: Analyse (L4)
PO2 Verb: **Analyse** (L4)
CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Evaluate the solutions of homogeneous and inhomogeneous recurrence relations.
Action Verb: Evaluate (L5)
PO2 Verb: Analyze (L4)
CO4 Action Verb is one level high to PO2 verb; Therefore correlation is high (3).

CO5: Apply the graph theory in solving computer science problems and finite difference approximation.
Action Verb: Apply(L3)
PO1 Verb: Apply (L3)
CO5 Action verb is equal to PO1 verb; therefore the correlation is high (3).

Course Code	Year & Sem	Universal Human Values	L	T / CLC	P	C
23AHM9905	II-I		2	1	**0**	**3**

Course Outcomes:

After studying the course, student will be able to

CO1:**Understand** the essentials of human values, self-exploration, happiness and prosperity for value added education.

CO2:**Analyze** the harmony in the human being as sentient „I" and the material „Body" in various aspects.

CO3:**Apply** the nine universal human values in relationships for harmony in the family and orderliness in the society.

CO4:**Evaluate** the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.

CO5:**Apply** the holistic understanding of harmony on professional ethics through augmenting universal human order.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the essentials of human values, self-exploration, happiness and prosperity for value added education.			**L2**
2	Analyze	the harmony in the human being as sentient „I" and the material „Body" in various aspects.			**L4**
3	Apply	the nine universal human values in relationships for harmony in the family and orderliness in the society.			**L3**
4	Evaluate	the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.			**L5**
5	Apply	the holistic understanding of harmony on professional ethics through augmenting universal human order.			**L3**

UNIT – I:	6 lectures and 3 tutorials for practice session

Introduction to Value Education (6 lectures and 3 tutorials for practice session)
Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 Sharing about Oneself
Lecture 3: self-exploration as the Process for Value Education
Lecture4: Continuous Happiness and Prosperity – the Basic Human Aspirations Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT – II:	6 lectures and 3 tutorials for practice session

Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
Lecture 7: Understanding Human being as the Co-existence of the self and the body. Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body. Lecture 9: The body as an Instrument of the self
Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self
Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT – III:	6 lectures and 3 tutorials for practice session

Harmony in the Family and Society (6 lectures and 3 tutorials for practice session) Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction Lecture 14: 'Trust' – the Foundational Value in Relationship Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust Lecture 15: 'Respect' – as the Right Evaluation Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect Lecture 16: Other Feelings, Justice in Human-to-Human Relationship Lecture 17: Understanding Harmony in the Society Lecture 18: Vision for the Universal Human Order Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal	
UNIT – IV:	4 lectures and 2 tutorials for practice session
Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session) Lecture 19: Understanding Harmony in the Nature Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature Lecture 21: Realizing Existence as Co-existence at All Levels Lecture 22: The Holistic Perception of Harmony in Existence Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.	
UNIT – V:	6 lectures and 3 tutorials for practice session
Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session) Lecture 23: Natural Acceptance of Human Values Lecture 24: Definitiveness of (Ethical) Human Conduct Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order Lecture 26: Competence in Professional Ethics Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies Lecture 28: Strategies for Transition towards Value-based Life and Profession Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order	

Textbooks

a. The Textbook
R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd
Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
b. The Teacher"s Manual
R R Gaur, R Asthana, G P Bagaria,Teachers" Manual for A Foundation Course in Human Values and
Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Online Learning Resources:

1. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%202023.pdf
5. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-

SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%202023-25%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

CO	CO Lesson Plan (Hrs)	%	Correlation	Verb	BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	7	19.4	2	Understand	2	PO8,PO11	Thumb Rule	2,2
2	8	22.2	3	Analyze	4	PO7,PO8	Thumb Rule	3,3
3	7	19.4	2	Apply	3	PO6,PO7,PO8	Thumb Rule	2,2,2
4	8	22.2	3	Evaluate	5	PO6,PO7,PO8,PO11	Thumb Rule	3,3,3,3
5	7	19.4	2	Apply	3	PO6,PO7,PO8,PO11	Thumb Rule	2,2,2,2

Justification Statements:

CO1: Understand the essentials of human values, self-exploration, happiness and prosperity for value added education.
Action Verb: Understand (L2)
CO1 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).
CO2: Analyze the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.
Action Verb: Analyze (L4)
CO2 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).
CO3: Apply the nine universal human values in relationships for harmony in the family and orderliness in the society.
Action Verb: Apply (L3)
CO3 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)
CO4: Evaluate the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.
Action Verb:Evaluate (L5)
CO4 Action Verb is Evaluate of BTL5. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).
CO5: Apply the holistic understanding of harmony on professional ethics through augmenting universal human order.
Action Verb: Apply (L3)
CO5 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Database Management Systems	L	T/CLC	P	C
23APC0508	II-I	**Common to CSE,AIML,CSE(DS) & CIC**	2	1	**0**	**3**

Course Outcomes:

After studying the course, student will be able to

CO1: Understand the fundamentals of databases to design relational models.

CO2: Apply the E-R model for database design of real world applications.

CO3: Apply the SQL and PL/SQL concepts to formulate queries.

CO4: Analyze normalization methods to enhance database structures

CO5: Analyze the concurrent transactions and recover systems to prevent data loss in system crash.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The fundamentals of databases		To design relational models.	L2
CO2	Apply	the E-R model		for database design of real world applications	L3
CO3	Apply	the SQL and PL/SQL concepts		To formulate queries.	L3
CO4	Analyze	normalization methods		to enhance database structures	L4
CO5	Analyze	the concurrent transactions and recover systems		to prevent data loss in system crash.	L4

UNIT - I		9 Hrs

Introduction: Database system, Characteristics (Database Vs File System), Database Users, Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

UNIT - II		9Hrs

Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance, Relational Algebra, Relational Calculus. BASIC SQL:Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update).

UNIT - III		9 Hrs

SQL: Basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(updatable and non-updatable), relational set operations.

NoSQL: Introduction and Properties of NoSQL, Different NoSQL Systems, Columnar families, Schema-Less Databases, Materialized Views, Distribution Models, Sharding

UNIT - IV		9 Hrs

Schema Refinement (Normalization): Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency Lossless join and dependency preserving decomposition, (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form(BCNF), MVD, Fourth normal form(4NF), Fifth Normal Form (5NF).

UNIT - V		9 Hrs

Transaction Concept: Transaction State, ACID properties, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, lock based, time stamp based, optimistic, concurrency protocols, Deadlocks, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

Introduction to Indexing Techniques: B+ Trees, operations on B+Trees, Hash Based Indexing:

Textbooks:

1. Database Management Systems, 3rd edition, Raghurama Krishnan, Johannes Gehrke, TMH (For Chapters 2, 3, 4)
2. Database System Concepts,5th edition, Silberschatz, Korth, Sudarsan,TMH (For Chapter 1 and Chapter 5)

Reference Books:
1. Introduction to Database Systems, 8thedition, C J Date, Pearson.
2. Database Management System, 6th edition, RamezElmasri, Shamkant B. Navathe, Pearson
3. Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

Online Learning Resources:
1. https://nptel.ac.in/courses/106/105/106105175/
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0127580666728202 2456_shared/overview

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	CO Lesson plan(Hrs)	%	Correlation	Co''s Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	9	20	2	CO1 :Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Review(L2)	2 3
2	9	20	2	CO2 :Apply	L3	PO1 PO2 PO11	PO1: Apply(L3) PO2: Review(L2) PO11: Thumb rule	3 3 2
3	9	20	2	CO3 :Apply	L3	PO1 PO2 PO3 PO4 PO5 PO7 PO8 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO7: Thumb rule PO8: Thumb rule PO11: Thumb rule	3 3 3 2 3 2 2 2
4	9	20	2	CO4 :Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO7	PO1: Apply(L3) PO2: Analyze(L4) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO7: Thumb rule	3 3 3 3 3 3
5	9	20	2	CO5 :Analyze	L4	PO2 PO3 PO4 PO5 PO7 PO8 PO11	PO2: Analyze(L4) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO7: Thumb rule PO8: Thumb rule PO11: Thumb rule	3 3 3 3 2 2 2
	45	100%						

Justification Statements:

CO1: Understand the fundamentals of databases to design relational models.

Action Verb: Understand(L2) PO1 Verb : Apply(L3)

CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)

PO2 Verb: Review(L2)

CO1 Action verb is same level as PO2 verb. Therefore the correlation is high (3)

CO2: Apply the E-R model for database design of real world applications.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Review (L2)
CO2 Action verb is greater than PO2 verb. Therefore the correlation is high (3)
PO11: Thumb rule
For some of DB applications, PL/SQL concepts are used to formulate queries. Therefore the correlation is moderate (2)

CO3: Apply the SQL and PL/SQL concepts to formulate queries.
Action Verb: Apply(L3)
PO1: Apply(L3)
CO3 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Review (L2)
CO3 Action verb is higher level as PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO3 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze(L4)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)
PO5: Apply(L3)
CO3 Action verb is same level as PO5 verb. Therefore the correlation is high (3)
PO7: Thumb rule
Since ethical principles should be followed to create a database. Therefore the correlation is moderate(2)
PO8 : Thumb rule
Team work is required between DBA and Database designer to create a database. Hence the correlation is moderate (2)
PO11: Thumb rule
For some of DB applications, ER model concepts are used to create designs. Therefore the correlation is moderate(2)

CO4: Analyze normalization methods to enhance database structures
Action Verb: Analyze(L4) PO1: Apply(L3)
CO4 Action verb is greater than PO1 verb . Therefore the correlation is high (3)
PO2: Analyze (L4)
CO4 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is greater than PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore the correlation is high (3)
PO5: Apply(L3)
CO4 Action verb is greater than PO5 verb. Therefore the correlation is high (3)
PO7: Thumb rule
Since ethical principles shall be followed in data manipulation. Therefore the correlation is high(3)

CO5: Analyze the concurrent transactions and recover systems to prevent data loss in system crash.
Action Verb: Analyze (L4) PO2: Analyze (L4)
CO5 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO5 Action verb is greater than PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is same level as PO4 verb. Therefore the correlation is high (3)
PO5: Apply(L3)
CO5 Action verb is greater than PO5 verb. Therefore the correlation is high (3)
PO7 : Thumb rule
Since ethical principles should be followed for transaction management. Therefore the correlation is moderate(2)
PO8: Thumb rule
Team work is required for transaction management and recovery of failure transactions. Hence the correlation is moderate (2)
PO11: Thumb rule
In real time transaction management is continuously updating. Therefore the correlation is moderate (2)

Course Code	Year & Sem	Advanced Data Structures and Algorithms Analysis	L	T/ CLC	P	C
23APC0504	II-I	(Common to CSE,CIC,CSE(DS),AIDS & AIML)	2	1	0	3

Course Outcomes:

After studying the course, student will be able to

CO1: **Understand** the asymptotic notations and operations on AVL, B-Trees.

CO2: **Apply** the Trees, Graphs, Divide and conquer method to solve various problems.

CO3: **Apply** the greedy and dynamic programming methods to solve real time problems.

CO4: **Evaluate** the backtracking , branch and bound methods to solve minimization problems.

CO5: **Analyze** the P, NP, NP hard and NP complete problems for solving reduction problems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The asymptotic notations	operations on AVL,B-Trees		L2
CO2	Apply	The Trees, Graphs, Divide and conquer method		to solve various problems	L3
CO3	Apply	The greedy and dynamic programming methods		to solve real time problems.	L3
CO4	Evaluate	The backtracking , branch and bound methods		to solve minimization problems	L5
CO5	Analyze	The P, NP, NP hard , NP complete problems		for solving reduction problems	L4

UNIT – I		9Hrs

Introduction to Algorithm Analysis, Space and Time Complexity analysis, Asymptotic Notations.
Review of Binary Search Trees: Binary Search Tree – Insertion, Deletion & Traversal
AVL Trees – Creation, Insertion, Deletion operations and Applications
B-Trees – Creation, Insertion, Deletion operations and Applications

UNIT – II		9 Hrs

Heap Trees (Priority Queues) – Min and Max Heaps, Operations and Applications Graphs – Terminology, Representations, Basic Search and Traversals, Connected Components and Biconnected Components, applications
Divide and Conquer: The General Method, Quick Sort, Merge Sort, Finding Minimum and Maximum, Strassen"s matrix multiplication.

UNIT – III		9 Hrs

Greedy Method: General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths
Dynamic Programming: General Method, Multi Stage graphs, All pairs shortest paths, Single Source Shortest Paths – General Weights (Bellman Ford Algorithm), Optimal Binary Search Trees, 0/1 Knapsack, Travelling Salesperson problem

UNIT – IV		8 Hrs

Backtracking: General Method, 8-Queens Problem, Sum of Subsets problem, Graph Coloring, 0/1 Knapsack Problem
Branch and Bound: The General Method, 0/1 Knapsack Problem, Travelling Salesperson problem.

UNIT – V		

NP Hard and NP Complete Problems: Basic Concepts, Cook"s theorem
NP Hard Graph Problems: Clique Decision Problem (CDP), Chromatic Number Decision Problem (CNDP), Traveling Salesperson Decision Problem (TSP)
NP Hard Scheduling Problems: Scheduling Identical Processors, Job Shop Scheduling

Textbooks:

1. Fundamentals of Data Structures in C++, Horowitz, Ellis; Sahni, Sartaj; Mehta, Dinesh 2nd Edition Universities Press.
2. Computer Algorithms/C++ Ellis Horowitz, SartajSahni, SanguthevarRajasekaran2nd Edition University Press

Reference Books:

1. Data Structures and program design in C, Robert Kruse, Pearson Education Asia
2. An introduction to Data Structures with applications, Trembley & Sorenson, McGraw Hill
3. The Art of Computer Programming, Vol.1: Fundamental Algorithms, Donald E Knuth, Addison-Wesley, 1997.
4. Data Structures using C & C++: Langsam, Augenstein&Tanenbaum, Pearson, 1995
5. Algorithms + Data Structures &Programs:,N.Wirth, PHI

6. Fundamentals of Data Structures in C++: Horowitz Sahni& Mehta, Galgottia Pub.
7. Data structures in Java:, Thomas Standish, Pearson Education Asia.

Online Learning Resources:

1. https://www.tutorialspoint.com/advanced_data_structures/index.asp
2. http://peterindia.net/Algorithms.html
3. Abdul Bari,1. Introduction to Algorithms (youtube.com)

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	CO Lesson plan(Hrs)	%	Correlation	Co"s Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level oF Correlation (0-3)
1	9	20	2	Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO11: Thumb rule	2 1 2
2	9	20	2	Apply	L3	PO1 PO2 PO4 PO6 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO4: Analyze(L4) PO6: Thumb rule PO11: Thumb rule	3 2 2 2 2
3	9	20	2	Apply	L3	PO1 PO2 PO3 PO4 PO6 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO3: Develop (L3) PO4: Analyze (L4) PO6: Thumb rule PO11: Thumb rule	3 2 3 2 2 2
4	9	20	2	Evaluate	L5	PO1 PO2 PO3 PO4 PO6 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO3: Develop (L3) PO4: Analyze (L4) PO6: Thumb rule PO11: Thumb rule	3 3 3 3 2 2
5	9	20	2	Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO11: Thumb rule	2 3 3 3 3 2
	45	100						

Justification Statements:

CO1: Understand the asymptotic notations and operations on AVL, B-Trees.
Action Verb: Understand (L2)
PO1 Verb: Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Analyze (L4)
CO1 Action verb is less than PO2 verb by two level. Therefore, the correlation is low (1)
PO11: Thumb rule
The asymptotic performance of algorithms, To Analyze the behavior of algorithms as their input increases. Therefore the correlation is moderate (2)

CO2: Apply the Trees, Graphs, Divide and conquer method to solve various problems.
Action Verb: Apply (L3)

PO1: Apply(L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)
CO2 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO4: Analyze (L4)
CO2 Action verb is lesser than PO4 verb by one level. Therefore, the correlation is moderate (2)
PO6: Thumb rule
Greedy and dynamic programming concepts were applied to solve traffic problems and finding best route to

the destination. Therefore, the correlation is moderate (2)
PO11: Thumb rule
Finding optimal solution to a real-world problem is a continuous activity. Therefore, the correlation is moderate (2)

CO3: Apply the greedy and dynamic programming methods to solve real time problems.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO3 Action verb is same level of PO1 verb. Therefore, the correlation is High (3)
PO2: Analyze (L4)
CO3 Action verb is less than of PO2 verb by one level. Therefore, the correlation is moderate (2)
PO3: Develop (L3)
CO3 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2))
PO6 : Thumb rule
backtracking and searching techniques were applied for GPS. Therefore, the correlation is moderate (2)
PO11: Thumb rule
backtracking and searching techniques will give optimal solutions to various problems. Therefore, the correlation is moderate (2)

CO4: Evaluate the backtracking, branch and bound methods to solve minimization problems.
Action Verb: Evaluate (L5)
PO1: Apply(L3)
CO3 Action verb is greater than of PO1 verb . Therefore, the correlation is High (3)
PO2: Analyze (L4)
CO3 Action verb is greater than of PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO3 Action verb is greater than of PO3 verb. Therefore the correlation is high(3)
PO4: Analyze (L4)
CO3 Action verb is greater than of PO4 verb. Therefore the correlation is high(3)
PO6 : Thumb rule
Backtracking and searching techniques were applied for GPS. Therefore, the correlation is moderate (2)
PO11: Thumb rule
Backtracking and searching techniques will give optimal solutions to various problems. Therefore, the correlation is moderate (2)

CO5: Analyze the P, NP, NP hard and NP complete problems for solving reduction problems.
Action Verb : Analyze (L4)
PO1: Apply(L3)
CO5 Action verb is less than of PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2: Analyze (L4)
CO5 Action verb is same level of PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO5 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply(L3)
CO5 Action verb is greater than PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
In research-oriented purpose P, NP concepts can be applied. Therefore, the correlation is moderate (2)

Course Code	Year & Sem	Object-Oriented Programming Through JAVA (common to CSE, CIC, CSE(DS), AIDS & AIML)	L	T / CLC	P	C
23APC0506	II-I		2	1	0	3

Course Outcomes:

After studying the course, student will be able to

CO1: Understand the Java language components and how to apply in applications

CO2: Apply the concepts of OOP‴s fundamentals like classes, Methods and class libraries to develop applications

CO3: Analyze the concepts of arrays, inheritance and interfaces to develop efficient java applications.

CO4: Evaluate the concepts of packages, file I/O, by using access control, and exception handling mechanisms to solve real world scenarios

CO5: Create the GUI applications by using concepts like multi-threading, Java FX, JDBC

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the Java language components		How to apply in applications	L2
CO2	Apply	the concepts of OOP‴s fundamentals	like classes, methods and class libraries	to develop applications	L3
CO3	Analyze	the concepts of arrays, inheritance and interfaces		to develop efficient java applications	L4
CO4	Evaluate	the concepts of packages , file I/O	by using access control, and exception handling mechanisms	to solve real world scenarios	L5
CO5	Create	The GUI applications, JDBC applications	by using concepts like multi-threading, Java FX, JDBC		L6

UNIT – I		**7 Hrs**

Object Oriented Programming: Basic concepts, Principles, Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style.

Data Types, Variables, and Operators: Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (- -) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

Control Statements: Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator?:, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.

UNIT – II		**12 Hrs**

Classes and Objects: Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

Methods: Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static.

UNIT – III		**19 Hrs**

Arrays: Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two-dimensional Arrays, Arrays of Varying Lengths, Three-dimensional Arrays, Arrays as Vectors.

Inheritance: Introduction, Process of Inheritance, Types of Inheritances, Universal Super Class Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

Interfaces: Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested

Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

UNIT – IV		**19 Hrs**

Packages and Java Library: Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto-boxing and Auto unboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

Exception Handling: Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions.

Java I/O and File: Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java(Text Book 2)

UNIT – V		**19 Hrs**

String Handling in Java: Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

Multithreaded Programming: Introduction, Need for Multiple Threads Multithreaded Programming for Multi-core Processor, Thread Class, Main Thread-Creation of New Threads, Thread States, Thread Priority-Synchronization, Deadlock and Race Situations, Inter-thread Communication - Suspending, Resuming, and Stopping of Threads.

Java Database Connectivity: Introduction, JDBC Architecture, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, ResultSet Interface

Java FX GUI: Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events (Text Book 3)

Textbooks:

1. JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
2. Joy with JAVA, Fundamentals of Object Oriented Programming, DebasisSamanta, MonalisaSarma, Cambridge, 2023.
3. JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.

Reference Books:

1. The complete Reference Java, 11thedition, Herbert Schildt,TMH
2. Introduction to Java programming, 7th Edition, Y Daniel Liang, Pearson

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105191/
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co"s Action verb		BTL			
1	12	13.63%	2	CO1: Understand		L2	PO1 PO2	PO1: Apply(L3) PO2: Analyze(L4)	2 1
2	13	14.77%	2	CO2: Apply		L3	PO2 PO3 PO4 PO5 PO10 PO11	PO2: Review (L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply(L3) PO10: Thumb Rule PO11: Thumb Rule	3 3 2 3 2 2

3	23	26.13%	3	CO3: Analyze	L4	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Analyze(L4) PO3: Design(L6) PO4: Interpret(L5) PO5: SSelect(L5)	3 3 1 2 2
4	20	22.72%	3	CO4: Evaluate	L5	PO1 PO2 PO4 PO5	PO1: Apply(L3) PO2: Analyze (L4) PO4: Analyze(L4) PO5: Select(L3)	3 3 3 3
5	20	22.72%	3	CO5: Create	L6	PO2 PO3 PO5 PO10 PO11	PO2: Formulate (L6) PO3: Design (L6) PO5: Create(L6) PO10: Thumb Rule PO11: Thumb rule	3 3 3 3 3
	88	100 %						

Justification Statements:
CO1: Understand the Java language components and how to apply in applications.
Action Verb: Understand(L2)
PO1 Verb: Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Analyze(L4)
CO1 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)

CO2: Apply the concepts of OOP's fundamentals like classes, Methods and class libraries to develop applications
Action Verb: Apply (L3)
PO2: Review (L2)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is High (3)
PO3: Develop (L3)
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is High (3)
PO4: Analyze(L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)
PO5: Apply(L3)
CO2 Action verb is less than PO5 verb by three level. Therefore, the correlation is High (3)
PO10: Thumb Rule
Create some Java programs to solve real world problems. Therefore, the correlation is moderate (2)
PO11: Thumb Rule
Learn java programs to solve. Therefore, the correlation is moderate (2)

CO3: Analyze the concepts of arrays, inheritance and interfaces to develop efficient java applications.
Action Verb: Analyze(L4)
PO1: Apply (L3)
CO3 Action verb is Greater than PO1. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO3 Action verb is same level as PO2. Therefore, the correlation is high (3)
PO3: Design (L6)
CO3 Action verb is less than PO3 verb by two level. Therefore, the correlation is low (1)
PO4: Interpret (L5)
CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO5: Select (L5)

CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)

CO4: Evaluate the concepts of packages, access control, file I/O, and exception handling mechanisms to solve real world scenarios
Action Verb: Evaluate(L5)
PO1: Apply(L3)
CO4 Action verb is Greater than PO1. Therefore, the correlation is high (3)
PO2: Analyze (L4)

CO4 Action verb is Greater than PO2. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO4 Action verb is Greater than PO4. Therefore, the correlation is high (3)
PO5: Select (L3)
CO4 Action verb is Greater than PO5. Therefore, the correlation is high (3)

CO5: Create GUI applications by using concepts like multi-threading, Java FX, JDBC
Action Verb: Create (L6)
PO2: Formulate (L6)
CO5 Action verb is same level as PO2. Therefore, the correlation is high (3)
PO3: Design (L6)
CO5 Action verb is same level as PO3. Therefore, the correlation is high (3)
PO5: Create (L6)
CO5 Action verb is same level as PO5. Therefore, the correlation is high (3)
PO10: Thumb Rule
Java is used to design simple and enterprise applications so need for project management. Therefore, the correlation is high (3)
PO11: Thumb Rule
It is a programming language so new version available so we need to learn. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES: TIRUPATI(Autonomous)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Advanced Data Structures and Algorithms Analysis Lab (Common to CSE,CIC,AIDS & AIML)	L	T/CLC	P	C
23APC0505	II-I		0	0	3	1.5

Course Outcomes:
After studying the course, student will be able to
CO1: Understand the operations on AVL Trees, B-Trees and graph traversals.
CO2: Create the Min, Max Heap using arrays and find BFT, DFT for the graphs.
CO3: Create the sorting techniques for finding the time complexities and use greedy method to find single source shortest path.
CO4: Apply backtracking strategy for finding the N-Queens ,0/1 knapsack problem.
CO5: Apply greedy strategy for job sequencing and using dynamic programming to find 0/1 knapsack problem.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the operations	on AVL Trees, B-Trees and graph traversals		L2
CO2	Create	the Min, Max Heap using arrays and find BFT, DFT		for the graphs	L6
CO3	Create	the sorting techniques		for finding the time complexities	L6
CO4	Apply	backtracking strategy		for finding the N-Queens ,0/1 knapsack problem	L3
CO5	Apply	greedy strategy		for job sequencing	L3

List of Experiments:

1. Construct an AVL tree for a given set of elements which are stored in a file. And implement insert and delete operation on the constructed tree. Write contents of tree into a new file using in-order.**(CO1)**
2. Construct B-Tree an order of 5 with a set of 100 random elements stored in array.Implement searching, insertion and deletion operations.**(CO1)**
3. Construct Min and Max Heap using arrays, delete any element and display the content of the Heap.**(CO2)**
4. Implement BFT and DFT for given graph, when graph is represented by
   a) Adjacency Matrix b) Adjacency Lists. **(CO2)**
5. Write a program for finding the bi-connected components in a given graph.**(CO2)**
6. Implement Quick sort and Merge sort and observe the execution time for various input sizes (Average, Worst and Best cases).**(CO2)**
7. Compare the performance of Single Source Shortest Paths using Greedy method when the graph is represented by adjacency matrix and adjacency lists.**(CO3)**
8. Implement Job sequencing with deadlines using Greedy strategy.**(CO5)**
9. Write a program to solve 0/1 Knapsack problem Using Dynamic Programming.**(CO4)**
10. Implement N-Queens Problem Using Backtracking.**(CO4)**
11. Use Backtracking strategy to solve 0/1 Knapsack problem.**(CO4)**
12. Implement Travelling Sales Person problem using Branch and Bound approach.**(CO5)**

Reference Books:

1. Fundamentals of Data Structures in C++, Horowitz Ellis, SahniSartaj, Mehta, Dinesh, 2ndEdition, Universities Press
2. Computer Algorithms/C++ Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, 2ndEdition, University Press
3. Data Structures and program design in C, Robert Kruse, Pearson Education Asia
4. An introduction to Data Structures with applications, Trembley& Sorenson, McGraw Hill

Online Learning Resources:

1. http://cse01-iiith.vlabs.ac.in/
2. http://peterindia.net/Algorithms.html

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	CO1 : Understand	L2	PO1 PO2 PO8 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO8: Thumb rule PO11: Thumb rule	2 1 1 2
2	CO2 : Create	L6	PO1 PO2 PO5 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO5: Develop (L6) PO11: Thumb rule	3 3 3 2
3	CO3 : Create	L6	PO1 PO2 PO3 PO4 PO8 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Design (L6) PO4: Design (L6) PO8: Thumb rule PO11: Thumb rule	3 3 3 3 1 1
4	CO4 : Apply	L3	PO1 PO2 PO8 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO8: Thumb rule PO11: Thumb rule	3 2 2 2
5	CO5 : Apply	L3	PO1 PO2 PO3 PO4 PO8 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop (L3) PO4: Develop (L3) PO8: Thumb rule PO11: Thumb rule	3 2 3 3 1 2

Justification Statements :

CO1: Understand the operations on AVL Trees, B-Trees and graph traversals.

Action Verb : Understand (L2)

PO1 Verb : Apply(L3)

CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)

PO2 Verb : Analyze(L4)

CO1 Action verb is less than PO2 verb by two levels. Therefore the correlation is low (1)

PO8: Thumb rule

Perform operations on AVL trees and B-trees are individual. There fore the correlation is low(1)

PO11 : Thumb rule

Apply different values of operations on AVL Trees, B-Trees and graph traversals is life long. Therefore the correlation is moderate (2)

CO2: Create the Min, Max Heap using arrays and find BFT, DFT for the graphs

Action Verb : Create (L6)

PO1 Verb : Apply(L3)

CO2 Action verb is greater than PO1 verb. Therefore the correlation is high (3)

PO2 Verb : Analyze(L4)

CO2 Action verb is greater than PO2 verb. Therefore the correlation is high (3)

PO5: Develop(L6)

CO2 Action verb is less than PO5 verb by one level. Therefore the correlation is high (3)

PO11: Thumb rule

To Apply the min and max heap on arrays and finding traversals on graphs is lifelong learning. Therefore the correlation is moderate (2)

CO3: Create the sorting techniques for finding the time complexities and use greedy method to find single

source shortest path.
Action Verb : Create (L6)
PO1: Apply(L3)
CO3   Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2:Analyze (L4)
CO3 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO3 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)
PO4: Develop (L6)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)
PO8: Thumb rule
Team work or individual work is required to analyze sorting techniques time complexities. Hence the correlation is low (1)
PO11: Thumb rule
To Develop sorting techniques and single source shortest path as life long learning. Therefore the correlation is low (1)

CO4: Apply backtracking strategy for finding the N-Queens ,0/1 knapsack problem
Action Verb : Apply (L3)
PO1: Apply(L3)
CO4   Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Analyze (L4)
CO4   Action verb is less than PO2 verb by one level. Therefore the correlation is medium (2)
PO8: Thumb rule
Team work/ individual work is required find the N-Queens and 0/1 Knapsack trough backtracking. Hence the correlation is medium (2)
PO11: Thumb rule
To Develop back tracking in N-Queens problem is life long learning. Therefore the correlation is medium (2)

CO5 : Apply greedy strategy for job sequencing and using dynamic programming to find 0/1 knapsack problem.
Action Verb : Apply (L3)
PO1: Apply (L3)
CO5 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Analyze (L4)
CO5 Action verb is less than PO2 verb by one level. Therefore the correlation is medium (2)
PO3: Design (L3)
CO5 Action verb is less than PO3 verb. Therefore the correlation is high (3)
PO4: Design (L3)
CO5 Action verb is less than PO4 verb. Therefore the correlation is high (3)
PO8: Thumb rule
Team work / individual work is required applying greedy strategy on job sequencing. Hence the correlation is low (1)
PO11: Thumb rule
To apply dynamic programming for 0/1 knapsack is life long learning. Therefore the correlation is medium (2)

Course Code	Year & Sem	Object-Oriented Programming Through Java Lab	L	T/CLC	P	C
23APC0507	II-I	(common to CSE,CIC, CSE(DS), AIDS & AIML)	0	0	3	1.5

Course Outcomes:

After studying the course, student will be able to

CO1: Understand the Java syntax, data types, control structures and OOPs principles.

CO2: Apply the problem-solving skills and algorithmic thinking by using OOP concepts

CO3: Apply the fundamental OOP principles to solve programming problems effectively.

CO4: Analyze the Java libraries to implement thread Applications.

CO5: Create graphical user interface (GUI) applications using JavaFX

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The Java syntax, data types, control structures and OOPs principles			L2
CO2	Apply	The problem-solving skills and algorithmic thinking	by using OOP concepts		L3
CO3	Apply	The fundamental OOP principles		to solve programming problems effectively	L3
CO4	Analyze	The Java libraries		to implement thread Applications.	L4
CO5	Create	graphical user interface (GUI) applications	using JavaFX		L6

List of Experiments:

Exercise – 1

a) Write a JAVA program to display default value of all primitive data type of JAVA **(CO1)**

b) Write a java program that display the roots of a quadratic equation $ax2+bx=0$. Calculate the discriminate D and basing on value of D, describe the nature of root. **(CO2)**

Exercise - 2

a) Write a JAVA program to search for an element in a given list of elements using binary search mechanism. b) Write a JAVA program to sort for an element in a given list of elements using bubble sort. **(CO2)**

c) Write a JAVA program using StringBuffer to delete, remove character. **(CO2)**

Exercise - 3

a) Write a JAVA program to implement class mechanism. Create a class, methods and invoke them inside main method. **(CO2)**

b) Write a JAVA program implement method overloading. **(CO3)**

c) Write a JAVA program to implement constructor**. (CO3)**

d) Write a JAVA program to implement constructor overloading. **(CO3)**

Exercise - 4

a) Write a JAVA program to implement Single Inheritance **(CO3)**

b) Write a JAVA program to implement multi level Inheritance **(CO3)**

c) Write a JAVA program for abstract class to find areas of different shapes **(CO3)**

Exercise - 5

a) Write a JAVA program give example for "super" keyword. **(CO3)**

b) Write a JAVA program to implement Interface. What kind of Inheritance can be achieved? **(CO3)**

c) Write a JAVA program that implements Runtime polymorphism **(CO3)**

Exercise - 6

a) Write a JAVA program that describes exception handling mechanism **(CO4)**

b) Write a JAVA program Illustrating Multiple catch clauses **(CO4)**

c) Write a JAVA program for creation of Java Built-in Exceptions **(CO4)**

d) Write a JAVA program for creation of User Defined Exception **(CO4)**

Exercise - 7

a) Write a JAVA program that creates threads by extending Thread class. First thread display "Good Morning "every 1 sec, the second thread displays "Hello "every 2 seconds and the third display "Welcome" every 3 seconds, (Repeat the same by implementing Runnable) **(CO4)**

b) Write a program illustrating is Alive and join () **(CO4)**

c) Write a Program illustrating Daemon Threads. **(CO4)**

d) Write a JAVA program Producer Consumer Problem **(CO4)**

Exercise – 8
a) Write a JAVA program that import and use the user defined packages **(CO4)**
b) Without writing any code, build a GUI that display text in label and image in an ImageView (use JavaFX) **(CO5)**
c) Build a Tip Calculator app using several JavaFX components and learn how to respond to user interactions with the GUI **(CO5)**

Exercise – 9
a) Write a java program that connects to a database using JDBC **(CO5)**
b) Write a java program to connect to a database using JDBC and insert values into it. **(CO5)**
c) Write a java program to connect to a database using JDBC and delete values from it. **(CO5)**

Textbooks:
1. JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
2. Joy with JAVA, Fundamentals of Object Oriented Programming, DebasisSamanta, MonalisaSarma, Cambridge, 2023.
3. JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.
Reference Books:
1. The complete Reference Java, 11th edition, Herbert Schildt,TMH
2. Introduction to Java programming, 7th Edition, Y Daniel Liang, Pearson
Online Resources:
1. https://nptel.ac.in/courses/106/105/106105191/
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547 618816347_shared/overview

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	CO1 :Understand	L2	PO2 PO5	PO2: Review(L2) PO5: Apply(L3)	3 2
2	CO2 :Apply	L3	PO2 PO3 PO4 PO5	PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply(L3)	3 3 2 3
3	CO3: Apply	L3	PO3 PO4 PO5	PO3: Develop(L3) PO4: Analyze(L4) PO5: Apply(L3)	3 2 3
4	CO4: Analyze	L4	PO2 PO3 PO4 PO5 PO8 PO10 PO11	PO2: Analyze (L4) PO3: Develop(L3) PO4: Analyze(L4) PO5: Apply(L3) PO8: Thumb Rule PO10: Thumb Rule PO11: Thumb Rule	3 3 3 3 3 3 3
5	CO5 :Create	L6	PO3 PO5 PO8 PO10 PO11	PO3: Design (L6) PO5: Create(L6) PO8: Thumb Rule PO10: Thumb Rule PO11: Thumb Rule	3 3 3 3 3

Justification Statements :

CO1: Understand Java syntax thoroughly, encompassing data types and control structures.
Action Verb : Understand(L2)

PO2: Review(L2)

CO1 Action verb is same PO2 verb. Therefore the correlation is High(3)

PO5: Apply(L3)

CO1 Action verb is less than PO5 verb by one level. Therefore the correlation is moderate (2)

CO2: Develop problem-solving skills and algorithmic thinking, applying OOP concepts to design efficient solutions to various programming challenges.
Action Verb : Apply (L3)

PO2: Review(L2)

CO2 Action verb is greater than PO2 verb. Therefore the correlation is High(3)

PO3: Develop (L3)

CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)

PO4: Analyze (L4)

CO2 Action verb is less than PO4 verb by one levels. Therefore the correlation is moderate (2)

PO5: Apply (L3)

CO2 Action verb is same level as PO5 verb. Therefore the correlation is high (3)

CO3: Apply fundamental OOP principles such as encapsulation, inheritance, polymorphism, and abstraction to solve programming problems effectively.
Action Verb : Apply(L3)

PO3: Develop (L3)

CO3 Action verb is same level as PO3 verb. Therefore the correlation is high (3)

PO4: Analyze (L4)

CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate(2)

PO5: Apply (L3)

CO3 Action verb is same as PO5 verb. Therefore the correlation is high(3)

CO4: Analyze the concepts of multithreading and collection frameworks for solving complex programs.
Action Verb :Analyze (L4)

PO2: Analyze (L4)

CO4 Action verb is same PO2 verb. Therefore the correlation is high (3)

PO3: Develop (L3)

CO4 Action verb is greater than PO3 verb. Therefore the correlation is high (3)

PO4: Analyze (L4)

CO4 Action verb is same as PO4 verb. Therefore the correlation is high (3)

PO5: Apply (L3)

CO4 Action verb is greater than PO5 verb. Therefore the correlation is high (3)

PO8: Thumb Rule

It is a programming language we need to collaborate with team. Therefore the correlation is high (3)

PO10: Thumb Rule

By using java to manage enterprise projects in multi-disciplinary environments . Therefore the correlation is high (3)

PO11: Thumb Rule

It is a programming language we need to learn lifelong because new concepts arise. Therefore the correlation is high (3)

CO5: Create GUI based applications using Java FX.
Action Verb : Create (L6)

PO3: Design (L6)

CO5 Action verb is same level as PO3 verb. Therefore the correlation is high (3)

PO5: Create(L6)

CO5 Action verb is same as PO5 verb. Therefore the correlation is high (3)

PO8: Thumb Rule

It is a programming language we need to collaborate with team. Therefore the correlation is high (3)

PO10: Thumb Rule

By using java to manage enterprise and web based projects in multi-disciplinary environments. Therefore the correlation is high (3)

PO11: Thumb Rule

It is a programming language we need to learn lifelong because new concepts arise. Therefore the correlation is high (3)

Course Code	Year & Sem	PYTHON PROGRAMMING (SKILL ENHANCEMENT COURSE) (Common to CSE,CIC,CSE(DS),AIDS & AIML)	L	T/CLC	P	C
23ASC0501	II-I		1	0	2	2

Course Outcomes:
After studying the course, student will be able to
CO1: Understand the Basic concepts of python programming to build scripts in IDLE.
CO2: Apply the modularity techniques to invoke user defined functions**.**
CO3: Apply the concept of Dictionaries, Tuples and sets to perform operations on data.
CO4: Analyze the file concepts and oops paradigms to manage data.
CO5: Apply the concepts of JSON and XML for data processing.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	Basic concepts of python programming		to build scripts in IDLE	L2
CO2	**Apply**	the modularity techniques		to invoke user defined functions	L3
CO3	**Apply**	the concept of Dictionaries, Tuples and sets		to perform operations on data.	L3
CO4	**Analyze**	the file concepts and oops paradigms.		to manage data	L4
CO5	**Apply**	the concepts of JSON and XML		for data processing	L3

UNIT – I	9Hrs

History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook.
Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the type () Function and Is Operator, Dynamic and Strongly Typed Language.
Control Flow Statements: if statement, if-else statement, if...elif...else, Nested if statement, while Loop, for Loop, continue and break Statements, Catching Exceptions Using try and except Statement.
 Sample Experiments:
1. Write a program to find the largest element among three Numbers.
2. Write a Program to display all prime numbers within an interval
3. Write a program to swap two numbers without using a temporary variable.
4. Demonstrate the following Operators in Python with suitable examples.
   i) Arithmetic Operators ii) Relational Operators iii) Assignment Operators iv) Logical Operators v) Bit wise Operators vi) Ternary Operator vii) Membership Operators
   viii) Identity Operators
5. Write a program to add and multiply complex numbers
6. Write a program to print multiplication table of a given number.

UNIT – II	9 Hrs

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments.
Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.
Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, del Statement.

 Sample Experiments:
7. Write a program to define a function with multiple return values.
8. Write a program to define a function using default arguments.
9. Write a program to find the length of the string without using any library functions.
10. Write a program to check if the substring is present in a given string or not.
11. Write a program to perform the given operations on a list:
    i.Addition   ii. Insertion   iii. slicing

12. Write a program to perform any 5 built-in functions by taking any list.

UNIT – III		9 Hrs

Dictionaries: Creating Dictionary, Accessing and Modifying key:value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement.

Tuples and Sets: Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozenset.

Sample Experiments:

13. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
14. Write a program to count the number of vowels in a string (No control flow allowed).
15. Write a program to check if a given key exists in a dictionary or not.
16. Write a program to add a new key-value pair to an existing dictionary.
17. Write a program to sum all the items in a given dictionary.

UNIT – IV		9 Hrs

Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules.

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, Constructor Method, Classes with Multiple Objects, Class Attributes Vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

Sample Experiments:

18. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
19. Python program to print each line of a file in reverse order.
20. Python program to compute the number of characters, words and lines in a file.
21. Write a program to create, display, append, insert and reverse the order of the items in the array.
22. Write a program to add, transpose and multiply two matrices.
23. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.

UNIT – V		9Hrs

Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy with Python, Pandas.

Sample Experiments:

24. Python program to check whether a JSON string contains complex object or not.
25. Python Program to demonstrate NumPy arrays creation using array () function.
26. Python program to demonstrate use of ndim, shape, size, dtype.
27. Python program to demonstrate basic slicing, integer and Boolean indexing.
28. Python program to find min, max, sum, cumulative sum of array
29. Create a dictionary with at least five keys and each key represent value as a list where this list contains at least ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows:
    a)   Apply head () function to the pandas data frame
    b)   Perform various data selection operations on Data Frame
30. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

Reference Books:

1. Gowrishankar S, Veena A., Introduction to Python Programming, CRC Press.
2. Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2ndEdition, Pearson, 2024
3. Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

Online Learning Resources/Virtual Labs

1. https://www.coursera.org/learn/python-for-applied-data-science-ai
2. https://www.coursera.org/learn/python?specialization=python#syllabus

Mapping of course outcomes with program outcomes

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

CO3	3	3	3	2	3							2		2
CO4	3	3	3	3	3								2	
CO5	3	3	3	2	3									2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	9	20	2	CO1 : Understand	L2	PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO5: Apply (L3)	2 3 2 2
2	9	20	2	CO2 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 2 3
3	9	20	2	CO3 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 2 3
4	9	20	2	CO4 : Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3) PO11:Thumb Rule	3 3 3 3 3 2
5	9	20	2	CO5 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 2 3
	53	100 %						

Justification Statements:
CO1: Understand the Basic concepts of python programming to build scripts in IDLE.
Action Verb : Understand(L2)
PO1 Verb : Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb : Review(L2)
CO1 Action verb is same as PO2 verb. Therefore the correlation is high (3)
PO3 Verb : Develop(L3)
CO1 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)
PO5 Verb : Apply(L3)
CO1 Action verb is less than PO5 verb by one level. Therefore the correlation is moderate (2)

CO2: Apply the modularity techniques to invoke user defined functions.
Action Verb : Apply (L3)
PO1: Apply(L3)
CO2 Action verb is same as PO1 verb. Therefore the correlation is high (3)
PO2 Verb : Review(L2)
CO2 Action verb is greater than PO2 verb. Therefore the correlation high (3)
PO3 Verb : Develop (L3)
CO2 Action verb same as PO3 verb. Therefore the correlation high (3)
PO4 Verb : Analyze(L4)
CO2 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)
PO5 Verb : Apply(L3)

CO2 Action verb is same as PO5 verb. Therefore the correlation is high (3)

CO3: Apply the concept of Dictionaries, Tuples and sets to perform operations on data.
Action Verb : Apply(L3)
PO1: Apply(L3)
CO3 Action verb is same as PO1 verb. Therefore the correlation is high (3)
PO2 Verb : Review(L2)
CO3 Action verb is greater than PO2 verb. Therefore the correlation high (3)
PO3 Verb : Develop (L3)
CO3 Action verb same as PO3 verb. Therefore the correlation high (3)
PO4 Verb : Analyze(L4)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)
PO5 Verb : Apply(L3)
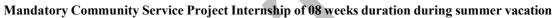CO3 Action verb is same as PO5 verb. Therefore the correlation is high (3)

CO4: Analyze the file concepts and oops paradigms to manage data.
Action Verb: Analyze(L4)
PO1: Apply(L3)
CO3 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2 Verb : Review(L2)
CO3 Action verb is greater than PO2 verb. Therefore the correlation high (3)
PO3 Verb : Develop (L3)
CO3 Action verb is greater than PO3 verb. Therefore the correlation high (3)
PO4 Verb : Analyze(L4)
CO3 Action verb is same as PO4 verb. Therefore the correlation is high (3)
PO5 Verb : Apply(L3)
CO3 Action verb is greater than PO5 verb. Therefore the correlation is high (3)
PO11: Thumb rule
To solve the real time problems oops and file concepts are necessary for data security. Therefore the correlation is medium(2)

CO5: Apply the concepts of JSON and XML for data processing.
Action Verb : Apply(L3)
PO1: Apply(L3)
CO3 Action verb is same as PO1 verb. Therefore the correlation is high (3)
PO2 Verb : Review(L2)
CO3 Action verb is greater than PO2 verb. Therefore the correlation high (3)
PO3 Verb : Develop (L3)
CO3 Action verb same as PO3 verb. Therefore the correlation high (3)
PO4 Verb : Analyze(L4)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)
PO5 Verb : Apply(L3)
CO3 Action verb is same as PO5 verb. Therefore the correlation is high (3)

S.No.	Category	Course code	Title	Hours per week			Credits	CIE	SEE	Total
				L	T/CLC	P	C			
1	HM	23AHMMB01	Managerial Economics and Financial Analysis	2	0	0	2	30	70	100
2	BS	23ABS9915	Statistical Methods for Data Science	2	1	0	3	30	70	100
3	PC	23APC3001	Artificial Intelligence	2	1	0	3	30	70	100
4	PC	23APC3201	Introduction to Data Science	2	1	0	3	30	70	100
5	PC	23APC0503	Digital Logic & Computer Organization	2	1	0	3	30	70	100
6	PC	23APC3002	Artificial Intelligence Lab	0	0	3	1.5	30	70	100
7	PC	23APC3202	Data Science Using Python Lab	0	0	3	1.5	30	70	100
8	SC	23ASC0503	Full Stack Development - 1	1	0	2	2	30	70	100
9	ES	23AES0304	Design Thinking & Innovation	2	0	0	2	30	70	100
10	MC	23AMC9901	Environmental Science	2	0	0	-	30	-	30
Total				**15**	**4**	**8**	**21**	**300**	**630**	**930**
Mandatory Community Service Project Internship of 08 weeks duration during summer vacation										

Course Code	MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS	L	T/CLC	P	C
23AHMMB01	(Common to ALL branches of Engineering)	2	0	0	2

Course Outcomes (CO):

CO1: Understand the fundamentals of managerial economics and Apply the forecasting techniques for estimation of demand.

CO2: Understand the production and cost concepts to optimize the output

CO3: Analyze the price output relationship in different markets.

CO4: Evaluate the capital budgeting techniques to invest in various projects.

CO5: Analyze the accounting statements to evaluate the financial performance of business entity.

CO	Action Verb	Knowledge Statement	Condition	Criteria	BL
CO1	Understand Apply	The fundamentals of Managerial economics and the demand of a product	by using statistical and survey methods.		L3
CO2	Understand	Production and cost concepts		To optimize the output	L2
CO3	Analyze	Price output relationship		In perfect and imperfect competition markets	L4
CO4	Evaluate	Capital budgeting techniques		To invest in various projects	L5
CO5	Analyze	Accounting statements		to evaluate the financial performance of business entity	L4

UNIT – I :   **Managerial economics**

Introduction – meaning, nature, significance, functions, and advantages, ME and its role in other fields. Demand **-** Concept, Function, Law of Demand- Demand Elasticity-Types– Measurement. Demand Forecasting- Factors governing forecasting, Methods.

UNIT-II   **Production and Cost Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least-cost combination– Short run and Long run Production Function- Iso quants and Iso costs, MRTS, Cobb-Douglas Production Function- Laws of Returns- Internal and External Economies of scale. Cost & Break-Even Analysis- Cost concepts and Cost behavior- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems) - Managerial significance and limitations of Break-Even Analysis.

UNIT-III   **Business Organizations and Markets**

Introduction-Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises.Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition, Monopoly- Monopolistic Competition– Oligopoly- Price-Output Determination- Pricing Methods and strategies.

UNIT-IV   **Capital Budgeting**

Introduction- Nature, meaning, significance, types of working capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting – Features, Proposals, Time value of money. Methods and Evaluation of Projects – Pay Back Method, Accounting Rate of Return (ARR), Net Present Value (NPV), and Internal Rate Return (IRR) Method, Profitability Index(PI) Method (simple problems).

UNIT-V   Financial Accounting and Analysis

Introduction - Concepts and Conventions- Double- Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). **Financial Analysis -** Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

Text books:
1. Varshney & Maheswari: Managerial Economics, Sultan Chand, 2013.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH, 2019

Reference Books:
1. Ahuja Hl Managerial economics Schand, 3/e, 2013
2. S.A.Siddiqui and A.S.Siddiqui: Managerial Economics and Financial Analysis, New Age International, 2013.
3. Joseph G.Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. DomnickSalvatore: Managerial Economics in a Global Economy, Cengage, 2013.

Online Learning Resources:
1. https://www.slideshare.net/123ps/managerial-economics-ppt
2. https://www.slideshare.net/rossanz/production-and-cost-45827016
3. https://www.slideshare.net/darkyla/business-organizations-19917607
4. https://www.slideshare.net/balarajbl/market-and-classification-of-market
5. https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396
6. https://www.slideshare.net/ashu1983/financial-accounting.

Course Title	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Managerial Economics and Financial Analysis	CO1	3												
	CO2	1									1			
	CO3	3									3			
	CO4										3			
	CO5										3			

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s):Action Verb and BTL	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	10	16.1%	2	CO1: Apply	L3	PO1	Apply	3
2	14	22.5%	3	CO2: Understand	L2	PO1,PO10	APPLY Apply	1 1
3	14	22.5%	3	CO3: Analyze	L4	PO1,PO10	Apply Apply	3 3
4	10	16.1%	2	CO4: Evaluate	L5	PO10	Apply	3
5	14	22.5%	3	CO5: Analyze	L4	PO10	Apply	3
total	62	100						

Justification Statements:
CO1: Understand the fundamentals of managerial economics and Apply the forecasting techniques for estimation of demand.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same as PO1verb. Therefore the correlation is high (3)

CO2: Understand the production and cost concepts to optimize the output.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO2 Action verb is less than PO1 verb by two levels. Therefore the correlation is low (1)
PO10: Apply (L3)
CO2 Action verb is less than PO1 verb by two levels. Therefore the correlation is low (1)

CO3: Analyze the price output relationship in different markets.
Action Verb: Analyze (L4)
PO1: Apply (L3)

CO3 Action verb is more than PO1 verb by one level. Therefore the correlation is high (3)

PO10: Apply (L3)
CO3 Action verb is more than PO1 verb by one level. Therefore the correlation is high (3)

CO4: Evaluate the capital budgeting techniques to invest in various projects.
Action Verb: Evaluate (L5)
PO10: Apply (L3)
CO4 Action verb is more than PO1 verb by one level. Therefore the correlation is high (3)

CO5: Analyze the accounting statements to evaluate the financial performance of   business entity.
Action Verb: Analyze (L4)
PO10: Apply (L3)
CO5 Action verb is more than PO1 verb by one level. Therefore the correlation is high (3)

Course Code	Year & Sem	STATISTICAL METHODS FOR DATA SCIENCE	L	T/CLC	P	C
23ABS9915	II-II		2	1	0	3

Course Outcomes (CO): Students will be able to

1) **Apply** the discrete and continuous probability distributions to the given random data
2) **Evaluate** the estimators using Methods of point estimation for given data.
3) **Apply** the methods of Interval estimation to the given data.
4) **Analyze** the techniques for testing of hypothesis and types of errors for large samples.
5) **Analyze** the techniques for testing of hypothesis for small samples.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
1	**Apply**	the discrete and continuous probability distributions	to the given random data		**L3**
2	**Evaluate**	the estimators using Methods of point estimation	for given data		**L5**
3	**Apply**	the methods of Interval estimation	to the given data		**L3**
4	**Analyze**	the techniques for testing of hypothesis and types of errors	for large samples		**L4**
5	**Analyze**	the techniques for testing of hypothesis	for small samples		**L4**

Unit I: Random Variables and Sampling Theory   9 Hrs
Random variables (discrete and continuous), probability density functions, properties, mathematical expectation. Probability distributions: Binomial, Poisson and Normal-their properties.
Sampling Theory: Population, sample, parameter and statistic; characteristics of a good estimator; Consistency – Invariance property of Consistent estimator, Sufficient condition for consistency; Unbiasedness; Sufficiency.

UNIT II: Point Estimation   **10** Hrs
Point Estimation- Estimator, Estimate, Methods of point estimation – Maximum likelihood method (the asymptotic properties of ML estimators are not included), Large sample properties of ML estimator (without proof)- applications, Method of moments, method of least squares, method of minimum chi-square and modified minimum chi-square-Asymptotic Maximum Likelihood Estimation and applications.

UNIT III: Interval Estimation   **10** Hrs
Confidence limits and confidence coefficient; Duality between acceptance region of a test and a confidence interval; Construction of confidence intervals for population proportion (small and large samples) and between two population proportions(large samples); Confidence intervals for mean and variance of a normal population; Difference between the mean and ratio of two normal populations.

Unit IV: Testing of hypotheses   9 Hrs
Types of errors, power of a test, most powerful tests; Neyman-Pearson Fundamental Lemma and its applications; Notion of Uniformly most powerful tests; Likelihood Ratio tests: Description and property of LR tests - Application to standard distributions.

Unit V: Small sample tests   9 Hrs
Student's t-test, test for a population mean, equality of two population means, paired t-test, F-test for equality of two population variances, Chi-square test for goodness of fit and test for independence of attributes, χ^2 test for testing variance of a normal distribution.

Textbooks:
1. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. Manoj Kumar Srivastava and Namita Srivastava, Statistical Inference – Testing of Hypotheses, Prentice Hall of India, 2014
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

Reference Books:
1. S. Ross, a First Course in Probability, Pearson Education India, 2002.
2. W. Feller, an Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.
3. Robert V Hogg, Elliot A Tannis and Dale L.Zimmerman, Probability and Statistical Inference, 9th edition, Pearson publishers,2013
4. S.Chand ,Probability and Statistics, Dr.T.K.V.Iyengar, Dr.B.Krishna Gandhi, S.Ranganatham, Dr.M.V.S.S.N.Prasad

Online Learning Resources:
1. https://onlinecourses.nptel.ac.in/noc21_ma74/preview
2. https://onlinecourses.nptel.ac.in/noc22_mg31/preview

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3										
2	3										
3	3										
4		3									
5		3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	13	18	2	Apply	L3	PO1	Apply (L3)	3
2	15	21	3	Evaluate	L5	PO1	Apply (L3)	3
3	14	20	3	Apply	L3	PO1	Apply (L3)	3
4	15	21	3	Analyze	L4	PO2	Analyze (L4)	3
5	15	21	3	Analyze	L4	PO2	Analyze (L4)	3

CO1: Apply the discrete and continuous probability distributions to the given random data.
CO Action Verb: Apply (L3)
PO2 Verb: Apply(L3)
CO1 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO2: Evaluate the estimators using Methods of point estimation for given data..
CO Action Verb: Evaluate (L5)
PO2 Verb: Apply(L3)
CO2 Action Verb high level to PO1 verb; Therefore correlation is high (3).

CO3: Analyze the methods of Interval estimation to the given data.
CO Action Verb: Apply (L3)
PO2 Verb: Apply(L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO4: Analyze the techniques for testing of hypothesis and types of errors for large samples.
CO Action Verb: Analyze (L4)
PO1 Verb: Analyze (L4)
CO4 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO5: Apply the techniques for testing of hypothesis for small samples.
CO Action Verb: Analyze (L4)
PO1 Verb: Analyze (L4)
CO5 Action verb is equal to PO2 verb ; therefore the correlation is high (3).

Course Code	Year & Sem	Artificial Intelligence	L	T/CLC	P	C
23APC3001	II-II	**(common to AIDS, AIML)**	2	1	0	3

Course Outcomes:

Student will able to After studying the course, students will be able to

CO1: Understand the basic concepts of artificial intelligence and intelligent agents

CO2: Apply the searching techniques for solving searching problems.

CO3: Apply the techniques for uncertainties and representing the knowledge

CO4: Understand learning methods for implementing logic concepts

CO5: Analyze the architecture and roles of expert systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the basic concepts of artificial intelligence and intelligent agents			L2
CO2	Apply	the searching techniques		for solving searching problems	L3
CO3	Apply	the techniques for uncertainties and representing the knowledge			L3
CO4	Understand	learning methods		for implementing logic concepts	L2
CO5	Analyze	the architecture and roles of expert systems			L4

UNIT – I			

Introduction: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

UNIT – II			

Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A* ,AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

UNIT – III			

Representation of Knowledge: Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Bayes" probabilistic interferences and dempstershafer theory.

UNIT – IV			

Logic concepts: First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning, Decision trees, Explanation based learning, Statistical Learning methods, Reinforcement Learning.

UNIT – V			

Expert Systems: Architecture of expert systems, Roles of expert systems – Knowledge Acquisition Meta knowledge Heuristics. Typical expert systems – MYCIN, DART, XCON: Expert systems shells.

Textbooks:

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach",

SecondEdition, Pearson Education.

2. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill

Reference Books:

1. David Poole, Alan Mackworth, Randy Goebel,"Computational Intelligence: a logical

approach", Oxford University Press.

2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex

problemsolving", Fourth Edition, Pearson Education.

3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1				CO1 :Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Review(L2)	2 3
2				CO2 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop (L3) PO4: Analyze (L4) PO5:Apply(L3)	3 2 3 2 3
3				CO3 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Identify(L3) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3)	3 3 3 2 3
4				CO4 : Understand	L2	PO2 PO3 PO5 PO11	PO2: Review(L2) PO3: Develop(L3) PO5: Apply(L3) PO11:Thumb Rule	3 2 2 2
5				CO5 :Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO11	PO1:Apply(L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO11: Thumb Rule	3 3 3 3 2 2

Justification Statements :

CO1: Understand the basic concepts of artificial intelligence and intelligent agents
Action Verb : Understand(L2)
PO1 : Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is medium (2)
PO2 : Review(L2)
CO1 Action verb is same level as PO2 verb. Therefore the correlation is high (3)

CO2: Apply the searching techniques for solving searching problems.
Action Verb : Apply (L3)
PO1: Apply(L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Analyze (L4)
CO2 Action verb is less than PO2 verb by one level. Therefore the correlation is medium(2)
PO3: Develop (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore the correlation is medium(2)
PO5:Apply(L3)
CO2 Action verb is same level as PO5 verb. Therefore the correlation is high (3)

CO3: Apply the techniques for uncertainties and representing the knowledge.
Action Verb : Apply(L3)
PO1: Apply(L3)
CO3 Action verb is same level as PO1 verb . Therefore the correlation is high (3)

PO2: Identify(L3)
CO3 Action verb is same level as PO2 verb . Therefore the correlation is high (3)
PO3: Develop (L3)
CO3 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is medium (2)
PO5:Apply(L3)
CO3 Action verb is same level as PO5 verb. Therefore the correlation is high(3)

CO4: Understand learning methods for implementing logic concepts
Action Verb : Understand(L1)
PO2: Review(L2)
CO4 Action verb is greater than PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is less than one level as PO3 verb. Therefore the correlation is medium (2)
PO4: Apply(L3)
CO4 Action verb is less than one level as PO4 verb. Therefore the correlation is medium (2)
PO11: Thumb rule
Artificial intelligence learning methods are used for developing intelligent agents. Therefore the correlation is medium(2)

CO5: Analyze the architecture and roles of expert systems.
Action Verb : Analyze(L4)
PO1: Apply(L3)
CO5 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Review (L2)
CO5 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO5 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is same level as PO4 verb. Therefore the correlation is high (3)
PO5:Apply(L3)
CO3 Action verb is less than one level as PO5 verb. Therefore the correlation is medium(2)
PO11: Thumb rule
For developing expert systems some of python program concepts are used to create programs. Therefore the correlation is medium (2)

Course Code	Year & Sem	Introduction to Data Science	L	T/CLC	P	C
23APC3201	II-II		2	1	0	3

Course Outcomes:

After studying the course, students will be able to

CO 1: Understand the basic significance of Data Science

CO 2: Analyze the large data sets using python libraries.

CO 3: Apply the ACID Principles of relational data and NOSQL Data

CO 4: Apply the Machine learning techniques for data analytics on standard data sets.

CO 5: Understand the python programs to present and interpret data sets using visualization packages in python.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloomslevel
CO1	**Understand**	The basic significanceof Data science			L2
CO2	**Analyze**	The large data sets	using pythonlibraries		L4
CO3	**Apply**	The ACID Principles of relational data and NOSQL Data			L3
CO4	**Apply**	The Machine learning techniques		for data analytics on standarddata sets	L3
CO5	**Understand**	the python programs to present and interpret data sets	using visualizationpackages in python.		L2

UNIT – I		9 Hrs

Introduction to Data science, benefits and uses, facets of data, data science process in brief, big data ecosystem and data science

Data Science process: Overview, defining goals and creating project charter, retrieving data, cleansing, integrating and transforming data, exploratory analysis, model building, presenting findings and building applications on top of them

UNIT – II		9 Hrs

Applications of machine learning in Data science, role of ML in DS, Python tools like sklearn, modelling process for feature engineering, model selection, validation and prediction, types of ML, semi-supervised learning

Handling large data: problems and general techniques for handling large data, programming tips for dealing large data, case studies on DS projects for predicting malicious URLs, for building recommender systems

UNIT – III		9 Hrs

NoSQL movement for handling Bigdata: Distributing data storage and processing with Hadoop framework, case study on risk assessment for loan sanctioning, ACID principle of relational databases, CAP theorem, base principle of NoSQL databases, types of NoSQL databases, case study on disease diagnosis and profiling

UNIT – IV		9 Hrs

Tools and Applications of Data Science: Introducing **Neo4j**for dealing with graph databases, graph query language **Cypher**, Applications graph databases, Python libraries like nltk and SQLite for handling Text mining and analytics, case study on classifying Reddit posts	
UNIT – V	9 Hrs
Data Visualization and Prototype Application Development: Data Visualization options, Crossfilter,the JavaScript MapReduce library, Creating an interactive dashboard with dc.js, Dashboard development tools.Applying the Data Science process for real world problem solving scenarios as a detailed case study.	

Textbooks:

1. Davy Cielen, Arno D.B.Meysman, and Mohamed Ali, "Introducing to Data Science using Python tools", Manning Publications Co, Dreamtech press, 2016

2. Prateek Gupta, "Data Science with Jupyter" BPB publishers, 2019 for basics

Reference Books:

1. Joel Grus, "Data Science From Scratch", OReilly, 2019

2. Doing Data Science: Straight Talk From The Frontline, 1 st Edition, Cathy O"Neil and Rachel Schutt, O"Reilly, 2013

Online Learning Resources:

www.nptel.ac.in

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 toPO11)	Level of Correlation(0-3)
	Lesson plan (Hrs)	%	Correlation	Co's Actionverb	BTL				
1	9	20	2	CO1: Understand	L2	PO1	PO1: Apply(L3)	2
						PO2	PO2: Review(L2)	3
						PO4	PO4: Analyze (L4)	1
2	9	20	2	CO2: Analyze	L4	PO1	PO1: Apply(L3)	3
						PO2	PO2: Review(L2)	3
						PO3	PO3: Develop (L3)	3
						PO4	PO4: Analyze (L4)	3
3	9	20	2	CO3: Apply	L3	PO1	PO1: Apply(L3)	3
						PO2	PO2: Review(L2)	2
						PO3	PO3: Develop (L3)	3
						PO4	PO4: Analyze (L4)	3
						PO5	PO5: Apply(L3)	3
						PO10	PO10: Thumb rule	2
4	9	20	2	CO4: Apply	L3	PO1	PO1: Apply(L3)	3
						PO2	PO2: Review(L2)	2
						PO3	PO3: Develop (L3)	3
						PO4	PO4: Analyze (L4)	2
						PO5	PO5: Apply(L3)	3

5	9	20	2	CO5: Understand	L2	PO1	PO1: Apply(L3)	2
						PO2	PO2: Review(L2)	3
						PO3	PO3: Develop (L3)	2
						PO4	PO4: Analyze (L4)	2
						PO5	PO5: Apply(L3)	2
						PO11	PO11: Thumb rule	2
	45	100						

Justification Statements:

CO 1: Understand the basic significance of Data Science
Action Verb: Understand (L2)
PO1 Verb: Apply(L3)
CO1 Action verb is less than of PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Review(L2)
CO1 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb. Therefore the correlation is Low (1)

CO 2: Analyze the large data sets using python libraries
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Review(L2)
CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO2 Action verb is greater than PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is same as PO4 verb. Therefore the correlation is high (3)

CO 3 : Apply the ACID Principles of relational data and NOSQL Data
Action Verb: Apply (L3)
PO1: Apply(L3)
CO3 Action verb is same as of PO1 verb. Therefore, the correlation is High (3)
PO2: Review (L2)
CO3 Action verb is greater than level as PO2 verb by one. Therefore, the correlation is medium (2)
PO3: Develop (L3)
CO3 Action verb is same as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is same as PO4 verb. Therefore the correlation is high (3)
PO5: Apply(L3)
CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO10: Thumb rule
The fundamental tools of data analysis and statistics to solve difficult problems in different data sets Therefore, the correlation is medium (2)

CO 4: Apply the Machine learning techniques for data analytics on standard data sets **Action Verb: Apply (L3)**
PO1: Apply(L3)
CO4 Action verb is same level of PO1 verb. Therefore the correlation is high (3)
PO2: Review(L2)
CO4 Action verb is greater than PO2 verb. Therefore the correlation is medium (2)
PO3: Develop (L3)

CO3 Action verb is same as PO3 verb. Therefore the correlation is high (3)

PO4: Analyze (L4)

CO3 Action verb is less than PO4 verb. Therefore the correlation is medium(2)

PO5: Apply(L3)

CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO 5: Understand the python programs to present and interpret data sets using visualization packages in python

Action Verb: Understand (L2)

PO1: Apply(L3)

CO5 Action verb is Less than of PO1 verb. Therefore, the correlation is Medium (2)

PO2: Review (L2)

CO5 Action verb is same as PO2 verb. Therefore, the correlation is High (3)

PO3: Develop (L3)

CO5 Action verb is Less than of PO3 verb. Therefore, the correlation is Medium (2)

PO4: Analyze (L4)

CO5 Action verb is Less than of PO4 verb. Therefore, the correlation is Medium (2)

PO5: Apply(L3)

Action verb is Less than of PO5 verb. Therefore, the correlation is Medium (2)

PO11: Thumb rule

To deployment of application need suitable visualization reports to be generated by project team members.Therefore, the correlation is medium (2)

Course Code	Year & Sem	DIGITAL LOGIC & COMPUTER ORGANIZATION (Common to CSE & CIC,AIDS)	L	T/CLC	P	C
23APC0503	II-II		2	1	0	3

CO Statements:

CO1: Understand the number system concepts, number conversions, logic gates using binary numbers

CO2: Understand the sequential circuits, flip-flops, registers and computer fundamentals.

CO3: Evaluate the Arithmetic operations for understanding execution process

CO4: Analyze the memory concepts, cache memory, virtual memory and managing requirements.

CO5: Apply Input/Output devices and Interfaces.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the Binay number system concepts number, conversions,logic		using binary numbers	L2
CO2	Understand	the sequential circuits, flip-flops, registers and computer fundamentals			L2
CO3	Evaluate	the Arithmetic operations		for understanding execution process	L5
CO4	Analyze	the memory concepts, cache memory, virtual memory and managing requirements			L4
CO5	Apply	Input/Output devices and Interfaces			L3

UNIT – I	9Hrs

Data Representation: Binary Numbers, Fixed Point Representation. Floating Point Representation. Number base conversions, Octal and Hexadecimal Numbers, components, Signed binary numbers,Character representation.

Digital Logic Circuits-I: Basic Logic Functions, Logic gates, universal logic gates, Minimization of Logic expressions. K-Map Simplification, Combinational Circuits, Decoders, Multiplexers,dumping.

UNIT – II	9Hrs

Digital Logic Circuits-II: Sequential Circuits, Flip-Flops, Binary counters, Registers, Shift Registers, Ripple counters

Basic Structure of Computers: Computer Types, Functional units, Basic operational concepts, Bus structures, Software, Performance, multiprocessors and multi computers, Computer Generations, Addressing modes,subroutines.

UNIT – III	9Hrs

Computer Arithmetic : Addition and Subtraction of Signed Numbers,Ripple carry adder,Ripple carry multiplier, Design of Fast Adders, Multiplication of Positive Numbers, Signed-operand Multiplication, Fast Multiplication, Integer Division, Floating-Point Numbers and Operations

Processor Organization: Fundamental Concepts, Execution of a Complete Instruction, Multiple-Bus Organization, Hardwired Control and Multi programmed Control

UNIT – IV	9Hrs

The Memory Organization: Memory hierarchy, Semiconductor RAM Memories, Read-Only Memories, Speed, Size and Cost, Cache Memories, Cache mappings, Performance Considerations, Virtual Memories, Memory Management Requirements, Secondary Storage

UNIT – V	9Hrs

Input /Output Organization: Accessing I/O Devices, Interrupts, Processor Examples, Direct Memory Access, Synchronous and Asynchronous bus, Interface Circuits, Standard I/O Interfaces

Textbooks

1.	Computer Organization, Carl Hamacher, ZvonkoVranesic, SafwatZaky, 6th edition, McGraw Hill, 2023.
2.	Digital Design, 6th Edition, M. Morris Mano, Pearson Education, 2018.
3.	Computer Organization and Architecture, William Stallings, 11thEdition, Pearson, 2022.

Reference Books

1.	Computer Systems Architecture, M.Moris Mano, 3rdEdition, Pearson, 2017.
2.	Computer Organization and Design, David A. Paterson, John L. Hennessy, Elsevier, 2004.
3.	Fundamentals of Logic Design, Roth, 5thEdition, Thomson, 2003.

Online Learning Resources:

https://nptel.ac.in/courses/106/103/106103068/

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome(PO)	PO(s) :Action Verband BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb		BTL			
1	9	20	2	CO1 : Understand		L2	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO3: Design (L6) PO11: Thumb rule	2 1 3 1
2	9	20	2	CO2 : Understand		L2	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Analyze(L4) PO3: Design (L6) PO11: Thumb rule	2 2 1 3 1
3	9	20	2	CO3 : Evaluate		L5	PO1 PO2 PO3 PO9 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Design (L6) PO9: Thumb rule PO11: Thumb rule	3 2 2 1 1
4	9	20	2	CO4 : Analyze		L4	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Analyze (L4) PO3: Design (L6) PO4: Design (L6)	2 3 3 3
5	9	20	2	CO5 : Apply		L3	PO1 PO4 PO5 PO9 PO11	PO1: Apply(L3) PO4: Analyze (L4) PO5: Develop (L6) PO9: Thumb rule PO11: Thumb rule	3 2 3 2 2
	45	100							

Justification Statements:

CO1: Understand the number system concepts, number conversions, logic gates using binary numbers
Action Verb: Understand(L2)
PO1 Verb: Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Analyze(L4)
CO1 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)
PO3: Design (L6)
CO1 Action verb is less than PO3 verb . Therefore, the correlation is high (3)
PO11: Thumb rule
updating the logical circuits and combinational circuits. Therefore, the correlation is low (1)

CO2: Understand the sequential circuits, flip-flops, registers and computer fundamentals.
Action Verb: Understand(L2)
PO1: Apply(L3)
CO2 Action verb is greater than level PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2: Analyze(L4)
CO2 Action verb is less than PO2 verb by two level. Therefore, the correlation is low (1)
PO3: Design (L6)
CO2 Action verb is less than PO3 verb . Therefore, the correlation is high (3)
PO11: Thumb rule
Update sequential circuits and registers. Therefore, the correlation is low (1)

CO3: Evaluate the Arithmetic operations for understanding execution process
Action Verb: Evaluate(L5)
PO1: Apply(L3)
CO3 Action verb is higher level than PO1 verb level by two level. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO3 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO3: Design (L6)
CO3 Action verb is less than PO3 verb by one level. Therefore, the correlation is moderate (2)
PO9: Thumb rule
Team work is required. Hence the correlation is low (1)
PO11: Thumb rule
Updating the Numbers and execution process. Therefore the correlation is low (1)

CO4: Analyze the memory concepts, cache memory, virtual memory and managing requirements.
Action Verb: Analyze(L4)
PO1: Apply(L3)
CO4 Action verb is less than PO1 by one level. Therefore, the correlation is moderate (2)
PO2: Analyze (L4)
CO4 Action verb is same as PO2 verb. Therefore, the correlation is High (3)
PO3: Design (L6)
CO4 Action verb is less than PO3 verb by two levels. Therefore, the correlation is High (3)
PO4: Design (L6)
CO4 Action verb is less than PO4 verb by two levels. Therefore, the correlation is High (3)

CO5: Apply Input/Output devices and Interfaces
Action Verb: Apply (L3)
PO1: Apply(L3)
CO5 Action verb is same as PO1. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)
PO5: Develop(L6)
CO5 Action verb is less than PO5 verb . Therefore, the correlation is high (3)
PO9 : Thumb rule
Team work is required to provide the solutions on different numbers. Hence the correlation is moderate (2)
PO11: Thumb rule
Updating the Numbers and execution process. Therefore, the correlation is moderate (2)

Course Code	Year & Sem	Artificial Intelligence Lab	L	T/CLC	P	C
23APC3002	II-II		0	0	3	1.5

Course Outcomes:

After studying the course, students will be able to

CO1: Analyze the various searching algorithms for finding solutions.

CO2: Apply the various searching algorithms for finding shortest path to a problem. **CO3: Apply** the machine learning methods using atomic sentences for finding solutions. **CO4: Analyze** the reasoning system to find conclusions using knowledge based system.

CO5: Apply the reasoning concepts through python programming

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the various searching algorithms		for finding solutions	L4
CO2	Apply	the various searching algorithms		for finding shortest path to a problem	L3
CO3	Apply	machine learning methods	using atomic sentences	for finding solutions	L3
CO4	Analyze	the reasoning system to find conclusions	using knowledge based system		L4
CO5	Apply	the reasoning concepts through python programming			L3

List of Experiments:
1. Write a Program to Implement Breadth First Search using Python.(CO1)
2. Write a program to implement Best First Searching Algorithm(CO1)
3. Write a Program to Implement Depth First Search using Python. (CO1)
4. Write a program to implement the Heuristic Search(CO2)
5. Write a python program to implement A* and AO* algorithm. (Ex: find the shortest path) (CO2)
6. Write a Program to Implement Water-Jug problem using Python. (CO3)
7. Write a Program to Implement Alpha-Beta Pruning using Python. (CO3)
8. Write a Program to implement 8-Queens Problem using Python. (CO3)
9. Write a program to schedule a meeting among a 5 busy people using Default Reasoning the output should give the time, place and day of the meeting. (CO4)
10. Write a program to implement the Unification algorithm(CO4)
11. Develop a knowledge base system consisting of facts and rules about some specialized knowledge domain(CO5)
12. Write a program to implement 8 puzzle programs using different heuristics. Using it play the game Tic-Tac-Toe at the end the game the program should display the no. of nodes generated, cutoff values at each stage in the form of a table. (CO5)

Textbooks:
1. PrateekJoshi,Artificial Intelligence with Python,Packt Publishing, 2017.
2. Xiao, Perry. Artificial intelligence programming with Python: from zero to hero. John Wiley & Sons, 2022.

Reference Books:
1. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach, Fourth Edition, Pearson,2020

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	CO1 : Analyze	L4	PO1 PO2	PO1: Apply(L3) PO2: Analyze(L4)	2 3
2	CO2 : Apply	L3	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb rule	3 2 2
3	CO3 :Apply	L3	PO1 PO2 PO3 PO4 PO9 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO4: Analyze (L4) PO9: Thumb rule PO11: Thumb rule	3 2 3 2 1 1
4	CO4 :Analyze	L4	PO1 PO2	PO1: Apply(L3) PO2: Analyze (L4)	2 3
5	CO5 : Apply	L3	PO2 PO3 PO4 PO5 PO8 PO9 PO11	PO2: Analyze (L4) PO3: Develop(L3) PO4: Analyze (L4) PO5: Apply (L3) PO8: Thumb rule PO9: Thumb rule PO11: Thumb rule	2 3 2 3 2 1 2

Justification Statements :
CO1: Analyze the basic concepts of Python Programming
Action Verb : Analyze (L4)
PO1 Verb : Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is medium (2)
PO2 Verb : Analyze(L4)
CO1 Action verb is same level as PO2 verb. Therefore the correlation is high (3)

CO2: Apply the loops and conditional statements of python using IDLE and programs.
Action Verb : Apply (L3)
PO1 Verb : Apply(L3)
CO1 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2 Verb : Analyze(L4)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is medium (2)
PO11: Thumb rule
For usage of the loops and conditional statements of python using IDLE is medium. Therefore the correlation is medium (2)

CO3: Analyze the compound data using Lists, Tuples and dictionaries using functions.
Action Verb : Apply(L3)
PO1: Apply(L3)
CO3 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2:Analyze (L4)
CO3 Action verb is higher level as PO2 verb. Therefore the correlation is medium (2)
PO3: Develop (L3)
CO3 Action verb is same level as PO3 verb . Therefore the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is greater than PO4 verb by one level. Therefore the correlation is medium (2)
PO9 : Thumb rule
Team work is required to Analyze the compound data using. Hence the correlation is low (1)
PO11: Thumb rule
Construct real time applications using functions can be lifelong learning. Therefore the correlation is low (1)

CO4: Apply the development applications using python datatypes to read and write data from files.
Action Verb : Analyze (L4)
PO1: Apply(L3)
CO4 Action verb is less than PO1 verb by one level. Therefore the correlation is medium (2)
PO2: Analyze (L4)
CO4 Action verb is same as PO2 verb. Therefore the correlation is high (3)

CO5: Design the solutions using OOPs concepts for real world problems in python.
Action Verb : Apply (L3)
PO2: Analyze (L4)
CO5 Action verb is less than PO2 verb by one levels. Therefore the correlation is medium (2)
PO3: Develop (L3)
CO5 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is greater than PO4 verb by one level. Therefore the correlation is medium (2)
PO5: Apply(L3)
CO5 Action verb is same level as PO5 verb. Therefore the correlation is high (3)
PO8 : Thumb rule
IOT Applications can be used to make society better place. Therefore the correlation is medium(2)
PO9 : Thumb rule
Team work is required to Create AI applications. Hence the correlation is low (1)
PO11: Thumb rule
In real time oops concepts are used to solve the societal problems by using Artificial intelligence applications. Therefore the correlation is medium (2)

Course Code	Year & Sem	Data Science using Python Lab	L	T/CLC	P	C
23APC3202	II-II		0	0	3	1.5

Course Outcomes:

After studying the course, students will be able to
CO1: Understand the concepts of Data frames, pandas and NumPy in Python programming for solving complex problems.
CO2: Apply the python libraries for basic statistical and descriptive analytics on the data sets.
CO3:Apply the corelation and regression analytics and standard data sets.
CO4:Analyse the python programs to present and interpret data using visualization reports
CO5: Understand the basic Python libraries for data science to optimize numeric applications

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts of Data frames, pandas and NumPy		for solving complex problems.	L2
CO2	Apply	the python libraries for basic statistical and descriptive analytics on the data sets			L3
CO3	Apply	the corelation and regression analytics and standard data sets			L3
CO4	Analyse	the python programs to present and interpret data		Visualization reports	L4
CO5	Understand	the basic Python libraries for data science		to optimize numeric applications	L2

List of Experiments

1. Creating a NumPy Array[CO1]
   a. Basic ndarray
   b. Array of zeros
   c. Array of ones
   d. Random numbers in ndarray
   e. An array of your choice
   f. Imatrix in NumPy
   g. Evenly spaced ndarray
 2. The Shape and Reshaping of NumPy Array[CO1]
   a. Dimensions of NumPy array
   b. Shape of NumPy array
   c. Size of NumPy array
   d. Reshaping a NumPy array
   e. Flattening a NumPy array
   f. Transpose of a NumPy array

3. Expanding and Squeezing a NumPy Array[CO1]
   a. Expanding a NumPy array
   b. Squeezing a NumPy array
   c. Sorting in NumPy Arrays
4. Indexing and Slicing of NumPy Array[CO2]
   a. Slicing 1-D NumPy arrays
   b. Slicing 2-D NumPy arrays
   c. Slicing 3-D NumPy arrays
   d. Negative slicing of NumPy arrays
5. Stacking and Concatenating NumPy Arrays[CO2]
   a. Stacking ndarrays
   b. Concatenating ndarrays
   c. Broadcasting in NumPy Arrays
6. Perform following operations using pandas[CO3]
   a. Creating dataframe
   b. concat()
   c. Setting conditions
   d. Adding a new column
7. Perform following operations using pandas[CO3]
   a. Filling NaN with string
   b. Sorting based on column values
   c. groupby()
8. Read the following file formats using pandas[CO4]
   a. Text files
   b. CSV files
   c. Excel files
   d. JSON files
9. Read the following file formats[CO4]
   a. Pickle files
   b. Image files using PIL
   c. Multiple files using Glob
   d. Importing data from database
10. Demonstrate web scraping using python[CO4]
11. Perform following preprocessing techniques on loan prediction dataset[CO5]
    a. Feature Scaling
    b. Feature Standardization
    c. Label Encoding
    d. One Hot Encoding
12. Perform following visualizations using matplotlib[CO5]
    a. Bar Graph
    b. Pie Chart
    c. Box Plot
    d. Histogram
    e. Line Chart and Subplots
    f. Scatter Plot
13. Getting started with NLTK, install NLTK using PIP[CO5]
14. Python program to implement with Python Sci Kit-Learn & NLTK[CO5]
15. Python program to implement with Python NLTK/Spicy/Py NLPI. [CO5]

Web References:

1. https://www.analyticsvidhya.com/blog/2020/04/the-ultimate-numpy-tutorial-for-data-science-beginners/
2. https://www.analyticsvidhya.com/blog/2021/07/data-science-with-pandas-2-minutes-guide-to-key-concepts/
3. https://www.analyticsvidhya.com/blog/2020/04/how-to-read-common-file-formats-python/
4. https://www.analyticsvidhya.com/blog/2016/07/practical-guide-data-preprocessing-python-scikit-learn/
5. https://www.analyticsvidhya.com/blog/2020/02/beginner-guide-matplotlib-data-visualization-exploration-python/6.https://www.nltk.org/book/ch01.html

Maping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO"s Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Understand	L2	PO1 PO2 PO3 PO4 PO5 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO5 : Apply(L3) PO11: Thumb rule	3 3 2 1 2 2
2	CO2: Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO5 : Apply(L3)	3 3 3 3 2
3	CO3: Apply	L3	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4)	3 3 3 3
4	CO4:Analyze	L4	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4)	3 3 3 3
5	CO5: Understand	L2	PO1 PO2 PO3 PO4 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO11: Thumb rule	2 3 2 1 2

Justification Statements:

CO 1: Understand the concepts of Data frames, pandas and NumPy in Python programming for solving complex problems.
Action Verb: Understand (L2)
PO1 Verb: Apply(L3)
CO1 Action verb is greater level of PO1 verb by one level. Therefore, the correlation is high (3)
PO2 Verb: Review(L2)
CO1 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO1 Action verb is less than PO3 verb. Therefore the correlation is medium (2)
PO4: Analyze (L4)
CO1 Action verb is greater than PO4 verb. Therefore the correlation is Low (1)
PO5 Verb: Apply(L3)
CO1 Action verb is less than PO5 verb. Therefore, the correlation is medium (2)
PO11: Thumb rule
To solve the different mathematical functions by using python data science predefine libraries to writing simple programs. Therefore, the correlation is medium (2)

CO 2: Apply the python libraries for basic statistical and descriptive analytics on the data sets.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Review(L2)
CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO2 Action verb is same as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is greater than PO4 verb. Therefore the correlation is high (3)
PO5 Verb: Apply(L3)
CO2 Action verb is less than PO5 verb. Therefore, the correlation is medium (2)

CO 3: Apply the correlation and regression analytics and standard data sets.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Review(L2)
CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO3 Action verb is same as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is less than PO4 verb. Therefore the correlation is medium (2)

CO 4: Analyze the python programs to present and interpret data using visualization reports
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO5 Action verb is greater level of PO1 verb. Therefore, the correlation is High (3)
PO2: Review (L2)
CO5 Action verb is greater level of PO2 verb. Therefore, the correlation is High (3)
PO3: Develop (L3)
CO5 Action verb is greater level of PO3 verb. Therefore, the correlation is High (3)

PO4: Analyze (L4)

CO5 Action verb is same as PO4 verb. Therefore, the correlation is High (3)

CO 5: Understand the basic Python libraries for data science to optimize numeric applications

Action Verb: Understand (L2)

PO1 Verb: Apply(L3)

CO5 Action verb is less than of PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Review(L2)

CO5 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO5 Action verb is less than PO3 verb. Therefore the correlation is medium (2)

PO4: Analyze (L4)

CO5 Action verb is less than PO4 verb. Therefore the correlation is low (1)

PO11: Thumb rule

To deployment of application need suitable visualization reports to be generated by project team members. Therefore, the correlation is medium (2)

Course Code	Year & Sem	FULL STACK DEVELOPMENT – 1 (Skill Enhancement Course) (Common to CSE/CIC/AIDS/AIML)	L	T/CLC	P	C
23ASC0503	II-II		1	0	2	2

Course Outcomes:

CO 1: Understand the web page and identify basic tags and properties in HTML.
CO 2: Apply the concept of CSS properties to design web pages.
CO 3: Analyze the web pages in real time applications of JavaScript for dynamic web pages.
CO 4: Apply the concepts of objects and methods in JavaScript for solving complex problem
CO 5: Evaluate the web pages for developing applications by using events and forms

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the web page and identify basic tags and properties in HTML.			L2
CO2	Apply	the concept of CSS properties		to design web pages.	L3
CO3	Analyze	the web pages in real-time applications of JavaScript		for dynamic web pages.	L4
CO4	Apply	the concepts of objects and methods in JavaScript		for solving complex problems	L3
CO5	Evaluate	the web pages for developing applications using events and forms		using events and forms	L5

List of Experiments:

1. Lists, Links and Images**[CO-1]**
a. Write a HTML program, to explain the working of lists.
Note: It should have an ordered list, unordered list, nested lists and ordered list in anunordered list and definition lists.
b. Write a HTML program, to explain the working of hyperlinks using <a> tag and href, target Attributes.
c. Create a HTML document that has your image and your friend"s image with a specific height and width. Also when clicked on the images it should navigate to their respective profiles.
d. Write a HTML program, in such a way that, rather than placing large images on a page,the preferred technique is to use thumbnails by setting the height and width parameters to something like to 100*100 pixels. Each thumbnail image is also a link to a full sized version of the image. Create an image gallery using this technique

2. HTML Tables, Forms and Frames[CO-1]

3. Write a HTML program, to explain the working of tables. (use tags: <table>, <tr>, <th>, <td> and attributes: border, rowspan, colspan) **[CO-1]**

4. Write a HTML program, to explain the working of tables by preparing a timetable. (Note: Use <caption> tag to set the caption to the table & also use cell spacing, cell padding, border, rowspan, colspan etc.). **[CO-1]**

5. Write a HTML program, to explain the working of forms by designing Registration form. (Note:

Include text field, password field, number field, date of birth field, checkboxes, radio buttons, list boxes using <select>&<option> tags, <text area> and two buttons ie: submit and reset. Use tables to provide a better view). **[CO-1]**

6. Write a HTML program, to explain the working of frames, such that page is to be divided into 3 parts on either direction. (Note: first frame image, second frame paragraph, third frame hyperlink. And also make sure of using "no frame" attribute such that frames to be fixed). **[CO- 1]**

7. HTML 5 and Cascading Style Sheets, Types of CSS[CO-2]

a. Write a HTML program, that makes use of <article>, <aside>, <figure>, <figcaption>, <footer>, <header>, <main>, <nav>, <section>, <div>, <span> tags.

b. Write a HTML program, to embed audio and video into HTML web page.

c. Write a program to apply different types (or levels of styles or style specification formats) - inline, internal, external styles to HTML elements. (identify selector, property andvalue).

8. Selector forms[CO-2]

a. Write a program to apply different types of selector forms
  - Simple selector (element, id, class, group, universal)
  - Combinator selector (descendant, child, adjacent sibling, general sibling)
  - Pseudo-class selector
  - Pseudo-element selector
  - Attribute selector

9. CSS with Color, Background, Font, Text and CSS Box Model[CO-2]

a. Write a program to demonstrate the various ways you can reference a color in CSS.

b. Write a CSS rule that places a background image halfway down the page, tilting it horizontally. The image should remain in place when the user scrolls up or down.

c. Write a program using the following terms related to CSS font and text:
  i. font-size   ii. font-weight   iii. font-style
  iv. text-decoration   v. text-transformation   vi. text-alignment

d. Write a program, to explain the importance of CSS Box model using
  i. Content   ii. Border   iii. Margin   iv. padding

10. Applying JavaScript - internal and external, I/O, Type Conversion[CO-2]

a. Write a program to embed internal and external JavaScript in a web page.

b. Write a program to explain the different ways for displaying output.

c. Write a program to explain the different ways for taking input.

d. Create a webpage which uses prompt dialogue box to ask a voter for his name and age. Display the information in table format along with either the voter can vote or not

11. JavaScript Pre-defined and User-defined Objects[CO-3]

a. Write a program using document object properties and methods.

b. Write a program using window object properties and methods.

c. Write a program using array object properties and methods.

d. Write a program using math object properties and methods.

e. Write a program using string object properties and methods.

f. Write a program using regex object properties and methods.

g. Write a program using date object properties and methods.

h. Write a program to explain user-defined object by using properties, methods, accessors, constructors and display.

1. JavaScript Conditional Statements and Loops[CO-4]

a. Write a program which asks the user to enter three integers, obtains the numbers from the user and outputs HTML text that displays the larger number followed by the words "LARGER NUMBER" in an information message dialog. If the numbers are equal, output HTML text as "EQUAL NUMBERS".

b. Write a program to display week days using switch case.

c. Write a program to print 1 to 10 numbers using for, while and do-while loops.

d. Write aprogram to print data in object using for-in, for-each and for-of loops

e. Develop a program to determine if a given number is ARMSTRONG NUM" or not. [Eg: 153 is an Armstrong num, since sum of cube of the digits is equal to the number i.e.,13 + 53+ 33 = 153]

f. Write a program to display the denomination of the amount deposited in the bank in terms of 100"s, 50"s, 20"s, 10"s, 5"s, 2"s & 1"s. (Eg: If deposited amount is Rs.163, the output should be 1-100"s, 1-50"s, 1- 10"s, 1-2"s & 1-1"s)

2. Javascript Functions and Events[CO-5]

a. Design a appropriate function should be called to display
   - Factorial of that number
   - Fibonacci series up to that number
   - Prime numbers up to that number
   - Is it palindrome or not

b. Design a HTML having a text box and four buttons named Factorial, Fibonacci, Prime,and Palindrome. When a button is pressed an appropriate function should be called to display
   11. Factorial of that number
   12. Fibonacci series up to that number
   13. Prime numbers up to that number
   14. Is it palindrome or not

c. Write a program to validate the following fields in a registration page
   i.   Name (start with alphabet and followed by alphanumeric and the length should not be less than 6 characters)
   ii. Mobile (only numbers and length 10 digits)
   iii. E-mail (should contain format like xxxxxxx@xxxxxx.xxx)

Textbooks:

1. Programming the World Wide Web, 7th Edition, Robet W Sebesta, Pearson, 2013.
2. Web Programming with HTML5, CSS and JavaScript, John Dean, Jones & Bartlett Learning, 2019 (Chapters 1-11).
3. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, 2nd edition, APress, O"Reilly.

Web Links:

1. https://www.w3schools.com/html
2. https://www.w3schools.com/css
3. https://www.w3schools.com/js/
4. https://www.w3schools.com/nodejs
5. https://www.w3schools.com/typescript

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Understand	L2	PO1 PO2 PO5 PO11	PO1: Apply(L3) PO2: Review(L2) PO5: Apply(L3) PO11: Thumb rule	2 3 3 2
2	CO2: Apply	L3	PO1 PO2 PO11	PO1: Apply(L3) PO2: Review(L2) PO11: Thumb rule	3 3 2
3	CO3: Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO10	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO10: Thumb rule	3 3 3 3 3 2
4	CO4: Apply	L3	PO1 PO2 PO3 PO4 PO5 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3) PO11: Thumb rule	3 3 3 3 3 2
5	CO5: Evaluate	L5	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply(L3)	3 3 3 3 3

Justification Statements:

CO1: Understand the web page and identify basic tags and properties in HTML.

Action Verb : Understand (L2)

PO1 Verb : Apply(L3)

CO1 Action verb is less than PO2 verb by one, Therefore the correlation is medium (2)

PO2 Verb : Review(L2)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO5 Verb : Apply(L2)

CO1 Action verb is less than PO2 verb by one, Therefore the correlation is medium (2)

PO11: Thumb rule

To make use of HTML elements and tags in application, need to upgrade for long period.
Therefore, the correlation is medium (2)

CO 2: Apply the concept of CSS properties to design web pages.

Action Verb : Apply (L3)

PO1: Apply(L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2: Review(L2)
CO2 Action verb is greater than PO2 verb by one, Therefore the correlation is high (3)
PO11: Thumb rule
The application can be designed specifically all kind of users and web browsers.
Therefore the correlation is medium (2)

CO 3: Analyze the web pages in real time applications of JavaScript for dynamic web pages.
Action Verb : Analyze (L4)
PO1: Apply(L3)
CO3 Action verb is greater level of PO1 verb. Therefore, the correlation is High (3)
PO2: Review (L2)
CO3 Action verb is greater than level as PO2 verb by one. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO3 Action verb is greater than PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is same PO4 verb. Therefore the correlation is high (3)
PO5: Apply(L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO10: Thumb rule
To make web site and web pages should be interactive understand by user, so need to provide proper forms.
Therefore, the correlation is medium (2)

CO4: Apply the concepts of objects and methods in JavaScript for solving complex problem
Action Verb: Apply (L3)
PO1: Apply(L3)
CO4 Action verb is same level of PO1 verb. Therefore the correlation is high (3)
PO2: Review(L2)
CO4 Action verb is greater than PO2 verb. Therefore the correlation is high (3)
PO3: Develop(L2)
CO4 Action verb is greater than PO3 verb. Therefore the correlation is high (3)
PO4: Analyze(L2)
CO4 Action verb is same level of PO4 verb. Therefore the correlation is high (3)
PO5: Apply(L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
The design application needs to upgrade for future specific requirement. Therefore the correlation is medium (2)

CO 5: Evaluate the web pages for developing applications by using events and forms
Action Verb : Evaluate (L5)
PO1: Apply(L3)
CO5 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2: Review (L2)
CO5 Action verb is greater than PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO5 Action verb is greater than PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is greater than two as PO4 verb. Therefore the correlation is high (3)
PO5: Apply(L3)
CO5 Action verb is greater than PO5 verb. Therefore the correlation is high (3)

Course Code	Year & Sem	Design Thinking & Innovation	L	T/CLC	P	C
23AES0304	II-II		2	0	0	2

Course Outcomes:
After studying the course, student will be able to
CO: 1   **Understand** the concepts and principles of design thinking process.

CO: 2   **Apply** the design thinking techniques for solving problems in various sectors.

CO: 3   **Analyze** the art of innovation & creativity in product development.

CO: 4   **Apply** the design guidelines for produced development.

CO: 5   **Analyze** the design thinking strategies for solving real time business issues.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts and principles of design thinking process.			L1
CO2	Apply	the design thinking techniques for solving problems in various sectors.			L3
CO3	Analyze	the art of innovation & creativity in product development.			L4
CO4	Apply	the design guidelines for produced development.			L3
CO5	Analyze	the design thinking strategies for solving real time business issues.			L4

Unit I:
Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

Unit II
Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development
Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

Unit III
Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations- Creativity to Innovation- Teams for innovation- Measuring the impact and value of creativity.
Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

Unit IV
Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications- Innovation towards product design- Case studies
Activity: Importance of modelling, how to set specifications, Explaining their own product design.

Unit V
Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs- Design thinking for Startups- Defining and testing Business Models and Business Cases- Developing & testing prototypes
Activity: How to market our own product, About maintenance, Reliability and plan for startup.
Text Books:
1. Tim Brown, Change by design, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons.

Reference Books:
1. David Lee, Design Thinking in the Classroom, Ulysses press
2. Shrutin N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritina holden, Jill Butter.
4. Chesbrough. H, The Era of Open Innovation – 2013

Online Learning Resources:
1. https://nptel.ac.in/courses/110/106/110106124/
2. https://nptel.ac.in/courses/109/104/109104109/
3. https://swayam.gov.in/nd1_noc19_mg60/preview

Course Title	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Design Thinking & Innovation	CO1	2		2									2	2
	CO2	2	2	2									2	2
	CO3	2	2	2			1						2	2
	CO4	2	2	2			1						2	2
	CO5	2	2	2			2						2	2

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	11	20.3	L3	Understand	L2	PO1 PO3	Apply (L3) Develop (L3)	2 2
2	10	18.5	L2	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	11	20.3	L3	Analyze	L4	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 1
4	12	22.2	L3	Apply	L3	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 1
5	10	18.5	L2	Analyze	L4	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 2
Total	54	100						

Justification Statements:
CO1: Understand the concepts and principles of design thinking process.
Action Verb: Understand (L2)
PO1Verb: **Apply (L3)**
CO1 Action verb is lower than PO1 verb. Therefore, the correlation is medium (2)
PO3 Verb: **Develop (L3)**
CO1 Action verb is lower than PO3 verb. Therefore, the correlation is medium (2)

CO2: Apply the design thinking techniques for solving problems in various sectors.
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the art of innovation & creativity in product development.
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule
As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO4: Apply the design guidelines for produced development.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule
As per thumb rule CO4 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO5: Analyze the design thinking strategies for solving real time business issues.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is low (1)
PO6 Verb: Thumb Rule
As per thumb rule CO5 co-relates moderately with PO6 verb. Therefore, the correlation is high (3)

Branch: Common to All

Course Code			L	T/CLC	P	C
23AMC9901	**ENVIRONMENTAL SCIENCE**		2	0	0	0
Pre-Requisites	ENVIRONMENTAL SCIENCE	Semester	**II**			

Course Outcomes (CO): Student will be able to

1. Understand the multidisciplinary nature of environmental studies and various renewable and nonrenewable resources.

2. Understand the ecosystem and biodiversity to solve complex environmental problems

3. Apply various types of pollution and solid waste management and related preventive measures

4. Apply rainwater harvesting, watershed management, ozone layer depletion and wasteland reclamation.

5. Understand the population explosion

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	Multidisciplinary nature of environmental studies and various renewable and nonrenewable resources			**L2**
2	**Understand**	Ecosystem and biodiversity to solve complex environmental problems	to solve complex environmental problems		**L2**
3	**Apply**	Various types of pollution and solid waste management and related preventive measures			**L3**
4	**Apply**	Rainwater harvesting, watershed management, ozone layer depletion and wasteland reclamation			**L3**
5	**Understand**	Population explosion			**L2**

UNIT – I   **(10Hr)**

Multidisciplinary Nature o**f Environmental Studies:** Introduction – Multidisciplinary Nature of Environmental Studies – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources: Renewable and non-renewable energy resources – Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and sub-surface – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, case studies.

Energy resources: Renewable and non-renewable energy resources.

UNIT – II   **(15Hr)**

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

Biodiversity And Its Conservation : Introduction- Definition: genetic, species and ecosystem diversity – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity:

habitat loss, poaching of wildlife, man – wildlife conflicts – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III   **(8Hr)**

Environmental Pollution: Definition, Causes, effects and its control measures of: Air Pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, and Thermal pollution and Nuclear hazards.

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone, Tsunami and landslides.

UNIT – IV (9Hr)

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting and watershed management – Resettlement and rehabilitation of people – Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies–Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Public awareness.

UNIT – V (8Hr)

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

TEXT BOOKS:
1. Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
2. Environmental Studies by Kaushik, New Age Publishers.
3. Environmental Studies by Sri Krishna Hitech publishing Pvt. Ltd.

REFERENCES:
1. Environmental studies by R.Rajagopalan, Oxford University Press.
2. Comprehensive Environmental studies by J.P.Sharma, Laxmi publications.
3. Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.
4. Environmental studies by A. Ravi Krishnan, G. Sujatha Sri Krishna Hitech publications.

Mapping of COs to POs and PSOs

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours				CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Register (Hrs)	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	10	12	23	3	Understand	L2	PO6,PO7	PO6: PO7:	2,2
2	15	15	28	3	Understand	L2	PO7	PO7:	2,2
3	8	8	15	2	Apply	L3	PO6 PO7	PO6: PO7:	2,2
4	9	10	19	2	Apply	L3	PO6,PO7	PO6: PO7:	2,2
5	8	8	15	2	Understand	L2	PO7	PO7:	2,2
	50	53	100						

JUSTIFICATION:

CO1: Understand the multidisciplinary nature of environmental studies and various renewable and nonrenewable resources.
Action Verb: Understand (L2)
CO1 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO2: Understand the ecosystem and biodiversity to solve complex environmental problems
Action Verb: Understand (L2)
CO2 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO3: Apply various types of pollution and solid waste management and related preventive measures
Action Verb: APPLY (L3)
CO3 Action Verb is **APPLY** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO4: Apply rainwater harvesting, watershed management, ozone layer depletion and wasteland reclamation.
Action Verb: APPLY (L3)
CO4 Action Verb is **APPLY** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO5: **Understand** the population explosion
Action Verb: Understand (L2)

CO5 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

COMMUNITY SERVICE PROJECT

……Experiential learning through community engagement

Introduction
- Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development.
- Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
- Community Service Project is meant to link the community with the college for mutual benefit. The community will benefit with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and emerge as a socially responsible institution.

Objective
Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

- To sensitize the students to the living conditions of the people who are around them,
- To help students to realize the stark realities of society.
- To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- To make students aware of their inner strength and help them to find new /out of box solutions to social problems.
- To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- To help students to initiate developmental activities in the community in coordination with public and government authorities.
- To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project
- Every student should put in 6 weeks for the Community Service Project during the summer vacation.
- Each class/section should be assigned with a mentor.
- Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, housewives, etc
- A logbook must be maintained by each of the students, where the activities undertaken/involved to be recorded.
- The logbook has to be countersigned by the concerned mentor/faculty in charge.
- An evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
- The final evaluation to be reflected in the grade memo of the student.
- The Community Service Project should be different from the regular programs of NSS/NCC/Green Corps/Red Ribbon Club, etc.
- Minor project reports should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
- Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training.

Procedure

- A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, to enable them to commute from their residence and return back by evening or so.
- The Community Service Project is a twofold one –
  - First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
  - Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –
    - Agriculture
    - Health
    - Marketing and Cooperation
    - Animal Husbandry
    - Horticulture
    - Fisheries
    - Sericulture
    - Revenue and Survey
    - Natural Disaster Management
    - Irrigation
    - Law & Order
    - Excise and Prohibition
    - Mines and Geology
    - Energy
    - Internet
    - Free Electricity
    - Drinking Water

EXPECTED OUTCOMES
BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS

Learning Outcomes

- Positive impact on students' academic learning
- Improves students' ability to apply what they have learned in "the real world"
- Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development.
- Improved ability to understand complexity and ambiguity

Personal Outcomes

- Greater sense of personal efficacy, personal identity, spiritual growth, and moral development
- Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills.

Social Outcomes

- Reduced stereotypes and greater inter-cultural understanding
- Improved social responsibility and citizenship skills
- Greater involvement in community service after graduation

Career Development

- Connections with professionals and community members for learning and career opportunities
- Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity.

Relationship with the Institution

- Stronger relationships with faculty
- Greater satisfaction with college
- Improved graduation rates

BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS

- Satisfaction with the quality of student learning
- New avenues for research and publication via new relationships between faculty and community
- Providing networking opportunities with engaged faculty in other disciplines or institutions
- A stronger commitment to one's research.

BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES

- Improved institutional commitment.
- Improved student retention
- Enhanced community relations

BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY

- Satisfaction with student participation
- Valuable human resources needed to achieve community goals.
- New energy, enthusiasm and perspectives applied to community work.
- Enhanced community-university relations.

SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY SERVICE PROJECT

The following the recommended list of projects for Engineering students. The lists are not exhaustive and open for additions, deletions, and modifications. Colleges are expected to focus on specific local issues for this kind of project. The students are expected to carry out these projects with involvement, commitment, responsibility, and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of project. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting should be ensured.

For Engineering Students

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programmes
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries
12. Animals and species
13. Nutrition
14. Traditional health care methods
15. Food habits
16. Air pollution
17. Water pollution
18. Plantation
19. Soil protection
20. Renewable energy
21. Plant diseases
22. Yoga awareness and practice
23. Health care awareness programmes and their impact
24. Use of chemicals on fruits and vegetables
25. Organic farming
26. Crop rotation
27. Floury culture

28. Access to safe drinking water
29. Geographical survey
30. Geological survey
31. Sericulture
32. Study of species
33. Food adulteration
34. Incidence of Diabetes and other chronic diseases
35. Human genetics
36. Blood groups and blood levels
37. Internet Usage in Villages
38. Android Phone usage by different people
39. Utilisation of free electricity to farmers and related issues
40. Gender ration in schooling lvel- observation.

Complimenting the community service project the students may be involved to take up some awareness campaigns on social issues/special groups. The suggested list of programs
Programs for School Children
1. Reading Skill Program (Reading Competition)
2. Preparation of Study Materials for the next class.
3. Personality / Leadership Development
4. Career Guidance for X class students
5. Screening Documentary and other educational films
6. Awareness Program on Good Touch and Bad Touch (Sexual abuse)
7. Awareness Program on Socially relevant
themes. Programs for Women Empowerment
1. Government Guidelines and Policy Guidelines
2. Women's Rights
3. Domestic Violence
4. Prevention and Control of Cancer
5. Promotion of Social

Entrepreneurship General Camps

1. General Medical camps
2. Eye Camps
3. Dental Camps
4. Importance of protected drinking water
5. ODF awareness camp
6. Swatch Bharath
7. AIDS awareness camp
8. Anti Plastic Awareness
9. Programs on Environment
10. Health and Hygiene
11. Hand wash programmes
12. Commemoration and Celebration of important days Programs
for Youth Empowerment

1. Leadership
2. Anti-alcoholism and Drug addiction
3. Anti-tobacco
4. Awareness on Competitive Examinations
5. Personality
Development Common
Programs
1. Awareness on RTI
2. Health intervention programmes
3. Yoga
4. Tree plantation

5. Programs in consonance with the Govt. Departments like –
   i. Agriculture
   ii. Health
   iii. Marketing and Cooperation
   iv. Animal Husbandry
   v. Horticulture
   vi. Fisheries
   vii. Sericulture
   viii. Revenue and Survey
   ix. Natural Disaster Management
   x. Irrigation
   xi. Law & Order
   xii. Excise and Prohibition
   xiii. Mines and Geology
   xiv. Energy

Role of Students:

- Students may not have the expertise to conduct all the programmes on their own. The students then can play a facilitator role.
- For conducting special camps like Health related, they will be coordinating with the Governmental agencies.
- As and when required the College faculty themselves act as Resource Persons.
- Students can work in close association with Non-Governmental Organizations like
- Lions Club, Rotary Club, etc or with any NGO actively working in that habitation.
- And also, with the Governmental Departments. If the program is rolled out, the District Administration could be roped in for the successful deployment of the program.
- An in-house training and induction program could be arranged for the faculty and participating students, to expose them to the methodology of Service Learning.

Timeline for the Community Service Project Activity

Duration: 8 weeks

1. **Preliminary Survey (One Week)**
   - A preliminary survey including the socio-economic conditions of the allotted habitation to be conducted.
   - A survey form based on the type of habitation to be prepared before visiting the habitation with the help of social sciences faculty. (However, a template could be designed for different habitations, rural/urban.
   - The Governmental agencies, like revenue administration, corporation and municipal authorities and village secreteriats could be aligned for the survey.

2. **Community Awareness Campaigns (One Week)**
   - Based on the survey and the specific requirements of the habitation, different awareness campaigns and programmesto be conducted, spread over two weeks of time. The list of activities suggested could be taken into consideration.

3. **Community Immersion Programme (Three Weeks)**
   Along with the Community Awareness Programmes, the student batch can also work with any one of the below-listed governmental agencies and work in tandem with them. This community involvement programme will involve the students in exposing themselves to experiential learning about the community and its dynamics. Programs could be in consonance with the Govt. Departments.

4. **Community Exit Report (One Week)**
   - During the last week of the Community Service Project, a detailed report of the outcome of the 8 weeks' works to be drafted and a copy shall be submitted to the local administration. This report will be a basis for the next batch of students visiting that habitation. The same report submitted to the teacher-mentor will be evaluated by the mentor and suitable marks are awarded for onward submission to the University.Throughout the Community Service Project, a daily logbook need to be maintained by the students batch, which should be countersigned by the governmental agency representative and the teacher-mentor, who is required to periodically visit the students and guide them.

B.Tech.–III Year I Semester

S.No.	Category	Course Code	Course Title	L	T/ CLC	P	C	CIE	SEE	Total
1	PC	23APC3003	Data warehousing and data mining	2	1	0	3	30	70	100
2	PC	23APC3005	Introduction to Machine Learning	2	1	0	3	30	70	100
3	PC	23APC3007	Multi Agent Systems	2	1	0	3	30	70	100
4	PE-I	23APE3001 23APE3002 23APE3003 23APE3004	1. Data Visualization 2. Soft computing 3. IoT for AI Applications 4. Exploratory Data Analysis with Python	2	1	0	3	30	70	100
5	ES	23AES0504	Introduction to Quantum Technologies and Applications	2	1	0	3	30	70	100
6	OE-1	23AOE9915	English for Competitive Examinations	2	1	0	3	30	70	100
7	PC	23APC3004	Data warehousing and data mining Lab	0	0	3	1.5	30	70	100
8	PC	23APC3006	Machine Learning Lab	0	0	3	1.5	30	70	100
9	SC	23ASC9901	Soft Skills	1	0	2	2	30	70	100
10	ES	23AES0404	Tinkering Lab	0	0	2	1	30	70	100
11	PR	23APR3001	Community Service Internship	-	-	-	2	100	-	100
			Total	13	6	10	26	400	700	1100

Open Elective – I

S. NO	Course Code	Course Name	Offered by the Dept.
1	23AOE0101	Green Buildings	CIVIL
2	23AOE0102	Construction Technology and Management	
3	23AOE0201	Electrical Safety Practices and Standards	EEE
4	23AOE0301	Sustainable Energy Technologies	ME
5	23AOE0401	Electronic Circuits	ECE
6	23AOE9901	Mathematics for Machine Learning and AI	Mathematics
7	23AOE9906	Materials Characterization Techniques	Physics
8	23AOE9911	Chemistry of Energy Systems	Chemistry
9	23AOE9915	English for Competitive Examinations	Humanities
	23AOEMB01	Entrepreneurship and New Venture Creation	

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(AUTONOMOUS)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	DATA WAREHOUSING AND DATA MINING (PROFESSIONAL CORE)	L	T	P	C
23APC3003	III-I		2	1	0	3

Course Outcomes (CO): At the end of the course students will be able to

CO 1: Understand data warehouse architecture and OLAP operations.
CO 2: Apply Prepare and preprocess large datasets for mining applications.
CO 3: Apply classification, clustering, and association techniques effectively.
CO 4: Analyze Evaluate data mining results using proper metrics and validation methods.
CO 5: Apply Utilize data mining tools for knowledge discovery in large datasets.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	**Understand**	Data warehouse architecture	OLAP operations		L2
CO2	**Apply**	Prepare and preprocess large datasets		Large datasets for mining applications	L3
CO3	**Apply**	Classification, clustering		Association techniques effectively	L4
CO4	**Analyze**	Evaluate data mining results	Using proper metrics and validation methods.		L3
CO5	**Apply**	Utilize data mining tools	Data mining tools for knowledge discovery in large datasets		L3

UNIT-I: Introduction to Data Warehousing and OLAP :

Introduction to Data Warehousing: Concepts and Applications, Data Warehouse Architecture: Components and 3-Tier Architecture, ETL Process: Extraction, Transformation, Loading, OLAP: Multidimensional Data Model, OLAP Operations, Star, Snowflake, and Fact Constellation Schemas, Data Cubes and Roll-Up/Drill-Down Analysis.

UNIT-II: Data Preprocessing and Data Understanding:

Data Cleaning, Integration, and Transformation, Data Reduction Techniques and Feature Selection, Handling Missing, Noisy, and Inconsistent Data, Data Discretization and Normalization, Measures of Similarity and Dissimilarity, Exploratory Data Analysis and Visualization.

UNIT-III: Association Rule Mining and Classification :

Basics of Association Rule Mining: Support, Confidence, Lift, Apriori Algorithm and FP-Growth Algorithm, Applications of Association Rule Mining, Classification Techniques: Decision Trees (ID3, C4.5), Bayesian Classifiers and Naïve Bayes, Rule-Based and Model-Based Classification.

UNIT-IV: Clustering and Advanced Mining Methods:

Introduction to Clustering: Types and Applications, Partitioning Methods: K-Means, K-Medoids, Hierarchical Clustering: Agglomerative and Divisive, Density-Based Clustering: DBSCAN, OPTICS, Evaluation of Clustering Results, Outlier Detection and Handling.

UNIT-V: Data Mining Applications and Tools:

Web Mining, Text Mining, and Spatial Data Mining, Temporal and Sequence Data Mining, Introduction to Big Data and Scalable Mining, Data Mining Tools: WEKA, RapidMiner, Orange, Case Studies: Business Intelligence, Fraud Detection, E-commerce, Ethical and Privacy Issues in Data Mining.

Textbooks:

1. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Elsevier.
 2. Paulraj Ponniah, Data Warehousing Fundamentals for IT Professionals, Wiley.
3. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson.

Reference Books:

1. Ralph Kimball, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Wiley.
2. Margaret H. Dunham, Data Mining: Introductory and Advanced Topics, Pearson.
 3. Arun K. Pujari, Data Mining Techniques, Universities Press.

Online Learning Resources:

1. Coursera - Data Mining Specialization (University of Illinois)
2. Data Warehousing for Business Intelligence – Coursera (Duke University)
3. WEKA Data Mining Tutorials – University of Waikato
4. Data Mining and Analysis – Stanford Online
 5. Khan Academy: Introduction to Data Mining

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Review (L2)	2 3
2	CO2: Apply	L3	PO1 PO2 PO3 PO5 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO5: Apply (L3) PO11: Thumb rule	3 2 3 3 2
3	CO3: Apply	L3	PO1 PO2 PO3 PO5 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO5: Apply (L3) PO11: Thumb rule	3 2 3 3 2
4	CO4: Analyze	L4	PO1 PO2	PO1: Apply(L3) PO2: Review (L2) PO3: Design(L6) PO4: Apply(L3)	2 1 1 2
5	CO4: Apply	L3	PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO5: Apply (L3)	3 2 3 3

Justification Statements:

CO1: Understand data warehouse architecture and OLAP operations.
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Review (L2)
CO1 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

CO2: Apply Apply Prepare and preprocess large datasets for mining applications.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO2 Action verb is less than as PO2 verb. Therefore, the correlation is Medium (2)
PO3: Develop (L3)
CO2 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO2 Action verb is same as PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
Using orange to visualize real world solutions the correlation is Medium (2)

CO3: Apply classification, clustering, and association techniques effectively.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO4 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO4 Action verb is less than as PO2 verb. Therefore, the correlation is Medium (2)
PO3: Develop (L3)
CO4 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is same as PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
Using orange to visualize real world solutions the correlation is Medium (2)

CO4 : Analyze Evaluate data mining results using proper metrics and validation methods.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Review (L2)
CO3 Action verb is same as PO2 verb. Therefore, the correlation is low (1)
PO3 Verb: Design(L6)
CO3 Action verb is same as PO3 verb. Therefore, the correlation is low (1)
PO4 Verb: Apply (L3)
CO3 Action verb is same as PO4 verb. Therefore, the correlation is medium (2)

CO5: Apply Utilize data mining tools for knowledge discovery in large datasets.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO5 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO5 Action verb is less than as PO2 verb. Therefore, the correlation is Medium (2)
PO3: Develop (L3)
CO5 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO5 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

Course Code	Year & Sem	INTRODUCTION TO MACHINE LEARNING	L	T	P	C
23APC3005	III-I	(Professional Core)	2	1	**0**	**3**

Course Outcomes:

CO1: Understand different types of learning methods.

CO2: Apply supervised learning algorithms to datasets.

CO3: Understand Support Vector Machines and Ensemble Methods.

CO4: Apply un-supervised learning algorithms to datasets.

CO5: Evaluate ML Models using different Case Studies.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	different types of learning methods			L2
CO2	Apply	supervised learning algorithms to datasets			L3
CO3	Understand	Support Vector Machines and Ensemble Methods to datasets			L2
CO4	Apply	un-supervised learning algorithms to datasets			L3
CO5	Evaluate	ML Models using different Case Studies		supervised learning / un-supervised / Reinforcement / Support Vector Machines and Ensemble /algorithms	L5

UNIT - I	Introduction to Machine Learning and Linear Models	
	Definition and Scope of Machine Learning, Applications and Types of Learning: Supervised, Unsupervised, Reinforcement, Linear Regression: Least Squares, Cost Function, Gradient Descent, Polynomial Regression and Over fitting, Evaluation Metrics: RMSE, MAE, R^2 Score, Bias-Variance Trade off.	
UNIT - II	**Classification Algorithms**	
Classification Overview and Decision Boundaries, Logistic Regression: Sigmoid Function and Cost, K-Nearest Neighbors (KNN), Naïve Bayes Classifier, Decision Trees and Random Forests, Model Evaluation: Confusion Matrix, Precision, Recall, F1-Score.		
UNIT - III	**Support Vector Machines and Ensemble Methods**	
Support Vector Machines: Concepts, Kernels, Hyperplane and Margin Concepts, Kernel Tricks: RBF and Polynomial, Ensemble Learning: Bagging, Boosting, and Voting, Gradient Boosting, AdaBoost, and XGBoost, Model Tuning and Hyperparameter Optimization.		
UNIT - IV	**Unsupervised Learning Techniques**	
Clustering Overview: Applications, K-Means Clustering Algorithm, Hierarchical Clustering, DBSCAN and Density-Based Methods, Principal Component Analysis (PCA) for Dimensionality Reduction, Silhouette Score, Davies-Bouldin Index for Cluster Validation.		
UNIT - V	**Advanced Topics and Applications**	
Reinforcement Learning Basics and Markov Decision Processes, Introduction to Neural Networks and Deep Learning, Cross-Validation Techniques: k-Fold, Leave-One-Out, Feature Engineering and Feature Selection, Deployment of ML Models (Flask, Streamlit, etc.), Case Studies: Medical Diagnosis, Spam Detection, Credit Scoring.		
Textbooks:		
1. Tom Mitchell, Machine Learning, McGraw-Hill Education.		
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media. 3. Ethem Alpaydin, Introduction to Machine Learning, MIT Press.		
Reference Books:		
1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer.		

2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.

3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1				Understand	L2	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	1 1 1 1 1 2
2				Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	3 3 3 2 3 2
3				Understand	L2	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	1 1 1 1 1 2
4				Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	3 3 3 2 3 2
5				Evaluate	L5	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3) PO6: Thumb rule	1 1 1 2 1 3

Justification Statements:

CO1: Understand different types of learning methods.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)

PO2 Verb: Identify (L3)

CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)

PO3: Apply (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by Two levels. Therefore the correlation is Moderate (1)
the correlation is low (1).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by four levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is moderate (2)

CO2: Apply supervised learning algorithms to datasets.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

CO3: Understand Support Vector Machines and Ensemble Methods.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO3: Apply (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO5: Create (L6)
CO1 Action verb less than PO5 verb by four levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is moderate (2)

CO4: Apply un-supervised learning algorithms to datasets.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

CO5: Evaluate ML Models using different Case Studies.
Action Verb: Evaluate (L5)
PO1 Verb: Apply (L3)
CO1 Action verb is grater than PO1 verb by two levels. Therefore the correlation is low (1)
PO2 Verb: Identify (L3)
CO1 Action verb is grater than PO1 verb by two levels. Therefore the correlation is low (1)
PO3: Apply (L3)
CO1 Action verb is grater than PO1 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO1 Action verb is greater than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

Course Code	Year & Sem	MULTI AGENT SYSTEMS (Professional Core)	L	T	P	C
23APC3007	III-I		2	1	**0**	**3**

Course Outcomes:
CO1: Understand the functioning and Architecture of individual intelligent agents.
CO2: Analyze the fundamentals and communication among multiple agent systems.
CO3: Apply the distributed problem-solving approaches to real-world multi agent systems.
CO4: Create the multi agent systems for practical applications using appropriate methodologies.
CO5: Evaluate the performance and scalability of multi-agent systems using game-theoretic approaches.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The functioning and Architecture of individual intelligent agents			L2
CO2	Analyze	the fundamentals and communication among multiple agent systems.			L4
CO3	Apply	the distributed problem-solving approaches to real-world multi agent systems.			L3
CO4	Create	The Multi agent system for practical applications	using different methodologies		L6
CO5	Evaluate	the performance and scalability of multi-agent systems	using game-theoretic approaches.		L5

UNIT - I	Introduction to Intelligent Agents	
Definition and characteristics of Agents, Types of agents: Reactive. Deliberative, Hybrid, Learning, Agent architectures: Subsumption, BDI, Layered, Environments: Deterministic/Stochastic, Episodic/Sequential, Rationality and autonomy, Simple agent Programming Models.		
UNIT - II	Multi-Agent Systems Fundamentals	
Definition and Properties of Multi-Agent Systems (MAS), Agent Communication Languages: KQML, FIPA ACL, Interaction Protocols: Contract Net, Auctions, Coordination Techniques: Blackboard, Mediator, Broker, Distributed Problem Solving (DPS) Concepts, Roles and Teamwork in MAS.		
UNIT - III	Cooperation, Negotiation, and Learning	
Cooperative and Non-Cooperative Agents, Negotiation Techniques: Bidding, Bargaining, Argumentation, Game Theory: Basics and Applications in MAS, Reinforcement Learning in Multi- Agent Settings, Case Studies: Multi-Robot Coordination, Resource Allocation, Conflict Resolution and Consensus Building		
UNIT - IV	Agent-Oriented Software Engineering	
Agent-Based System Design Methodologies: Gaia, Tropos, Agent UML: Notations and Modeling, MAS Design Patterns and Best Practices, Ontologies and Semantic Web Integration, Middleware and Frameworks for MAS (JADE, SPADE), Scalability, Fault-Tolerance, and Deployment Challenges		
UNIT - V	Advanced Topics and Applications	

Emergence and Self-Organization in MAS, Swarm Intelligence and Distributed Optimization, Trust, Privacy, and Ethics in MAS, Real-Time and Embedded MAS Applications, MAS in Smart Grid, IoT, and Traffic Systems, Case Studies: Amazon Robotics, Autonomous Trading Agents

Textbooks:
1. Michael Wooldridge, An Introduction to MultiAgent Systems, Wiley, 2nd Edition.
2. Gerhard Weiss, Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press.

Reference Books:
1. 1Yoav Shoham and Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press.
2. Nikos Vlassis, A Concise Introduction to Multiagent Systems and Distributed Artificial Intelligence, Morgan & Claypool.
   Mehdi Dastan et al., Programming Multi-Agent Systems, Springer

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

Mapping of course outcomes with program outcomes

Unit No.	CO						Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Corre lation	Co's Action verb	BTL				
1				Understand	L2		PO1 PO2 PO3	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply(L3)	2 2 2
2				Analyze	L4		PO1 PO2 PO3 PO4 PO8	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Evaluate(L4) PO8: Thumb Rule	3 3 3 2 2
3				Apply	L3		PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify (L3) PO3: Apply(L6) PO4: Analyze (L4) PO5: Create(L6)	3 3 2 3 2
4				Create	L6		PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Formulate (L6) PO3: Develop (L6) PO4: Analyze(L4) PO5: Apply(L3)	3 2 2 3 3
5				Evaluate	L5		PO1 PO2 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO5: Apply(L3) PO6: Thumb Rule	2 2 3 3

Justification Statements:

CO1: Understand the functioning and Architecture of individual intelligent agents.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO3: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Analyze the fundamentals and communication   among multiple agent systems
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is Moderate (2)
PO8: Thumb rule
Formulating methodological frameworks, communication formats, protocol designs, and technical strategies. Therefore, the correlation is moderate (2).

CO3: Apply distributed problem-solving approaches to real-world multi agent systems**.**
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO3 Action verb more than PO2 verb. Therefore, the correlation is high (3)
PO3: Design (L6)
CO3 Action verb less than PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO4: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels. Therefore, the correlation is moderate (2)

CO4: Create the multi agent systems for practical applications using appropriate methodologies.
Action Verb: Create (L6)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2: Formulate (L6)
CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO3: Develop (L6)
CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is more than PO5 verb. Therefore, the correlation is high (3)

CO5: Evaluate the performance and scalability of multi-agent systems using game-theoretic.
Action Verb: Evaluate (L5)
PO1 : Apply (L3)
CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 : Identify (L3)
CO5 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO5: Apply (L3)
CO5 Action verb is more than PO5 verb. Therefore, the correlation is high (3)
PO6: Thumb rule
Investigating Performance Metrics and Scalability Factors in Multi-Agent Systems Using Game-Theoretic Models.
Therefore, the correlation is high (3)

Course Code	Year & Sem	Data Visualization (Professional Elective-I)	L	T	P	C
23APE3001	III-I		2	1	0	3

Course Outcomes:

CO1: **Understand** the principles, techniques, and tools of data visualization
CO2: **Apply** the transform data into visual insights using different types of charts and plots.
CO3: **Understand** the cognitive and perceptual foundations of effective data visualization
CO4: **Apply** tools and programming environments (like Python, Tableau, or Power BI) for creating interactive and dynamic visualizations
CO5: **Analyze** real-world datasets and effectively communicate data-driven findings visually

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The principles, techniques, and tools of data visualization			L2
CO2	Apply	The transform data into visual insights	Using different types of charts and plots.		L3
CO3	Understand	The cognitive and perceptual foundations of effective data visualization			L2
CO4	Apply	Tools and programming environments (like Python, Tableau, or Power BI)	.	For creating interactive and dynamic visualizations	L3
CO5	Analyze	Real-world datasets and effectively communicate data-driven findings visually			L4

UNIT I: : Introduction to Data Visualization & Perception
Introduction to Data Visualization, Importance and Scope of Data Visualization, Data Types and Sources, Visual Perception: Pre-attentive Processing, Gestalt Principles, Data-Ink Ratio, Data Density, Lie Factor, Visualization Process and Design Principles, Tools Overview: Tableau, Power BI, Python Libraries

UNIT II: Visualization Techniques for Categorical & Quantitative Data
Charts for Categorical Data: Bar Charts, Pie Charts, Column Charts, Charts for Quantitative Data: Histograms, Line Charts, Boxplots, Scatter Plots, Bubble Charts, Heatmaps, Choosing the Right Chart Type, Best Practices in Labeling, Coloring, and Scaling

UNIT III: Multidimensional, Temporal and Hierarchical Data Visualization
Visualizing Multivariate Data: Parallel Coordinates, Radar Charts, Time-Series Visualization: Time Plots, Animation over Time, Geographic Data Visualization: Maps, Choropleths, Hierarchical Data: Treemaps, Sunburst Charts, Network and Graph Visualization

UNIT IV:Data Visualization Using Python and Dashboards
Introduction to Matplotlib, Seaborn, and Plotly, Creating Static and Interactive Charts, Pandas Visualization Capabilities, Dashboards with Dash, Streamlit, Power BI, Case Studies: Real-world Dataset Visualization.

UNIT V: Storytelling with Data and Ethical Visualization
Storytelling and Narrative Techniques in Visualization, Dashboards and Reporting, Misleading Visualizations and Bias, Ethical Principles in Data Visualization, Final Project: Create a Storytelling Dashboard with Real Data

Textbooks
1. Munzner, **Visualization Analysis and Design**, CRC Press, 2014.
2. Nathan Yau, **Data Points: Visualization That Means Something**, Wiley, 2013

Reference Books
1. Alberto Cairo, **The Truthful Art: Data, Charts, and Maps for Communication**, New Riders, 2016.
2. Cole Nussbaumer Knaflic, **Storytelling with Data: A Data Visualization Guide for Business Professionals**, Wiley, 2015.
3. Claus O. Wilke, **Fundamentals of Data Visualization**, O'Reilly, 2019.
4. Rohan Chopra, **Hands-On Data Visualization with Bokeh**, Packt Publishing, 2019

Online Courses
1. NPTEL: Data Visualization - IIT Madras
2. Coursera: Data Visualization with Python by IBM
Mapping of course outcomes with program outcomes

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

Correlation matrix:

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1				Understand	L2	PO1 PO2 PO3	PO1: Apply(L3) PO2: Develop(L3) PO3: Apply (L3)	3 3 2
2				Apply	L3	PO1 PO2 PO3	PO1: Apply(L3) PO2: Develop(L3) PO3: Apply(L3)	2 2 2
3				Understand	L2	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Develop(L3) PO3: Analyze(L4) PO4: Apply (L3)	3 3 2 3
4				Apply	L3	PO1 PO2 PO3	PO1: Apply(L3) PO2: Design(L6) PO3: Analyze(L4)	3 3 2
5				Analyze	L4	PO1 PO3 PO5 PO11	PO1: Apply(L3) PO3: Develop(L3) PO5:Create(L6) PO11:ThumbRule	3 2 2 2

Justification Statements:

CO1: Understand the principles, techniques, and tools of data visualization
Action Verb: Understand (L2)
PO1: Apply(L3)
CO1 Action verb is greater than PO1 verb by one level. Therefore the correlation is high (3)
PO2: Develop(L3)

CO1 Action verb is greater than PO2 verb by one level. Therefore the correlation is high (3)
PO3: Apply (L3)
CO1 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)

CO2: Apply the transform data into visual insights using different types of charts and plots

Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2: Develop(L3)
CO2 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO3: Apply (L3)
CO2 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)

CO3: Understand the cognitive and perceptual foundations of effective data visualization
Action Verb: Understand(L2)
PO1: Apply(L3)
CO3 Action verb is more than PO1 verb. Therefore the correlation is high (3)
PO2: Develop(L3)
CO3 Action verb more than PO2 verb. Therefore the correlation is high (3)
PO3: Analyze(L4)
CO3 Action verb less than PO2 verb by one levels. Therefore the correlation is moderate (2)
PO4: Apply (L3)
CO3 Action verb same as PO5 verb. Therefore the correlation is high (3)

CO4: Apply tools and programming environments (like Python, Tableau, or Power BI) for creating interactive and dynamic visualizations

Action Verb: Apply(L3)
PO1: Apply(L3)
CO4 Action verb is greater than PO1 verb by one level. Therefore the correlation is high (3)
PO2: Design(L6)
CO4 Action verb isgreater than PO2 verb by one levels. Therefore the correlation is high (3)
PO3: Analyze(L4)
CO4 Action verb is less than PO3 verbby one levels. Therefore the correlation is moderate (2)

CO5:Analyze real-world datasets and effectively communicate data-driven findings visually
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO5 Action verb is greater than PO1 verb by one level. Therefore the correlation is is high (3)
PO3:Develop(L3)
CO5 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)
PO5: Create(L6)
CO5 Action verb is less than PO5 verb by one level. Therefore the correlation is moderate (2)
PO11:ThumbRule
We are using the problem solving skills in deep learning   Therefore the correlation is moderate (2)

Course Code	Year & Sem	**Soft computing**	L	T	P	C
23APE3002	III-I	**(Professional Elective-I)**	2	1	**0**	**3**

Course Outcomes:

CO1: Understand the components and applications of soft computing.

CO2: Apply the fuzzy logic concepts to real-world problems.

CO3: Evaluate the train various neural network models.

CO4: Analyze the genetic algorithms for problem-solving and optimization.

CO5: Create the hybrid systems using soft computing techniques.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the components and applications of soft computing.			L2
CO2	**Apply**	the fuzzy logic concepts to real-world problems.		to real-world problems	L3
CO3	**Evaluate**	the train various neural network models.			L5
CO4	**Analyze**	genetic algorithms for problem-solving and optimization.		for problem-solving and optimization	L4
CO5	**Create**	the hybrid systems using soft computing techniques	using soft computing techniques		L6

UNIT - I	**Introduction to Soft Computing and Fuzzy Logic**	
Introduction to Soft Computing: Definition, Components, Differences with Hard Computing, Applications of Soft Computing, Fuzzy Logic: Crisp Sets vs Fuzzy Sets, Membership Functions, Fuzzy Set Operations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems: Mamdani and Sugeno Models, Defuzzification Techniques.		
UNIT - II	**Artificial Neural Networks – I**	
Introduction to Neural Networks: Biological Neurons vs Artificial Neurons, Architecture of Neural Networks: Feed forward, Feedback, Learning Rules: Hebbian, Delta, Perceptron Learning Rule, Single Layer Perceptron		

and its Limitations, Multi-Layer Perceptron: Back propagation Algorithm, Applications of Neural Networks

UNIT - III	Artificial Neural Networks – II	

Hopfield Networks and Associative Memories, Radial Basis Function Networks, Self-Organizing Maps (SOM), Recurrent Neural Networks (RNNs) – Basic Concepts, Convolutional Neural Networks (CNNs) – Overview and Applications, Practical Use Cases in Image and Pattern Recognition,

UNIT - IV	Genetic Algorithms and Optimization	

Introduction to Genetic Algorithms, GA Operators: Selection, Crossover, Mutation, Fitness Function and Evaluation, Schema Theorem, Elitism, Applications in Function Optimization, Scheduling, and Robotics, Introduction to Particle Swarm Optimization (PSO).

UNIT - V	Hybrid Systems and Advanced Topics	

Security and Privacy in Cloud-based AI, Identity and Access Management (IAM) in Cloud, Cost Management and Billing for AI Services, Ethical Issues and Fairness in Cloud AI, Case Study: AI in Healthcare Cloud Solutions, Case Study: Real-Time Analytics in Financial Cloud Services.

Textbooks:

1. S. N. Sivanandam, S. N. Deepa, —Principles of Soft Computing‖, Wiley India, 3rd Edition
 2. Timothy J. Ross, —Fuzzy Logic with Engineering Applications‖, Wiley, 4th Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, —Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications‖, PHI

Reference Books:

1. Laurene Fausett, —Fundamentals of Neural Networks: Architectures, Algorithms and Applications‖, Pearson
 2. David E. Goldberg, —Genetic Algorithms in Search, Optimization and Machine Learning‖, Pearson
3. Simon Haykin, —Neural Networks and Learning Machines‖, Pearson, 3rd Edition 4. Bart Kosko, —Neural Networks and Fuzzy Systems‖, Prentice Hall

Online Learning Resources:

Online Learning Resources: 1. NPTEL – Soft Computing by Prof. S. Sengupta (IIT Kharagpur) 2. Coursera – Neural Networks and Deep Learning (Andrew Ng)

Unit No.	CO					Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)	
	Lesson plan(Hrs)	%	Corre lation	Co's Action verb	BT L				
1				Understand	L2	PO1	PO1: Apply(L3)	2	
						PO2	PO2: Identify(L3)	2	
						PO3	PO3: Apply(L3)	2	
2				Analyze	L4	PO1	PO1: Apply(L3)	3	
						PO2	PO2: Identify(L3)	3	
						PO3	PO3: Apply (L3)	3	
						PO4	PO4: Evaluate(L4)	2	
						PO8	PO8: Thumb Rule	2	M appi ng of cour se outc omes with progr
3				Apply	L3	PO1	PO1: Apply(L3)	3	
						PO2	PO2: Identify (L3)	3	
						PO3	PO3: Apply(L6)	2	
						PO4	PO4: Analyze (L4)	3	
						PO5	PO5: Create(L6)	2	
4				Create	L6	PO1	PO1: Apply(L3)	3	

am outcomes

							PO2	PO2: Formulate (L6)	2
							PO3		2
							PO4	PO3: Develop (L6)	3
							PO5	PO4: Analyze(L4)	3
								PO5: Apply(L3)	
5				Evaluate	L5		PO1	PO1: Apply(L3)	2
							PO2	PO2: Identify(L3)	2
							PO5	PO5: Apply(L3)	3

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

Justification Statements:

CO1: Understand the components and applications of soft computing.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO3: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Apply the fuzzy logic concepts to real-world problems.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is Moderate (2)
PO8: Thumb rule
Formulating methodological frameworks, communication formats, protocol designs, and technical strategies.
Therefore, the correlation is moderate (2).

CO3: Evaluate the train various neural network models.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO3 Action verb more than PO2 verb. Therefore, the correlation is high (3)
PO3: Design (L6)
CO3 Action verb less than PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO4: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels. Therefore, the correlation is moderate (2)

CO4: Analyze the genetic algorithms for problem-solving and optimization.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2: Formulate (L6)
CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO3: Develop (L6)
CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is more than PO5 verb. Therefore, the correlation is high (3)

CO5: Create the hybrid systems using soft computing techniques.
Action Verb: Create (L6)
PO1 : Apply (L3)
CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 : Identify (L3)
CO5 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO5: Apply (L3)
CO5 Action verb is more than PO5 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(AUTONOMOUS)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	INTERNET OF THINGS for AI APPLICATIONS	L	T	P	C
23APE3003	III-I	(Professional Elective-I)	2	1	**0**	**3**

Course Outcomes:

- **CO1: Understand** the general concepts of Internet of Things.
- **CO2: Apply** the design concept to IoT solutions
- **CO3: Analyze** the various M2M and IoT architectures
- **CO4: Evaluate** the design issues in IoT applications
- **CO5: Create** IoT solutions using sensors, actuators and Devices

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the general concepts of Internet of Things.			L2
CO2	**Apply**	the design concept		to IoT solutions	L3
CO3	**Analyze**	the various M2M and IoT architectures			L4
CO4	**Evaluate**	the design issues in IoT applications			L5
CO5	**Create**	IoT solutions		using sensors, actuators and Devices	L6

UNIT - I	**Introduction to IoT**	
Introduction to IoT :Definition and Characteristics of IoT, physical design of IoT, IoT communication models, IoT Communication APIs, Communication protocols, Embedded Systems, IoT Levels and Templates		
UNIT - II	**Prototyping IoT Objects using Microprocessor/Microcontroller**	
Prototyping IoT Objects using Microprocessor/Microcontroller: Working principles of sensors and actuators, setting up the board – Programming for IoT, Reading from Sensors, Communication: communication through Bluetooth, Wi-Fi.		
UNIT - III	**IoT Architecture and Protocols**	
IoT Architecture and Protocols: Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, Protocols- 6LowPAN, RPL, CoAP, MQTT, IoT frameworks- Thing Speak.		
UNIT - IV	**Device Discovery and Cloud Services for IoT**	
Device Discovery and Cloud Services for IoT: Device discovery capabilities- Registering a device, Deregister a device, Introduction to Cloud Storage models and communication APIs Web-Server, Web server for IoT.		
UNIT - V	**UAV IoT**	
UAV IoT: Introduction to Unmanned Aerial Vehicles/Drones, Drone Types, Applications: Defense, Civil, Environmental Monitoring; UAV elements and sensors- Arms, motors, Electronic Speed Controller(ESC), GPS, IMU, Ultra sonic sensors; UAV Software –Arudpilot, Mission Planner, Internet of Drones(IoD)- Case study FlytBase		
Textbooks:		

1. Vijay Madisetti and ArshdeepBahga, ─ Internet of Things (A Hands-on-Approach)‖, 1st Edition, VPT, 2014.
2. Handbook of unmanned aerial vehicles, *K Valavanis;George J Vachtsevanos,* New York, Springer, Boston, Massachusetts : Credo Reference, 2014. 2016.

Reference Books:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, ─ From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence‖, 1st Edition, Academic Press, 2014.
2. ArshdeepBahga, Vijay Madisetti - Internet of Things: A Hands-On Approach, Universities Press, 2014.
3. The Internet of Things, Enabling technologies and use cases – Pethuru Raj, Anupama C. Raman, CRC Press.
4. Francis daCosta, ─Rethinking the Internet of Things: A Scalable Approach to Connecting Everything‖, 1st Edition, Apress Publications, 2013
5. Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 9781- 4493- 9357-1
6. DGCA RPAS Guidance Manual, Revision 3 – 2020
7. Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs,John Baichtal.

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correl ation	Co's Action verb	BT L				
1				Understand	L2		PO1 PO2	PO1: Apply(L3) PO2: Identify(L3)	2 2
2				Apply	L3		PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4)	3 3 3 2
3				Analyze	L4		PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify (L3) PO3: Design(L6) PO4: Analyze (L4) PO5: Create(L6)	3 3 1 3 1
4				Evaluate	L5		PO1 PO2 PO3 PO4 PO5 PO6 PO8	PO1: Apply(L3) PO2: Formulate (L6) PO3: Develop (L6) PO4: Analyze(L4) PO5: Apply(L3) PO6: Thumb rule PO8: Thumb rule	3 1 1 3 3 3 3
5				Create	L6		PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Design(L6) PO4: Analyze (L4) PO5: Create (L6) PO6: Thumb rule	3 3 1 3 2 3

Justification Statements:
CO1: Understand the general concepts of Internet of Things.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)

CO2: Apply the design concept to IoT solutions.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
CO3: Analyze the various M2M and IoT architectures**.**
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO3 Action verb more than PO2 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO3 Action verb less than PO2 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore the correlation is high (3)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)

CO4: Evaluate the design issues in IoT applications.
Action Verb: Analyze (L5)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2: Formulate (L6)
CO4 Action verb is PO2 verb by two levels. Therefore the correlation is low (1)
PO3: Develop (L6)
CO4 Action verb is PO2 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is more than PO5 verb. Therefore the correlation is high (3)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)
PO8: Thumb rule
Some ethical principles should be followed while developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

CO5: Create the IoT solutions using sensors, actuators and Devices.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO5 Action verb is more than PO1 verb by one level. Therefore the correlation is high(3)
PO2 Verb: Identify (L3)
CO5 Action verb is more than PO2 verb by one level. Therefore the correlation is high (3)
PO3: Design (L6)
CO5 Action verb less than PO2 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)

CO5 Action verb is more than PO4 verb by one level. Therefore the correlation is high (3)
the correlation is moderate (2).
Create (L6)
CO5 Action verb equal or some less than PO5 verb by two levels. Therefore the correlation is Moderate (2)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the
correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(AUTONOMOUS)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Exploratory Data Analysis with Python	L	T	P	C
23APE3004	III-I	(Professional Elective-I)	2	1	0	3

Course Outcomes:
CO1: Understand the key concepts of EDA and data processing.
CO2: Apply the exploratory analysis using Python libraries and interpret and interpret results.
CO3: Analyze the handle missing data, outliers and categorical features effectively
CO4: Evaluate the visualizations to support data-driven insights.
CO5: Create the EDA as a foundation for data science workflows.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The key concepts of EDA and data processing			L2
CO2	Apply	The exploratory analysis	Using Python libraries and interpret and interpret results.		L3
CO3	Analyze	The handle missing data, outliers and categorical features effectively			L4
CO4	Evaluate	The visualizations		to support data-driven insights	L5
CO5	Create	The EDA as a foundation		for data science workflows.	L6

UNIT - I	Introduction to EDA and Python Environment	
Introduction to Data Science and EDA, Importance of EDA in Data Science Life Cycle, Setting up Python Environment: Jupyter, Anaconda, VS Code, Introduction to NumPy and Pandas: Arrays, Series, DataFrames, Data loading, viewing, basic operations (info, describe, shape)		
UNIT - II	**Data Wrangling and Preprocessing**	
Handling Missing Data (mean, median, drop, interpolation), Dealing with Duplicates, Outliers, and Anomalies, Encoding Categorical Variables (Label, One-hot), Data Transformation: Scaling, Normalization, Binning, Data Types Conversion and Data Type Casting		
UNIT - III	**Univariate and Bivariate Analysis**	
Measures of Central Tendency and Dispersion, Distribution Plots: Histograms, Boxplots, KDE, Bar Charts, Count Plots, Pie Charts, Bivariate Analysis: Scatter Plots, Pair Plots, Heatmaps, Correlation and Covariance Analysis		
UNIT - IV	**Data Visualization Techniques**	
Visualization with Matplotlib and Seaborn, Customizing Plots: Titles, Legends, Labels, Themes, Advanced Visuals: Violin Plots, Strip Plots, Swarm Plots, Multivariate Visualization and Subplots, Plotly and Interactive Visualizations (basic overview)		
UNIT - V	**EDA Case Studies and Real-Time Datasets**	
Step-by-step EDA on Sample Datasets (Titanic, Iris, Sales, etc.), Outlier Detection Techniques, Feature Engineering Techniques in EDA, EDA Report Generation using Python Notebooks, Preparing Data for Machine Learning Models		
Textbooks:		

1. Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly, 2016.
2. Wes McKinney, Python for Data Analysis, 2nd Edition, O'Reilly, 2018.
Reference Books:
1. Joel Grus, Data Science from Scratch, O'Reilly, 2019.
2. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 2nd Edition, O'Reilly, 2019. 3. Allen B. Downey, Think Stats: Probability and Statistics for Programmers, O'Reilly, 2014.

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL				
1				Understand	L2		PO1 PO2 PO5 PO7 PO11	PO1: Apply(L3) PO2: Identify(L3) PO5: Apply (L3) PO7:Thumb rule PO11:Thumb rule	2 2 2 2 2
2				Apply	L3		PO1 PO2 PO4 PO5	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO5: Apply (L3)	3 3 3 3
3				Analyze	L4		PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify (L3) PO3: Design(L6) PO4: Analyze (L4) PO5: Create(L6)	2 2 1 3 1
4				Evaluate	L5		PO1 PO2 PO3 PO5 PO9	PO1: Apply(L3) PO2: Formulate (L6) PO3: Develop (L6) PO5: Apply(L3) PO9: Thumb rule	3 1 1 3 3
5				Create	L6		PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Identify(L3) PO3: Develop (L6) PO5: Apply(L3)	3 3 3 3

Justification Statements:

CO1: Understand the key concepts of EDA and data processing.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO5: Apply (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO7: Thumb rule
EDA is the process of summarizing the main characteristics of data, often with visual methods, to understand patterns, spot anomalies, test hypotheses, and check assumptions.
Therefore the correlation is moderate (2)
PO11: Thumb rule
Data Processing involves preparing the data for analysis or modeling by cleaning, transforming, and formatting it so it is life long process. Therefore the correlation is moderate (2)

CO2: Apply the exploratory analysis using Python libraries and interpret and interpret results.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO5: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)

CO3: Analyze the handle missing data, outliers and categorical features effectively
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO3 Action verb more than PO2 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO3 Action verb less than PO2 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore the correlation is high (3)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)

CO4: Evaluate the visualizations to support data-driven insights.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2: Formulate (L6)
CO4 Action verb is PO2 verb by two levels. Therefore the correlation is low (1)
PO3: Develop (L6)
CO4 Action verb is PO2 verb by two levels. Therefore the correlation is low (1)
PO5: Apply (L3)
CO4 Action verb is more than PO5 verb. Therefore the correlation is high (3)
PO9: Thumb rule
Since we are developing data science engineering and societal departments.
Therefore the correlation is high (3)

CO5: Create the EDA as a foundation for data science workflows.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO5 Action verb is more than PO1 verb. Therefore the correlation is high (3)
PO2 Verb: Identify (L3)
CO5 Action verb is more than PO2 verb. Therefore the correlation is high (3)
PO3: Develop (L6)
CO5 Action verb is more than PO3 verb. Therefore the correlation is high (3)
PO5: Apply (L3)
CO5 Action verb is more than PO5 verb. Therefore the correlation is high (3)

Course Code	Year & Sem	INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS	L	T	P	C
23AES0504	III-I	**(Qualitative Treatment)**	2	1	**0**	**3**

Course Outcomes:
After studying the course, student will be able to
  CO1: Understand the transition from classical to quantum physics and quantum states.
  CO2: Understand qubits, quantum systems, and their philosophical significance.
  CO3: Analyze quantum computer requirements, system fragility, hardware platforms, and software roles.
  CO4: Analyze quantum information, communication, computing, and their future potential.
  CO5: Apply quantum applications, industry cases, challenges, and opportunities.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the transition from classical		to quantum physics and quantum states.	L2
CO2	**Understand**	qubits, quantum systems, and their philosophical significance			L2
CO3	**Analyze**	quantum computer requirements, system fragility, hardware platforms, and software roles.			L4
CO4	**Analyze**	quantum information, communication, computing, and their future potential.			L4
CO5	**Apply**	quantum applications, industry cases, challenges, and opportunities.			L3

UNIT – I	Introduction to Quantum Theory and Technologies	9 **Hrs**

The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison,Quantum states and measurement: nature of observation,Overview of quantum systems: electrons, photons, atoms,The concept of quantization: discrete energy levels,Why quantum? Strategic, scientific, and technological significance,A snapshot of quantum technologies: Computing, Communication, and Sensing,National and global quantum missions: India's Quantum Mission, EU, USA, China

UNIT – II	Theoretical Structure of Quantum Information Systems	9 **Hrs**

What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non-engineering view),Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract,The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences,Philosophical implications: randomness, determinism, and observer role

UNIT – III	Building a Quantum Computer – Theoretical Challenges and Requirements	9 **Hrs**

What is required to build a quantum computer (conceptual overview)?,Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers:
Why maintaining entanglement is difficult,Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison),Superconducting circuits, Trapped ions, Photonics, Visionvs reality: what's working and what remains elusive,The role of quantum software in managing theoretical complexities

UNIT – IV	Quantum Communication and Computing – Theoretical Perspective	9 **Hrs**

Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD),Role of Entanglement in Communication,The Idea of the Quantum Internet – Secure Global Networking,Introduction to Quantum Computing,Quantum Parallelism (Many States at Once),Classical vs Quantum Gates, Challenges: Decoherence and Error Correction,Real-World Importance and Future Potential

UNIT – V	Applications, Use Cases, and the Quantum Future	9 **Hrs**

Real-world application domains: Healthcare (drug discovery),Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum,Ethical,

societal, and policy considerations, Challenges to adoption: cost, skills, standardization,Emerging careers in quantum: roles, skillsets, and preparation pathways,Educational and research landscape – India's opportunity in the global quantum race

Textbooks:
1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
3. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019.

Reference Books:
1. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.
3. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013.
4. **Alastair I.M. Rae**, *Quantum Physics: A Beginner's Guide*, Oneworld Publications, Revised Edition, 2005.
5. **Eleanor G. Rieffel, Wolfgang H. Polak**, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
6. **Leonard Susskind, Art Friedman**, *Quantum Mechanics: The Theoretical Minimum*, Basic Books, 2014.
7. **Bruce Rosenblum, Fred Kuttner**, *Quantum Enigma: Physics Encounters Consciousness*, Oxford University Press, 2nd Edition, 2011.
8. **GiulianoBenenti, GiulioCasati, GiulianoStrini**, *Principles of Quantum Computation and Information, Volume I: Basic Concepts*, World Scientific Publishing, 2004.
9. **K.B. Whaley et al.**, *Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document*, Quantum Flagship, European Commission, 2020.
10. **Department of Science & Technology (DST), Government of India**, *National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers*, MeitY/DST Publications, 2020 onward.

<div align="center">Online Learning Resources:</div>

- IBM Quantum Experience and Qiskit Tutorials
- Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley
- edX – The Quantum Internet and Quantum Computers
- YouTube – Quantum Computing for the Determined by Michael Nielsen
- Qiskit Textbook – IBM Quantum

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	9	20	2	CO1: Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	2 1 3
2	9	20	2	CO2: Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	2 1 3
3	9	20	2	CO3: Analyze	L4	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	3 3 3
4	9	20	2	CO4: Analyze	L4	PO1 PO2	PO1: Apply(L3) PO2: Analyze (L4)	3 3

							PO11	PO11: Thumb Rule	3
5	9	20	2	CO5: Analyze	L4		PO1 PO2 PO11	PO1: Apply(L3) PO2: Apply(L3) PO11: Thumb Rule	3 3 3
	45	100							

Justification Statements:

CO1: Understand the transition from classical to quantum physics and quantum states**.**
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
 CO1 Action verb is less than one level PO1 verb. Therefore, the correlation is moderate (2)
 PO2 Verb: Analyze (L4)
 CO1 Action verb is less than two level PO2 verb. Therefore, the correlation is low (1)
 PO11: Thumb Rule
Quantum physics demands that we accept probability and discreteness at nature's core. Therefore, the correlation is high (3)

CO2: Understand qubits, quantum systems, and their philosophical significance.
 Action Verb: Understand (L2)
 PO1: Apply (L3)
CO2 Action verb is less than one level PO1 verb. Therefore, the correlation is moderate (2)
 PO2: Analyze **(L4)**
CO2 Action verb is less than two level PO2 verb. Therefore, the correlation is low (1)
 PO11: Thumb Rule
A qubit is a superposed quantum state that enables powerful new ways to store and process information. Therefore, the correlation is high (3)

CO3: Analyze quantum computer requirements, system fragility, hardware platforms, and software roles.
 Action Verb: Apply (L3)
 PO1: Apply (L3)
CO3 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
 PO2: Analyze (L4)
CO3 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
 PO11: Thumb Rule
Building a quantum computer requires stable qubits, precise control, error correction, and scalability. Therefore, the correlation is high (3)

CO4: Analyze quantum information, communication, computing, and their future potential.
 Action Verb: Analyze (L4)
 PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
 PO2: Analyze (L4)
CO4 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
 PO11: Thumb Rule
Quantum communication and computing leverage superposition, entanglement, and no-cloning to enable secure communication and powerful computation. Therefore, the correlation is high (3)

CO5: Analyze quantum applications, industry cases, challenges, and opportunities.
 Action Verb: Analyze (L4)
 PO1: Apply (L3)
CO5 Action verb is same as PO . Therefore, the correlation is high(3)
 PO2: Apply(L3)
CO5 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
 PO11: Thumb Rule
Quantum technologies enable breakthroughs in healthcare, materials, optimization, and security. Therefore, the correlation is high (3)

Course Code	Year & Sem	GREEN BUILDING	L	T	P	C
23AOE0101	III-I	**(Open Elective I)**	**2**	**1**	**0**	**3**

Course Outcomes (CO)

	Student will be able to
CO1	Understand the fundamental concepts and significance of green buildings, including their necessity, benefits and sustainable features.
CO2	Apply knowledge of typical energy-saving approaches and sustainable practices to enhance the design and performance of green buildings.
CO3	Analyze strategies for maximizing system efficiency in energy usage by integrating renewable energy sources in buildings and industrial process
CO4	Apply principles of energy modeling to assess building performance in terms of energy consumption and savings.
CO5	Analyze indoor environmental quality parameters such as air conditioning systems, indoor air quality, and control of tobacco smoke for healthy building environments.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the fundamental concepts and significance, including their necessity, benefits and sustainable features.	of green buildings		L2
2	Apply	Knowledge of typical energy saving approaches and sustainable practices	Of green buildings	To enhance and design performance	L3
3	Analyze	Strategies for maximizing system efficiency in energy usage by integrating renewable energy sources	In building and industrial process		L4
4	Apply	principles of energy modeling to assess building performance		in terms of energy consumption and savings.	L3
5	Analyze	indoor environmental quality parameters such as air conditioning systems, indoor air quality, and control of tobacco smoke		for healthy building environments.	L4

UNIT - I	INTRODUCTION TO GREEN BUILDING	9 Hrs

Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing A Green Building, Important Sustainable Features for Green Buildings.

UNIT - II	GREEN BUILDING CONCEPTS AND PRACTICES	9 Hrs

Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and Energy Efficiency.

UNIT - III	GREEN BUILDING DESIGN	9 Hrs

Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT - IV	AIR CONDITIONING	9 Hrs

Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling towers, Selection of Air Handling Units, Pre-Cooling of Fresh Air, Interior Lighting Systems, Key Features of The Building, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT - V	MATERIAL CONSERVATION	9 Hrs

Handling of Non-Process Waste, Waste Reduction During Construction, Materials with Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture. Indoor Environment Quality and Occupational Health– Air Conditioning, Indoor Air Quality, Sick Building Syndrome, tobacco Smoke.

Textbooks:

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by tom woolley and Sam kimings, 2009

Reference Books:

1. Complete Guide to Green Buildings by Trish riley
2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009
3. Energy Conservation Building Code –ECBC-2020, published by BEE

Online Learning Resources:
https://archive.nptel.ac.in/courses/105/102/105102195/

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No	Course Outcomes					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson Plan Hrs	%	Correlation	CO's Action Verb	BTL			
1	12	20	2	Understand	L2	PO1	Apply (L3)	2
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
2	12	20	2	Apply	L3	PO1	Apply (L3)	3
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
3	12	20	2	Analyze	L4	PO1	Apply (L3)	2
						PO2	Analyze (L4)	3
						PO4	Analyze (L4)	3
						PO6	Thumb Rule	3
4	12	20	2	Apply	L3	PO1	Apply (L3)	3
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
5	12	20	2	Analyze	L4	PO1	Apply (L3)	2
						PO2	Analyze (L4)	3
						PO4	Analyze (L4)	3
						PO6	Thumb Rule	3

CO-PO MAPPING JUSTIFICATION:
JUSTIFICATION STATEMENTS:

CO 1: Understand the fundamental concepts and significance of green buildings, including their necessity, benefits and sustainable features.
Action Verb: Understand (L2)
PO1: Apply(L3)
CO Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO 1 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO 1 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

CO 2: Apply knowledge of typical energy-saving approaches and sustainable practices to enhance the design and performance of green buildings.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO Action verb is equal to PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO 2: Action Verb is low to PO2 verb. Therefore, the correlation is medium (2)
CO 2 Action verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 as moderate (2).

CO 3: Analyze strategies for maximizing system efficiency in energy usage by integrating renewable energy sources in buildings and industrial process
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO 3 Action verb is greater than PO1 verb. Therefore, the correlation is moderate (2)
PO2: Analyze (L4)
CO Action verb is equal to PO2 verb. Therefore, the correlation is high (3)
PO 4: Analysis (L4)
CO 3 Action Verb is equal to PO4; Therefore, correlation is high (3)
CO 3 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 as high (3).

CO4: Apply principles of energy modeling to assess building performance in terms of energy consumption and savings.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO Action verb is equal to PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO 4: Action Verb is low to PO2 verb. Therefore, the correlation is medium (2)
CO 4 Action verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 as moderate (2).

CO 5: Analyze indoor environmental quality parameters such as air conditioning systems, indoor air quality, and control of tobacco smoke for healthy building environments.
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO Action verb is greater than PO1 verb. Therefore, the correlation is moderate (2).
PO2: Analyze (L4)
CO Action verb is equal to PO2 verb. Therefore, the correlation is high (3)
PO 4: Analysis (L4)
CO 5 Action Verb is equal to PO4; Therefore, correlation is high (3)
CO 5 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 as high (3).

Course Code	Year & Sem	CONSTRUCTION TECHNOLOGY AND MANAGEMENT (Open Elective-1)	L	T	P	C
23AOE0102	III-I		2	1	0	3

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

Student will be able to	
CO1	Understand the project management fundamentals, organizational structures, and leadership principles in construction.
CO2	Understand the manpower planning, equipment management, and cost estimation in civil engineering projects.
CO3	Apply the planning, scheduling, and project management techniques such as CPM and PERT.
CO4	Understand the various contract types, contract formation, and legal aspects in construction management
CO5	Understand the safety management practices, accident prevention strategies, and quality management systems in construction.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the project management fundamentals, organizational structures, and leadership principle		in construction	L2
CO2	Understand	the manpower planning, equipment management, and cost estimation		in civil engineering projects.	L2
CO3	Apply	the planning, scheduling, and project management techniques such as CPM and PERT.		in construction projects	L3
CO4	Understand	the various contract types, contract formation, and legal aspects		in construction management	L2
CO5	Understand	the safety management practices, accident prevention strategies, and quality management systems		in construction	L2

UNIT - I		9 Hrs

IINTRODUCTION: Project forms, Management Objectives and Functions; Organizational Chart of A Construction Company; Manager's Duties and Responsibilities; Public Relations; Leadership and Team - Work; Ethics, Morale, Delegation and Accountability.

UNIT - II		9Hrs

MAN AND MACHINE: Man-Power Planning, Training, Recruitment, Motivation, Welfare Measures and Safety Laws; Machinery for Civil Engineering., Earth Movers and Hauling Costs, Factors Affecting Purchase, Rent, and Lease of Equipment, and Cost Benefit Estimation.

UNIT - III		9 Hrs

PLANNING, SCHEDULING AND PROJECT MANAGEMENT: Planning Stages, Construction Schedules and Project Specification, Monitoring and Evaluation; Bar-Chart, CPM, PERT, Network- formulation and Time Computation.

UNIT - IV		9 Hrs

CONTRACTS: Types of Contracts, formation of Contract – Contract Conditions – Contract forLabour, Material, Design, Construction – Drafting of Contract Documents Based On IBRD/ MORTH Standard Bidding Documents – Construction Contracts – Contract Problems – Arbitration and Legal Requirements Computer Applications in Construction Management: Software for Project Planning, Scheduling and Control.

UNIT - V		9 Hrs

SAFETY MANAGEMENT: Implementation and Application of QMS in Safety Programs, ISO 9000 Series, Accident Theories, Cost of Accidents, Problem Areas in Construction Safety, Fall Protection, Incentives, Zero Accident Concepts, Planning for Safety, Occupational Health and Ergonomics.

Textbooks:
1. Construction Project Management, SK. Sears, GA. Sears, RH. Clough, John Wiley and Sons, 6th Edition, 2016.
2. Construction Project Scheduling and Control by Saleh Mubarak, 4th Edition, 2019

Pandey, I.M (2021) Financial Management 12th edition. Pearson India Education Services Pvt. Ltd.

Reference Books:
1. Brien, J.O. and Plotnick, F.L., CPMin Construction Management, Mcgraw Hill, 2010.
2. Punmia, B.C., and Khandelwal, K.K., Project Planning and control with PERT and CPM, Laxmi Publications, 2002.
3. Construction Methods and Management: Pearson New International Edition 8 th Edition Stephens Nunnally.
4. Rhoden, M and Cato B, Construction Management and Organisational Behaviour, Wiley-Blackwell, 2016.

Online Learning Resources:
>   **https://archive.nptel.ac.in/courses/105/104/105104161/**
>   **https://archive.nptel.ac.in/courses/105/103/105103093/**

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No	Course Outcomes					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson Plan Hrs	%	Correlation	CO's Action Verb	BTL			
1	10	18.18	3	Understand	L1	PO1 PO6 PO7 PO10	Apply (L3) Thumb Rule Thumb Rule Thumb Rule	2 2 2 2
2	10	18.18	3	Understand	L1	PO1 PO6 PO10	Apply (L3) Thumb Rule Thumb Rule	2 2 2
3	15	27.27	3	Apply	L3	PO1 PO2 PO6 PO10	Apply (L3) Analyze (L4) Thumb Rule Thumb Rule	3 2 2 2
4	10	18.18	3	Understand	L1	PO1 PO6 PO10	Apply (L3) Thumb Rule Thumb Rule	2 2 2
5	10	18.18	3	Understand	L1	PO1 PO6 PO10	Apply (L3) Thumb Rule Thumb Rule	2 2 2

Course Code	Year & Sem	ELECTRICAL SAFETY PRACTICES AND STANDARDS	L	T	P	C
23AOE0201	III-I	(Open Elective-1)	2	1	0	3

After completion of the course, students will be able to:	
CO1	Understanding the Fundamentals of Electrical Safety -L2
CO2	Identifying and Applying Safety Components -L3
CO3	Analyzing Grounding Practices and Electrical Bonding-L4
CO4	Applying Safety Practices in Electrical Installations and Environments- L4
CO5	Evaluating Electrical Safety Standards and Regulatory Compliance -L5

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Understand	Fundamentals of Electrical Safety			L2
CO2	Identify	Applying Safety Components			L3
CO3	Analyze	Grounding Practices and Electrical Bonding			L4
CO4	Apply	Safety Practices in Electrical Installations and Environments			L4
CO5	Evaluate	Electrical Safety Standards and Regulatory Compliance			L5

UNIT - I	Introduction To Electrical Safety	9 Hrs

Fundamentals of Electrical safety-Electric Shock- physiological effects of electric current - Safety requirements –Hazards of electricity- Arc - Blast- Causes for electrical failure.

UNIT - II	Safety Components	9Hrs

Introduction to conductors and insulators- voltage classification -safety against over voltages- safety against static electricity-Electrical safety equipment's - Fire extinguishers for electrical safety.

UNIT - III	Grounding	9 Hrs

General requirements for grounding and bonding- Definitions- System grounding-Equipment grounding - The Earth - Earthing practices- Determining safe approach distance-Determining arc hazard category.

UNIT - IV	Safety Practices	9 Hrs

General first aid- Safety in handling hand held electrical appliances tools- Electrical safety in train stations-swimming pools, external lighting installations, medical locations-Case studies.

UNIT - V	Standards For Electrical Safety	9 Hrs

Electricity Acts- Rules & regulations- Electrical standards-NFPA 70 E-OSHA standards-IEEE standards-National Electrical Code 2005 – National Electric Safety code NESC-Statutory requirements from electrical inspectorate

Textbooks:

1. Massimo A.G.Mitolo, ―Electrical Safety of Low-Voltage Systems‖, McGraw Hill, USA, 2009.
2. Mohamed El-Sharkawi, ―Electric Safety - Practice and Standards‖, CRC Press, USA, 2014

Reference Books:

1. Kenneth G.Mastrullo, Ray A. Jones, ―The Electrical Safety Program Book‖, Jones and Bartlett Publishers, London, 2nd Edition, 2011
2. Palmer Hickman, ―Electrical Safety-Related Work Practices‖, Jones & Bartlett Publishers, London, 2009.
3. Fordham Cooper, W., ―Electrical Safety Engineering‖, Butterworth and Company, London, 1986.
4. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, ―Electrical Safety Hand book, McGraw-Hill, New York, USA, 4th edition, 2012.

Mapping of Course outcomes with Program outcomes (High-3, Medium-2, Low-1)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	–	–	–	1	–	–	–	–	1	1	2
CO2	3	3	–	–	–	2	–	–	–	–	2	2	3
CO3	3	–	1	–	3	3	–	–	–	–	3	3	3
CO4	3	2	–	–	3	2	–	–	–	–	2	2	3
CO5	3	3	2	–	3	3	1	–	–	–	2	3	3

Mapping of Course outcomes with Program outcomes Justification Table

CO No.	Lesson Plan (Hrs.)	%	correlation	Verb	BTL	Program Outcomes (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of correlation (1-3)
1				Understand	L2	PO1 PO2 PO6	Apply-L3 Analyse-L4 Analyse-L4	Medium-2 Low-1 Low-1
2				Identify	L3	PO1 PO2 PO6	Apply-L3 Analyse-L4 Analyse-L4	High-3 Medium-2 Medium-2
3				Analyze	L4	PO1 PO3 PO5 PO6	Apply-L3 Design-L6 Apply-L3 Analyse-L4	High-3 Low-1 High-3 High-3
4				Apply	L4	PO1 PO2 PO5 PO6	Apply-L3 Analyse-L4 Apply-L3 Analyse-L4	High-3 High-3 High-3 High-3
5				Evaluate	L5	PO1 PO2 PO3 PO5 PO6 PO7	Apply-L3 Analyse-L4 Design-L6 Apply-L3 Analyse-L4 Apply-L3	High-3 High-3 Medium-1 High-3 High-3 High-3

Justification:
CO1:   Understanding the Fundamentals of Electrical Safety
Action Verb: L2
CO1 Action Verb is Less than PO1 Action By1 Therefore The Correlation Is Medium-2
CO1 Action Verb is Less than PO2 Action By2 Therefore The Correlation Is Low-1
CO1 Action Verb is Less Than PO6 Action By2 Therefore The Correlation Is Low-1

CO2: Identifying and Applying Safety Components
Action Verb: L3
C02 Action Verb Is Equal To PO1 Therefore The Correlation Is High-3
C02 Action Verb Is Less than PO2 Action by one Therefore The Correlation Is Medium-2
C02 Action Verb Is Less than PO6 action by one Therefore The Correlation Is Medium-2
CO3: Analyzing Grounding Practices and Electrical Bonding
Action Verb: L4

CO3 Action Verb Is greater than PO1 action by one Therefore The Correlation Is High-3
CO3 Action Verb Is Less than PO3 Action by 2 Therefore The Correlation Is Low-1
CO3 Action Verb Is greater than PO5 Action by 1 Therefore The Correlation Is High-3
CO3 Action Verb Is Equal To PO6 Therefore The Correlation Is High-3

CO4: Applying Safety Practices in Electrical Installations and Environments
Action Verb: L4
CO4 Action Verb Is Greater Than PO1 Action By 1 Therefore The Correlation Is High-3
CO4 Action Verb Is Equal To PO2 Therefore The Correlation Is High-3
CO4 Action Verb Is Greater Than PO5 Action By 1 Therefore The Correlation Is High-3
CO4 Action Verb Is Equal To PO6 Therefore The Correlation Is High-3

CO5: Evaluating Electrical Safety Standards and Regulatory Compliance
Action Verb: L5
CO5 Action Verb Is Greater Than PO1 Action By 2 Therefore The Correlation Is High-3
CO5 Action Verb Is Greater Than PO2 Action By 1 Therefore The Correlation Is High-3
CO5 Action Verb Is less Than PO3 Action By One Therefore The Correlation Is Medium-1
CO5 Action Verb Is Greater Than   PO5 Action By 2therefore The Correlation Is High-3
CO5 Action Verb Is Greater Than PO6 Action By 1therefore The Correlation Is High-3
CO5 Action Verb Is Greater Than PO7 Action By 2 Therefore The Correlation Is High-3

Course Code	Year & Sem	Sustainable Energy Technologies (Open Elective-1)	L	T	P	C
23AOE0301	III-I		2	1	0	3

	After completion of the course, students will be able to:
CO1	Analyze solar radiation data, PV module characteristics, and the environmental impact of solar power systems.
CO2	Evaluate the performance of various solar thermal collectors and select appropriate battery storage systems for PV applications.
CO3	Apply the principles of wind and biomass energy conversion to analyze the performance of renewable energy systems.
CO4	Analyze the operational principles and applications of geothermal, ocean energy, and fuel cell systems.
CO5	Design an off-grid solar PV power plant considering component selection, system integration, and economic aspects

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Analyze	Solar radiation data, PV module characteristics, and the environmental impact of solar power systems.			L4
CO2	Evaluate	The performance of various solar thermal collectors and select appropriate battery storage systems.	for PV applications.		L5
CO3	Apply	The principles of wind and biomass energy conversion.	to analyze the performance of renewable energy systems.		L3
CO4	Analyze	The operational principles and applications of geothermal, ocean energy, and fuel cell systems.			L4
CO5	Design	An off-grid solar PV power plant.	considering component selection, system integration, and economic aspects.		L6

UNIT - I		9 Hrs

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems

UNIT - II		9Hrs

SOLAR PV MODULES AND PV SYSTEMS: PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance

UNIT - III		9 Hrs

STORAGE IN PV SYSTEMS: Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.
SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.
SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT - IV		9 Hrs

G**WIND ENERGY**: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT - V	Standards For Electrical Safety	9 Hrs

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits

OCEAN ENERGY: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Textbooks:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006

Reference Books:

1. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider / Taylor &Francis
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3. Renewable Energy Technologies -Ramesh & Kumar /Narosa
4. Non-conventional Energy Source- G.D Roy/Standard Publishers.

Online Learning Resources:

- https://nptel.ac.in/courses/112106318
- https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=-mwIa2X-SuSiNy13
- https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=Apfjx6oDfz1Rb_N3
- https://youtu.be/zx04Kl8y4dE?si=VmOvp_OgqisILTAF

Mapping of Course outcomes with Program outcomes (High-3, Medium-2, Low-1)

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

Mapping of Course outcomes with Program outcomes Justification Table

CO No.	CO					Program Outcomes (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of correlation (1-3)
	Lesson Plan (Hrs.)	%	correlation	Verb	BTL			
1				Analyze	L4	PO1, PO2, PO4	Apply(L3) Analyze(L4) Analyze(L4)	3
2				Evaluate	L5	PO1, PO2, PO3	Apply(L3) Analyze(L4) Design(L6)	3
3				Apply	L3	PO1, PO2	Apply(L3) Analyze(L4)	3
4				Analyze	L4	PO1, PO2, PO4	Apply(L3) Analyze(L4) Analyze(L4)	3

5				Design	L6	PO2, PO3, PO5, PO6	Analyze(L4) Design(L6) Usage(L3) Design(L6)	3

Justification Statements:

CO1: Analyze solar radiation data, PV module characteristics, and the environmental impact of solar power systems.

Action Verb: Analyze (L4)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4), Sustainability (L3)

The CO1 Action Verb 'Analyze' (L4) is at a higher cognitive level than PO1 and PO7 verbs and is equal to PO2's 'Analyze' (L4). This outcome requires analyzing complex data in the context of sustainable engineering. Therefore, the correlation is high (3).

CO2: Evaluate the performance of various solar thermal collectors and select appropriate battery storage systems for PV applications.

Action Verb: Evaluate (L5)

PO2 & PO3 Verbs: Analyze (L4), Design (L6)

The CO2 Action Verb 'Evaluate' (L5) is a higher-order skill that requires analysis (PO2) and is a critical component of designing solutions (PO3). The ability to make judgments based on criteria is fundamental to these POs. Therefore, the correlation is high (3).

CO3: Apply the principles of wind and biomass energy conversion to analyze the performance of renewable energy systems.

Action Verb: Apply (L3)

PO1 & PO2 Verbs: Apply (L3), Analyze (L4)

The CO3 Action Verb 'Apply' (L3) is at the same cognitive level as PO1's verb and is a prerequisite for PO2's 'Analyze' (L4). It involves applying fundamental engineering knowledge to solve problems. Therefore, the correlation is high (3).

CO4: Analyze the operational principles and applications of geothermal, ocean energy, and fuel cell systems.

Action Verb: Analyze (L4)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

The CO4 Action Verb 'Analyze' (L4) is at a higher level than PO1's 'Apply' (L3) and is equal to the verbs for PO2 and PO4. It requires a detailed investigation of complex energy systems. Therefore, the correlation is high (3).

CO5: Design an off-grid solar PV power plant considering component selection, system integration, and economic aspects.

Action Verb: Design (L6)

PO2, PO3 & PO5 Verbs: Analyze (L4), Design (L6), Usage (L3)

The CO5 Action Verb 'Design' (L6) is at the same cognitive level as PO3's verb.

This complex design task requires in-depth analysis of the problem (PO2) and the use of modern engineering tools (PO5). Therefore, the correlation is high (3).

Course Code	Year & Sem	ELECTRONIC CIRCUITS	L	T	P	C
23AOE0401	III-I	(Open Elective-1)	2	1	0	3

After completion of the course, students will be able to:	
CO1	**Understand** the operation of various semiconductor diodes and their applications.
CO2	**Analyze** the BJT characteristics, biasing methods and stabilization techniques.
CO3	**Understand** the single and multi-stage amplifiers using simplified hybrid model.
CO4	**Evaluate** the parameters of feedback amplifiers and frequency of various oscillators.
CO5	**Analyze** the characteristics, operation of Operational amplifier and it's applications

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	Operation of various semiconductor diodes and their applications.		Rectifiers, Clampers, Clippers, voltage regulators.	L2
CO2	Analyze	BJT characteristics, biasing methods and stabilization techniques.			L4
CO3	Understand	Single and multi-stage amplifiers using simplified hybrid model.		BJT, Coupled amplifiers	L2
CO4	Evaluate	Parameters of feedback amplifiers and frequency of various oscillators.			L5
CO5	Analyze	characteristics, operation of Operational amplifier and it's applications			L4

UNIT – I		16Hrs

Semiconductor Diode and Applications: Introduction, PN junction diode – structure, operation and VI characteristics, Half- wave, Full-wave and Bridge Rectifiers with and without Filters, Positive and Negative Clipping and Clamping circuits (Qualitative treatment only). Special Diodes: Zener and Avalanche Breakdowns, VI Characteristics of Zener diode, Zener diode as voltage

regulator, Construction, operation and VI characteristics of Tunnel Diode, LED, Varactor Diode, Photo Diode .

UNIT – II		17Hrs

Bipolar Junction Transistor (BJT): Principle of Operation, Common Emitter, Common Base and Common Collector

Configurations, Transistor as a switch and Amplifier, Transistor Biasing and Stabilization - Operating point, DC & AC load lines, Biasing - Fixed Bias, Self Bias, Bias Stability, Bias Compensation using Diodes.

UNIT – III		19 Hrs

Single stage amplifiers: Classification of Amplifiers - Distortion in amplifiers, Analysis of CE, CC and CB configurations with simplified hybrid model.

Multistage amplifiers: Different Coupling Schemes used in Amplifiers - RC coupled amplifiers, Transformer Coupled Amplifier, Direct Coupled Amplifier; Multistage RC coupled BJT amplifier (Qualitative treatment only).

UNIT – IV		20 Hrs

Feedback amplifiers: Concepts of feedback, Classification of feedback amplifiers, Effect of feedback on amplifier characteristics, Voltage Series, Voltage Shunt, Current Series and

Current Shunt Feedback Configurations (Qualitative treatment only). **Oscillators:** Classification of oscillators, Condition for oscillations, RC Phase shift Oscillators, Generalized analysis of LC Oscillators-Hartley and Colpitts Oscillators, Wien Bridge Oscillator.	
UNIT – V	18 Hrs
Op-amp: Classification of IC'S, basic information of Op-amp, ideal and practical Op-amp, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential. **Applications of op-amp :** Summing, scaling and averaging amplifiers, Integrator, Differentiator, phase shift oscillator and comparator.	
Textbooks:	
1. Electronics Devices and Circuits, J.Millman and Christos. C. Halkias, 3rd edition, Tata McGraw Hill, 2006. 2. Electronics Devices and Circuits Theory, David A. Bell, 5th Edition, Oxford University press. 2008.	
Reference Books:	
1. Electronics Devices and Circuits Theory, R.L.Boylestad, LousisNashelsky and K.Lal Kishore, 12th edition, 2006, Pearson, 2006. 2. Electronic Devices and Circuits, N.Salivahanan, and N.Suresh Kumar, 3rd Edition, TMH, 2012 3. Microelectronic Circuits, S.Sedra and K.C.Smith, 5th Edition, Oxford University Press.	
Online Learning Resources:	
nptel videos	

Mapping of course outcomes with program outcomes

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

Unit No.	CO Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlatio n (0-3)
1	16	18%	2	Understand	L2	PO1 PO2	PO1: Apply (L3) PO2: Review(L2)	2 3
2	17	19%	2	Analyze	L4	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Develop(L3) PO4: Analyze(L4)	3 3 3 3
3	19	21%	3	Understand	L2	PO1 PO2 PO3 PO5	PO1: Apply (L3) PO2:Review (L2) PO3:Analyze(L4) PO5: Select(L1)	2 3 1 3
4	20	22%	3	Evaluate	L5	PO1 PO2 PO4 PO5	PO1: Apply (L3) PO2:Identify(L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 3
5	18	20%	2	Analyze	L4	PO1 PO2 PO4	PO1: Apply (L3) PO2: Identify (L3) PO4: Analyze(L4)	3 3 3
	90	100%						

Correlation atrix Justification Statements:

CO1: Understand the operation of various semiconductor diodes and their applications.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3) CO1 Action Verb is less than PO1 verb by one level; Therefore, the correlation is moderate (2). PO2 Verbs: Review (L2) CO1 Action Verb is equal to PO2 verb; Therefore, the correlation is high (3).

CO2: Analyze the BJT characteristics, biasing methods and stabilization techniques.
Action Verb: Analyze(L4)
PO1 Verbs: Apply (L3) CO2 Action Verb is greater than PO1 verb; Therefore, the correlation is high (3). PO2 Verbs: Identify (L3) CO2 Action Verb is greater than PO2 verb; Therefore, the correlation is high (3). PO3 Verbs: Develop (L3) CO2 Action Verb is greater than PO3 verb; Therefore, the correlation is high (3). PO4 Verbs: Analyze (L4) CO2 Action Verb is equal to PO4 verb; Therefore, the correlation is high (3).

CO3: Understand the single and multi-stage amplifiers using simplified hybrid model.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3),CO3 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2). PO2 Verbs: Review (L2),CO3 Action Verb is equal to PO2 verb by same levels; therefore, correlation is High (3). PO4 Verbs: Analyze-L4,CO3 Action Verb is less than PO4 verb by two levels; therefore, correlation is low (1).
PO5 Verbs: Select-L1,CO3 Action Verb is more than PO5 verb by one level; therefore, correlation is high (3).

CO4: Evaluate the parameters of feedback amplifiers and frequency of various oscillators.
Action Verb: Evaluate(L5)
PO1 Verbs: Apply (L3)CO4 Action Verb is high than PO1 verb by two levels ; Therefore, correlation is high (3). PO2 Verb: Identify (L3)CO4 Action Verb is high than PO2 verb by two levels ; Therefore, correlation is high (3). PO4 Verbs: Analyze(L4)CO4 Action Verb is higher than PO4 verb by one levels; therefore, correlation is high (3). PO5 Verbs: Apply (L3),CO4 Action Verb is higher than PO5 verb by two levels; Therefore, correlation is high (3).

CO5: Analyze the characteristics, operation of Operational amplifiers and it's applications
Action Verb: Analyze(L4)
PO1 Verbs: Apply (L3)CO5 Action Verb is PO1 verb by two levels ; Therefore, correlation is high (3).
PO2 Verb: Identify (L3)CO5 Action Verb is high than PO2 verb by two levels ; Therefore, correlation is high (3). PO4 Verbs: Analyze(L4)CO5 Action Verb is higher than PO4 verb by one levels; therefore, correlation is high (3).

Course Code	Year & Sem	Mathematical Foundations for Machine Learning and AI (Open Elective-1)	L	T	P	C
23AOE9901	III-I		2	1	0	3

Course Outcomes (CO): Student will be able to

1. Apply linear algebra concepts to ML techniques like PCA and regression.
2. Analyze probabilistic models and statistical methods for AI applications.
3. Apply optimization techniques for machine learning algorithms.
4. Apply vector calculus and transformations in AI-based models.
5. Evaluate graph-based AI models using mathematical representations.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Apply**	linear algebra concepts	to ML techniques like PCA and regression.		**L3**
2	**Analyze**	probabilistic models and statistical methods	for AI applications.		**L4**
3	**Apply**	optimization techniques	for machine learning algorithms.		**L3**
4	**Apply**	vector calculus and transformations	in AI-based models.		**L3**
5	**Evaluate**	graph-based AI models	using mathematical representations.		**L5**

UNIT I: Linear Algebra for Machine Learning   **8 hours**
Review of Vector spaces, basis, linear independence, Vector and matrix norms, Matrix factorization techniques, Eigen values, eigenvectors, diagonalization, Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).

UNIT II: Probability and Statistics for AI   **8 hours**
Probability distributions: Gaussian, Binomial, Poisson. Bayes' Theorem, Maximum Likelihood Estimation (MLE), and Maximum a Posteriori (MAP).Entropy and Kullback-Leibler (KL) Divergence in AI, Cross entropy loss, Markov chains.

UNIT III: Optimization Techniques for ML   **8 hours**
Multivariable calculus: Gradients, Hessians, Jacobians. Constrained optimization: Lagrange multipliers and KKT conditions. Gradient Descent and its variants (Momentum, Adam) Newton's method, BFGS method.

UNIT IV: Vector Calculus & Transformations   **8 hours**
Vector calculus: Gradient, divergence, curl. Fourier Transform & Laplace Transform in ML applications.

UNIT V: Graph Theory for AI   **8 hours**
Graph representations: Adjacency matrices, Laplacian matrices. Bayesian Networks & Probabilistic Graphical Models. Introduction to Graph Neural Networks (GNNs).

Textbooks:
1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 2020.
2. Pattern Recognition and Machine Learning by Christopher Bishop, Springer.

Reference Books:

1. Gilbert Strang, Linear Algebra and Its Applications, Cengage Learning, 2016.
2. Jonathan Gross, Jay Yellen, Graph Theory and Its Applications, CRC Press, 2018.

Web References:
- MIT– Mathematics for Machine Learning https://ocw.mit.edu

- Stanford CS229 – Machine Learning Course https://cs229.stanford.edu/
- Deep AI – Mathematical Foundations for AI https://deepai.org

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3										
2		3									
3	3										
4	3										
5			3								

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Apply	L3	PO1	Apply	3
2				Analyze	L4	PO2	Analyze	3
3				Apply	L3	PO1	Apply	3
4				Apply	L3	PO1	Apply	3
5				Evaluate	L5	PO3	Evaluate	3

CO1: Apply linear algebra concepts to ML techniques like PCA and regression.
 Action Verb: Apply(L3)
PO1 Verbs: Apply (L3)
CO1 Action Verb is equal toPO1 verb ; Therefore correlation is high (3).
CO2: Analyze probabilistic models and statistical methods for AI applications.
Action Verb: Analyze (L4)
PO2 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
CO3: Apply optimization techniques for machine learning algorithms.
Action Verb: Apply **(L3)**
PO1 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).
CO4: Apply vector calculus and transformations in AI-based models.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).
CO5: Evaluate graph-based AI models using mathematical representations.
Action Verb: Evaluate(L5)
PO3 Verb: Evaluate (L6)
CO5 Action verb is equal to PO3 verb; therefore the correlation is high (3).

Course Code	Year & Sem	MATERIALS CHARACTERIZATION TECHNIQUES (Open Elective-1)	L	T	P	C
23AOE9906	III-I		2	1	0	3

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

CO1	Understand the crystal structure and crystal size by using X-ray Diffraction (XRD) technique.
CO2	Analyze the basic principles of Scanning Electron Microscopy (SEM).
CO3	Analyze the fundamentals of Transmission Electron Microscope (TEM).
CO4	Apply the various spectroscopic techniques for engineering applications.
CO5	Analyze the electric and magnetic properties of a specimen using various characterization techniques.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Understand	The crystal structure and crystal size by using X-ray Diffraction (XRD) technique.			L2
CO2	Analyze	The various spectroscopic techniques for engineering applications.			L4
CO3	Analyze	The fundamentals of Transmission Electron Microscope (TEM).			L4
CO4	Apply	The various spectroscopic techniques for engineering applications.			L3
CO5	Analyze	The electric and magnetic properties of a specimen using various characterization techniques.			L4

UNIT - I	Structure analysis by Powder X-Ray Diffraction	9 Hrs

Introduction, Bragg's law of diffraction, Intensity of Diffracted beams, Factors affecting Diffraction, Intensities, Structure of polycrystalline Aggregates, Determination of crystal structure, Crystallite size by Scherer and Williamson-Hall (W-H) Methods, Small angle X-ray scattering (SAXS) (in brief).

UNIT - II	Microscopy technique -1 –Scanning Electron Microscopy (SEM)	9Hrs

Introduction, Principle, Construction and working principle of Scanning Electron Microscopy, Specimen preparation, Different types of modes used (Secondary Electron and Backscatter Electron), Advantages, limitations and applications of SEM.

UNIT - III	Microscopy Technique -2 - Transmission Electron Microscopy (TEM)	9 Hrs

Construction and Working principle, Resolving power and Magnification, Bright and dark fields, Diffraction and image formation, Specimen preparation, Selected Area Diffraction, Applications of Transmission Electron Microscopy, Difference between SEM and TEM, Advantage and Limitations of Transmission Electron Microscopy.

UNIT - IV	Spectroscopy techniques	9 Hrs

Principle, Experimental arrangement, Analysis and advantages of the spectroscopic techniques – (i) UV-Visible spectroscopy (ii) Raman Spectroscopy, (iii) Fourier Transform infrared (FTIR) spectroscopy, (iv) X-ray photoelectron spectroscopy (XPS).

UNIT - V	Electrical & Magnetic Characterization techniques	9 Hrs

Electrical Properties analysis techniques (DC conductivity, AC conductivity) Activation Energy, Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method, Vibrating sample Magnetometer (VSM) and SQUID.

Textbooks:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Leng – John Wiley & Sons (Asia) Pvt. Ltd. 2013.
   2. Microstructural Characterization of Materials - David Brandon, Wayne D Kalpan, John Wiley & Sons Ltd., 2008.

Reference Books:

1. Fundamentals of Molecular Spectroscopy – IV Ed. – Colin Neville BanwellandElaine M. McCash, Tata McGraw-Hill, 2008.
2. Elements of X-ray diffraction – Bernard Dennis Cullity& Stuart R Stocks, Prentice Hall , 2001 – Science.
3. Practical Guide to Materials Characterization: Techniques and Applications - Khalid Sultan – Wiley – 2021.
4. Materials Characterization Techniques -Sam Zhang, Lin Li, Ashok Kumar -CRC Press - 2008

Online Learning Resources:

1. https://nptel.ac.in/courses/115/103/115103030/
2. https://nptel.ac.in/content/syllabus_pdf/113106034.pdf
3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm08/

Mapping of Course outcomes with Program outcomes (High-3, Medium-2, Low-1)

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

Mapping of Course outcomes with Program outcomes Justification Table									
CO No.	**CO**					**Program Outcomes (PO)**	**PO(s): Action verb and BTL(for PO1 to PO5)**	**Level of correlation(1-3)**
	Lesson Plan (Hrs.)	**%**	**correlation**	**Verb**	**BTL**			
1				Understand	L2	PO1	PO1: Apply (L3)	2
2				Analyze	L4	PO1	PO1: Apply (L3)	3
3				Analyze	L4	PO1, PO5	PO1, PO5: Apply (L3)	3
4				Apply	L3	PO1	PO1: Apply (L3)	3
5				Analyze	L4	PO1, PO2	PO1, PO2: Apply (L3)	3

Justification:
CO1: Understand the crystal structure and crystal size by using X-ray Diffraction (XRD) technique.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO1 Action Verb level is less than PO1 verb by one level; Therefore, correlation is moderate (2).
CO2: Analyze the basic principles of Scanning Electron Microscopy (SEM).
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO2 Action Verb level is greater than PO1 verb by one level; Therefore, correlation is high (3).
CO3: Analyze the fundamentals of Transmission Electron Microscope (TEM).
Action Verb: Analyze (L4)
PO1 and PO5 Verbs: Apply (L3)

CO3 Action Verb level is greater than PO1 and PO5 verbs by one level; Therefore correlation is high (3).
CO4: Apply the various spectroscopic techniques for engineering applications.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
 CO4 Action Verb is equal to PO1 verb; Therefore, correlation is high (3).
CO5: Analyze the electric and magnetic properties of a specimen using various characterization techniques.
Action Verb: Analyze (L4)
PO1 and PO2 Verb: Apply (L3)
CO5 Action verb is greater than PO1 and PO2 verbs by one level; therefore, the correlation is high (3).

Course Code	Year & Sem	Chemistry of Energy Systems	L	T	P	C
23AOE9911	III-I	(Open Elective-1)	2	1	0	3

	After completion of the course, students will be able to:
CO1	Understand the problems based on electrode potential and concept of batteries.
CO2	Apply fuel technology in various energy and engineering contexts.
CO3	Analyze the advantages of photoelectric catalytic process such as high effieiency, low environmental impact and renewable energy applications.
CO4	Apply the electrochemical principles to photo voltaic cell, solar power and solar cells.
CO5	Analyze various methods for storage of hydrogen fuel.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Understand	the problems based on electrode potential and concept of batteries.			L2
CO2	Apply	fuel technology in various energy and engineering contexts.			L3
CO3	Analyze	the advantages of photoelectric catalytic process such as high efficiency, low environmental impack and renewable energy applications.			L4
CO4	Apply	the electrochemical principles to photo voltaic cell, solar power and solar cells.			L3
CO5	Analyze	various methods for storage of hydrogen fuel.			L4

UNIT - I	Electrochemical Systems	9 Hrs
	Galvanic cell, Nernst equation, standard electrode potential, application of EMF, electrical double layer, polarization, Batteries- Introduction ,Lead-acid ,Nickel- cadmium, Lithium ion batteries and their applications.	

UNIT - II	Fuel Cells	9Hrs
	Fuel cell- Introduction, Basic design of fuel cell, working principle, Classification of fuel cells, Polymer electrolyte membrane (PEM) fuel cells, Solid-oxide fuel cells (SOFC), Fuel cell efficiency and applications	

UNIT - III	Photo and Photo electrochemical Conversions)	9 Hrs
	Photochemical cells Introduction and applications of photochemical reactions, specificity of photo electrochemical cell, advantage of photoelectron catalytic conversions and their applications.	

UNIT - IV	Solar Energy	9 Hrs
	Introduction and prospects, photovoltaic (PV) technology, concentrated solar power (CSP), Solar cells and applications	

UNIT - V	Hydrogen Storage	9 Hrs
	Hydrogen storage and delivery: State-of-the art, Established technologies, Chemical and Physical methods of hydrogen storage, Compressed gas storage, Liquid hydrogen storage, Other storage methods, Hydrogen storage in metal hydrides, metal organic frameworks (MOF), Metal oxide porous structures, hydrogel , and Organic hydrogen carriers.	
Textbooks:		
1.Physical chemistry by Ira N. Levine		

2.Essentials of Physical Chemistry, Bahl and Bahl and Tuli.	
3.Inorganic Chemistry, Silver and Atkins	
Reference Books:	
1.Fuel Cell Hand Book 7th Edition, by US Department of Energy (EG&G technical services And corporation)	
2.Hand book of solar energy and applications by ArvindTiwari and Shyam	
3.Solar energy fundamental, technology and systems by Klaus Jagar et.al.	
4.Hydrogen storage by Levine Klebonoff	
Online Learning Resources:	
2. https://nptel.ac.in/courses/115/103/115103030/	
2. https://nptel.ac.in/content/syllabus_pdf/113106034.pdf	
3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm08/	

Mapping of Course outcomes with Program outcomes (High-3, Medium-2, Low-1)

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

Mapping of Course outcomes with Program outcomes Justification Table

CO No.	CO					Program Outcomes (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of correlation (1-3)
	Lesson Plan (Hrs.)	%	correlation	Verb	BTL			
1				**Understand**	**L2**	PO1	PO1: Apply (L3)	2
2				**Apply**	**L3**	PO1	PO1: Apply (L3)	3
3				**Analyze**	**L3**	PO1	PO1: Apply (L3)	3
4				**Apply**	**L4**	PO1	PO1: Apply (L3)	3
5				**Analyze**	**L4**	PO1	PO1: Apply (L3)	3

Justification:
CO1: Understand the problems based on electrode potential and concept of batteries
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO1 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
CO2: Apply fuel technology in various energy and engineering contexts
Action Verb: Apply (L3)
PO1 Verbs: Apply (L3)
CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).
CO3: Analyze the advantages of photoelectric catalytic process such as high efficiency, low environmental impact and renewable energy applications
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO3 Action Verb is less than PO1 verb; Therefore correlation is high (2).
CO4: Apply the electrochemical principles to photo voltaic cell, solar power and solar cells
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO5 Analyze various methods for storage of hydrogen fuel
Action Verb: Analyze (L4)
PO1 Verb: Analyze (L4)
CO5 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

Course Code	Year & Sem	English For Competitive Examinations (Open Elective-1)	L	T	P	C
23AOE9915	III-I		2	1	0	3

Course Outcomes (CO)

Student will be able to	
CO1	Understand the basics of English grammar to develop proficiency in language skills.
CO2	Apply the grammatical structures in sentences for an effective communication
CO3	Apply the use of various concepts in grammar and vocabulary in everyday use and competitive exams
CO4	Analyze unfamiliar passages to draw logical conclusions, thereby enhancing reading comprehension and vocabulary skills
CO5	Create effective writing forms like essays and precise writing by using grammar and structure rules

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the basics of English grammar to develop proficiency in language skills.			L2
2	**Apply**	the grammatical structures in sentences for an effective communication			L3
3	**Analyze**	the use of various concepts in grammar and vocabulary in everyday use and competitive exams		in everyday use and competitive exams	L3
4	**Understand**	Analyze unfamiliar passages to draw logical conclusions, thereby enhancing reading comprehension and vocabulary skills			L4
5	**Evaluate**	effective writing forms like essays and precise writing by using grammar and structure rules.	by using grammar and structure rules.		L6

UNIT - I	GRAMMAR-1	9 Hrs

Nouns-classification-errors-Pronouns-types-errors-Adjectives-types-errors-Articles-definite-indefinite- Degrees of Comparison-Adverbs-types- errors-Conjunctions-usage-
repositions-usage-Tag Questions, types-identifying errors- Practice

UNIT - II	GRAMMAR-2	9 Hrs

Verbs-tenses- structure-usages- negatives- positives- time adverbs-Sequence of tenses--If Clause-Voice-active voice and passive voice- reported Speech-Agreement- subject and verb-Modals-Spotting Errors-Practices

UNIT - III	VERBAL ABILITY	9 Hrs

Sentence completion-Verbal analogies-Word groups-Instructions-Critical reasoning-Verbal deduction-Select appropriate pair-Reading Comprehension-Paragraph-Jumbles-Selecting the proper statement by reading a given paragraph.

UNIT - IV	READING COMPREHENSION AND VOCUBALARY	9 Hrs

Competitive Vocabulary :Word Building – Memory techniques-Synonyms, Antonyms, Affixes-Prefix &Suffix-One word substitutes-Compound words-Phrasal Verbs-Idioms and Phrases-Homophones- Linking Words-Modifiers-

Intensifiers - Mastering Competitive Vocabulary- Cracking the unknowing passage-speed reading techniques-Skimming & Scanning-types of answering–Elimination methods		
UNIT - V	**WRITING FOR COMPETITIVE EXAMINATIONS**	**9 Hrs**
Punctuation- Spelling rules- Word order-Sub Skills of Writing- Paragraph meaning-salient features-types - Note-making, Note-taking, summarizing-precise writing- Paraphrasing-Expansion of proverbs- Essay writing-types		

Textbooks:

1.Wren & Martin, English for Competitive Examinations, S.Chand & Co, 2021
2.Objective English for Competitive Examination, Tata McGraw Hill, New Delhi, 2014.

Reference Books:

1.Hari Mohan Prasad, Objective English for Competitive Examination, Tata McGraw Hill, New Delhi, 2014.
2.Philip Sunil Solomon, English for Success in Competitive Exams, Oxford 2016
3.Shalini Verma , Word Power Made Handy, S Chand Publications
4.Neira, Anjana Dev & Co. Creative Writing: A Beginner's Manual. Pearson Education India, 2008.
5.Abhishek Jain,Vocabulary Learning Techniques Vol.I&II,RR Global Publishers 2013.
6.Michel Swan, Practical English Usage,Oxford,2006.

Online Learning Resources:

1.https://www.grammar.cl/english/parts-of-speech.html
2.https://academicguides.waldenu.edu/writingcenter/grammar/partsofspeech
3.https://learnenglish.britishcouncil.org/grammar/english-grammar-reference/active- passive-voice
4.https://languagetool.org/insights/post/verb-tenses/
5.https://www.britishcouncil.in/blog/best-free-english-learning-resources-british-council
https://www.careerride.com/post/social-essays-for-competitive-exams-586.aspx

Mapping of course outcomes with program outcomes

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

(*3: Highly Correlated, 2: Moderately Correlated, 1: Weakly Correlated)

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Understand			Thumb Rule	
2	CO2: Apply			Thumb Rule	
3	CO3: Analyze			Thumb Rule	
4	CO4: Apply			Thumb Rule	
5	CO5: Evaluate			Thumb Rule	

Justification Statements:

CO1: Understand the basics of English grammar to develop proficiency in language skills.
Action Verb: Understand (L2)
CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Apply the grammatical structures in sentences for an effective communication.
CO2 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)

CO3: Apply the use of various concepts in grammar and vocabulary in everyday use and competitive exams
CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).

CO4: Analyze unfamiliar passages to **draw** logical conclusions, thereby **enhancing** reading comprehension and vocabulary skills
Action Verb: Analyze (L4)

CO4 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).

CO5: Create effective writing forms like essays and precise writing by using grammar and structure rules.
Action Verb: Create(L6)
CO5 Action Verb Create is of BTL 6. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).

Course Code	Year & Sem	Entrepreneurship and New Venture Creation (Open Elective-1)	L	T	P	C
23AOEMB01	III-I		2	1	0	3

Course Outcomes

CO1: Understand the entrepreneurial mind – set for venture creation and Intrapreneurial Leadership.

CO2: Analyze the process of problem-opportunity identification through design thinking, and validating with the potential customer.

CO3: Understand Prototype Development and validate MVP of their venture idea.

CO4: Evaluate the financial and market viability of a venture by conducting financial and marketing feasibility.

CO5: Understand an investible pitch deck of their practice venture to attract stakeholders.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	an entrepreneurial mind – set		for venture creation and Entrepreneurial Leadership	L2
CO2	Analyze	the process of problem-opportunity identification	Through design thinking, and validating with the potential customer.		L4
CO3	Understand	Proto type Development and validate MVP of their venture idea			L2
CO4	Evaluate	the financial and market viability of a venture	by conducting financial and marketing feasibility.		L5
CO5	Understand	an investible pitch deck of their practice venture		to attract stakeholders	L2

UNIT-I: Entrepreneurship Fundamentals and context

Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skill sets, attributes and networks while on campus.

Unit II: Problem & Customer Identification

Understanding and analyzing the macro-Problem and Industry perspective - technological, socioeconomic and urbanization trends and their implication on new opportunities - Identifying passion - identifying and defining problem using Design thinking principles - Analyzing problem and validating with the potential customer - Understanding customer segmentation, creating and validating customer personas.

Unit III: Solution design, Prototyping & Opportunity Assessment and Sizing

Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition - Understanding prototyping and Minimum Viable product (MVP) - Developing a feasibility prototype with differentiating value, features and benefits - Assess relative market position via competition analysis - Sizing the market and assess scope and potential scale of the opportunity.

UNIT-IV: Business & Financial Model, Go-to-Market Plan

Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach. Business planning: components of Business plan- Sales plan, People plan and financial plan. Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analyzing financial performance.

Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity Map the Start-up Life-cycle to Funding Options.

UNIT-V: Scale Outlook and Venture Pitch readiness

Understand and identify potential and aspiration for scale vis-à-vis your venture idea. Persuasive Storytelling and its key components. Build

an Investor ready pitch deck.

Textbooks:
- Robert D.Hisrich, Michael P.Peters, Dean A. Shepherd, Sabyasachi Sinha. Entrepreneurship,McGrawHill,11thEdition(2020)
- Ries E, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses.CrownBusiness,(2011).
- Oster walder, A., & Pigneur, Y. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.(2010).

References:
- Simon Sinek, *Start with Why,* Penguin Books limited.(2011)
- BrownTim,*Change by Design Revised &Updated: HowDesign Thinking*
- *Transforms Organizations and Inspires Innovation,*HarperBusiness.(2019)
- NamitaThapar(2022)The Dolphin and the Shark:Stories on Entrepreneurship , Penguin Books Limited
- Saras D.Sarasvathy, (2008) Effectuation:Elements of Entrepreneurial Expertise, Elgar Publishing Ltd.

Mapping of course outcomes with program outcomes

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Entrepreneurship and new venture creation	CO1	**2**												
	CO2			**3**										
	CO3				3									
	CO4	**3**												
	CO5									2				

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s):Action Verb and BTL	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	CO Correlation	Co's Action verb	BTL			
1	10	14.93	2	Understand	L2	PO1	Apply (L3)	2
2	12	17.91	2	Analyze	L4	PO3	Apply (L3)	3
3	12	17.91	2	Create	L6	PO4	Apply (L3)	3
4	18	26.86	3	Evaluate	L5	PO1	Apply (L3)	3
5	15	22.38	3	Understand	L2	PO9	Thumb Rule	2
Total	**67**	**100**						

Justification Statements:
CO1: Understand an entrepreneurial mind – set for venture creation and Intrapreneurial Leadership.
Action Verb: Understand (L2)
PO1 Verb: Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is medium (2)

CO2: Analyze the process of problem-opportunity identification through design thinking, and validating with the potential customer.
Action Verb: Analyze (L4)
PO3: Apply (L3)
CO2 Action verb is more than PO3 verb. Therefore the correlation is High (3)

CO3: Understand Prototype Development and validate MVP of their venture idea.
Action Verb: Understand (L2)
PO4: Apply (L3)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is medium (2)

CO4: Evaluate the financial and market viability of a venture by conducting financial and marketing feasibility.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO4 Action verb is more than PO1 verb by two levels. Therefore the correlation is High (3)

CO5: Understand an investible pitch deck of their practice venture to attract stakeholders.
Action Verb: Understand (L2)
PO9: Thumb Rule
As using thumb rule, correlates with PO9. Therefore the correlation is medium (2)

Course Code	Year & Sem		L	T	P	C
23APC3004	III-I	**DATA WAREHOUSING AND DATA MINING LAB**	**0**	**0**	**3**	**1.5**

Course Outcomes:

CO 1: Understand data warehouse design concepts such as Star and Snowflake schemas and perform OLAP operations using SQL.

CO 2: Apply data preprocessing techniques including importing data, cleaning, handling missing values, and normalization for high-quality analysis

CO 3: Analyze Association rule mining algorithms such as Apriori and FP-Growth to discover frequent item sets and generate rules

CO 4: Apply classification algorithms like Naïve Bayes, Decision Trees, and K-Nearest Neighbors with performance metrics (accuracy, precision, recall).

CO 5: Apply Unsupervised learning techniques such as K-Means, Hierarchical clustering, and PCA, and visualize patterns and results effectively.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	**Understand**	data warehouse design concepts such as Star		Snowflake schemas and perform OLAP operations using SQL.	L2
CO2	**Apply**	data preprocessing techniques including importing data		cleaning, handling missing values, and normalization for high-quality analysis	L3
CO3	**Analyze**	Association rule mining algorithms such as Apriori		FP-Growth to discover frequent item sets and generate rules	L4
CO4	**Apply**	classification algorithms like Naïve Bayes	Trees, and K-Nearest Neighbours with performance metrics (accuracy, precision, recall).		L3
CO5	**Apply**	Unsupervised learning techniques such as K-Means	K-Means, Hierarchical clustering, and PCA, and visualize patterns and results effectively.		L3

List of Experiments:

1. Create a Star and Snowflake schema for a sample sales dataset using SQL
2. Perform OLAP operations (Roll-up, Drill-down, Slice, Dice, Pivot) using SQL
3. Import a CSV dataset and perform data cleaning, missing value handling, and normalization
4. Implement Apriori algorithm to find frequent itemsets and generate association rules
5. Use FP-Growth algorithm for mining frequent patterns from a retail dataset
6. Implement Naïve Bayes classifier and evaluate it using accuracy, precision, and recall
7. Build a Decision Tree using ID3 or C4.5 algorithm and visualize the result
8. Perform classification using K-Nearest Neighbors (KNN) and analyze the results
9. Apply K-Means clustering on a dataset and visualize cluster separation
10. Use Hierarchical clustering and dendrogram visualization
11. Perform Principal Component Analysis (PCA) on a high-dimensional dataset
12. Mini-project: Apply classification/clustering/association on a real-world dataset and present findings

Tools/Technologies to be used:
- Python (pandas, scikit-learn, matplotlib, seaborn)
- R / RStudio • WEKA / Orange Data Mining Tool
- SQL for OLAP operations
- Jupyter Notebook / Google Colab

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Review (L2)	2 3
2	CO2: Apply	L3	PO1 PO2 PO3 PO5 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO5: Apply (L3) PO11: Thumb rule	3 2 3 3 2
3	CO3: Analyze	L4	PO1 PO2	PO1: Apply(L3) PO2: Review (L2) PO3: Design(L6) PO4: Apply(L3)	2 1 1 2
4	CO4: Apply	L3	PO1 PO2 PO3 PO5 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO5: Apply (L3) PO11: Thumb rule	3 2 3 3 2
5	CO4: Apply	L3	PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop(L3) PO5: Apply (L3)	3 2 3 3

Justification Statements:

CO1: Understand data warehouse design concepts such as Star and Snowflake schemas and perform OLAP operations using SQL.
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Review (L2)
CO1 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

CO2: Apply data preprocessing techniques including importing data, cleaning, handling missing   values, and normalization for high-quality analysis

Action Verb: Apply (L3)

PO1: Apply (L3)

CO2 Action verb is same as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO2 Action verb is less than as PO2 verb. Therefore, the correlation is Medium (2)

PO3: Develop (L3)

CO2 Action verb is same as PO3 verb. Therefore, the correlation is high (3)

PO5: Apply (L3)

CO2 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

Using orange to visualize real world solutions the correlation is Medium (2)

CO3: Analyze Association rule mining algorithms such as Apriori and FP-Growth to discover frequent item sets and generate rules

Action Verb: Analyze (L4)

PO1 Verb: Apply (L3)

CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Review (L2)

CO3 Action verb is same as PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: Design(L6)

CO3 Action verb is same as PO3 verb. Therefore, the correlation is low (1)

PO4 Verb: Apply (L3)

CO3 Action verb is same as PO4 verb. Therefore, the correlation is medium (2)

CO4: Apply classification algorithms like Naïve Bayes, Decision Trees, and K-Nearest Neighbors   with performance metrics (accuracy, precision, recall).

Action Verb: Apply (L3)

PO1: Apply (L3)

CO4 Action verb is same as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO4 Action verb is less than as PO2 verb. Therefore, the correlation is Medium (2)

PO3: Develop (L3)

CO4 Action verb is same as PO3 verb. Therefore, the correlation is high (3)

PO5: Apply (L3)

CO4 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

Using orange to visualize real world solutions the correlation is Medium (2)

CO5: Apply Unsupervised learning techniques such as K-Means, Hierarchical clustering, and PCA, and visualize patterns and results effectively.

Action Verb: Apply (L3)

PO1: Apply (L3)

CO5 Action verb is same as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO5 Action verb is less than as PO2 verb. Therefore, the correlation is Medium (2)

PO3: Develop (L3)

CO5 Action verb is same as PO3 verb. Therefore, the correlation is high (3)

PO5: Apply (L3)

CO5 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

Course Code	Year & Sem		L	T	P	C
23APC3006	III-I	**MACHINE LEARNING LAB**	0	0	3	1.5

Course Outcomes:

CO1: Apply various supervised and unsupervised machine learning algorithms.

CO2: Evaluate Preprocess and visualize data using appropriate techniques.

CO3: Analyze Train, test, and evaluate models using standard metrics.

CO4: Apply Python-based ML libraries (e.g., scikit-learn, TensorFlow, Keras) effectively.

CO5: Apply machine learning solutions for real-world datasets and problems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	various supervised and unsupervised machine learning algorithms			L3
CO2	Evaluate	Preprocess and visualize data using appropriate techniques .			L5
CO3	Analyze	Train, test, and evaluate models		using standard metrics.	L4
CO4	Apply	Python-based ML libraries (e.g., scikit-learn, TensorFlow, Keras) effectively			L3
CO5	Apply	machine learning solutions		for real-world datasets and problems.	L3

List of Experiments (with Bloom's Cognitive Levels):

1. Data Preprocessing: Handling missing values, encoding categorical data, scaling
2. Implement Linear Regression and evaluate using MSE/R^2 score
3. Implement Logistic Regression for binary classification
4. Apply K-Nearest Neighbors (KNN) algorithm and visualize decision boundaries
5. Build a Decision Tree and analyze its accuracy and feature importance
6. Implement Naïve Bayes classifier for text classification
7. Implement Support Vector Machine (SVM) for multi-class classification
8. Perform K-Means Clustering and visualize clusters with elbow method
9. Apply PCA (Principal Component Analysis) for dimensionality reduction
10. Build an Artificial Neural Network using Keras/TensorFlow
11. Perform model evaluation using confusion matrix, ROC curve, AUC
12. Mini Project: Develop a complete ML pipeline from preprocessing to evaluation

Tools/Technologies Required:
1. Python 3.x
2. Jupyter Notebook / Google Colab
3. Libraries: scikit-learn, pandas, numpy, matplotlib, seaborn
4. TensorFlow / Keras
5. Optional: R / Weka for algorithm implementation

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Corre lation	Co's Action verb	BT L			
1				Apply	L3	PO4	PO4: Analyze (L4)	2
						PO5	PO5: Apply(L3)	3
						PO6	PO6:Thumb rule	2
2				Evaluate	L5	PO4	PO4: Analyze (L4)	2
						PO5	PO5: Apply(L3)	1
						PO6	PO6:Thumb rule	3
3				Analyze	L4	PO4	PO4: Analyze (L4)	3
						PO5	PO5: Apply(L3)	2
						PO6	PO6:Thumb rule	3
4				Apply	L3	PO4	PO4: Analyze (L4)	2
						PO5	PO5: Apply(L3)	3
						PO6	PO6:Thumb rule	3
5				Apply	L3	PO4	PO4: Analyze (L4)	2
						PO5	PO5: Apply(L3)	2
						PO6	PO6:Thumb rule	2
						PO11	PO11: Thumb rule	3

Justification Statements:

CO1: Apply various supervised and unsupervised machine learning algorithms.
Action Verb: Apply **(L3)**
PO4: Analyze (L4)
CO1 Action verb is greater than PO4 verb by one level. Therefore the correlation is moderate (2)
PO5: Apply(L3)
CO1 Action verb is same PO5 verb level. Therefore the correlation is high (3)
PO6: Thumb rule
Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to health, safety. Therefore the correlation is moderate (3)

CO2: Evaluate Preprocess and visualize data using appropriate techniques.
Action Verb: Create (L6)
PO4: Analyze (L4)
CO1 Action verb is greater than PO4 verb by two levels. Therefore the correlation is moderate (1)
PO5: Apply(L3)
CO1 Action verb is greater than PO5 verb by three levels. Therefore the correlation is moderate (1)
PO6: Thumb rule
Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to health, safety. Therefore the correlation is high (3)

CO3: Analyze Train, test, and evaluate models using standard metrics.
Action Verb: Apply (L3)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)

PO5: Apply(L3)

CO1 Action verb is same PO5 verb level. Therefore the correlation is high (3)

PO6: Thumb rule

Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to health, safety. Therefore the correlation is moderate (2)

CO4: Apply Python-based ML libraries (e.g., scikit-learn, TensorFlow, Keras) effectively.

Action Verb: Apply (L3)

PO4: Analyze (L4)

CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)

PO5: Apply(L3)

CO1 Action verb is same PO5 verb level. Therefore the correlation is high (3)

PO6: Thumb rule

Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to health, safety. Therefore the correlation is moderate (2)

CO5: Apply machine learning solutions for real-world datasets and problems.

Action Verb: Analyze **(L4)**

PO4: Analyze (L4)

CO1 Action verb is same PO4 verb level. Therefore the correlation is high (3)

PO5: Apply(L3)

CO1 Action verb is greater than PO5 verb by one level. Therefore the correlation is moderate (2)

PO6: Thumb rule

Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to health, safety. Therefore the correlation is high (3)

PO11: Thumb rule

The preparation and ability for independent and life-long learning, adaptability to new and emerging technologies and critical thinking in the broadest context of technological change. Therefore the correlation is high (3)

Course Code	Year & Sem	SOFT SKILLS	L	T	P	C
23ASC9901	III-I	SKILL ENHANCEMENT COURSE	1	0	2	2

Course Outcomes (CO): Student will be able to
CO1: Understand the various techniques of soft skills and communication skills.
CO2: Analyze the listening and thinking skills to enhance professional development.
CO3: Apply the critical thinking skills in problem solving and decision making through Discussions.
CO4: Evaluate the emotional intelligence and stress management for individuals and groups.
 CO5: Apply the corporate etiquette atmosphere to enhance professional behavior in workplace environment.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the various techniques of soft skills and communication skills.			**L2**
2	Analyze	the listening and thinking skills to enhance professional development.			**L4**
3	Apply	the critical thinking skills in problem solving and decision making through Discussions .			**L3**
4	Evaluate	the emotional intelligence and stress management to control in themselves and others.			**L5**
5	Apply	the corporate etiquette atmosphere to enhance processional behavior in workplace environment.			**L3**

UNIT I   Soft Skills & Communication Skills
 Soft Skills - Introduction, Need - Mastering Techniques of Soft Skills – Communication Skills -Significance, process, types - Barriers of communication - Improving techniques.

Activities:
Intrapersonal Skills- Narration about self- strengths and weaknesses- clarity of thought – self- expression – articulating with felicity.
(The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes and literary sources)
Interpersonal Skills- Group Discussion – Debate – Team Tasks - Book and film Reviews by groups - Group leader presenting views (non- controversial and secular) on contemporary issues or on a given topic.
Verbal Communication- Oral Presentations- Extempore- brief addresses and speeches- convincing- negotiating-agreeing and disagreeing with professional grace.
Non-verbal communication – Public speaking – Mock interviews – presentations with an objective to identify non-verbal clues and remedy the lapses on observation.
UNIT II   Critical Thinking
Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness – Creative Thinking - Positive thinking - Reflection

Activities:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues –placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis

UNIT III   Problem Solving & Decision Making

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution – Team building - Effective decision making in teams – Methods & Styles

Activities:

Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.
Case Study & Group Discussion

UNIT IV   Emotional Intelligence & Stress Management

Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation – Stress factors – Controlling Stress – Tips

Activities:

Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, sympathy, and confidence, compassion in the form of written or oral presentations.
Providing opportunities for the participants to narrate certain crisis and stress –ridden situations caused by failure, anger, jealousy, resentment and frustration in the form of written and oral presentation, Organizing Debates

UNIT V   Corporate Etiquette

Etiquette- Introduction, concept, significance - Corporate etiquette - meaning, modern etiquette, benefits - Global and local culture sensitivity - Gender Sensitivity - Etiquette in interaction- Cell phone etiquette - Dining etiquette - Netiquette - Job interview etiquette -Corporate grooming tips -Overcoming challenges

Activities

Providing situations to take part in the Role Plays where the students will learn about bad and good manners and etiquette - Group Activities to showcase gender sensitivity, dining etiquette etc. - Conducting mock job interviews - Case Study - Business Etiquette Games

Prescribed Books:
1. Mitra Barun K, Personality Development and Soft Skills, Oxford University Press, Pap/Cdr edition 2012
2. Dr Shikha Kapoor, Personality Development and Soft Skills: Preparing for Tomorrow,   I K International Publishing House, 2018

Reference Books:
1. Sharma, Prashant, Soft Skills: Personality Development for Life Success, BPB Publications 2018.
2. Alex K, Soft Skills S.Chand & Co, 2012 (Revised edition)
3. Gajendra Singh Chauhan &   Sangeetha Sharma, Soft Skills: An Integrated Approach to Maximise Personality Published by Wiley, 2013
4. Pillai, Sabina & Fernandez Agna, Soft Skills and Employability Skills, Cambridge University Press, 2018
5. Soft Skills for a Big Impact (English, Paperback, Renu Shorey) Publisher: Notion Press

6. Dr. Rajiv Kumar Jain, Dr. Usha Jain, Life Skills (Paperback English) Publisher : Vayu Education of India, 2014

Online Learning Resources:
1. https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q
2. https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ
3. https://youtu.be/-Y-R9hDl7lU
4. https://youtu.be/gkLsn4ddmTs
5. https://youtu.be/2bf9K2rRWwo
6. https://youtu.be/FchfE3c2jzc
7. https://www.businesstrainingworks.com/training-resource/five-free-business-etiquette-training-games/
8. https://onlinecourses.nptel.ac.in/noc24_hs15/preview
9. https://onlinecourses.nptel.ac.in/noc21_hs76/preview

Correlation of COs with the POs & PSOs

Course Title	Course Outcome COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
Soft Skills Lab	CO1										2	
	CO2									3	3	
	CO3									2		
	CO4									3		
	CO5									2	2	

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours		CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO6 to PO11)	Level of Correlation (0-3)
	(Approx. Hrs)	%	corr	Verb	BTL			
1			CO1	UNDERSTAND	L2	PO10	Thumb rule	2
2			CO2	ANALYZE	L4	PO9, PO10	Thumb rule	3,3
3			CO3	APPLY	L3	PO9	Thumb rule	2
4			CO4	EVALUATE	L5	PO9	Thumb rule	3
5			CO5	Apply	L3	PO9, PO10	Thumb rule	2,2

JUSTIFICATION:

CO1: Understand the various techniques of soft skills and communication skills.

Action Verb: Understand (L2)
CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO2: Analyze the listening and thinking skills to enhance professional development.

Action Verb: Analyze **(L4)**
CO2 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3)

CO3: Apply the critical thinking skills in problem solving and decision making through Discussions .

Action Verb: Apply (L3)
CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

CO4: Evaluate the emotional intelligence and stress management to control themselves and others.

Action Verb: Evaluate **(L5)**
CO4 Action Verb Evaluate is of BTL 5. Using Thumb rule, L2 correlates PO6 to PO12 as high(3).

CO5: : : Apply the corporate etiquette atmosphere to enhance processional behavior in workplace environment.
Action Verb: Create e (L3)
CO5 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

Course Code	Year & Sem	Tinkering Lab	L	T	P	C
23AES0404	III-I		0	0	2	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

Course Outcomes: After studying the course, student will be able to
CO1: Develop arduino/ESP32 programming for basic circuits using breadboard/Tinkercad
CO2: **Analyze** the LDR interfacing circuits with arduino / ESP32 controllers.
CO3: **Analyze** the control of traffic light circuit, sensor-based servomotor and mobile app-based LED.
CO4: Design a walking robot and rocket using 3-Dimensional (3D) printing Technology.
CO5: **Create** a prototype for soil moisture monitor and redesign a motor bike using Design Thinking steps.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Develop**	Arduino/ESP32 programming for basic circuits	breadboard/Tinkercad		L3
CO2	**Analyze**	The LDR interfacing circuits	Arduino / ESP32		L4
CO3	**Analyze**	The control of traffic light circuit, sensor-based servomotor and mobile app-based LED			L4
CO4	**Design**	A walking robot and rocket	3D Printing Technology		L6
CO5	**Create**	A prototype for soil moisture monitor and redesign a motor bike	Design Thinking steps		L6

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start- ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments:
1) Make your own parallel and series circuits using breadboard for any application of your choice. **(CO1)**
2) Demonstrate a traffic light circuit using breadboard.**(CO3)**
3) Build and demonstrate automatic Street Light using LDR. **(CO2)**
4) Simulate the Arduino LED blinking activity in Tinkercad. **(CO1)**
5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE.(CO1)
6) Interfacing IR Sensor and Servo Motor with Arduino.(CO3)
7) Blink LED using ESP32. **(CO1)**
8) LDR Interfacing with ESP32.**(CO2)**
9) Control an LED using Mobile App. (CO3)
10) Design and 3D print a Walking Robot **(CO4)**
11) Design and 3D Print a Rocket. **(CO4)**
12) Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plan in your computer dashboard. (CO5)
13) Demonstrate all the steps in design thinking to redesign a motor bike. **(CO5)**

Students need to refer to the following links:

Course Outcomes: The students will be able to experiment, innovate, and solve real-world challenges.
1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf

4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

Mapping of course outcomes with program outcomes

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

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation BTL (0-3)
1	**CO1: Develop**	L3	**PO1** **PO5**	**PO1: Apply(L3)** **PO5: Select(L1)**	3 3
2	**CO2: Analyze**	L4	**PO2** **PO3** **PO5**	**PO2: Review (L3)** **PO3: Develop(L3)** **PO5: Create (L6)**	3 3 1
3	**CO3: Analyze**	L4	**PO3** **PO5** **PO9** **PO10**	**PO3: Design (L6)** **PO5: Create(L6)** **PO9: Thumb rule** **PO10: Thumb rule**	1 1 3 3
4	**CO4: Design**	L6	**PO3** **PO4** **PO5**	**PO3: Analyze(L4)** **PO4: Design(L6)** **PO5: Create(L6)**	3 3 3
5	**CO5: Create**	L6	**PO2** **PO3** **PO5** **PO6** **PO9** **PO10** **PO11**	**PO2: Review(L2)** **PO3: Analyze(L4)** **PO5:Create(L6)** **PO6:Thumb rule** **PO9:Thumb rule** **PO10:Thumb rule** **PO11: Thumb rule**	3 3 3 3 3 3 3

Justification Statements:

CO1: Develop Arduino/ESP32 programming for basic circuits using breadboard/Tinkercad
Action Verb: **Develop (L3)**
PO1 Verb: Apply (L3)
CO1 Action verb is equal as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: Select (L1)
CO1 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)

CO2: Analyze the LDR interfacing circuits with Arduino / ESP32 controllers.

Action Verb: Analyze (L4)
PO2 Verb: Review (L3)
CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: Create (L6)
CO2 Action verb is lesser than as PO5 verb by two levels Therefore, the correlation is low (1)

CO3: Analyze the control of traffic light circuit, sensor-based servomotor and mobile app-based LED.
Action Verb: Analyze (L4)
PO3 Verb: Design (L6)
CO3 Action verb is lesser than PO3 verb by two levels. Therefore, the correlation is low (1)

PO5 Verb: Create (L6)
CO3 Action verb is lesser than PO5 verb by two levels Therefore, the correlation is low (1)
PO9: Thumb rule
CO3 using Thumb rule, correlates with PO9 as high (3)
PO10: Thumb rule
CO3 using Thumb rule, correlates with PO10 as high (3)

CO4: Design a walking robot and rocket using 3-Dimensional (3D) printing Technology.

Action Verb: Design (L6)
PO3 Verb: Analyze (L4)
CO4 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: Design (L6)
CO4 Action verb is equal to PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: Create (L6)
CO4 Action verb is equal to as PO5 verb. Therefore, the correlation is high (3)

CO5: Create a prototype for soil moisture monitor and redesign a motor bike using Design Thinking steps
Action Verb: Create (L6)

PO2 Verb: Review (L2)
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Analyze (L4)
CO5 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: Create (L6)
CO5 Action verb is equal to PO5 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb rule
CO5 using Thumb rule, correlates with PO6 as high (3)
PO9: Thumb rule
CO5 using Thumb rule, correlates with PO9 as high (3)
PO10: Thumb rule
CO5 using Thumb rule, correlates with PO10 as high (3)
PO11: Thumb rule
CO5 using Thumb rule, correlates with PO11 as high (3)

Semester VI (Third year)

S.No.	Category	Course code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T / CL C	P				
1	PC	23APC3008	Big Data Analytics	2	1	0	3	30	70	100
2	PC	23APC3010	Deep learning	2	1	0	3	30	70	100
3	PC	23APC3012	Natural Language Processing	2	1	0	3	30	70	100
4	PE-II	**23APE3005 23APE3006 23APE3007 23APE3008**	1. Reinforcement learning 2. Recommender Systems 3. Predictive Analytics 4. AI for Finance	2	1	0	3	30	70	100
5	PE-III	**23APE3009 23APE3010 23APE3011 23APE3012**	1. Quantum Computing 2. Computer Vision 3. Cloud Computing for AI 4. Social Network Analysis	2	1	0	3	30	70	100
	OE-II	23AOE0402	**Open Elective – II**	2	1	0	3	30	70	100
7	PC	23APC3009	Deep learning Lab	0	0	3	1.5	30	70	100
8	PC	23APC3011	Big data analytics & Data Visualization Lab	0	0	3	1.5	30	70	100
9	SC	23ASC3001	Full Stack Development-II	1	0	2	2	30	70	100
10	AC	23AMC9902	Technical Paper Writing & IPR	2	0	0	-	30	-	30
11	SC	23ASC3002	Workshop	-	-	-	-	--	-	-
			TOTAL	15	6	08	23	300	630	930

NOTE: Workshop can be conducted either in III-I or III-II and the participation certificate with 90% and above attendance on it shall be submitted to the Department /Exam section before III-II Regular exam notification released

Open Elective – II

S NO	Course Code	Course Name	Offered by the Dept.
1	23AOE0103	Disaster Management	CIVIL
2	23AOE0104	Sustainability In Engineering Practices	
3	23AOE0202	Renewable Energy Sources	EEE
4	23AOE0302	Automation and Robotics	ME
5	23AOE0402	Digital Electronics	ECE
6	23AOE9902	Optimization Techniques	Mathematics
7	23AOE9907	Physics Of Electronic Materials And Devices	Physics
8	23AOE9912	Chemistry Of Polymers And Applications	Chemistry
9	23AOE9916	Academic Writing and Public Speaking	Humanities

Course Code	Year & Sem	BIG DATA ANALYTICS	L	T	P	C
23APC3008	III-II	Professional Core	2	1	0	3

CO Statements:

CO1: Understand the characteristics of Big Data and explain the architecture and Components of the Hadoop ecosystem including HDFS, YARN, and related tools.

CO2: Apply execute basic MapReduce programs and apply Hive and Pig for efficient data processing in Hadoop.

CO3: Analyze the NoSQL database models with RDBMS and perform basic HBase operations integrated with Hadoop.

CO4: Analyze the Big Data analytics using Apache Spark components such as Spark SQL,Streaming Curd operations, and MLlib.

CO5: Evaluate real-world Big Data applications across sectors and develop a mini-project integrating cloud platforms and Big Data tools.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The characteristics of big data and architecture and Components	Hadoop ecosystem including HDFS, YARN, and related tools		L2
CO2	Apply	Execute basic Map Reduce programs Hive and Pig for efficient data processing in Hadoop.		Hive and Pig for efficient data processing in hadoop	L3
CO3	Analyze	The NoSQL database models with RDBMS and performs basic HBase operations integrated with hadoop	The NoSQL database models with RDBMS	Performs basic HBase operations integrated with hadoop	L4
CO4	Analyze	The Big Data analytics using Apache Spark components such as Spark SQL, Streaming, Curd operations and MLlib.	The Big Data analytics using Apache Spark components	contrast models Spark SQL, Streaming, Curd operations and MLlib.	L4
CO5	Evaluate	Real-world Big Data applications across sectors and develop a mini-project integrating cloud platforms and Big Data tools.	Real-world Big Data applications	sectors and develop a mini-project integrating cloud platforms and Big Data tools.	L5

UNIT - I	Introduction to Big Data and Hadoop Ecosystem	

Definition, Characteristics of Big Data (Volume, Variety, Velocity, Veracity, Value), Types of Data: Structured, Semi-Structured, and Unstructured, Traditional vs Big Data Systems, Big Data Challenges and Benefits, Introduction to Hadoop: Architecture and Components, Hadoop Distributed File System (HDFS): Features, Design, Blocks, YARN and MapReduce Overview, Hadoop Ecosystem Components:

Pig, Hive, HBase, Sqoop, Flume.

UNIT - II	**MapReduce Programming and Hadoop Tools**	

MapReduce Programming Model: Mapper, Reducer, Partitioner, Input Split and Record Reader, Combiner, Writing MapReduce Programs in Java, Advanced MapReduce Concepts: Counters, Joins, Secondary Sort, Hive: Data Warehousing Concepts, HiveQL, Partitions, Buckets, Pig: Data Flow, Pig Latin Scripts, Data Import & Export with Sqoop, Real-Time Data Collection using Flume.

UNIT - III	**NoSQL Databases and HBase**	

Introduction to NoSQL Databases, Types of NoSQL: Key-Value, Document, Column, Graph, Differences between RDBMS and NoSQL, HBase Data Model: Column Families, Regions, Tables, HBase Architecture and Internals, HBase CRUD Operations using Java, Integration of HBase with Hadoop, Case Study: Big Data Storage in social media.

UNIT - IV	**Apache Spark and Big Data Analytics**	

Apache Spark: RDDs and DAG Execution Model, Spark Core and Spark SQL, Data Frames and Datasets in Spark, Spark Streaming: Architecture and Streams, Spark MLlib: Machine Learning on Big Data, Graphex: Graph Processing in Spark, Performance Tuning and Optimization in Spark, Case Study: Building a Spark Application for Real-Time Analytics.

UNIT - V	**Applications and Case Studies in Big Data**	

Big Data in Healthcare: Predictive Analysis, Genomics, Big Data in Finance: Fraud Detection, Risk Analytics, Big Data in E-Commerce: Customer Behavior, Personalization, Sentiment Analysis using Big Data, Big Data for Smart Cities and IoT, Big Data and Cloud Computing Integration (AWS, GCP, Azure), Data Privacy, Security, and Ethical Issues – (E), Mini-Project: Design and Development of a Big Data Solution.

Textbooks:

1. Tom White, Hadoop: The Definitive Guide, O'Reilly Media.
2. V. Srinivasa Subramanian, Big Data Analytics, Wiley India.
3. Anand Rajaraman and Jeffrey D. Ullman, Mining of Massive Datasets, Cambridge University Press.

Reference Books:

1. Chuck Lam, Hadoop in Action, Manning Publications.
 2. Bill Franks, Taming the Big Data Tidal Wave, Wiley.
3. Alex Holmes, Hadoop in Practice, Manning Publications.
4. Michael Minelli, Big Data, Big Analytics: Emerging Business Intelligence, Wiley..

CO-relation matrix:

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

Unit No.	CO						Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan (Hrs)	%	Correlation	Co's Action verb	BTL				
1				CO1: Understand	L2		PO1 PO2	PO1: Apply(L3) PO2: Identify(L3)	2 2
2				CO2: Apply	L3		PO1 PO2 PO4 PO5 PO11	PO1: Apply(L3) PO2: Identify (L3) PO4: Analyze (L4) PO5: Select(L3) PO11: Thumb rule	3 3 3 3 1
3				CO3: Analyze	L4		PO1	PO1: Apply(L3)	2

						PO2 PO4 PO11	PO2: Analyze (L4) PO4: Analysis (L4) PO11: Thumb rule	3 3 1
4				CO4: Analyze	L4	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify (L3) PO4: Analysis(L4) PO11: Thumb rule	1 1 3 2
5				CO5: Evaluate	L6	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify(L3) PO4: Analysis(L4) PO11: Thumb rule	1 1 1 1

Justification Statements:

CO1: Understand the characteristics of Big Data and explain the architecture and Components of the Hadoop ecosystem including HDFS, YARN, and related tools
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

CO2: Apply execute basic MapReduce programs and apply Hive and Pig for efficient data processing in Hadoop
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is high (3)
PO5: Select (L3)
CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
For use some different technologies to handling big data. Therefore, the correlation is low (1)

CO3: Analyze the NoSQL database models with RDBMS and perform basic HBase   operations integrated with Hadoop.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2: Analyze (L4)
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4: Analysis (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO11: Thumb rule
For use map reduce and H base technologies to handling big data. Therefore, the correlation is   low (1)

CO4: Analyze the Big Data analytics using Apache Spark components such as Spark SQL Streaming Curd operations, and MLlib.
Action Verb: Evaluate (L5)
PO1: Apply(L3)
CO4 Action verb is less than PO1 verb by two levels. Therefore, the correlation is low (1)
PO2: Identify (L3)
CO4 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)
PO3: Design (L6)

CO4 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)

PO4: Analysis (L4)

CO4 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)

PO11: Thumb rule

For use map reduce applications to test and debug big data. Therefore, the correlation is medium (2)

CO5: Evaluate real-world Big Data applications across sectors and develop a mini-project   integrating cloud platforms and Big Data tools

Action Verb: Create (L6)

PO1: Apply(L3)

CO5 Action verb is less than PO1 verb by two levels. Therefore, the correlation is low (1)

PO2: Identity (L3)

CO5 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)

PO4: Analysis (L4)

CO5 Action verb is less than PO4 verb by two levels. Therefore, the correlation is low (1)

PO11: Thumb rule

For use to create data base application using Hive and NoSQL technologies to handling big data. Therefore,   the correlation is high (3)

Course Code	Year & Sem	DEEP LEARNING	L	T	P	C
23APC3010	III-II	**Professional Core**	**2**	**1**	**0**	**3**

CO Statements:

CO1: Understand the fundamentals of neural networks and deep learning, including perceptions, activation functions, forward/backpropagation, and optimization algorithms.
CO2: Creating Design, train, and evaluate deep neural networks using appropriate training techniques and frameworks such as TensorFlow and PyTorch.
CO3: Apply convolutional neural networks (CNNs) for image classification and computer vision tasks, including the use of transfer learning and visualization techniques.
CO4: Analyze Implement sequence models using RNNs, LSTMs, and GRUs for NLP tasks such as sentiment analysis and machine translation.
 CO5: Evaluate Explore advanced topics such as autoencoders, GANs, reinforcement learning, and assess ethical issues in deep learning applications.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	The fundamentals of neural networks and deep learning, including perceptions,	Activation functions, forward/backpropagation, and optimization algorithms.		L2
CO2	**Creating**	Design, train, and evaluate deep neural networks using appropriate		Training techniques and frameworks such as TensorFlow and PyTorch.	L6
CO3	**Apply**	Convolutional neural networks (CNNs) for image classification		computer vision tasks, including the use of transfer learning and visualization techniques	L3
CO4	**Analyze**	Implement sequence models using RNNs	GRUs for NLP tasks such as sentiment analysis and machine translation		L4
CO5	**Evaluate**	Explore advanced topics such as auto encoders		GANs, reinforcement learning, and assess ethical issues in deep learning applications	L5

UNIT - I	**Fundamentals of Neural Networks and Deep Learning**	

Introduction to Neural Networks and Deep Learning, Biological vs Artificial Neurons, Perceptron and Multilayer Perceptron, Activation Functions: Sigmoid, Tanh, ReLU, Leaky ReLU, Forward Propagation and Loss Functions, Gradient Descent, Backpropagation, Optimization Algorithms: SGD, Momentum, RMSProp, Adam, Challenges in Deep Learning: Overfitting, Vanishing/Exploding Gradients.

UNIT - II	**Deep Neural Network Architectures and Training Techniques**	

Deep Feedforward Neural Networks (DNNs), Batch Normalization and Dropout, Hyperparameter Tuning: Learning Rate, Epochs, Batch Size, Weight Initialization and Early Stopping, K-Fold Cross Validation, Model Evaluation Metrics: Accuracy, Precision, Recall, F1-Score, Introduction to TensorFlow and PyTorch, Implementing Basic DNN using Python.

UNIT - III	**Convolutional Neural Networks (CNNs)**	

Introduction to CNNs: Architecture and Layers, Convolution Operation, Filters, Feature Maps, Pooling Layers and Non-linearity, CNN for Image Classification, Transfer Learning and Pre-trained Networks (VGG, ResNet, Inception), Fine-tuning and Feature Extraction, Case Study: Object Detection and Image Segmentation, Visualizing CNNs and Activation Maps

UNIT - IV	**Recurrent Neural Networks (RNNs) and Sequence Models**	

Introduction to RNNs and Sequence Modeling, Challenges in RNN: Vanishing Gradients, BPTT, Long Short-Term Memory (LSTM) Networks, Gated Recurrent Units (GRU), Bidirectional RNNs, Applications: Text Generation, Sentiment Analysis, Language Modeling, Attention Mechanisms and Transformers (Intro), Sequence-to-Sequence Models for Machine Translation

UNIT - V	Advanced Topics and Applications in Deep Learning	

Autoencoders and Denoising Autoencoders, Generative Adversarial Networks (GANs): Architecture, Applications, Deep Reinforcement Learning: Basics and Use Cases, Neural Style Transfer, Deep Learning in Healthcare, Finance, and Autonomous Systems, Ethical Issues in Deep Learning: Bias, Fairness, Explainability, Model Compression and Quantization.

Textbooks:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press.
2. Josh Patterson and Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media.
3. Francois Chollet, Deep Learning with Python, Manning Publications.

Reference Books:

1. Michael Nielsen, Neural Networks and Deep Learning, Free online book.
2. Nikhil Buduma, Fundamentals of Deep Learning, O'Reilly Media.
3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer.
4. Rajalingappaa Shanmugamani, Deep Learning for Computer Vision, Packt.

Correlation Matrix

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

Justification Statements:

CO1: Understand the fundamentals of neural networks and deep learning, including perceptions, activation functions, forward/backpropagation, and optimization algorithms
Action Verb: Understand (L2)

Unit No.	CO					Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan (Hrs)	%	Correlation	Co's Action verb	BTL			
1				CO1: Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Identify(L3)	2 2
2				CO2: Creating	L6	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify (L3) PO4: Analyze (L4) PO11: Thumb rule	1 1 2 1
3				CO3: Apply	L3	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO4: Analysis (L4) PO11: Thumb rule	3 2 2 1
4				CO4: Analyze	L4	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify (L3) PO4: Analysis(L4) PO11: Thumb rule	2 2 3 2
5				CO5: Evaluate	L6	PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify(L3) PO4: Analysis(L4) PO11: Thumb rule	1 1 1 3

PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

CO2: Creating Design, train, and evaluate deep neural networks using appropriate training techniques and frameworks such as TensorFlow and PyTorch.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is low (1)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is low (1)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO11: Thumb rule
For use some. train, and evaluate deep neural networks Therefore, the correlation is low (1)

CO3: Apply convolutional neural networks (CNNs) for image classification and computer vision tasks, including the use of transfer learning and visualization techniques.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2: Analyze (L4)
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4: Analysis (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO12: Thumb rule
For use map reduce and H base technologies to handling big data. Therefore, the correlation is   low (1)

CO4: Analyze Implement sequence models using RNNs, LSTMs, and GRUs for NLP tasks such as sentiment analysis and machine translation
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO4 Action verb is less than PO1 verb by two levels. Therefore, the correlation is low (1)
PO2: Identify (L3)
CO4 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)
PO3: Design (L6)
CO4 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)
PO4: Analysis (L4)
CO4 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO12: Thumb rule
For use map reduce applications to test and debug big data. Therefore, the correlation is medium (2)

 CO5: Evaluate Explore advanced topics such as autoencoders, GANs, reinforcement learning, and assess ethical issues in deep learning applications.
Action Verb: Evaluate (L5)
PO1: Apply(L3)
CO5 Action verb is less than PO1 verb by two levels. Therefore, the correlation is low (1)
PO2: Identity (L3)
CO5 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)
PO4: Analysis (L4)
CO5 Action verb is less than PO4 verb by two levels. Therefore, the correlation is medium (2)
PO11: Thumb rule
For use to deep learning applications. Therefore, the correlation is high (3)

Course Code	Year & Sem	NATURAL LANGUAGE PROCESSING	L	T	P	C
23APC3012	III-II	(Professional Core)	2	1	0	3

Course Outcomes

CO1: Understand the morphological processing and the structure of words and documents.
CO2: Analyze the syntactic structures using various parsing algorithms.
CO3: Apply the semantic parsing techniques to interpret natural language text.
CO4: Understand the predicate-argument structures and meaning representation systems.
CO5: Apply the cross-lingual language models and speech recognition techniques in NLP applications

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the morphological processing and the structure of words and documents.			L2
CO2	Analyze	the syntactic structures	using various parsing algorithms.		L4
CO3	Apply	the semantic parsing techniques to interpret natural language text.			L3
CO4	Understand	the predicate-argument structures and meaning representation systems.			L2
CO5	Apply	the cross-lingual language models and speech recognition techniques in NLP applications			L3

UNIT I: Introduction to NLP
Introduction to NLP: Origins and Challenges, Language and Grammar in NLP, Regular Expressions and Finite-State Automata, Tokenization: Text Segmentation and Sentence Splitting, Morphological Parsing: Stemming and Lemmatization, Spelling Error Detection and Correction, Minimum Edit Distance and Applications, Statistical Language Models: Unigram, Bigram, and Trigram Models, Processing Indian Languages in NLP.
UNIT II: Word-Level and Syntactic Analysis
Introduction, Part-of-Speech (POS) Tagging: Rule-Based, Stochastic and Transformation-Based Approaches, Hidden Markov Models (HMM) and Maximum Entropy Models for POS Tagging, Context-Free Grammar (CFG) and Constituency Parsing, Treebanks and Normal Forms for Grammar, Top-Down and Bottom-Up Parsing Strategies, CYK Parsing Algorithm, Probabilistic Context-Free Grammars (PCFGs), Feature Structures and Unification.
UNIT III: Text Classification and Information Retrieval
Naïve Bayes Classifier for Text Classification, Training and Optimization for Sentiment Analysis, Information Retrieval: Basic Concepts and Design Features, Information Retrieval Models: Classical, Non-Classical, and Alternative Models, Cluster Model, Fuzzy Model, and LSTM-Based Information, Retrieval, Word Sense Disambiguation (WSD) Methods: Supervised and Dictionary-Based Approaches.
UNIT IV: Machine Translation and Semantic Processing
Introduction to Machine Translation (MT), Language Divergence and Typology in MT EncoderDecoder Model for Machine Translation, Translating in Low-Resource Scenarios, MT Evaluation Metrics and Techniques, Bias
and Ethical Issues in NLP and Machine Translation, Semantic Analysis and First-Order Logic in NLP, Thematic Roles and Selectional Restrictions in Semantics, Word Senses and Relations Between Senses
UNIT V: Speech Processing and Advanced NLP Models
Speech Fundamentals: Phonetics and Acoustic Phonetics, Digital Signal Processing in Speech Analysis, Feature

Extraction in Speech: Short-Time Fourier Transform (STFT), Mel-Frequency Cepstral Coefficients (MFCC) and Perceptual Linear Prediction (PLP), Hidden Markov Models (HMMs) in Speech Recognition.

Textbooks (Core Learning Materials)
1. Daniel Jurafsky & James H. Martin – Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson Education, 2023.
2. Tanveer Siddiqui & U.S. Tiwary – Natural Language Processing and Information Retrieval, Oxford University Press.

Reference Books (Supplementary Learning)
1. T.V. Geetha – Understanding Natural Language Processing – Machine Learning and Deep Learning Perspectives, Pearson, 2024.
2. Akshay Kulkarni & Adarsha Shivananda – Natural Language Processing Recipes - Unlocking Text Data with Machine Learning and Deep Learning using Python, Apress, 2019.

Web links and Video Lectures (e-Resources):
1. **https://www.youtube.com/watch?v=M7SWr5xObkA**
2. **https://onlinecourses.nptel.ac.in/noc23_cs45/preview**
3. **https://archive.nptel.ac.in/courses/106/106/106106211/**

Mapping of course outcomes with program outcomes

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

CO relation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL				
1				Understand	L2		PO1 PO5	PO1: Apply(L3) PO5: Apply (L3)	2 2
2				Analyze	L4		PO1 PO2 PO3	PO1: Apply(L3) PO2: Analysis(L4) PO3: Develop(L3)	2 3 2
3				Apply	L3		PO1 PO2 PO3 PO5 PO11	PO1: Apply(L3) PO2: Analysis(L4) PO3: Develop(L3) PO5: Apply (L3) PO11: ThumbRule	3 2 3 3 2
4				Understand	L2		PO1 PO2 PO3 PO5 PO6	PO1: Apply(L3) PO2: Analysis(L4) PO3: Develop(L3) PO5: Apply (L3) PO6: ThumbRule	2 2 1 2 2
5				Apply	L3		PO1 PO3 PO5 PO7 PO11	PO1: Apply(L3) PO3: Develop(L3) PO5: Apply (L3) PO7: ThumbRule PO11:ThumbRule	3 3 3 2 2

Justification Statements:

CO1: Understand the morphological processing and the structure of words and documents.
Action Verb: Understand (L2)
PO1: Apply(L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO5: Apply (L3)
CO1 Action verb is less than PO5 verb by one level. Therefore the correlation is moderate (2)

CO2: Analyze the syntactic structures using various parsing algorithms.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action verb is Greater than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2: Analysis(L4)
CO2 Action verb is same level as PO2verb. Therefore the correlation is high (3)
PO3: Develop (L3)
CO2 Action verb is Greater than PO1 verb by one level PO3 verb. Therefore the correlation is moderate (2)

CO3: Apply the semantic parsing techniques to interpret natural language text.
Action Verb: Apply(L3)
PO1: Apply(L3)
CO3 Action verb is more than PO1 verb. Therefore the correlation is high (3)
PO2: Analysis(L4)
CO3 Action verb is Greater than PO2 verb. Therefore the correlation is moderate (2)
PO3: Develop(L3)
CO3 Action verb more than PO2 verb. Therefore the correlation is high (3)
PO4: Analyze(L4)
CO3 Action verb less than PO2 verb by one levels. Therefore the correlation is moderate (2)
PO5: Apply (L3)
CO3 Action verb same as PO5 verb. Therefore the correlation is high (3)
PO11: Thumb rule
The NLP models are Code generation and completion tools are lifelong learning. Therefore the correlation is Moderate (2)

CO4: Understand the predicate-argument structures and meaning representation systems.
Action Verb: Understand (L2)
PO1: Apply(L3)
CO4 Action verb is less than PO1 verb by one level. Therefore the correlation is Moderate (2)
PO2: Analysis(L4)
CO4 Action verb is less than PO2 verb by two level. Therefore the correlation is Low(1)
PO3: Develop(L3)
CO4 Action verb is less than PO3 verb by one levels. Therefore the correlation is Moderate (2)
PO5: Apply (L3)
CO4 Action verb is less than PO5 verb by two levels. Therefore the correlation is Moderate (2)
PO6: Thumb rule
Since we are developing NLP Models and applications. Therefore the correlation is Moderate (2)

CO5: Apply the cross-lingual language models and speech recognition techniques in NLP applications
Action Verb: Appy (L3)
PO1: Apply(L3)
CO5 Action verb is same as PO1 verb. Therefore the correlation is High (3)
PO3: Develop(L3)
CO5 Action verb is same as PO3 verb. Therefore the correlation is High (3).
PO5: Apply (L3)
CO5 Action verb is same as PO3 verb. Therefore the correlation is High (3).
PO7: ThumbRule
Apply the Ethical Principal for creating the Security tools in NLP. Therefore the correlation is moderate (2)
PO11: ThumbRule
We are using the NLP Tools in lifelong Learning. Therefore the correlation is moderate (2)

Course Code	Year & Sem	Reinforcement learning	L	T	P	C
23APE3005	III-II	**(Professional Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes:

CO1: Understand the fundamentals of Reinforcement Learning, including agent-environment interaction, rewards, returns, and value functions.
CO2: Apply the dynamic Programming and Monte Carlo techniques to evaluate and improve policies for decision-making problems.
CO3: **Evaluate** the temporal-Difference learning methods such as TD (0), SARSA, Q-Learning, Expected SARSA, n-step returns, and TD (λ) for value function estimation in reinforcement learning.
CO4: Apply the function approximation and deep learning methods, such as DQNs, to solve large-scale or complex RL problems.
CO5: Create the optimize policy-based reinforcement learning algorithms using policy gradient and Actor-Critic architectures.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The fundamentals of Reinforcement Learning including agent-environment interaction, rewards, returns, and value functions			L2
CO2	Apply	Dynamic Programming and Monte Carlo techniques		to evaluate and improve policies for decision-making problems.	L3
CO3	Evaluate	Temporal-Difference learning methods such as TD(0), SARSA, Q-Learning, Expected SARSA, n-step returns, and TD(λ)			L5
CO4	Analyze	the function approximation and deep learning methods, such as DQNs,		to solve large-scale or complex RL problems.	L4
CO5	Create	the optimize policy-based reinforcement learning algorithms	using policy gradient and Actor-Critic architectures.		L6

UNIT - I	**Introduction to Reinforcement Learning**	

Introduction to Machine Learning and RL, Agent-environment interface, Goals and rewards, Returns: episodic and continuing tasks, Markov Decision Processes (MDP), Value functions: state-value and action-value functions.

UNIT - II	**Dynamic Programming and Monte Carlo Methods**	

Policy evaluation and improvement, Policy iteration and value iteration, Generalized policy iteration, Monte Carlo prediction and control, On-policy and off-policy MC methods.

UNIT - III	**Temporal-Difference Learning and Eligibility Traces**	

TD Prediction (TD(0)), SARSA and Q-Learning, Expected SARSA, n-step returns, Eligibility traces, TD(λ) methods.

UNIT - IV	**Function Approximation and Deep RL**	

Linear and non-linear function approximation, Feature construction, Deep Q Networks (DQN), Experience replay and fixed Q-targets, Double DQN and Dueling DQN, Challenges in deep RL

UNIT - V	Policy Gradient and Actor-Critic Methods	

Policy gradient theorem, REINFORCE algorithm, Variance reduction techniques, Actor-Critic architecture, Proximal Policy Optimization (PPO), Applications in Robotics and Games

Textbooks:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", 2nd Edition, MIT Press, 2018. (Free online at http://incompleteideas.net/book/the-book2nd.html)

Reference Books:

1. Csaba Szepesvári, "Algorithms for Reinforcement Learning", Morgan & Claypool, 2010.
2. Marco Wiering and Martijn van Otterlo, "Reinforcement Learning: State-of-the-Art", Springer, 2012.
3. David Silver, Reinforcement Learning Lecture Series, University College London (UCL).
4. François-Lavet et al., "An Introduction to Deep Reinforcement Learning", Foundations and Trends® in Machine Learning, 2018.

Correlation matrix:

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

Unit No.	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1				Understand	L2	PO1 PO2 PO7 PO11	PO1:Apply(L3) PO2:Identify(L3) PO7:Thumb rule PO11: Thumb rule	2 2 3 1
2				Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6	PO1:Apply(L3) PO2:Identify(L3) PO3: Design(L6) PO4:Analyze(L4) PO5:Apply(L3) PO6:Thumb rule	3 3 1 1 3 3
3				Evaluate	L5	PO2 PO3 PO4 PO5 PO10	PO2: Identify(L3) PO3:Formulate(L6) PO4: Analyze(L4) PO5:Create(L6) PO10:Thumb rule	1 2 2 1 1
4				Analyze	L4	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Analyze(L4) PO3: Design(L6) PO4: Analyze(L4)	2 3 1 3
5			2	Develop	L6	PO1 PO3 PO5 PO6 PO8 PO10	PO1: Apply(L3) PO3: Design(L6) PO5: Create(L6) PO6: Thumb rule PO8: Thumb rule PO10: Thumb rule	3 3 3 3 3 3

Justification Statements:

CO1: Understand the fundamentals of Reinforcement Learning, including agent-environment interaction, rewards, returns, and value functions.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO7: Thumb rule
The agent takes actions within the environment, and the environment responds with rewards and new states. The agent's goal is to maximize its cumulative returns over time. Therefore the correlation is high (3)
PO11: Thumb rule
The value functions estimate the long-term desirability of states or state-action pairs. Therefore the correlation is low (1).

CO2: Apply the dynamic Programming and Monte Carlo techniques to evaluate and improve policies for decision-making problems.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO1 Action verb is less than PO3 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is low (1)
PO5: Apply (L3)
CO2 Action verb is same level as PO5 verb. Therefore the correlation is high (3)
PO6: Thumb rule
Dynamic programming (DP) and Monte Carlo (MC) methods are both used in reinforcement learning, but they differ in their approach to learning. Therefore the correlation is high (3).

CO3: **Evaluate** the temporal-Difference learning methods such as TD (0), SARSA, Q-Learning, Expected SARSA, n-step returns, and TD (λ) for value function estimation in reinforcement learning.
Action Verb: Evaluate (L5)
PO2: Identify (L3)
CO3 Action verb is more than PO2 verb. Therefore the correlation is low (1)
PO3: Formulate (L6)
CO3 Action verb less than PO3 verb by two levels **.** Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO3 Action verb is more than PO4 verb. Therefore the correlation is moderate (2)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels **.**Therefore the correlation is low (1)
PO10: Thumb rule
 State-Action-Reward-State-Action. It's an on-policy method that updates the action-value function based on the actual action taken by the agent, the reward received, and the next action the agent takes. Therefore the correlation is low (1)

CO4: Apply the function approximation and deep learning methods, such as DQNs, to solve large-scale or complex RL problems.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore the correlation is moderate (2)
PO2: Analyze (L4)
CO4 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO4 Action verb is less thanPO3 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore the correlation is high (3)

CO5: Create the optimize policy-based reinforcement learning algorithms using policy gradient and

Actor-Critic architectures.

Action Verb: Create(L6)

PO1 Verb: Apply (L3)

CO5 Action verb is greater than PO1 verb. Therefore the correlation is high (3)

PO3 Verb: Design (L6)

CO5 Action verb is same as PO3 verb. Therefore the correlation is high (3)

PO5 Verb: Create(L6)

CO5 Action verb is same as PO5 verb. Therefore the correlation is high (3)

PO6 Verb: Thumb rule

Instead of learning a value function to evaluate states or state-action pairs, policy-based methods directly adjust the policy parameters to maximize cumulative reward.

Therefore the correlation is high (3).

PO8 Verb: Thumb rule

The policy is typically represented by a parameterized function and the algorithm optimizes these parameters.

Therefore the correlation is high (3).

PO10 Verb: Thumb rule

In an actor-critic setup, the actor might be updated based on the error calculated by the critic, guiding the actor to choose better actions.

Therefore the correlation is high (3).

Course Code	Year & Sem	RECOMMENDER SYSTEMS	L	T	P	C
23APE3006	III-II	(Professional Elective-II)	2	1	0	3

Course Outcomes:
 CO1: Understand the core concepts and types of recommender systems.
 CO2: Analyze the basic collaborative and content-based filtering techniques.
 CO3: Apply the matrix factorization and deep learning models to recommendation problems.
 CO4: Evaluate the recommender system performance using appropriate metrics.
 CO5: **Create** scalable and context-aware recommender systems for diverse applications.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the core concepts and types of recommender systems.			L2
CO2	**Analyze**	the basic collaborative and content-based filtering techniques.			L3
CO3	**Apply**	matrix factorization and deep learning models.		to recommendation problems.	L3
CO4	**Evaluate**	the recommender systems performance	Using appropriate metrics.		L5
CO5	**Create**	scalable and context-aware recommender systems		for diverse applications.	L6

UNIT I: Introduction to Recommender Systems

Introduction to Information Filtering Systems, Types of Recommender Systems: Content-based, Collaborative, Hybrid, Data Sources: Explicit vs Implicit Feedback, Applications and Challenges in Recommendation, User and Item Profiling, Popularity, Personalization, and Serendipity Trade-offs.

UNIT II: Collaborative Filtering Techniques

User-based Collaborative Filtering, Item-based Collaborative Filtering, Similarity Measures: Cosine, Pearson, Jaccard, Neighborhood Selection and k-NN, Cold-start and Data Sparsity Issues, Memory- based vs Model-based Collaborative Filtering.

UNIT III: Content-based and Hybrid Systems

Item Feature Extraction and Vector Representation, TF-IDF and Cosine Similarity in Recommendations, User Profile Learning, Limitations of Content-based Filtering, Hybrid Recommender Architectures, Case Study: Netflix, Amazon Hybrid Systems.

UNIT IV: Matrix Factorization and Deep Learning Approaches

Latent Factor Models and SVD, ALS and SGD for Matrix Factorization, Non-negative Matrix Factorization (NMF), Neural Collaborative Filtering (NCF), Deep Learning Models: Autoencoders, CNNs, RNNs for Recommendations, Graph-based and Knowledge Graph Recommenders.

UNIT V: Evaluation, Ethics, and Industrial Applications

Evaluation Metrics: Precision, Recall, F1, NDCG, MAP, A/B Testing in Recommender Systems, Explainability in Recommendations, Fairness, Bias, and Privacy in Recommenders, Scalability and Real-time Recommendations, Deploying Recommender Systems at Scale (e.g., Spotify, YouTube)
Textbooks:
1. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.

2. Francesco Ricci, Lior Rokach, and Bracha Shapira, Recommender Systems Handbook, Springer, 2nd Ed., 2015.

Reference Books:
1. Jannach, Dietmar et al.**,**Recommender Systems: An Introduction, Cambridge University Press, 2010.
2. Michael Ekstrand, Joseph A. Konstan**,**Collaborative Filtering Recommender Systems, Now Publishers, 2011.
3. Research papers from ACM RecSys Conference proceedings.

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL				
1				Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Identify(L3)	2 2
2				Analyze	L3	PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply (L3)	3 3 3 2 3
3				Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify (L3) PO3: Design(L6) PO4: Analyze (L4) PO5: Create(L6)	3 3 1 2 1
4				Evaluate	L5	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Formulate (L6) PO3: Develop (L6) PO4: Analyze(L4) PO5: Apply(L3)	3 2 2 3 3
5				Create	L6	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify(L3) PO3: Design(L6) PO4: Analyze(L4) PO5: Apply(L3)	3 3 3 3 3

Justification Statements:

CO1: Understand the core concepts and types of recommender systems.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)

CO2: Analyze the basic collaborative and content-based filtering techniques.
Action Verb: Analyze (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore the correlation is Moderate (2)
PO5: Apply (L3)
CO2 Action verb is same as PO5 verb. Therefore the correlation is high (3)

CO3: Apply the matrix factorization and deep learning models to recommendation problems.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO3 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO3 Action verb less than PO2 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is moderate (2)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)

CO4: Evaluate the recommender system performance using appropriate metrics.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2: Formulate (L6)
CO4 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate(2)
PO3: Develop (L6)
CO4 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO4 Action verb is greater than PO4 verb. Therefore the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is greater than PO5 verb. Therefore the correlation is high (3)

CO5: Create scalable and context-aware recommender systems for diverse applications.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2 Verb: Identify (L3)
CO5 Action verb is greater than PO2 verb. Therefore the correlation is high (3)
PO3: Design (L6)
CO4 Action verb is same as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO4 Action verb is greater than PO4 verb. Therefore the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is greater than PO5 verb. Therefore the correlation is high (3)

Course Code	Year & Sem	PREDICTIVE ANALYTICS	L	T	P	C
23APE3007	III-II	**(Professional Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes
After studying the course, student will be able to
CO1: Understand the principles and importance of predictive analytics.
CO2: Apply Data Cleaning, Dimensionality Reduction, and Feature Scaling for datasets.
CO3: Understand regression and classification models for predictive tasks.
CO4: Evaluate and validate models using standard metrics.
CO5: Create predictive solutions to solve domain-specific challenges.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the principles and importance of predictive analytics.			L2
CO2	Apply	Data Cleaning, Dimensionality Reduction, and Feature Scaling for datasets.		PCA, LDA	L3
CO3	Understand	regression and classification models for predictive tasks.			L2
CO4	Evaluate	models using standard metrics		Confusion Matrix	L5
CO5	Create	predictive solutions to solve domain-specific challenges		AdaBoost, XGBoost, ANN,and LSTM	L6

UNIT - I	Introduction to Predictive Analytics	

Introduction to Predictive Analytics and Business Intelligence, Types of Predictive Models: Classification, Regression, Time Series, Supervised vs Unsupervised Learning, Predictive Modeling Workflow, Applications in Marketing, Finance, Healthcare, Challenges in Predictive Analytics.

UNIT - II	Data Preparation and Feature Engineering	

Data Cleaning: Handling Missing, Noisy, and Inconsistent Data, Feature Selection and Dimensionality Reduction (PCA, LDA), Feature Scaling: Normalization, Standardization, Encoding Categorical Variables, Feature Extraction and Construction, Dealing with Imbalanced Datasets.

UNIT - III	Predictive Modeling with Regression and Classification	

Linear Regression and Polynomial Regression, Logistic Regression for Binary Classification, Decision Trees and Random Forest, k-Nearest Neighbors (k-NN) and Naïve Bayes, Support Vector Machines (SVM), Model Selection and Comparison.

UNIT - IV	Model Evaluation and Validation	

Training, Testing, and Validation Sets, Cross-Validation Techniques (k-Fold, Stratified, LOOCV), Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, ROC-AUC, Confusion Matrix and Classification Report, Bias-Variance Trade-off and Overfitting, Hyperparameter Tuning: Grid Search, Random Search.

UNIT - V	Advanced Topics and Applications	

Ensemble Learning: Bagging, Boosting (AdaBoost, XGBoost), Predictive Analytics with Time Series (ARIMA, Prophet), Deep Learning for Predictive Modeling (ANNs, LSTM), Use of Predictive Analytics in IoT, Retail, and Healthcare, Ethics and Privacy in Predictive Analytics, Building and Deploying End-to-End Predictive Systems.

Textbooks:

1. Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst, Wiley, 2014.
2. John D. Kelleher, Brendan Tierney, Data Science: Predictive Analytics and Data Mining, MIT Press, 2018.

Reference Books:

1. Galit Shmueli et al.,Data Mining for Business Analytics: Concepts, Techniques, and Applications in R, Wiley, 2017.
2. Eric Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Wiley, 2016.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer, 2009.

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1				Understand	L2	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	1 1 1 1 1 2
2				Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	3 3 3 2 3 2
3				Understand	L2	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3 PO6: Thumb rule	1 1 1 1 1 2
4				Evaluate	L5	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3) PO6: Thumb rule	1 1 1 2 1 3
5				Create	L6	PO1 PO2 PO3 PO4 PO5 PO6	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply(L3) PO6: Thumb rule	1 1 1 2 1 3

Justification Statements:
CO1: Understand the principles and importance of predictive analytics.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO3: Apply (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by Two levels. Therefore the correlation is Moderate (1)
the correlation is low (1).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by four levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is moderate (2)

CO2: Apply Apply Data Cleaning, Dimensionality Reduction, and Feature Scaling for datasets.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

CO3: Understand regression and classification models for predictive tasks.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO3: Apply (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO5: Create (L6)
CO1 Action verb less than PO5 verb by four levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is moderate (2)

CO4: Evaluate and validate models using standard metrics.
Action Verb: Evaluate (L5)
PO1 Verb: Apply (L3)
CO1 Action verb is grater than PO1 verb by two levels. Therefore the correlation is low (1)
PO2 Verb: Identify (L3)
CO1 Action verb is grater than PO1 verb by two levels. Therefore the correlation is low (1)
PO3: Apply (L3)
CO1 Action verb is grater than PO1 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO1 Action verb is greater than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
PO5: Create (L6)
CO1 Action verb less than PO5 verb by two levels. Therefore the correlation is low (1)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

CO5: Create predictive solutions to solve domain-specific challenges.
Action Verb: Evaluate (L6)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by three levels. Therefore the correlation is low (1)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO1 verb by three levels. Therefore the correlation is low (1)
PO3: Apply (L3)
CO1 Action verb is less than PO1 verb by three levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO1 Action verb is greater than PO4 verb by one level. Therefore the correlation is Moderate (2)
the correlation is moderate (2).
PO5: Create (L6)
CO1 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO6: Thumb rule
Since we are developing scenes and 3d objects for engineering and societal departments. Therefore the correlation is high (3)

Course Code	Year & Sem	AI FOR FINANCE	L	T	P	C
23APE3008	III-II	(Professional Elective-II)	2	1	0	3

Course Outcomes:

CO1: Understand the fundamentals of AI techniques applicable to finance**.**
CO2: Analyze financial time series data using AI-based models.
CO3: Apply the machine learning Models for fraud detection and credit risk analysis.
CO4: Evaluate predictive models for stock prices, trading, and customer segmentation.
CO5: Evaluate the limitations and ethical implications of AI in financial systems

UNIT - I	Introduction to Finance and AI Applications	

Introduction to Financial Markets and Instruments, Overview of AI Techniques in Finance, Types of Financial Data: Market, Transactional, Customer, Financial Statements and Key Indicators, AI Use Cases in Banking, Insurance, and Investment, FinTech and the Rise of Robo-Advisors.

UNIT - II	Machine Learning in Finance	

Supervised Learning for Credit Scoring, Unsupervised Learning for Customer Segmentation, Feature Engineering for Financial Data, Handling Imbalanced Datasets in Fraud Detection, Time Series Forecasting with Regression and ARIMA, Model Validation and Backtesting in Finance.

UNIT - III	Deep Learning and NLP in Finance	

Introduction to Deep Learning for Finance, Stock Price Prediction using LSTM and RNNs, Sentiment Analysis from Financial News and Tweets, NLP for Document Classification: Earnings Reports, Chatbots and Virtual Assistants in Banking, Reinforcement Learning for Portfolio Optimization.

UNIT - IV	AI-Driven Financial Applications	

Fraud Detection Systems using ML and DL, Credit Risk and Loan Default Prediction, AI in Algorithmic and High-Frequency Trading, Robo-Advisors: Architecture and Optimization, Blockchain and AI Integration for Financial Security, Case Studies: AI in Wealth Management & Insurance

UNIT - V	Ethics, Regulation, and Future of AI in Finance	

Regulatory Frameworks in AI-based Finance, Explainability and Interpretability of Financial Models, Ethical Issues: Bias, Fairness, Transparency, Data Privacy and GDPR in Financial AI, Responsible AI Practices in Finance, Emerging Trends: Quantum AI, Decentralized Finance (DeFi).

Textbooks:

1. Yves Hilpisch, Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly, 2020.
2. Yves Hilpisch, Python for Finance: Mastering Data-Driven Finance, O'Reilly, 2018.
3. Markus Loecher, Machine Learning for Finance, Packt Publishing, 2021.

Reference Books:

1. A. W. Lo, The Evolution of Technical Analysis, Wiley Finance, 2010.
2. Tony Guida, Big Data and Machine Learning in Quantitative Investment, Wiley, 2019.
3. Tucker Balch, AI for Trading – Georgia Tech Specialization, Coursera

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamentals of AI techniques applicable to finance			L2
CO2	Analyze	financial time series data		using AI-based models.	L4
CO3	Apply	the machine learning Models		for fraud detection and credit risk analysis.	L3
CO4	Evaluate	predictive models		for stock prices, trading, and customer segmentation.	L5
CO5	Evaluate	the limitations and ethical implications of AI		in financial systems.	L5

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

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb		BTL			
1				Understand		L2	PO1 PO2 PO3 PO4 PO5 PO6 PO7	PO1: Apply(L3) PO2:Review(L2) PO3: Design (L6) PO4: Analyze (L4) PO5: Create (L6) PO6: Thumb rule PO7: Thumb rule	3 2 2 1 1 2 1
2				Analyze		L4	PO1 PO2 PO3 PO4 PO5 PO6 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop(L3) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb rule PO11: Thumb rule	3 2 2 2 2 2 1
3				Apply		L3	PO1 PO2 PO3 PO4 PO5 PO6 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Design(L6) PO4: Analyze (L4) PO5: Apply(L3) PO6: Thumb rule PO11: Thumb rule	3 2 2 2 1 1 1
4				Evaluate		L5	PO1 PO2 PO3 PO5 PO6 PO11	PO1: Apply(L3) PO2:Review(L2) PO3: Develop (L6) PO5: Analyze(L4) PO6: Thumb rule PO11: Thumb rule	3 2 2 2 1 1
5				Evaluate		L5	PO1 PO4 PO6 PO7	PO1: Apply(L3) PO4: Analyze(L4) PO6: Thumb rule PO7:Thumb rule	3 2 2 2

Correlation matrix

Justification Statements:

CO1: Understand the fundamentals of AI techniques applicable to finance.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is high (3)
PO2 Verb: Review(L2)
CO1 Action verb is same level as PO2 verb. Therefore the correlation is moderate (2)

PO3 Verb: Design (L6)
CO1 Action verb is less than PO3 verb by one level. Therefore the correlation is moderate (2)
PO4 Verb: Analyze(L4)
CO1 Action verb is less than PO4 verb by one level. Therefore the correlation is low (1)
PO5 Verb:Create (L6)
CO1 Action verb is less than PO5 verb by one level. Therefore the correlation is low (1)

PO6 Verb: Thumb rule
CO1. Understanding AI fundamentals in finance involves mastering machine learning, deep learning, NLP, and reinforcement learning techniques, alongside robust data preprocessing and modeling. Therefore the correlation is moderate (2).
PO7 Verb: Thumb rule
CO1. Understanding AI in finance requires not only technical mastery but also a strong awareness of societal, legal, and ethical responsibilities. Therefore the correlation is low (1).

CO2: Analyze financial time series data using AI-based models.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action verb is more than PO1 verb. Therefore the correlation is high (3)
PO2: Review (L2)
CO2 Action verb is more than PO2 verb. Therefore the correlation is moderate (2)
PO3: Develop(L3)
CO2 Action verb is more than PO3 verb. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO2 Action verb is same level as PO4 verb. Therefore the correlation is moderate (2)
PO5: Apply (L3)
CO2 Action verb is more than PO5 verb. Therefore the correlation is moderate (2)
PO6: Thumb rule
CO2 Analyzing financial time series data with AI involves using advanced models like RNNs, LSTMs, and transformers, supported by robust preprocessing and evaluation techniques. Therefore the correlation is moderate (2).
PO11: Thumb rule
CO2 Applying AI to financial time series analysis demands careful attention to ethics, privacy, fairness, and regulatory compliance. Therefore the correlation is low (1).

CO3: Apply the machine learning Models for fraud detection and credit risk analysis.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Review(L2)
CO3 Action verb more than PO2 verb. Therefore the correlation is moderate (2)
PO3: Design (L6)
CO3 Action verb less than PO3 verb by two levels. Therefore the correlation is moderate (2)
PO4: Analyze (L4)
CO3 Action verb less than PO4 verb by two levels. Therefore the correlation is moderate (2)
PO5: Apply (L3)
CO3 Action verb is same level as PO5 verb. Therefore the correlation is low (1)
PO6: Thumb rule
CO3 Applying ML models for fraud detection and credit risk analysis involves using advanced classification, anomaly detection, and feature engineering techniques. Therefore the correlation is low (1).
PO11: Thumb rule
CO3 Applying machine learning to fraud detection and credit risk analysis involves more than technical accuracy. Therefore the correlation is low (1).

CO4: Evaluate predictive models for stock prices, trading, and customer segmentation.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2: Review (L2)
CO4 Action verb is greater than PO2 verb. Therefore the correlation is moderate (2)
PO3: Develop (L6)
CO4 Action verb is less than PO3 verb by two levels. Therefore the correlation is moderate (2)
PO5: Analyze (L4)
CO4 Action verb is less than PO5 verb. Therefore the correlation is moderate (2)
PO6: Thumb rule
CO4 Evaluating predictive models in stock forecasting, trading, and customer segmentation requires the use of appropriate ML/DL techniques, tools, and validation strategies. Therefore the correlation is low (1).
PO11: Thumb rule

CO4 Evaluating predictive models for stock prices, trading, and customer segmentation requires attention to ethics, fairness, transparency, and legal compliance. Therefore the correlation is low (1).

CO5: Evaluate the limitations and ethical implications of AI in financial systems.
Action Verb: Evaluate(L5)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO4 Verb: Analyze (L4)
CO5 Action verb is greater than PO2 verb. Therefore the correlation is moderate (2)
PO6 Verb: Thumb rule
CO5 Evaluating the limitations and ethical implications of AI in financial systems requires a practical, tool-based approach to detect biases, ensure transparency, and maintain accountability. Therefore the correlation is moderate (2)
PO7 Verb: Thumb rule
CO5. AI in financial systems are evaluated through the lens of societal impact, legal obligations, safety, and cultural sensitivity .Therefore the correlation is moderate (2)

Course Code	Year & Sem	QUANTUM COMPUTING	L	T	P	C
23APE3009	III-II	**(Professional Elective-III)**	**2**	**1**	**0**	**3**

Course Outcomes:

CO1: Understand the fundamental concepts of quantum mechanics used in computing.
CO2: Analyze quantum circuits using standard gates.
CO3: Apply quantum algorithms like Deutsch-Jozsa, Grover's, and Shor's.
CO4: Understand simple quantum programs using Qiskit or similar platforms.
CO5: Analyze applications and challenges of quantum computing in real-world domains.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the fundamental concepts of quantum mechanics used in computing.			L2
CO2	Analyze	quantum circuits	using standard gates.		L4
CO3	Apply	quantum algorithms like Deutsch-Jozsa, Grover's, and Shor's.			L3
CO4	Understand	simple quantum programs	using Qiskit or similar platforms		L2
CO5	Analyze	applications and challenges of quantum computing in real-world domains.		-	L4

UNIT – I	**Fundamentals of Quantum Mechanics and Linear Algebra**	
Classical vs Quantum Computation, Complex Numbers, Vectors, and Matrices, Hilbert Spaces and Dirac Notation, Quantum States and Qubits, Superposition and Measurement, Tensor Products and Multi-Qubit Systems		
UNIT – II	**Quantum Gates and Circuits**	
quantum Logic Gates:Pauli, Hadamard, Phase, Controlled Gates and CNOT, Unitary Operations and Reversibility, Quantum Circuit Representation, Quantum Teleportation, Simulation of Quantum Circuits		
UNIT – III	**Quantum Algorithms and Complexity**	
Quantum Parallelism and Interference, Deutsch and Deutsch-Jozsa Algorithms, Grover's Search Algorithm, Shor's Factoring Algorithm, Quantum Fourier Transform, Complexity Classes: BQP, P, NP, and QMA		
UNIT - IV	**Quantum Programming and Simulation Platforms**	
Introduction to Qiskit and IBM Quantum Experience, Writing Quantum Circuits in Qiskit, Measuring Qubits and Results, Classical-Quantum Hybrid Programs, Noisy Intermediate-Scale Quantum (NISQ) Systems, Limitations and Current State of Quantum Hardware		
UNIT - V	**Applications and Future of Quantum Computing**	
Quantum Machine Learning: Basics and Models, Quantum Cryptography and Quantum Key Distribution, Quantum Algorithms in AI and Optimization, Quantum Advantage and Supremacy, Ethical and Societal Impact of Quantum Technologies, Future Trends and Research Directions		
Textbooks:		
1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.		
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.		

3. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019	
Reference Books:	
1. David McMahon, *Quantum Computing Explained*, Wiley, 2008.	
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.	
3. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013	
Online Learning Resources:	
1. IBM Quantum Experience and Qiskit Tutorials	
2. Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley	
3. edX – The Quantum Internet and Quantum Computers	
4. YouTube – Quantum Computing for the Determined by Michael Nielsen	
5. Qiskit Textbook – IBM Quantum	

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0–3)
	Lesson Plan(Hrs)	%	Corre Lation	CO's Action Verb	BTL			
1				Understand	L2	PO1 PO2	PO1: Apply (L3) PO2: Identify (L3)	2 2
2				Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO6 PO9	PO1: Apply (L3) PO2: Identify (L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb rule PO9: Thumb rule	3 3 3 3 3 2 2
3				Apply	L3	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Design (L6) PO4: Analyze (L4)	3 3 1 2
4				Understand	L5	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Analyze (L4) PO3: Develop (L6) PO4: Analyze (L4) PO5: Apply (L3)	3 3 2 3 3
5				Analyze	L6	PO1 PO2 PO3 PO4 PO5 PO6 PO9	PO1: Apply (L3) PO2: Identify (L3) PO3: Design (L6) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb rule PO9: Thumb rule	3 3 3 3 3 2 3
	Total							

Justification Statements:

CO1: Understand the fundamental concepts of quantum mechanics used in computing.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2).
PO2 Verb: **Identify (L3)**

CO1 action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2).

CO2: Analyze quantum circuits using standard gates.
Action Verb: **Analyze (L4)**
PO1 Verb: Apply (L3)
CO2 action verb is greater than PO1 verb by one level. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO2 action verb is greater than PO2 verb by one level. Therefore, the correlation is high (3).
PO3 Verb: **Apply (L3)**
CO2 action verb is greater than PO3 verb by one level. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO2 action verb is same as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Apply (L3)**
CO2 action verb is greater than PO5 verb by one level. Therefore, the correlation is high (3).
PO6: **Thumb rule**
Computer vision techniques are applied in multiple domains like medical imaging, remote sensing, and robotics. Therefore, the correlation is moderate (2).
PO9: **Thumb rule**
Feature extraction and analysis require collaboration between engineers, analysts, and domain experts. Therefore, the correlation is moderate (2).

CO3: Apply quantum algorithms like Deutsch-Jozsa, Grover's, and Shor's.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO3 action verb is same as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: Identify (L3)
CO3 action verb is same as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: Design (L6)
CO3 action verb is less than PO3 verb by three levels. Therefore, the correlation is low (1).
PO4 Verb: Analyze (L4)
CO3 action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2).

CO4: Understand simple quantum programs using Qiskit or similar platforms.
Action Verb:Understand (L2)
PO1 Verb: Apply (L3)
CO4 action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3).
PO2 Verb: **Analyze (L4)**
CO4 action verb is greater than PO2 verb by one level. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L6)**
CO4 action verb is less than PO3 verb by one level. Therefore, the correlation is moderate (2).
PO4 Verb: **Analyze (L4)**
CO4 action verb is greater than PO4 verb by one level. Therefore, the correlation is high (3).
PO5 Verb: **Apply (L3)**
CO4 action verb is greater than PO5 verb by two levels. Therefore, the correlation is high (3).

CO5: Analyze applications and challenges of quantum computing in real-world domains.
Action Verb:Analyze(L4)
PO1 Verb: Apply (L3)
CO5 action verb is greater than PO1 verb by three levels. Therefore, the correlation is high (3).
PO2 Verb: Identify (L3)
CO5 action verb is greater than PO2 verb by three levels. Therefore, the correlation is high (3).
PO3 Verb: Design (L6)
CO5 action verb is same as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: Analyze (L4)
CO5 action verb is greater than PO4 verb by two levels. Therefore, the correlation is high (3).
PO5 Verb: Apply (L3)
CO5 action verb is greater than PO5 verb by three levels. Therefore, the correlation is high (3).
PO6: Thumb rule
The use of ethical AI practices and modern 3D vision models ensures safety, societal impact, and sustainability. Therefore, the correlation is moderate (2).
PO9: Thumb rule
Creation of practical Computer Vision applications requires collaboration with multi-disciplinary teams and stakeholders. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI (AUTONOMOUS)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Computer Vision	L	T	P	C
23APE3010	III-II	**(Professional Elective-III)**	**2**	**1**	**0**	**3**

Course Outcomes:

CO1: Understand the fundamental concepts of image formation, color models, image enhancement and filtering techniques.

CO2: Analyze visual features using edge detection, corner detection and blob detection techniques across various image types.

CO3: Apply segmentation methods, contour analysis and object recognition algorithms to vision-based tasks.

CO4: Evaluate convolutional neural network architectures for solving classification and object detection problems.

CO5: Create computer vision applications using 3D vision approaches, scene understanding models and ethical AI practices.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the fundamental concepts of image formation, color models, image enhancement and filtering techniques	—	—	**L2**
CO2	Analyze	visual features using edge detection, corner detection and blob detection techniques	across various image types	—	**L4**
CO3	Apply	segmentation methods, contour analysis and object recognition algorithms	—	to vision-based tasks	**L3**
CO4	Evaluate	convolutional neural network architectures	—	for classification and object detection problems	**L5**
CO5	Create	computer vision applications using 3D vision approaches, scene understanding models and ethical AI practices	—	-	**L6**

UNIT – I	Introduction to Image Processing and Computer Vision	
Introduction to Computer Vision and its Applications, Image Formation, Image Sensing and Acquisition, Color Models: RGB, HSV, YCbCr, Image Enhancement Techniques, Geometric Transformations and Image Resizing, Noise Removal and Filtering Techniques.		
UNIT – II	**Feature Detection and Description**	
Edge Detection: Canny, Sobel, and Laplacian, Corner Detection: Harris and FAST, Blob Detection: LoG, DoG, SIFT, SURF, and ORB Descriptors, Image Matching and Feature Correspondence, Homography and Perspective Transformation.		
UNIT – III	**Image Segmentation and Object Recognition**	
Thresholding and Region-Based Segmentation, Clustering Methods: K-means, Mean Shift, Graph-Based and Watershed Algorithms, Contour Detection and Shape Analysis, Template Matching and Object Detection, Introduction to Object Tracking Algorithms.		
UNIT - IV	**Deep Learning for Computer Vision**	
Introduction to Convolutional Neural Networks (CNNs), CNN Architecture: Layers, Activation, Pooling, Pretrained Models: VGG, ResNet, MobileNet, Image Classification using CNNs, Object Detection: R-CNN, Fast R-CNN, YOLO, SSD, Transfer Learning and Fine-Tuning.		
UNIT - V	**Advanced Topics and Applications**	
3D Vision and Depth Estimation, Structure from Motion (SfM) and SLAM, Facial Recognition Systems, Scene Understanding and Semantic Segmentation, Vision Applications in Healthcare, AR/VR, Robotics, Ethics, Bias, and Fairness in Vision Systems.		

Textbooks:
1. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2022.
2. Simon J. D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012.
3. Adrian Rosebrock, *Deep Learning for Computer Vision with Python*, PyImageSearch, 2019.
Reference Books:
1. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, Pearson, 4th Edition, 2018.
2. Jan Erik Solem, *Programming Computer Vision with Python*, O'Reilly Media, 2012.
3. Bernd Jähne, *Digital Image Processing*, Springer, 6th Edition, 2005.
Online Learning Resources:
1. Coursera – Computer Vision by University at Buffalo
2. Fast.ai – Practical Deep Learning for Coders
3. PyImageSearch Blog and Courses

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0–3)
	Lesson Plan(Hrs)	%	Corre Lation	CO's Action Verb	BTL			
1				Understand	L2	PO1 PO2	PO1: Apply (L3) PO2: Identify (L3)	2 2
2				Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO6 PO9	PO1: Apply (L3) PO2: Identify (L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb rule PO9: Thumb rule	3 3 3 3 3 2 2
3				Apply	L3	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Design (L6) PO4: Analyze (L4)	3 3 1 2
4				Evaluate	L5	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Analyze (L4) PO3: Develop (L6) PO4: Analyze (L4) PO5: Apply (L3)	3 3 2 3 3
5				Create	L6	PO1 PO2 PO3 PO4 PO5 PO6 PO9	PO1: Apply (L3) PO2: Identify (L3) PO3: Design (L6) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb rule PO9: Thumb rule	3 3 3 3 3 2 3
	Total							

Justification Statements:

CO1: Understand the fundamental concepts of image formation, color models, image enhancement, and filtering techniques.
Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2).

PO2 Verb: **Identify (L3)**

CO1 action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2).

CO2: Analyze visual features using edge detection, corner detection, and blob detection techniques across various image types.

Action Verb: **Analyze (L4)**

PO1 Verb: Apply (L3)

CO2 action verb is greater than PO1 verb by one level. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO2 action verb is greater than PO2 verb by one level. Therefore, the correlation is high (3).

PO3 Verb: **Apply (L3)**

CO2 action verb is greater than PO3 verb by one level. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO2 action verb is same as PO4 verb. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO2 action verb is greater than PO5 verb by one level. Therefore, the correlation is high (3).

PO6: **Thumb rule**

Computer vision techniques are applied in multiple domains like medical imaging, remote sensing, and robotics. Therefore, the correlation is moderate (2).

PO9: **Thumb rule**

Feature extraction and analysis require collaboration between engineers, analysts, and domain experts. Therefore, the correlation is moderate (2).

CO3: Apply segmentation methods, contour analysis and object recognition algorithms to vision-based tasks.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO3 action verb is same as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: Identify (L3)

CO3 action verb is same as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: Design (L6)

CO3 action verb is less than PO3 verb by three levels. Therefore, the correlation is low (1).

PO4 Verb: Analyze (L4)

CO3 action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2).

CO4: Evaluate convolutional neural network architectures for solving classification and object detection problems.

Action Verb: Evaluate (L5)

PO1 Verb: Apply (L3)

CO4 action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3).

PO2 Verb: **Analyze (L4)**

CO4 action verb is greater than PO2 verb by one level. Therefore, the correlation is high (3).

PO3 Verb: **Develop (L6)**

CO4 action verb is less than PO3 verb by one level. Therefore, the correlation is moderate (2).

PO4 Verb: **Analyze (L4)**

CO4 action verb is greater than PO4 verb by one level. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO4 action verb is greater than PO5 verb by two levels. Therefore, the correlation is high (3).

CO5: Create computer vision applications using 3D vision approaches, scene understanding models and ethical AI practices.

Action Verb: **Create (L6)**

PO1 Verb: Apply (L3)

CO5 action verb is greater than PO1 verb by three levels. Therefore, the correlation is high (3).

PO2 Verb: Identify (L3)

CO5 action verb is greater than PO2 verb by three levels. Therefore, the correlation is high (3).

PO3 Verb: Design (L6)

CO5 action verb is same as PO3 verb. Therefore, the correlation is high (3).

PO4 Verb: Analyze (L4)

CO5 action verb is greater than PO4 verb by two levels. Therefore, the correlation is high (3).
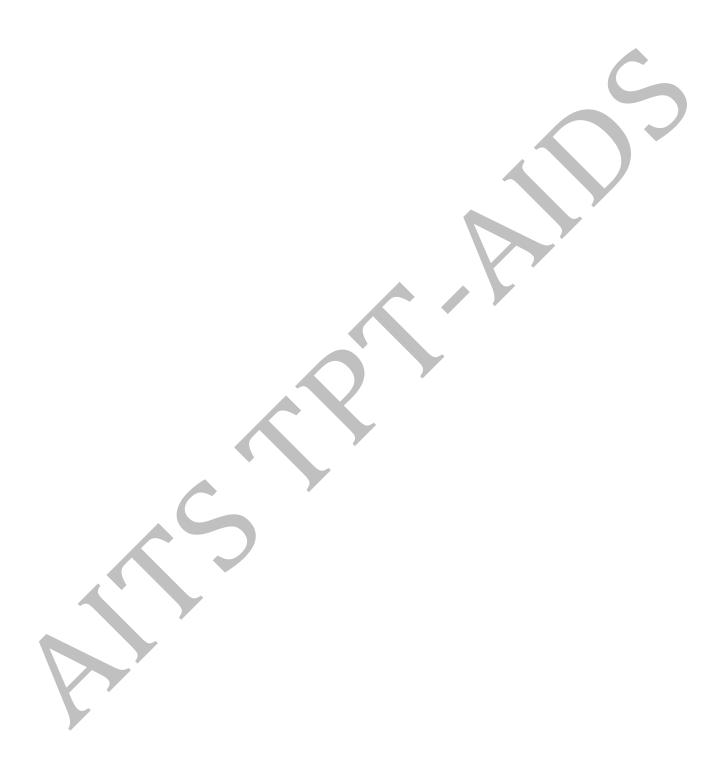
PO5 Verb: Apply (L3)

CO5 action verb is greater than PO5 verb by three levels. Therefore, the correlation is high (3).

PO6: Thumb rule
The use of ethical AI practices and modern 3D vision models ensures safety, societal impact, and sustainability. Therefore, the correlation is moderate (2).
PO9: Thumb rule
Creation of practical Computer Vision applications requires collaboration with multi-disciplinary teams and stakeholders. Therefore, the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(AUTONOMOUS)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	CLOUD COMPUTING FOR AI	L	T	P	C
23APE3011	III-II	(Professional Elective-III)	2	1	0	3

Course Outcomes:
CO1: Understand the cloud computing architecture, services, and deployment models.
CO2: Apply the cloud platforms (AWS, GCP, Azure) for training and deploying AI models.
CO3: Evaluate the large-scale data storage and processing in the cloud environment.
CO4: Analyze the AI workflows using serverless and container-based architectures.
CO5: Analyze the challenges in security, cost, scalability, and performance of cloud-based AI systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the cloud computing architecture, services, and deployment models			L2
CO2	Apply	the cloud platforms (AWS, GCP, Azure)		for training and deploying AI models	L3
CO3	Evaluate	the large-scale data storage and processing in the cloud environment		to accommodate growing data volumes and processing needs	L5
CO4	Analyze	the AI workflows using serverless and container-based architectures	using serverless and container-based architectures	to manage containerized AI applications	L4
CO5	Analyze	the challenges in security, cost, scalability, and performance of cloud-based AI systems		to reduce computational complexity and improve response times	L4

UNIT - I	Introduction to Cloud Computing and AI Integration	
Basics of Cloud Computing: Characteristics, Models, and Services, Cloud Service Models: IaaS, PaaS, SaaS, Deployment Models: Public, Private, Hybrid, Community, AI and Cloud Convergence: Benefits and Challenges, Use Cases of AI in Cloud: NLP, Vision, Analytics, Overview of Cloud Providers for AI: AWS, Azure, GCP.		
UNIT - II	**Storage, Computing, and Data Processing in the Cloud**	
Cloud Storage Services: S3, Blob, BigQuery, Virtualization and Elastic Computing, Distributed Computing with Hadoop and Spark, Data Ingestion and Processing Pipelines, Data Lakes and Warehousing in the Cloud, Cost Optimization for Storage and Compute Resources.		
UNIT - III	**Cloud-based Machine Learning and Deep Learning**	
ML Services on AWS (SageMaker), Azure ML, GCP Vertex AI, Training and Deploying Models on Cloud, AutoML and Custom ML Model Workflows, GPUs/TPUs for Model Training, Experiment Tracking and Model Evaluation, Integration of Notebooks (Jupyter, Colab) with Cloud Storage.		
UNIT - IV	**Advanced Cloud Concepts for AI Applications**	
Containers and Docker for AI Applications, Kubernetes and Cloud-native AI Workflows, Serverless Computing: AWS Lambda, Azure Functions, CI/CD Pipelines for AI Models in Cloud, Scaling AI Applications using Load Balancers and Auto-Scaling. Monitoring and Logging in Cloud for AI Workflows.		
UNIT - V	**Security, Ethics, and Case Studies in Cloud AI**	
Security and Privacy in Cloud-based AI, Identity and Access Management (IAM) in Cloud, Cost Management and Billing for AI Services, Ethical Issues and Fairness in Cloud AI, Case Study: AI in Healthcare Cloud Solutions, Case Study: Real-Time Analytics in Financial Cloud Services.		
Textbooks:		

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, McGraw-Hill.
2. Judith Hurwitz et al., Cloud Computing for Dummies, Wiley.
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.

Reference Books:
1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, Distributed and Cloud Computing, Morgan Kaufmann.
 2. Tomasz Kajdanowicz et al., Practical Cloud AI, Springer.
3. Mark Wilkins, AI and Machine Learning for Coders in Cloud, Packt Publishing.

Online Learning Resources:
1. AWS Cloud Practitioner & Machine Learning Path – AWS Training
2. Google Cloud AI and ML Specialization – Coursera
3. Microsoft Azure AI Engineer Associate – Learn Portal

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1				Understand	L2	PO1 PO2 PO4 PO5	PO1:Apply(L3) PO2:Identify(l3) PO4:Analyze(L4) PO5:Apply(l3)	2 2 1 1
2				Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6 PO7	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb rule(L4) PO9: Thumb rule(L6)	3 3 3 1 3 1 1
3				Evaluate	L5	PO1 PO2 PO3 PO5 PO11	PO1: Apply(L3) PO2: Identify (L3) PO3: Design(L6) PO5: Create(L6) PO11: Thumb rule(L6)	1 1 1 1 1
4				Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO8	PO1: Apply(L3) PO2: Formulate (L6) PO3: Develop (L6) PO4: Analyze(L4) PO5: Apply(L3) PO8: Thumb rule(L5)	2 1 1 3 2
5				Analyze	L4	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify(L3) PO3:Discuss(L6) PO4:Explain(L5) PO5:create(L6)	2 2 1 1 1

Justification Statements:

CO1 Understand the cloud computing architecture, services, and deployment models.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by two levels. Therefore the correlation is moderate (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO4 verb by two levels. Therefore the correlation is moderate (2)
PO4 Verb: Analyze (L4)
CO1 Action verb less than PO4 verb by two levels. Therefore the correlation is low (1)
PO5 Verb: Apply (L3)
CO1 Action verb less than PO5 verb by one level. Therefore the correlation is low (1)

CO2: Apply the cloud platforms (AWS, GCP, Azure) for training and deploying AI models
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore the correlation is Moderate (2)
PO5: Apply (L3)
CO2 Action verb is same as PO5 verb. Therefore the correlation is high (3)
PO6: Thumb rule(L4)
For training AI models. Therefore the correlation is moderate (2).
PO7: Thumb rule(6)
For deploying AI models. Therefore the correlation is moderate (2).

CO3: Evaluate the large-scale data storage and processing in the cloud environment.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb by two levels. Therefore the correlation is is low (1)
PO2: Identify (L3)
CO3 Action verb is more than PO2 verb by two levels. Therefore the correlation is low (1)
PO3: Design(L6)
CO3 Action verb is less than PO3 verb by by one level. Therefore the correlation is low (1)
PO5: Create(L6)
CO3 Action verb is less than PO4 verb by one level. Therefore the correlation is low (1)
PO11: Thumb rule(L6)
CO3 Action verb is less than PO5 verb by one level. Therefore the correlation is low (1)

CO4: Analyze the AI workflows using serverless and container-based architectures.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO4 Action verb is more than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2: Formulate (L6)
CO4 Action verb is less than PO2 verb by two levels. Therefore the correlation is low (1)
PO3: Develop (L6)
CO4 Action verb is less than PO3 verb by two levels. Therefore the correlation is low (1)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore the correlation is high (3)
PO5: Apply (L3)
CO5 Action verb is more than PO5 verb by one level. Therefore the correlation is moderate (2)
PO8: Thumb rule
Design each function to perform a single, well-defined task. This modular approach simplifies debugging, testing, and scaling. Therefore the correlation is high (3)

CO5: Analyze the challenges in security, cost, scalability, and performance of cloud-based AI systems.
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO5 Action verb is more than PO1 verb by one level. Therefore the correlation is moderate (2)
PO2: Identify(L3)

CO5 Action verb is more than PO2 verb by one level. Therefore the correlation is moderate (2)
PO3:Discuss(L6)
CO5 Action verb is than PO3 verb by two levels. Therefore the correlation is low (1)
PO4:Explain(L5)
CO5 Action verb is less than PO4 verb by one level. Therefore the correlation is low (1)
PO5:create(L6)
CO5 Action verb is less than PO5 verb by two levels. Therefore the correlation is low (1)

Course Code	Year & Sem	SOCIAL NETWORK ANALYSIS	L	T	P	C
23APE3012	III-II	**(Professional Elective-III)**	**2**	**1**	**0**	**3**

Course Outcomes:
CO1: Understand social network structures and basic network models.
CO2: Analyze the structure and properties of large-scale social networks.
CO3: Apply community detection algorithms and influence maximization.
CO4: Evaluate diffusion models for viral marketing and Networks influences.
CO5: Apply the tools such as Gephi, Pajek, SNAP, Applications and Ethics for real-world SNA.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	Social Network structures and basic network models.			L2
CO2	Analyze	Structure and properties of large-scale social networks.			L4
CO3	Apply	Community Detection algorithms and influence maximization.			L3
CO4	Evaluate	Diffusion models for viral marketing and Networks influence.			L5
CO5	Apply	Tools, Applications and Ethics for real-world SNA			L3

UNIT - I	Introduction to Social Networks and Graph Theory	
Basic Concepts: Graphs, Nodes, Edges, Directed/Undirected Graphs, Real-world Examples: Facebook, Twitter, LinkedIn, Adjacency Matrix and Graph Representation, Types of Social Networks: Ego, Bipartite, Multilayer, Degree Distribution, Path Length, and Connectivity, Random Graph Models: Erdős–Rényi and Watts-Strogatz		
UNIT - II	Structural Properties of Networks	
Network Centrality Measures: Degree, Closeness, Betweenness, Eigenvector Centrality and PageRank, Network Clustering and Community Detection Basics, Triadic Closure and Clustering Coefficient, Small-world Phenomenon and Milgram's Experiment, Homophily, Influence, and Structural Balance.		
UNIT - III	Community Detection and Subgroup Analysis	
Girvan–Newman Algorithm and Modularity, Label Propagation and Louvain Method, Clique Detection and k-Core Decomposition, Overlapping Communities and Fuzzy Clustering, Cohesive Subgroups and Structural Equivalence, Evaluation Metrics: NMI, Modularity Score		
UNIT - IV	Information Diffusion and Influence in Networks	
Models of Diffusion: Linear Threshold and Independent Cascade, Influence Maximization and Viral Marketing, Contagion Models and Epidemic Spreading, Rumor Propagation and Cascade Models, Information Bottlenecks and Bridges, Measuring Influence and Reach.		
UNIT - V	Tools, Applications, and Ethics in SNA	
SNA Tools: Gephi, Pajek, NetworkX, SNAP, Case Study: Twitter and Hashtag Analysis, LinkedIn Network Mining and Graph Features, Applications in Marketing, Security, and Epidemiology, Ethical Issues in Social Network Data Mining, Building and Visualizing Your Own Social Graph.		

Mapping of course outcomes with program outcomes:

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

Correlation matrix

Unit No.	CO Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1				Understand	L2	PO1 PO2 PO3 PO5 PO9	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO5: Apply (L3) PO9: Thumb Rule	2 2 2 2 2
2				Analyze	L4	PO1 PO2 PO3 PO4	PO1: Apply(L3) PO2: Identify(L3) PO3: Apply (L3) PO4: Analyze (L4)	3 3 3 2
3				Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Identify (L3) PO3: Design(L6) PO4: Analyze (L4) PO5: Apply(L3)	3 3 2 2 2
4				Evaluate	L5	PO1 PO2 PO3 PO4 PO5 PO7 PO8	PO1: Apply(L3) PO2: Formulate (L6) PO3: Develop (L6) PO4: Analyze(L4) PO5: Apply(L3) PO7: Thumb Rule PO8: Thumb Rule	3 2 2 3 3 2 2
5				Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6 PO9	PO1: Apply(L3) PO2: Identify(L3) PO3: Design(L6) PO4: Analyze (L4) PO5: Apply(L3) PO6: Apply(L3) PO9: Analyze (L4)	2 2 3 3 2 2 2

Justification Statements:
CO1: Understand social network structures and basic network models
Action Verb: Understand (L2)
PO1: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 : Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is moderate (2)
PO5: Apply (L3)
CO2 Action verb is same as PO5 verb. Therefore, the correlation is moderate(2)
PO9: Thumb rule
Recognizing social networks through Graph Theory Therefore, the correlation is Moderate (2)

CO2: Analyze the structure and properties of large-scale social networks.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is moderate (2)

CO3: : Apply community detection algorithms and influence maximization.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO3 Action verb more than PO2 verb. Therefore, the correlation is high (3)
PO3: Design (L6)
CO3 Action verb less than PO2 verb by two levels. Therefore, the correlation is moderate(2)
PO4: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5: Create (L6)
CO3 Action verb less than PO5 verb by two levels. Therefore, the correlation is moderate (2)

CO4: Evaluate diffusion models for viral marketing and Networks influences.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2: Formulate (L6)
CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO3: Develop (L6)
CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is moderate (2)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is more than PO5 verb. Therefore, the correlation is high (3)
PO7: Thumb rule
Sharing Responsibility in modelling and Conflict management with role clarity. Therefore, the correlation is moderate (2).
PO8: Thumb rule
Identifying Ethical risks and Collaborate Effectively in multi role teams. Therefore, the correlation is moderate (2).

CO5: Apply the tools such as Gephi, Pajek, SNAP, Applications and Ethics for real-world SNA.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)
PO2 Verb: Identify (L3)

CO5 Action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2)

PO3: Develop (L6)

CO4 Action verb is PO2 verb by two levels. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is high (3)

PO5: Apply (L3)

CO2 Action verb is same as PO5 verb. Therefore, the correlation is moderate (2)

PO6: Thumb rule

Ensuring, Applying and Mastering the Network Analysis. Therefore, the correlation is moderate (2).

PO9: Thumb rule

Recognizing the tools, Evaluating the applications and Grounding the Ethics. Therefore, the correlation is moderate (2).

Course Code	Year & Sem	DISASTER MANAGEMENT	L	T	P	C
23AOE0103	III-II	**(Open Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes: After studying the course, students will be able to

CO1	Understand the fundamental concepts of natural disasters, their occurrence and disaster risk reduction strategies.
CO2	Understand the impact of cyclones on structures and explore retrofitting techniques for adaptive reconstruction
CO3	Understand engineering principles and computational techniques in designing wind-resistant structures
CO4	Understand earthquake effects on buildings and develop strategies for seismic retrofitting.
CO5	Understand seismic safety planning, design considerations, and innovative construction materials for disaster-resistant structures

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	fundamental concepts of natural disasters, their occurrence		disaster risk reduction strategies	L2
2	Understand	impact of cyclones on structures and explore retrofitting techniques	for adaptive reconstruction	using various strain gauge techniques.	L2
3	Understand	engineering principles and computational techniques		in designing wind resistant structures	L2
4	Understand	earthquake effects on buildings and develop strategies		for seismic retrofitting	L2
5	Understand	seismic safety planning, design considerations, and innovative construction materials		for disaster-resistant structures	L2

UNIT-I
Introduction to Natural Disasters– Brief Introduction to Different Types of Natural Disasters, Occurrence of Disasters in Different Climatic and Geographical Regions, Hazard Maps (Earthquake and Cyclone) of The World and India, Regulations for Disaster Risk Reduction, Post-Disaster Recovery and Rehabilitation (Socioeconomic Consequences).
UNIT-II
Cyclones and Their Impact– Climate Change and Its Impact On Tropical Cyclones, Nature of Cyclonic Wind, Velocities and Pressure, Cyclone Effects, Storm Surges, Floods, and Landslides. Behavior of Structures in Past Cyclones and Windstorms, Case Studies. Cyclonic Retrofitting, Strengthening of Structures, and Adaptive Sustainable Reconstruction. Life-Line Structures Such as Temporary Cyclone Shelters.
UNIT-III
Wind Engineering and Structural Response– Basic Wind Engineering, Aerodynamics of Bluff Bodies, Vortex Shedding, and Associated Unsteadiness Along and Across Wind forces. Lab: Wind Tunnel Testing and Its Salient Features. Introduction to Computational Fluid Dynamics (CFD). General Planning and Design Considerations Under Windstorms and Cyclones. Wind Effects On Buildings, towers, Glass Panels, Etc., and Wind-Resistant Features in Design. Codal Provisions, Design Wind Speed, Pressure Coefficients. Coastal Zoning Regulations for Construction and Reconstruction in Coastal Areas. Innovative Construction Materials and Techniques, Traditional Construction

Techniques in Coastal Areas.

UNIT-IV
Seismology and Earthquake Effects– Causes of Earthquakes, Plate Tectonics, Faults, Seismic Waves; Magnitude, Intensity, Epi center, Energy Release, and Ground Motions. Earthquake Effects– On Ground, Soil Rupture, Liquefaction, Landslides. Performance of Ground and Buildings in Past Earthquakes– Behavior of Various Types of Buildings and Structures, Collapse Patterns; Behavior of Non-Structural Elements Such as Services, Fixtures, and Mountings – Case Studies. Seismic Retrofitting– Weakness in Existing Buildings, Aging, Concepts in Repair, Restoration, and Seismic Strengthening.

UNIT-V
Planning and Design Considerations for Seismic Safety– General Planning and Design Considerations; Building forms, Horizontal and Vertical Eccentricities, Mass and Stiffness Distribution, Soft Storey Effects, Etc.; Seismic Effects Related to Building Configuration. Plan and Vertical Irregularities, Redundancy, and Setbacks. Construction Details– Various Types of Foundations, Soil Stabilization, Retaining Walls, Plinth Fill, Flooring, Walls, Openings, Roofs, Terraces, Parapets, Boundary Walls, Underground and Overhead Tanks, Staircases, and Isolation of Structures. Innovative Construction Materials and Techniques. Local Practices– Traditional Regional Responses. Computational Investigation Techniques.

TEXTBOOKS:
1. David Alexander, *Natural Disasters*, 1st Edition, CRC Press, 2017.
2. Edward A. Keller and Duane E. DeVecchio, *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*, 5th Edition, Routledge, 2019.

REFERENCES:
1. Ben Wisner, J.C. Gaillard, andIlanKelman (Editors), *Handbook of Hazards and Disaster Risk Reduction and Management*, 2nd Edition, Routledge, 2012.
2. Damon P. Coppola, *Introduction to International Disaster Management*, 4th Edition, Butterworth-Heinemann, 2020.
3. BimalKanti Paul, *Environmental Hazards and Disasters: Contexts, Perspectives and Management*, 2nd Edition, Wiley-Blackwell, 2020.

WEB RESOUCES:
https://nptel.ac.in/courses/124107010
https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

CORRELATION OF COS WITH THE POS & PSOS:

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

CO-PO MAPPING JUSTIFICATION:

Unit No	Course Outcomes					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson Plan Hrs	%	Correlation	CO's Action Verb	BTL			
1				Understand	L2	PO1	Apply (L3)	2
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
2				Understand	L2	PO1	Apply (L3)	2
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
3				Understand	L2	PO1	Apply (L3)	2
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
4				Understand	L2	PO1	Apply (L3)	2
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
5				Understand	L2	PO1	Apply (L3)	2
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2

JUSTIFICATION STATEMENTS:
CO1: **Understand the fundamental concepts of natural disasters, their occurrence and disaster risk reduction strategies.**
Action Verb: Understand (L2)
PO1: Apply(L3)
CO1 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO1 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO1 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

CO2: **Understand the impact of cyclones on structures and explore retrofitting techniques for adaptive reconstruction.**
Action Verb: Understand (L2)
PO1: Apply(L3)
CO2 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO2 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO2 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

CO3: **Understand engineering principles and computational techniques in designing wind-resistant structures**
Action Verb: Understand (L2)
PO1: Apply(L3)
CO3 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO3 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO3 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

CO4: **Understand earthquake effects on buildings and develop strategies for seismic retrofitting.**
Action Verb: Understand (L2)
PO1: Apply(L3)
CO4 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO4 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO4 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).
CO5: **Understand seismic safety planning, design considerations, and innovative construction materials for disaster-resistant structures**
Action Verb: Understand (L2)
PO1: Apply(L3)
CO5 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO5 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO5Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

Course Code	Year & Sem	SUSTAINABILITY IN ENGINEERING PRACTICES	L	T	P	C
23AOE0104	III-II	**(Open Elective-II)**	2	1	0	3

Course Outcomes: After studying the course, students will be able to

CO1	Understand concept of sustainability in the context of construction and CO_2 contribution of building materials along with their environmental impact
CO2	Understand the relation between construction materials and indoor air quality
CO3	Apply concepts to calculate embodied energy for commonly used construction materials using standard methodologies
CO4	Apply concepts of energy codes and green building rating systems for building envelops
CO5	Understand the environmental impacts and control methods of non-renewable energy sources

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	Concept of sustainability and CO_2 contribution of building materials along with their environmental impact		in the context of construction	L2
2	**Understand**	The relation between construction materials and indoor air quality			L2
3	**Apply**	concepts to calculate embodied energy for commonly used construction materials	using standard methodologies		L3
4	**Apply**	concepts of energy codes and green building rating systems		for building envelops	L3
5	**Understand**	the environmental impacts and control methods		of non-renewable energy sources	L2

UNIT-I

INTRODUCTION

Introduction and Definition of Sustainability - Carbon Cycle - Role of Construction Material: Concrete and Steel, Etc. - CO_2 Contribution from Cement and Other Construction Materials.

UNIT-II

MATERIALS USED in SUSTAINABLE CONSTRUCTION

Construction Materials and Indoor Air Quality - No/Low Cement Concrete - Recycled and Manufactured Aggregate - Role of QC and Durability - Life Cycle and Sustainability.

UNIT-III

ENERGY CALCULATIONS

Components of Embodied Energy - Calculation of Embodied Energy for Construction Materials - Energy Concept and Primary Energy - Embodied Energy Via-A-Vis Operational Energy in Conditioned Building - Life Cycle Energy Use

UNIT-IV

GREEN BUILDINGS

Control of Energy Use in Building - ECBC Code, Codes in Neighbouring Tropical Countries - OTTV Concepts and Calculations – Features of LEED and TERI – GRIHA Ratings – Role of Insulation and Thermal Properties of Construction Materials - Influence of Moisture Content and Modeling - Performance Ratings of Green Buildings - Zero Energy Building

UNIT-V

ENVIRONMENTAL EFFECTS

Non-Renewable Sources of Energy and Environmental Impact– Energy Norm, Coal, Oil, Natural Gas - Nuclear Energy - Global Temperature, Green House Effects, Global Warming - Acid Rain: Causes, Effects and Control Methods - Regional Impacts of Temperature Change.

TEXTBOOKS:
1. Charles J Kibert, Sustainable Construction: Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.

REFERENCES:
1. Craig A. Langston & Grace K.C. Ding, Sustainable Practicesin the Built Environment, Butterworth Heinemann Publishers, 2011.
2. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2012.

WEB RESOUCES:
   https://archive.nptel.ac.in/courses/105/105/105105157/

CORRELATION OF COS WITH THE POS & PSOS:

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

CO-PO MAPPING JUSTIFICATION:

Unit No	Course Outcomes					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson Plan Hrs	%	Correlation	CO's Action Verb	BTL			
1				Understand	L2	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	2 2 2
2				Understand	L2	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	2 2 2
3				Apply	L3	PO1 PO2 PO4 PO6	Apply (L3) Analyze (L4) Analyze (L4) Thumb Rule	3 2 2 2
4				Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
5				Understand	L2	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	2 2 2

JUSTIFICATION STATEMENTS:

CO 1: Understand concept of sustainability in the context of construction and CO_2 contribution of building materials along with their environmental impact
Action Verb: Understand (L2)
PO1: Apply(L3)
CO 1 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO1 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO 1 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

CO 2: Understand the relation between construction materials and indoor air quality
Action Verb: Understand (L2)
PO1: Apply(L3)
CO 2 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).
PO2: Analyze (L4)
CO 2 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
CO 2 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

CO 3: Apply concepts to calculate embodied energy for commonly used construction materials using standard methodologies
Action Verb: Apply (L3)
PO1: Apply(L3)
CO 3 Action verb is equal to PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO 3: Action Verb is low to PO2 verb. Therefore, the correlation is medium (2)

PO4: Analyze (L4)

CO 3: Action Verb is low to PO2 verb. Therefore, the correlation is medium (2)

CO 3 Action verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 as moderate (2).

CO 4: Apply concepts of energy codes and green building rating systems for building envelops
Action Verb: Apply (L3)

PO1: Apply(L3)

CO 4 Action verb is equal to PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO 4: Action Verb is low to PO2 verb. Therefore, the correlation is medium (2)

CO 4 Action verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 as moderate (2).

CO 5: Understand the environmental impacts and control methods of non-renewable energy sources

Action Verb: Understand (L2)

PO1: Apply(L3)

CO 5 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2: Analyze (L4)

CO 5 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).

CO 5 Action Verb is of BTL 2. Using Thumb rule, L2 correlates PO6 as moderate (2).

Course Code	Year & Sem	RENEWABLE ENERGY SOURCES	L	T	P	C
23AOE0202	III-II	**(Open Elective-II)**	**2**	**1**	**0**	**3**

After completion of the course, students will be able to:	
CO1	Understand solar radiation concepts, solar angles, and solar energy collection and storage methods.
CO2	Analyze the working principles, technologies, characteristics, and configurations of solar PV systems.
CO3	Analyze the components, design, and performance factors of wind energy conversion systems.
CO4	Understand Geothermal energy sources, applications, and their potential in India.
CO5	Understand the working principles, technologies, and limitations of ocean, biomass, and fuel cell energy systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
CO1	Understand	Solar radiation concepts, solar angles, and solar energy collection and storage methods			L2
CO2	Analyze	Working principles, technologies, characteristics, and configurations of solar PV systems			L4
CO3	Analyze	Components, design, and performance factors of wind energy conversion systems			L4
CO4	Understand	Geothermal energy sources, applications, and potential in India			L2
CO5	Understand	Working principles, technologies, and limitations of ocean, biomass, and fuel cell energy systems			L2

SYLLABUS
UNIT-I

TITLE: Solar Energy

Solar radiation - beam and diffuse radiation, solar constant, Sun at Zenith, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. Flat plate collectors, concentrating collectors, storage of solar energy-thermal storage.

UNIT-II

TITLE: PV Energy Systems

Introduction, The PV effect in crystalline silicon basic principles, the film PV, Other PV technologies, Solar PV modules from solar cells, mismatch in series and parallel connections design and structure of PV modules, Electrical characteristics of silicon PV cells and modules, Stand-alone PV system configuration, Grid connected PV systems.

UNIT-III

TITLE: Wind Energy

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades; wind data and energy estimation and site selection considerations.

UNIT-IV

TITLE : Geothermal Energy

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo- pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

UNIT-V
TITLE: Miscellaneous Energy Technologies
Ocean Energy: Tidal Energy-Principle of working, Operation methods, advantages and limitations. Wave Energy-Principle of working, energy and power from waves, wave energy conversion devices, advantages and limitations.
Bio mass Energy: Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration.
Fuel cell: Principle of working of various types of fuel cells and their working, performance and limitations.

Text books:	
1	G. D. Rai, —Non-Conventional Energy Sources‖, 4th Edition, Khanna Publishers, 2000.
2	...etan Singh Solanki —Solar Photovoltaics fundamentals, technologies and applications‖ 2nd Edition PHI Learning Private Limited. 2012.
Reference books:	
1	Stephen Peake, —Renewable Energy Power for a Sustainable Future‖, Oxford International Edition, 2018.
2	S. P. Sukhatme, —Solar Energy‖, 3rd Edition, Tata Mc Graw Hill Education Pvt. Ltd, 2008.
3	B H Khan, — Non-Conventional Energy Resources‖, 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011.
4	S. Hasan Saeed and D.K.Sharma, —Non-Conventional Energy Resources‖, 3rd Edition, S.K.Kataria& Sons, 2012.
5	G. N. Tiwari and M.K.Ghosal, —Renewable Energy Resource: Basic Principles and Applications‖, Narosa Publishing House, 2004.
Web Resources:	
1	https://nptel.ac.in/courses/103103206
2	https://nptel.ac.in/courses/108108078

Mapping of Course outcomes with Program outcomes (High-3, Medium-2, Low-1)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO 2
CO1	2	1		1		1						3	2
CO2	3	3	1			3						3	3
CO3	3	3	1			3						3	3
CO4	2					1						2	2
CO5	2					1						2	2

Mapping of Course outcomes with Program outcomes Justification Table

CO No.	Lesson Plan (Hrs.)	%	CO correlation	Verb	BTL	Program Outcomes (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of correlation (1-3)
1				Understand	L2	PO1, PO2, PO4, PO6	PO1:Apply(L3) PO2:Analyze(L4) PO4:Analyze(L4) PO6: Analyze(L4)	2 1 1 1
2				Analyze	L4	PO1, PO2, PO3, PO6	PO1:Apply(L3) PO2:Analyze(L4) PO3:Design(L6) PO6:Analyze(L4)	3 3 1 3

3				Analyze	L4	**PO1, PO2, PO3, PO6**	**PO1:Apply(L3) PO2:Analyze(L4) PO3:DesignL6) PO6:Analyze(L4)**	3 3 1 3
4				Understand	L2	**PO1, PO6**	**PO1:Apply(L3) PO6:Analyze(L4)**	2 1
5				Understand	L2	**PO1, PO6**	**PO1:Apply(L3) PO6:Analyze(L4)**	2 1

CO1: Understand solar radiation concepts, solar angles, and solar energy collection and storage methods.
Action Verb: Understand (L2)
PO1Verbs: Apply (L3)
CO1 ActionVerb is less than PO1 verb by one level; Therefore, correlation is Moderate (2).
PO2 Verbs: Analyze (L4)
CO1 ActionVerb is Less than PO2 verb by two level; Therefore, correlation is low (1).
PO4 Verbs: Analyze (L4)
CO1 ActionVerb is Less than PO2 verb by two level; Therefore, correlation is low (1).
PO6 Verbs: Analyze (L4)
CO1 ActionVerb is Less than PO2 verb by two level; Therefore, correlation is low (1).
CO2: Analyze the working principles, technologies, characteristics, and configurations of solar PV systems.
Action Verb: Analyze (L4)
PO1Verbs: Apply (L3)
CO2 ActionVerb is Greater than PO1 verb by one level; Therefore, correlation is High (3).
PO2 Verbs: Analyze (L4)
CO2 ActionVerb is Same to PO2 verb ; Therefore, correlation is High (3).
PO3Verbs: Design (L6)
CO2 ActionVerb is Less than PO2 verb by two level; Therefore, correlation is low (1).
PO6 Verbs:Analyze (L4)
CO2 ActionVerb is Same to PO6 verb ; Therefore, correlation is High (3).
CO3: Analyze the components, design, and performance factors of wind energy conversion systems.
Action Verb: Analyze (L4)
PO1Verbs: Apply (L3)
CO3 ActionVerb is Greater than PO1 verb by one level; Therefore, correlation is High (3).
PO2 Verbs: Analyze (L4)
CO3 ActionVerb is Same to PO2 verb ; Therefore, correlation is High (3).
PO3Verbs: Design (L6)
CO3 ActionVerb is Less than PO2 verb by two level; Therefore, correlation is low (1).
PO6 Verbs:Analyze (L4)
CO3 ActionVerb is Same to PO6 verb ; Therefore, correlation is High (3).
CO4: Understand Geothermal energy sources, applications, and their potential in India.
Action Verb: Understand (L2)
PO1Verbs: Apply (L3)
CO4 ActionVerb is less than PO1 verb by one level; Therefore, correlation is Moderate (2).
PO6 Verbs: Analyze (L4)
CO4 ActionVerb is less than PO2 verb by two level; Therefore, correlation is low (1).
CO5: Understand the working principles, technologies, and limitations of ocean, biomass, and fuel cell energy systems.
Action Verb: Understand (L2)
PO1Verbs: Apply (L3)
CO4 ActionVerb is less than PO1 verb by one level; Therefore, correlation is Moderate (2).
PO6 Verbs: Analyze (L4)
CO4 ActionVerb is less than PO2 verb by two level; Therefore, correlation is low (1).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(AUTONOMOUS)
B. Tech - Artificial Intelligence and Data Science (AI&DS)

Course Code	Year & Sem	Automation and Robotics	L	T	P	C
23APE0302	III-II	(Open Elective-II)	2	1	0	3

Course Outcomes:

CO: 1	Explain the need, types, and elements of automation systems and analyze different levels of automation strategies in industry.
CO: 2	Demonstrate the operation of automated flow lines and apply methods for assembly line balancing and optimization.
CO: 3	Identify robotic components and describe their configuration, degrees of freedom, and industrial applications in various processes.
CO: 4	Apply transformation techniques and D-H notation to solve problems in robot kinematics and evaluate actuator and sensor selection.
CO: 5	Analyze robot dynamics using Jacobians and Euler formulations and develop suitable trajectories for obstacle-free motion.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	structure and functions of automated		manufacturing systems	L2
CO2	Analyze	automated flow lines with or without buffer storage		assembly line balancing	L3
CO3	Understand	robot configurations	production efficiency		L2
CO4	Apply	kinematic and dynamic modeling		real-world industrial scenario	L3
CO5	Create	program, and implement robotic systems		Manufacturing.	L6

Unit I: Introduction to Automation: Introduction to Automation, Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation, Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.

Unit II
Automated flow lines: Automated flow lines, Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. Assembly line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

Unit III
Introduction to Industrial Robotics: Introduction to Industrial Robotics, Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers. Robot actuators and Feedback components: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.

Unit IV
Manipulator Kinematics: Manipulator Kinematics, Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics. Manipulator Dynamics: Differential transformations, Jacobians, Lagrange - Euler and Newton – Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.

Unit V
Robot Programming: Robot Programming, Methods of programming - requirements and features of

programming languages, software packages. Problems with programming languages. Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.

Text Books:
1. Automation, Production systems and CIM, M.P. Groover /4thEdition, Pearson education (2016)
2. Industrial Robotics - M.P. Groover, TMH (1996)

Reference Books:
1. Robotics, Fu K S, McGraw Hill, 4th edition, 2010.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering, Richard D. Klafter, Prentice Hall
4. Robotics, Fundamental Concepts and analysis – Ashitave Ghosal, Oxford Press, 1/e, 2006
5. Robotics and Control, Mittal R K & Nagrath I J, TMH.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Automat ion & Robotics	CO1	3	3				3							
	CO2	3	3											
	CO3	3	3			3	2							
	CO4	3	3	3		2								
	CO5	3	3			3	1							

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Understand	L2	PO1	Apply (L3)	2
						PO2	Identify (L3)	2
						PO6	Develop (L3)	2
2				Analyze	L3	PO1	Apply (L3)	3
						PO2	Identify (L3)	3
3				Understand	L2	PO1	Apply (L3)	2
						PO2	Identify (L3)	2
						PO5	Select (L1)	3
						PO6	Apply (L3)	2
4				Apply	L3	PO1	Apply (L3)	3
						PO2	Identify (L3)	3
						PO3	Create (L6)	3
						PO5	Create (L6)	3
5				Create	L6	PO1	Apply (L3)	3
						PO2	Identify (L3)	3
						PO5	Create (L6)	3
						PO6	Apply (L3)	3

Justification Statements:
CO1: Understand the structure and functions of automated manufacturing systems for efficient production.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO1: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO6 Verb: **Develop (L3)**
CO1 Action verb is same level as PO6 verb. Therefore, the correlation is high (3)
CO2: Analyze automated flow lines with or without buffer storage, perform quantitative evaluations, assembly line balancing techniques.
Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: Understand robot configurations and select suitable actuators and sensors to optimize production efficiency and flexibility.

Action Verb: **Creating (L6)**

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **select (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: **Apply (L3)**

CO3: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

CO4: Apply kinematic and dynamic modeling using D-H notation and select appropriate hardware and control strategies for real-world industrial scenario.

Action Verb: **Evaluate (L5)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Creating (L6)**

CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO5: Create program, and implement robotic systems to perform manufacturing tasks.

Action Verb: **Creating (L6)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: **apply (L3)**

CO3: Action verb is same level as PO6 verb. Therefore, the correlation is high (3)

Course Code	Year & Sem	DIGITAL ELECTRONICS	L	T	P	C
23AOE0402	III-II	(Open Elective-II)	2	1	0	3

Course Outcomes:

CO1: Understand the logic gates and minimization of Boolean functions using K-Maps.
CO2: Analyze the design procedure of Arithmetic circuits and code conversions using logic gates.
CO3: Analyze the design concepts of combinational logic circuits using logic gates.
CO4: Analyze the design aspects of sequential logic circuits using flip flops.
CO5: Understand various programmable logic devices and digital ICs.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the logic gates and minimization of Boolean functions using K-Maps.	using K-Maps		L2
CO2	Analyze	the design procedure of Arithmetic circuits and code conversions using gates.	using logic gates.		L4
CO3	Analyze	the design concepts of combinational logic circuits	using logic gates.		L4
CO4	Analyze	the design aspects of sequential logic circuits using flip flops.	using flip flops.		L4
CO5	Understand	various programmable logic devices and digital ICs.			L2

UNIT - I		21Hrs

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Introduction to Logic Gates, Ex-OR, Ex-NOR operations, Minimization of Switching Functions: Karnaugh map method, Logic function realization: AND-OR, OR-AND and NAND/NOR realizations.

UNIT - II		12Hrs

Introduction to Combinational Design 1: Binary Adders, Subtractors and BCD adder, Code converters - Binary to Gray, Gray to Binary, BCD to excess3, BCD to Seven Segment display

UNIT - III		19Hrs

Combinational Logic Design 2: Decoders, Encoders, Priority Encoder, Multiplexers, Demultiplexers, Comparators, Implementations of Logic Functions using Decoders and Multiplexers.

UNIT - IV		12Hrs

Sequential Logic Design: Latches, Flip-flops, S-R, D, T, JK and Master-Slave JK FF, Edge triggered FF, set up and hold times, Ripple counters, Shift registers

UNIT - V		11Hrs

Programmable Logic Devices: ROM, Programmable Logic Devices (PLA and PAL).
Digital IC's: Decoder (74x138), Priority Encoder (74x148), multiplexer (74x151) and de-multiplexer (74x155), comparator (74x85).

Textbooks:

1. Digital Design, M.Morris Mano & Michel D. Ciletti, 5th Edition, Pearson Education, 1999.
2. Switching theory and Finite Automata Theory, ZviKohavi and NirahK.Jha, 2nd Edition, Tata McGraw Hill, 2005.

Reference Books:

	1. Fundamentals of Logic Design, Charles H Roth,Jr., 5th Edition, Brooks/cole Cengage Learning, 2004

Online Learning Resources:

Nptel videos

Mapping of Course Outcomes with Program Outcomes

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

Correlation matrix

Unit No.	CO Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
1	14	18%	2	Understand	L2	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Develop (L3) PO4: Analyze (L4)	2 2 2 1
2	18	23%	4	Analyze	L4	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Develop (L3) PO4: Analyze(L4)	3 3 3 3
3	14	18%	4	Analyze	L4	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Develop (L3) PO4: Analyze(L4)	3 3 3 3
4	16	21%	4	Analyze	L4	PO1 PO3 PO4	PO1: Apply (L3) PO3: Develop (L3) PO4: Analyze(L4)	3 3 3
5	16	20%	2	Understand	L2	PO1 PO2 PO3	PO1: Apply (L3) PO2: Identify (L3) PO3: Develop (L3)	2 2 2
	76	100%						

Justification Statements:

CO1: Understand the logic gates and minimization of Boolean functions using K-Maps.

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3) CO1 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2 Verbs: Identify (L3) CO1 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).

PO3 Verbs: Develop (L3) CO1 Action Verb is less than PO3 verb by one level; Therefore, correlation is moderate (2).

PO4 Verbs: Analyze (L4) CO1 Action verb is less than PO4 verb by two levels. Therefore, the correlation is low (1)

CO2: Analyze the design procedure of Arithmetic circuits and code conversions using logic gates.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3) CO2 Action verb is more than PO1 verb by one level. Therefore, the correlation is high (3)

PO2 Verbs: Identify (L3) CO2 Action verb is more than PO2 verb by one level. Therefore, the correlation is high (3)

PO3 Verbs: Develop (L3) CO2 Action verb is more than PO3 verb by one level. Therefore, the correlation is high (3)

PO4 Verbs: Analyze (L4) CO2 Action Verb is equal to PO4 verb; Therefore, correlation is high (3).

CO3: Analyze the design concepts of combinational logic circuits using logic gates.

Action Verb: Analyze (L4)

PO1 Verbs: CO3 Action verb is more than PO1 verb by one level. Therefore, the correlation is high (3).

PO2 Verbs: CO3 Action verb is more than PO2 verb by one level. Therefore, the correlation is high (3).

PO3 Verb: CO3 Action verb is more than PO3 verb by one level. Therefore, the correlation is high (3).

PO4 Verbs: CO3 Action Verb is equal to PO4 verb, therefore correlation is high (3).

CO4: Analyze the design aspects of sequential logic circuits using flip flops.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3) CO4 Action verb is more than PO1 verb by one level. Therefore, the correlation is high (3).

PO2 Verb: Identify (L3) CO4 Action verb is more than PO3 verb by one level. Therefore, the correlation is high (3).

PO4 Verb: Develop (L3) CO4 Action Verb is equal to PO4 verb; Therefore, correlation is high (3).

CO5: Understand various programmable logic devices and digital ICs.

Action Verb: Understand (L2)

PO1 Verb: CO5 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2 verb: CO5 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).

PO3 verb: CO5 Action Verb is less than PO3 verb by one level; Therefore, correlation is moderate (2).

Course Code	Year & Sem	ADVANCED OPERATIONS RESEARCH	L	T	P	C
23AOE9902	**III-II**	**(Open Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes (CO): Student will be able to

1. Understand the concepts of linear programming in solving practical problems in industry.
2. Analyze the transportation models to trace the solutions to the real-world problems.
3. Apply mathematical skills to solve nonlinear programming models arising from a wide range of applications.
4. Apply the concept of non-linear programming for solving non-linear constraints.
5. Apply the concept of unconstrained geometric programming for solving the non-linear constraints.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the concepts of linear programming	in solving practical problems in industry.		**L2**
2	**Analyze**	the transportation models	to trace the solutions	to the real-world problems.	**L4**
3	**Apply**	mathematical skills	to solve nonlinear programming models	arising from a wide range of applications.	**L3**
4	**Apply**	the concept of non-linear programming	for solving non-linear constraints.		**L3**
5	**Apply**	the concept of unconstrained geometric programming	for solving the non-linear constraints.		**L3**

UNIT–I:
Linear programming I 8
hours
Introduction, Applications of Linear Programming, Standard form of a Linear Programming Problem, Geometry of Linear Programming Problems, Basic Definitions in Linear Programming.
UNIT–II : Linear programming II: Duality in Linear Programming 8
hours
Simplex Method, Simplex Algorithm and, Big-M method. Symmetric Primal-Dual Relations, General Primal-Dual Relations, Duality Theorem, Dual Simplex Method.
UNIT – III : Linear programming III
Transportation Problem and assignment problem, Complementary slackness Theorem.
UNIT – IV : Non-linear programming: Unconstrained optimization techniques 8
hours
Introduction: Classification of Unconstrained minimization methods,
Direct Search Methods: Random Search Methods: Descent Method and Fletcher Powell Method, Grid Search Method.
UNIT – V : Non-linear programming: Constrained optimization techniques 8
hours
Introduction, Characteristics of a constrained problem, Random Search Methods, complex method, Sequential linear programming, Basic approach in methods of Feasible directions, Zoutendijk's method of feasible directions: direction finding problem, determination of step length, Termination criteria.

TEXT BOOK:
1. Singiresu S Rao., Engineering Optimization: Theory and Practices, New Age Int. (P) Ltd. Publishers, New Delhi.
2. J. C. Panth, Introduction to Optimization Techniques, (7-e) Jain Brothers, New Delhi.

REFERENCES:
1. Harvey M. Wagner, Principles of Operation Research, Printice-Hall of India Pvt. Ltd. New Delhi.

2. Peressimi A.L., Sullivan F.E., Vhl, J. J. Mathematics of Non-linear Programming, Springer – Verlag.

Web Reference:

https://onlinecourses.nptel.ac.in/noc24_ee122/preview
https://archive.nptel.ac.in/courses/111/105/111105039/
https://onlinecourses.nptel.ac.in/noc21_ce60/preview

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1		1									
2		3									
3	3										
4	3										
5	3										

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				**Understand**	**L2**	PO2	**Analyze**	1
2				**Analyze**	**L4**	PO2	**Analyze**	3
3				**Apply**	**L3**	PO1	**Apply**	3
4				**Apply**	**L3**	PO1	**Apply**	3
5				**Apply**	**L3**	PO1	**Apply**	3

CO1: Understand the concepts of linear programming in solving practical problems in industry.
 Action Verb: Understand (L2)
PO2 Verbs: Analyze (L4)
CO1 Action Verb is two levels low to PO2 verb ; Therefore correlation is low (1).

CO2: Analyze the transportation models to trace the solutions to the real-world problems.
Action Verb: Analyze (L4)
PO2 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO3: Apply mathematical skills to solve nonlinear programming models arising from a wide range of applications.
Action Verb: Apply **(L3)**
PO1 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO4: Apply the concept of non-linear programming for solving non-linear constraints.
 Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO5: Apply the concept of unconstrained geometric programming for solving the non-linear constraints.
 Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO5 Action verb is equal to PO1 verb; therefore the correlation is high (3).

Course Code	Year & Sem	PHYSICS OF ELECTRONIC MATERIALS AND DEVICES	L	T	P	C
23AOE9907	**III-II**	**(Open Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes (CO): At the end of the course students will be able to
1. **Understand the fundamentals of crystal growth and thin films.**
2. **Analyze the charge carrier dynamics in semiconductors by implementing the equations of state.**
3. **Understand the basics of Semiconductors for Engineering Applications.**
4. **Analyze the concepts of excitons and luminescence in Semiconductors.**
5. **Apply the fundamentals of semiconductors for various display devices.**

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	**The fundamentals of crystal growth and thin films.**			**L2**
2	**Analyze**	**The charge carrier dynamics in semiconductors by implementing the equations of state.**			**L4**
3	**Understand**	**The basics of Semiconductors for Engineering Applications.**			**L2**
4	**Analyze**	**The concepts of excitons and luminescence in Semiconductors.**			**L4**
5	**Apply**	**The fundamentals of semiconductors for various display devices.**			**L3**

UNIT I   Fundamentals of Materials Science   9 Hrs
Introduction, Phase rule, Phase Diagram, Elementary idea of Nucleation and Growth, Methods of crystal growth. The basic idea of point, line, and planar defects. Concept of thin films, preparation of thin films, Deposition of thin film using sputtering methods (RF and glow discharge).

UNIT II Semiconductors   9 Hrs
Introduction, charge carriers in semiconductors, effective mass, Diffusion and drift, Diffusion and recombination, Diffusion length. The Fermi level & Fermi-Dirac distribution, Electron and Hole in quantum well, Change of electron-hole concentration- Qualitative analysis, Temperature dependency of carrier concentration, Conductivity and mobility, Effects of temperature and doping on mobility, High field effects.

UNIT III Physics of Semiconductor Devices: 9 Hrs
Introduction, Band structure, PN junctions and their typical characteristics under equilibrium and under bias, Heterojunctions, Transistors, MOSFETs.

UNIT IV Excitons and Luminescence: 9 Hrs
Luminescence: Different types of luminescence, basic definitions, Light emission in solids, Inter-band luminescence, Direct and indirect gap materials. Photoluminescence : General Principles of photoluminescence, Excitation and relaxation, OLED, Quantum-dot. Electro-luminescence : General Principles of electroluminescence, light emitting diode, diode laser.

UNIT V Display devices :   9 Hrs
LCD, three-dimensional display: Holographic display, light-field displays: Head-mounted display, MOEMS (Micro-Opto-Electro-Mechanical Systems) and MEMS displays.

Textbooks:
1. Principles of Electronic Materials and Devices-S.O. Kasap, McGraw-Hill Education (India) Pvt. Ltd.,4thedition, 2021.
2. Semiconductor physics & devices: basic principles, 4th Edition, McGraw-Hill, 2012.

Reference Books:
1. Solid State Electronic Devices -B.G. Streetman and S. Banerjee, PHI Learning,6th edition
2. Electronic Materials Science- Eugene A. Irene, Wiley, 2005
3. Electronic Components and Materials, Grover and Jamwal, DhanpatRai and Co., New Delhi.,

2012. 4. An Introduction to Electronic Materials for Engineers-Wei Gao, Zhengwei Li, Nigel Sammes, World Scientific Publishing Co. Pvt. Ltd. 2nd Edition,2011

NPTEL course links:

1. **https://nptel.ac.in/courses/113/106/113106062/**
2. **https://onlinecourses.nptel.ac.in/noc20_ph24/preview**

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Understand	L2	PO1, PO5	PO1: Apply (L3)	2
2				Analyze	L4	PO1, PO2	PO1: Apply (L3)	3
3				Understand	L2	PO1, PO5	PO1, PO5: Apply (L3)	2
4				Analyze	L4	PO1, PO5	PO1, PO5: Apply (L3)	3
5				Apply	L3	PO1	PO1: Apply (L3)	3

Mapping of COs to POs and PSOs

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

CO1: Understand the fundamentals of crystal growth and thin films.
Action Verb: Understand (L2)
PO1 & PO5 Verbs: Apply (L3)
CO1 Action Verb is lesser than PO1 and PO5 verbs by one level; Therefore,correlation is moderate (2).
CO2: Analyze the charge carrier dynamics in semiconductors by implementing the equations of state.
Action Verb: Analyze (L4)
PO1 & PO2 Verbs: Apply (L3)
CO2 Action Verb is greater than PO1 and PO2 verbs; Therefore correlation is high (3).
CO3: Understand the basics of Semiconductors for Engineering Applications.
Action Verb: Understand (L2)
PO1 and PO5 Verbs: Apply (L3)
CO3 Action Verb is less than PO1 and PO5 verb by one level; Therefore correlation is moderate (2).
CO4: Analyze the concepts of excitons and luminescence in Semiconductors.
Action Verb: Analyze (L4)
PO1 Verb and PO5 verbs: Apply (L3)
CO4 Action Verb is greater than PO1 and PO5 verbs by one level; Therefore, correlation is high (3).
CO5: Apply the fundamentals of semiconductors for various display devices.
Action Verb: Analyze (L4)
PO1 : Apply (L3)
CO5 Action verb is equal to PO1 verb; therefore, the correlation is high (3).

Course Code	Year & Sem	**Chemistry of Polymers and Applications**	L	T	P	C
23AOE9912	**III-II**	**(Open Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes (CO): At the end of the course students will be able to
1. Understand polymer fundamentals and classification systems.
2. Analyze the chemical and physical properties of natural polymers and their applications.
3. Apply the knowledge of thermoplastic and thermoset polymers in practical situations.
4. Understand the fundamental principles of hydrogel in polymer networks.
5. Analyze the preparation and mechanism of conducting and degradable polymers.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	polymer fundamentals and classification systems.			L2
2	**Analyze**	the chemical and physical properties of natural polymers and their applications.			L4
3	**Apply**	the knowledge of thermoplastic and thermoset polymers in practical situations			L3
4	**Understand**	the fundamental principles of hydrogel in polymer networks.			L2
5	**Analyze**	the fundamental principles of hydrogel in polymer networks			L4

Unit – I: Polymers-Basics and Characterization:-
Basic concepts: monomers, repeating units, degree of polymerization, linear, branched and network polymers, classification of polymers, Polymerization: addition, condensation, copolymerization and coordination polymerization. Average molecular weight concepts: number, weight and viscosity average molecular weights, polydispersity and molecular weight distribution. Measurement of molecular weight: End group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers.

Unit – II: Natural Polymers & Modified cellulosics
Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins.
Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals, Liquid crystalline polymers; specialty plastics- PES, PAES, PEEK, PEA.

Unit – III: Synthetic Polymers
Addition and condensation polymerization processes– Bulk, Solution, Suspension and Emulsion polymerization. Preparation and significance, classification of polymers based on physical properties. Thermoplastics, Thermosetting plastics, Fibers and elastomers, General Applications. Preparation of Polymers based on different types of monomers, Olefin polymers(PE,PVC), Butadiene polymers(BUNA-S,BUNA-N), nylons, Urea-formaldehyde, phenol – formaldehyde, Melamine Epoxy and Ion exchange resins.

Unit-IV: Hydrogels of Polymer networks
Definitions of Hydrogel, polymer networks, Types of polymer networks, Methods involved in hydrogel preparation, Classification, Properties of hydrogels, Applications of hydrogels in drug delivery.

Unit – V: Conducting and Degradable Polymers:
Conducting polymers: Introduction, Classification, Mechanism of conduction in Poly Acetylene, Poly Aniline, Poly Thiophene, Doping,Applications.
Degradable polymers: Introduction, Classifications, Examples, Mechanism of degradation, poly lactic acid, Nylon-6, Polyesters, applications.

Text Books:
1. A Text book of Polymer science, Billmayer
2. Polymer Chemistry – G.S.Mishra
3. Polymer Chemistry – Gowarikar

References Books:
1. Organic polymer Chemistry, K.J.Saunders, Chapman and Hall
2. Advanced Organic Chemistry, B.Miller, Prentice Hall
3. Polymer Science and Technology by Premamoy Ghosh, 3rd edition, McGraw-Hill, 2010.

Mapping of COs to POs and PSOs

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

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours				CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Register (Hrs)	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1					Understand	L2	PO1	PO1: Apply (L3)	2
2					Analyze	L4	PO1	PO1: Apply (L3)	3
3					Apply	L3	PO1	PO1: Apply (L3)	3
4					Understand	L2	PO1	PO1: Apply (L3)	3
5					Analyze	L4	PO1	PO1: Apply (L3)	3

CO1: Understand polymer fundamentals and classification systems.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO1 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
CO2: Analyze the chemical and physical properties of natural polymers and their applications
Action Verb: Analyze(L4)
PO1 Verbs: Apply (L3)
CO2 Action Verb is less than PO1 verb; Therefore correlation is moderate (2).
CO3: Apply the knowledge of thermoplastic and thermoset polymers in practical situations.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).
CO4: Understand the fundamental principles of hydrogel in polymer networks.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO3 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
CO5 Analyze the preparation and mechanism of conducting and degradable polymers
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO5 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).

Course Code	Year & Sem	ACADEMIC WRITING AND PUBLIC SPEAKING	L	T	P	C
23AOE9916	**III-II**	**(Open Elective-II)**	**2**	**1**	**0**	**3**

Course Outcomes (CO): Student will be able to

CO1: Apply the essential features of Academic Writing in scholarly works.L3

CO2: Apply the strategies of writing skills in research paper writing without plagiarism.L3

CO3: Create a coherent and well-organized paragraphs in essays, reports, reviews and SOP. L6

CO4: Analyze the characteristics and strategies of public speaking skills for impactful speeches.L4

CO5: Apply non-verbal communication skills for effective public speaking. L3

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	the essential features of Academic Writing in scholarly works			L3
2	Apply	the strategies of writing skills in research paper writing without plagiarism.	without plagiarism.		L3
3	Create	a coherent and well-organized paragraphs in essays, reports, reviews and SOP			L6
4	Analyze	the characteristics and strategies of public speaking skills for impactful speeches.		for impactful speeches.	L4
5	Apply	non-verbal communication skills for effective public speaking..		for effective public speaking..	L3

UNIT - I	Introduction to Academic Writing	Lecture Hrs
Introduction to Academic Writing – Essential Features of Academic Writing – Courtesy – Clarity – Conciseness – Correctness – Coherence – Completeness – Types – Descriptive, Analytical, Persuasive, Critical writing		
UNIT - II	**Academic Journal Article**	Lecture Hrs
Art of condensation- summarizing and paraphrasing - Abstract Writing, writing Project Proposal, writing application for internship, Technical/Research/Journal Paper Writing – Conference Paper writing - Editing, Proof Reading - Plagiarism		
UNIT - III	**Essay & Writing Reviews**	Lecture Hrs
Compare and Contrast – Argumentative Essay – Exploratory Essay – Features and Analysis of Sample Essays – Writing Book Report, Summarizing, Book/film Review- SoP		
UNIT - IV	**Public Speaking**	Lecture Hrs
Introduction, Nature, characteristics, significance of Public Speaking – Presentation – 4 Ps of Presentation – Stage Dynamics – Answering Strategies –Analysis of Impactful Speeches- Speeches for Academic events		
UNIT - V	**Public Speaking and Non-Verbal Delivery**	Lecture Hrs
Body Language – Facial Expressions-Kinesics – Oculesics – Proxemics – Haptics – Chronomics - Paralanguage - Signs		
Textbooks:		
3. *Critical Thinking, Academic Writing and Presentation Skills*: MG University Edition Paperback – 1 January 2010 Pearson Education; First edition (1 January 2010)		
4. Pease, Allan & Barbara. *The Definitive Book of Body Language*RHUS Publishers, 2016		

ference Books:
1. <u>Alice Savage</u>, <u>Masoud Shafiei</u> *Effective Academic Writing,***2Ed.,**2014 .sserP ytisrevinU drofxO
2. Shalini Verma, *Body Language*, S Chand Publications 2011.
3. Sanjay Kumar and Pushpalata,*Communication Skills* 2E 2015, Oxford.
4. Sharon Gerson, Steven Gerson,*Technical Communication Process and Product,* Pearson, New Delhi, 2014
5. *Elbow, Peter. Writing with Power. OUP USA, 1998*

Online Learning Resources:
1. https://youtu.be/NNhTIT81nH8
2. phttps://www.youtube.com/watch?v=478ccrWKY-A
3. https://www.youtube.com/watch?v=nzGo5ZC1gMw
4. https://www.youtube.com/watch?v=Qve0ZBmJMh4
5. https://courses.lumenlearning.com/publicspeakingprinciples/chapter/chapter-12-nonverbal- aspects-of-delivery/
6. https://onlinecourses.nptel.ac.in/noc21_hs76/preview
7. https://archive.nptel.ac.in/courses/109/107/109107172/#
8. https://archive.nptel.ac.in/courses/109/104/109104107/

Correlation of COs with the POs & PSOs f

Course Title	Course Outcomes COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ACADEMIC WRITING AND PUBLIC SPEAKING OPEN ELECTIVE - II	CO1									2		
	CO2									2		
	CO3									3		
	CO4									3		3
	CO5									2		2

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1							Thumb Rule	
2							Thumb Rule	
3							Thumb Rule	
4							Thumb Rule	
5							Thumb Rule	

CO1: Apply the essential features of Academic Writing in scholarly works.
Action Verb: Apply (L3)
CO1 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).
CO2: Apply the strategies of writing skills in research paper writing without plagiarism.
CO2 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)
CO3: Create a coherent and well-organized paragraphs in essays, reports, reviews and SOP.
CO3 Action Verb Create is of BTL 6. Using Thumb rule, L6 correlates PO6 to PO11 as high (3).
CO4: Analyze the characteristics and strategies of public speaking skills for impactful speeches.
Action Verb: Analyze (L4)
CO4 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).
CO5: Apply non-verbal communication skills for effective public speaking.
Action Verb: Apply (L3)
CO5 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as modera

Course Code	Year & Sem	MATHEMATICAL FOUNDATION OF QUANTUM TECHNOLOGIES	L	T	P	C
23AOE9903	III-II	(Open Elective-II)	2	1	0	3

Course Outcomes (CO): Student will be able to
1. Apply the applications to quantum systems through the study of vector spaces, inner products, and linear operators.
2. Analyze the transition from finite to infinite dimensional systems with linear algebra concepts to function spaces.
3. Analyze the quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution.
4. Evaluate the statistical interpretations through quantum mechanical principles to solve problems in simple quantum systems.
5. Create the understanding of measurement processes and modern quantum theory from the advanced concepts in composite systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Apply**	the applications to quantum systems	through the study of vector spaces, inner products, and linear operators.		**L3**
2	**Analyze**	the transition from finite to infinite dimensional systems	with linear algebra concepts to function spaces.		**L4**
3	**Analyze**	the quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution.	.		**L4**
4	**Evaluate**	statistical interpretations through quantum mechanical principles	to solve problems in simple quantum systems.		**L5**
5	**Create**	the understanding of measurement processes and modern quantum theory	from the advanced concepts in composite systems.		**L6**

UNIT I: Linear Algebra Foundation for Quantum Mechanics   **10 hours**
Vector spaces definition and examples (R^2, R^3, function spaces), Inner products (dot product, orthogonality, normalization), Linear operators (matrices, eigen values, eigen vectors), Finite-dimensional examples (2×2 matrices, spin-1/2 systems), Dirac notation introduction ($|\psi\rangle$, $\langle\varphi|$, $\langle\varphi|\psi\rangle$), Change of basis (transformations, unitary matrices).

UNIT II: From Finite to Infinite Dimensions   **8 hours**
Function spaces (L^2 space, square-integrable functions), Inner products for functions ($\int\psi^*\varphi\,dx$), Orthogonal function sets (Fourier series, basis functions), Introduction to Hilbert space concept (complete inner product spaces), Position and momentum representations (wave functions), Operators on functions (d/dx, multiplication by x).

UNIT III: Quantum Mechanical Formalism   **8 hours**
Mathematical formulation (states as vectors, observables as operators), Measurement theory (Born rule, expectation values, probabilities), Uncertainty relations (mathematical derivation from commutators), Time evolution (Schrödinger equation, unitary evolution).

UNIT IV: Applications and Statistical Interpretation   **6 hours**
Simple applications (infinite square well, harmonic oscillator), Statistical interpretation (ensembles, pure vs mixed states), Measurement process (von Neumann measurement scheme).

UNIT V: Advanced Topics   **8 hours**
Composite systems (tensor products basic introduction), Reversibility and irreversibility (unitary evolution vs measurement), Thermodynamic connections (equilibrium states, entropy), Modern perspectives (decoherence, measurement problem conceptual).

Textbooks:

- David J. Griffiths, Darrell F. Schroeter, "Introduction to Quantum Mechanics", 3rd Edition, Cambridge University Press (2018).
- R. Shankar, Principles of Quantum Mechanics, 2nd Edition, Kluwer Academy/Plenum Publishers (1994).

Reference Books:
- George. F. Simmons, "Introduction to Topology and Modern Analysis",MedTech Science Press.
- Gilbert Strang, Linear Algebra and Its Applications, 4th Edition, Cengage Learning (2006).
- John von Neumann and Robert T Beyer, Mathematical Foundations of Quantum Mechanics, Princeton Univ. Press (1996).

Web Resources

1. https://eclass.uoa.gr/modules/document/file.php/CHEM248/Griffiths%20-%20Introduction%20to%20Quantum%20Mechanics%203rd%20ed%202018.pdf

2. https://fisica.net/mecanica-quantica/Shankar%20-%20Principles%20of%20quantum%20mechanics.pdf

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3										
2		3									
3		3									
4			3								
5			3								

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Apply	L3	PO1	Apply	3
2				Analyze	L4	PO2	Analyze	3
3				Analyze	L4	PO2	Analyze	3
4				Evaluate	L5	PO3	Evaluate	3
5				Create	L6	PO3	Create	3

CO1: Apply the applications to quantum systems through the study of vector spaces, inner products, and linear operators.
Action Verb: Apply(L3)
PO1 Verbs: Apply (L3)
CO1 Action Verb is equal to PO1 verb ; Therefore correlation is high(3).
CO2: Analyze the transition from finite to infinite dimensional systems with linear algebra concepts to function spaces.
Action Verb: Analyze (L4)
PO2 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
CO3: Analyze the quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).
CO4: Evaluate the statistical interpretations through quantum mechanical principles to solve problems in simple quantum systems.
Action Verb: Evaluate (L5)
PO3 Verb: Evaluate (L5)
CO4 Action Verb level is equal to PO3 verb; Therefore correlation is high (3).
CO5: Create the understanding of measurement processes and modern quantum theory from the advanced concepts in composite systems.
Action Verb: Create (L6)
PO3 Verb: Create (L6)
CO5 Action verb is equal to PO3 verb; therefore the correlation is high (3).

Course Code	Year & Sem	DEEP LEARING LAB	L	T	P	C
23APC3009	III-II		**0**	**0**	**3**	**1.5**

CO Statements:

CO1: Understand the functioning of basic neural networks including Perceptions and Multilayer Perceptrons using Python frameworks.

CO2: Evaluate the impact of activation functions and optimization algorithms on training deep learning models.

CO3: Creating Design and develop Convolutional Neural Networks (CNNs) with data augmentation and transfer learning for image classification tasks.

CO4: Apply Recurrent Neural Networks (RNNs), LSTMs, and sequence models for text-based data analytics.

 CO5: Evaluate Deploy advanced deep learning models such as GANs and complete real-world case studies.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	The functioning of basic neural networks including Perceptions		Multilayer Perceptrons using Python frameworks.	L2
CO2	**Evaluate**	The impact of activation functions and optimization	Algorithms on training deep learning models.		L5
CO3	**Creating**	Design and develop Convolutional Neural Networks (CNNs)	Data augmentation and transfer learning for image classification tasks.		L6
CO4	**Apply**	Recurrent Neural Networks (RNNs), LSTMs		Sequence models for text-based data analytics.	L4
CO5	**Evaluate**	Deploy advanced deep learning models		Such as GANs and complete real-world case studies.	L5

List of Experiments

 1. Implement a basic Perceptron using Python and classify binary data.

 2. Build and train a Multilayer Perceptron (MLP) using TensorFlow/Keras on the MNIST dataset.

 3. Experiment with different activation functions (ReLU, sigmoid, tanh) and observe effects on learning.

 4. Compare optimizers (SGD, Adam, RMSprop) on convergence and performance.

 5. Implement Convolutional Neural Networks (CNN) for image classification on CIFAR-10 dataset.

 6. Perform data augmentation techniques and evaluate improvements in model accuracy.

 7. Implement Recurrent Neural Networks (RNN) and LSTMs for sentiment analysis on IMDB dataset.

 8. Train a GAN (Generative Adversarial Network) to generate handwritten digits.

 9. Use Transfer Learning (e.g., ResNet, VGG) for fine-tuning on a custom dataset.

 10. Evaluate model using metrics such as precision, recall, F1-score, ROC curves.

 11. Deploy a trained deep learning model using Flask or Streamlit for web-based inference.

 12. Case Study: Develop an end-to-end solution (e.g., face mask detector, plant disease detection

Textbooks

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
2. François Chollet, Deep Learning with Python, Manning Publications, 2nd Edition, 2021.
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, O'Reilly, 3rd Edition, 2022.

Reference Books

1. Nikhil Buduma, Fundamentals of Deep Learning, O'Reilly Media, 2017.
2. Josh Patterson and Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly, 2017.
3. Michael Nielsen, Neural Networks and Deep Learning (Online Book).

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

Correlation Matrix

Unit No.	CO						Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan (Hrs)	%	Correlation	Co's Action verb	BTL				
1				CO1: Understand	L2		PO1 PO2	PO1: Apply(L3) PO2: Identify(L3)	2 2
2				CO2: Evaluate	L5		PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify (L3) PO4: Analyze (L4) PO11: Thumb rule	1 1 2 1
3				CO3: Creating	L6		PO1 PO2 PO4	PO1: Apply(L3) PO2: Analyze (L4) PO4: Analysis (L4)	1 2 2
4				CO4: Apply	L3		PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify (L3) PO3: Analysis(L4) PO11: Thumb rule	3 3 3 2
5				CO5: Evaluate	L5		PO1 PO2 PO4 PO11	PO1: Apply(L3) PO2: Identify(L3) PO3: Analysis(L4) PO11: Thumb rule	2 2 2 2

JUSTIFICATION STATEMENTS:

CO1: Understand the functioning of basic neural networks including Perceptions and Multilayer Perceptrons using Python frameworks.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

CO2: Evaluate the impact of activation functions and optimization algorithms on training deep learning models.
Action Verb: Evaluate (L5)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is medium (2)
PO2: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is medium (2)
PO4: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO11: Thumb rule
For use some training deep learning models. Therefore, the correlation is low (1)

CO3: Creating Design and develop Convolutional Neural Networks (CNNs) with data augmentation and transfer learning for image classification tasks.
Action Verb: Creating (L6)
PO1: Apply (L3)
CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is low (1)
PO2: Analyze (L4)
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is medium (2)
PO4: Analysis (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is medium (2)
PO11: Thumb rule
For use map reduce and H base technologies to handling big data. Therefore, the correlation is medium (2)

CO4: Apply Recurrent Neural Networks (RNNs), LSTMs, and sequence models for text-based data analytics.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO4 Action verb is less than PO1 verb by two levels. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO4 Action verb is less than PO2 verb by two levels. Therefore, the correlation is high (3)
PO3: Design (L6)
CO4 Action verb is less than PO3 verb by one level. Therefore, the correlation is high (3)
PO4: Analysis (L4)
CO4 Action verb is less than PO4 verb by one level. Therefore, the correlation is high (3)
PO11: Thumb rule
For use map reduce applications to test and debug big data. Therefore, the correlation is medium   (2)

CO5: Evaluate Deploy advanced deep learning models such as GANs and complete real-world case studies.
Action Verb: Evaluate (L5)
PO1: Apply(L3)
CO5 Action verb is less than PO1 verb by two levels. Therefore, the correlation is medium (2)
PO2: Identity (L3)
CO5 Action verb is less than PO2 verb by two levels. Therefore, the correlation is medium (2)
PO4: Analysis (L4)
CO5 Action verb is less than PO4 verb by two levels. Therefore, the correlation is medium (2)
PO11: Thumb rule
For use to deep learning models such as GANs. Therefore, the correlation is high (3)

Course Code	Year & Sem	BIG DATA ANALYTICS AND DATA VISUALIZATION LAB	L	T	P	C
23APC3011	III–II		**0**	**0**	**3**	**1.5**

Course Outcomes:
- **CO1: Understand** the big data ecosystems and tools.
- **CO2: Apply** the data analysis tasks using Hadoop and Spark.
- **CO3: Apply** the data visualization using Python and BI platforms.
- **CO4: Analyze** the patterns, trends, and correlations in large datasets.
- **CO5: Create** the dashboards and interactive visual insights.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the big data ecosystems and tools.			L2
CO2	Apply	the data analysis tasks	Using Hadoop and Spark.		L3
CO3	Apply	the data visualization	using Python and BI platforms		L3
CO4	Analyze	the patterns, trends, and correlations		For large datasets.	L4
CO5	Create	the dashboards and interactive visual insights		for dashboards and interactive visual insights	L6

List of Experiments

1. Installation of Hadoop ecosystem and execution of basic HDFS commands
2. Word Count and File Processing using Hadoop MapReduce
3. Working with Hive: Table creation, loading data, and performing analytical queries
4. Data cleaning and transformation using PySpark DataFrames
5. Implementing MLlib algorithms (e.g., Classification/Clustering) on Spark
6. Connecting Spark with MongoDB/Cassandra for NoSQL-based Big Data processing
7. Visualizing data using Matplotlib and Seaborn for univariate and bivariate analysis
8. Creating interactive plots using Plotly and Dash
9. Exploratory Data Analysis (EDA) and feature analysis with Pandas and Seaborn
10. Real-time data ingestion (Twitter API or sensor data) and live visualization with Kafka + Spark Streaming
11. Developing a dashboard using Tableau/Power BI for insights from processed Big Data
12. Mini Project: End-to-end pipeline integrating Big Data processing and visualization using any real dataset

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO						Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Corre lation	Co's Action verb	BT L				
1				Understand	L2		PO1 PO2 PO5	PO1: Apply(L3) PO2: Identify(L3) PO5:Apply(L3)	2 2 2
2				Apply	L3		PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Analyze(L4) PO3: Apply (L3) PO5: Apply (L3)	3 2 3 3
3				Apply	L3		PO1 PO2 PO3 PO5 PO9	PO1: Apply(L3) PO2: Identify (L3) PO3: Design(L6) PO5: Apply(L3) PO9:Thumbrule	3 3 1 3 3
4				Analyze	L4		PO1 PO2 PO5	PO1: Apply(L3) PO2: Analyze (L4) PO4: Analyze(L4) PO5: Analyze(L4)	3 3 3 3
5				Create	L6		PO1 PO3 PO6	PO1: Apply(L3) PO3: Create(L6) PO6: Thumb rule	3 3 3

Justification Statements:
CO1: Understand the big data ecosystems and tools.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore the correlation is moderate (2).
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2).
PO5: Apply(L3)
CO1 Action verb is less than PO5 verb by one level. Therefore the correlation is moderate (2).

CO2: Apply the data analysis tasks using Hadoop and Spark.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore the correlation is high (3).
PO2: Analyze(L4)
CO2 Action verb is less than PO2 verb by one level. Therefore the correlation is moderate (2).
PO3: Apply (L3)
CO2 Action verb is same level as PO3 verb. Therefore the correlation is high (3).
PO5: Apply (L3)
CO2 Action verb is same as PO5 verb. Therefore the correlation is high (3).

CO3: Apply the data visualization using Python and BI platforms.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore the correlation is high (3).
PO2: Identify (L3)

CO3 Action verb is same level as PO2 verb. Therefore the correlation is high (3).
PO3: Design (L6)
CO3 Action verb less than PO3 verb by three levels. Therefore the correlation is low (1).
PO5: Apply(L3)
CO3 Action verb is same level as PO5 verb. Therefore the correlation is high (3).
PO9: Thumb rule
Apply data visualization techniques using Python and BI platforms to clearly present analytical results and communicate insights effectively to both technical and non-technical audiences. Therefore the correlation is high (3).

CO4: Analyze the patterns, trends, and correlations in large datasets.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore the correlation is high (3)
PO2: Analyze (L4)
CO4 Action verb is same level as PO2 verb. Therefore the correlation is high (3)
PO 4: Analyze (L4)
CO4 Action verb is same level as PO4 verb. Therefore the correlation is high (3)
PO5: Analyze (L4)
CO4 Action verb is same level as PO5 verb. Therefore the correlation is high (3)

CO5: Create the dashboards and interactive visual insights.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb. Therefore the correlation is high (3).
PO3 Verb: Create (L6)
CO5 Action verb is same level as PO3 verb. Therefore the correlation is high (3).
PO6 Verb: Thumb rule
Create dashboards and interactive visual insights using modern tools to solve engineering problems and communicate data-driven solutions that address societal and global challenges. Therefore the correlation is high (3).

Course Code	Year & Sem	Skill Enhancement course	L	T	P	C
23ASC3001	III-II	**Full Stack Development-II**	1	0	2	2

Course Outcomes:
CO1: Understand the foundational concepts of web development including HTML, CSS, shell scripting, version control using Git, and web servers.
CO2: Analyze the front-end behavior of web applications using JavaScript, jQuery, AJAX, and JSON for responsive and dynamic interactions.
CO3: Apply ReactJS and Redux principles to build and manage state in single-page web applications.
CO4: Evaluate Java-based backend development using Spring MVC and RESTful APIs, and manage projects using Maven.
CO5: Create full-stack web applications by integrating SQL databases, Spring JDBC, and deploying them using cloud platforms with agile methodologies.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the foundational concepts of web development including HTML, CSS, shell scripting, version control using Git, and web servers	—	—	**L2**
CO2	Analyze	the front-end behavior of web applications using JavaScript, jQuery, AJAX, and JSON	for responsive and dynamic interactions	—	**L4**
CO3	Apply	ReactJS and Redux principles	—	to build and manage state in single-page web applications	**L3**
CO4	Evaluate	Java-based backend development using Spring MVC and RESTful APIs	—	and manage projects using Maven	**L5**
CO5	Create	full-stack web applications by integrating SQL databases, Spring JDBC	—	and deploying them using cloud platforms with agile methodologies	**L6**

UNIT – I	Web Development Basics	
Web Development Basics: Web development Basics – HTML & Web servers, Shell – UNIX CLI, Version control – Git & Github, HTML, CSS.		
UNIT – II	Frontend Development	
Frontend Development: JavaScript basics, OOPS Aspects of JavaScript, Memory usage and Functions in JS, AJAX for data exchange with server, jQuery Framework, jQuery events, UI components etc., JSON data format.		
UNIT – III	REACT JS	
REACT JS: Introduction to React, React Router and Single Page Applications, React Forms, Flow Architecture and Introduction to Redux, More Redux and Client-Server Communication.		
UNIT – IV	Java Web Development	
Java Web Development: JAVA PROGRAMMING BASICS, Model View Controller (MVC) Pattern, MVC Architecture using Spring, RESTful API using Spring Framework, Building an application using Maven.		
UNIT – V	Databases & Deployment	
Databases & Deployment: Relational schemas and normalization, Structured Query Language (SQL), Data persistence using Spring JDBC, Agile development principles and deploying application in Cloud.		

Textbooks:
1. Web Design with HTML, CSS, JavaScript and JQuery Set Book by Jon Duckett Professional JavaScript for Web Developers Book by Nicholas C. Zakas
2. Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites by Robin Nixon
3. Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB. Copyright © 2015 BY AZAT MARDAN

Reference Books:
1. Full-Stack JavaScript Development by Eric Bush
2. Mastering Full Stack React Web Development Paperback – April 28, 2017 by Tomasz Dyl, Kamil Przeorski, Maciej Czarnecki

Mapping of course outcomes with program outcomes

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

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0–3)
	Lesson Plan(Hrs)	%	Corre lation	CO's Action Verb	BTL			
1				Understand	L2	PO1 PO2	PO1: Apply (L3) PO2: Identify (L3)	2 2
2				Analyze	L4	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Identify (L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply (L3)	3 3 3 3 3
3				Apply	L3	PO1 PO2 PO3 PO4	PO1: Apply (L3) PO2: Identify (L3) PO3: Apply (L3) PO4: Analyze (L4)	3 3 3 2
4				Evaluate	L5	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Identify (L3) PO3: Apply (L3) PO4: Analyze (L4) PO5: Apply (L3)	3 3 3 3 3
5				Create	L6	PO1 PO2 PO3 PO4 PO5 PO9	PO1: Apply (L3) PO2: Identify (L3) PO3: Design (L6) PO4: Analyze (L4) PO5: Apply (L3) PO9: Thumb rule	3 3 3 3 3 3
	Total							

Justification Statements:

CO1: Understand the foundational concepts of web development including HTML, CSS, shell scripting, version control using Git, and web servers.
Action Verb: **Understand (L2)**
PO1 Verb: **Apply (L3)**
CO1 action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2).
PO2 Verb: Identify (L3)
CO1 action verb is less than PO2 verb by one level. Therefore, the correlation is moderate (2).

CO2: Analyze the front-end behavior of web applications using JavaScript, jQuery, AJAX, and JSON

for responsive and dynamic interactions.

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO2 action verb is greater than PO1 verb by one level. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO2 action verb is greater than PO2 verb by one level. Therefore, the correlation is high (3).

PO3 Verb: **Apply (L3)**

CO2 action verb is greater than PO3 verb by one level. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO2 action verb is same as PO4 verb. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO2 action verb is greater than PO5 verb by one level. Therefore, the correlation is high (3).

CO3: Apply ReactJS and Redux principles to build and manage state in single-page web applications.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO3 action verb is same as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO3 action verb is same as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: **Apply (L3)**

CO3 action verb is same as PO3 verb. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO3 action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2).

CO4: Evaluate Java-based backend development using Spring MVC and RESTful APIs, and manage projects using Maven.

Action Verb: **Evaluate (L5)**

PO1 Verb: **Apply (L3)**

CO4 action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO4 action verb is greater than PO2 verb by two levels. Therefore, the correlation is high (3).

PO3 Verb: Apply (L3)

CO4 action verb is greater than PO3 verb by two levels. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO4 action verb is greater than PO4 verb by one level. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO4 action verb is greater than PO5 verb by two levels. Therefore, the correlation is high (3).

CO5: Create full-stack web applications by integrating SQL databases, Spring JDBC, and deploying them using cloud platforms with agile methodologies.

Action Verb: Create (L6)

PO1 Verb: Apply (L3)

CO5 action verb is greater than PO1 verb by three levels. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO5 action verb is greater than PO2 verb by three levels. Therefore, the correlation is high (3).

PO3 Verb: **Design (L6)**

CO5 action verb is same as PO3 verb. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO5 action verb is greater than PO4 verb by two levels. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO5 action verb is greater than PO5 verb by three levels. Therefore, the correlation is high (3).

PO9: Thumb rule

CO5 focuses on cloud deployment and agile methods, requiring team collaboration and communication. Therefore, the correlation is high (3).

Course Code	Year & Sem	Technical Paper Writing & IPR	L	T	P	C
23AMC9902	**III-II**	**Audit Course**	**2**	**0**	**0**	**-**

	Course Outcomes (CO): Student will be able to	
CO1	Understand various principles and styles of technical writing by avoiding confusion, repetition, unclear language and plagiarism.	L2
CO2	Apply the fundamentals of technical research paper writing by organizing abstract, objectives, limitations, literature review to frame effective research questions.	L3
CO3	Apply the research process and publication mechanisms and follow citation rules and proofreading techniques for paper writing.	L3
CO4	Evaluate the rights and responsibilities of the holder of Intellectual Property.	L5
CO5	Apply various forms of copy rights and patents at national and international levels.	L3

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	various principles and styles of technical writing by avoiding confusion, repetition, unclear language and plagiarism.	by avoiding confusion, repetition,unclear language and plagiarism.		L2
2	Apply	the fundamentals of technical research paper writing by organizing abstract, objectives, limitations, literature review to frame effective research questions.	by organizing abstract, objectives, limitations, literature review to frame effective research questions.		L3
3	Apply	the research process and publication mechanisms and follow citation rules and proofreading techniques for paper writing.		for paper writing.	L3
4	Evaluate	rights and responsibilities of holder of Patent, Copyright, trademark, International Trademark etc.			L5
5	Apply	various forms of copy rights and patents at national and international levels		At national and international levels	L3

UNIT – I:

Principles of Technical Writing: styles in technical writing; clarity, precision, coherence and logical sequence in writing-avoiding ambiguity- repetition, and vague language -highlighting your findings-discussing your limitations - hedging and criticizing -plagiarism and paraphrasing.

UNIT – II:
Technical Research Paper Writing: Abstract- Objectives-Limitations Review of Literature- Problems and Framing Research Questions- Synopsis

UNIT – III:
Process of research: publication mechanism: types of journals- indexing-seminars- conferences- proof reading –plagiarism style; seminar & conference paper writing; Methodology-discussion- results- citation rules

UNIT – IV:

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting technical evaluating trade mark, trade mark registration processes

UNIT – V:

Law of copy rights: Fundamentals of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer, Patent law, intellectual property audits.

Textbooks:

1. Deborah. E. Bouchoux, *Intellectual Property Rights*, Cengage Learning India, 2013
2. Meenakshi Raman, Sangeeta Sharma. *Technical Communication: Principles and practices.* Oxford.

Reference Books:

1. R.Myneni, *Law of Intellectual Property*, 9th Ed, Asia law House, 2019.
2. Prabuddha Ganguli, *Intellectual Property Rights* Tata Mcgraw Hill, 2001
3. P.Naryan, *Intellectual Property Law*, 3rd Ed, Eastern Law House, 2007.
4. Adrian Wallwork. *English for Writing Research Papers* Second Edition. Springer Cham Heidelberg New York ,2016
5. Dan Jones, Sam Dragga, *Technical Writing Style*

Online Resources

1. **https://theconceptwriters.com.pk/principles-of-technical-writing/**
2. **https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/Tech PaperWriting.h tml**
3. **https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/Tech PaperWriting.h tml**
4. **https://www.manuscriptedit.com/scholar-hangout/process-publishing- research-paper- journal/**
5. **https://www.icsi.edu/media/website/IntellectualPropertyRightLaws&Practice.pdf**
6. **https://lawbhoomi.com/intellectual-property-rights-notes/**
7. **https://www.extension.purdue.edu/extmedia/ec/ec-723.pdf**

SCorrelation of COs with the POs & PSOs

Course Title	Course Outcomes COs	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11
TECHNICAL PAPER WRITING AND INTELLECTUAL PROPER RIGHTS (Audit Course)	CO1									2		
	CO2		3									
	CO3									2		2
	CO4											3
	CO5											2

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1							Thumb Rule	
2							Thumb Rule	
3							Thumb Rule	

| 4 | | | | | | | Thumb Rule | |
| 5 | | | | | | | Thumb Rule | |

CO1: Understand various principles and styles of technical writing by avoiding confusion, repetition, unclear language and plagiarism.
Action Verb: Understand (L2)
CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Apply the fundamentals of technical research paper writing by organizing abstract, objectives, limitations, literature review to frame effective research questions.
Action Verb: Apply (L3)
CO2 Action Verb Apply is of BTL 3. L3 is equal to PO2, then correlation is high (3)

CO3: Apply the research process and publication mechanisms and follow citation rules and proofreading techniques for paper writing.
Action Verb: Apply (L3)
CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)

CO4: Evaluate the rights and responsibilities of the holder of Intellectual Property.
Action Verb: Evaluate (L5)
CO4 Action Verb Analyze is of BTL 4. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).

CO5: Apply various forms of copy rights and patents at national and international levels.
Action Verb: Apply (L3)
CO5 Action Verb Analyse is of BTL 4. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).