Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	**: Diploma In Electronics & Tele-communication Engg.**		
Programme Code	**: EJ**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 16 WEEKS**
Semester	**: Sixth** **NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	MANAGEMENT	MAN	AEC	315301	1	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	EMERGING TRENDS IN ELECTRONICS	ETE	DSC	316337	-	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
3	OPTICAL NETWORK AND SATELLITE COMMUNICATION	ONS	DSC	316332	-	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175
4	COMPUTER NETWORK & DATA COMMUNICATION	CND	DSC	316338	-	4	-	4	2	10	5	3	30	70	100	40	25	10	-	-	25	10	150
5	CAPSTONE PROJECT	CPE	INP	316004	-	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150
other (Any - One)																								
6	AUTOMATION & PLC	ATP	DSE	316334	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
	DRONE TECHNOLOGY	DRT	DSE	316335	2	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
	VLSI APPLICATIONS	VLS	DSE	316340	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
Total					**3**	**18**		**12**	**10**		**20**		**150**	**350**	**500**		**125**		**100**		**175**		**900**

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :
1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg.**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE**
Semester	**: Fifth / Sixth**
Course Title	**: MANAGEMENT**
Course Code	**: 315301**

I. RATIONALE

Effective management is the cornerstone of success for both organizations and individuals. It empowers diploma engineers/ professionals to accomplish their tasks with finesse and efficiency through strategic planning and thoughtful execution, projects can optimize finances, enhance safety measures, facilitate sound decision-making, foster team collaboration and cultivate a harmonious work environment. The diploma engineers require leadership and management skills with technical knowledge of the core field to carry out various tasks smoothly. This course aims to instill fundamental management techniques, empowering diploma engineers/ professionals to enhance their effectiveness in the workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply the relevant managerial skills for achieving optimal results at workplace.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use relevant management skills to handle work situation
- CO2 - Apply appropriate techniques of product, operations and project management
- CO3 - Use comprehensive tools of recent management practices
- CO4 - Plan suitable marketing strategy for a product / service
- CO5 - Utilize supply chain and human resource management techniques for effective management

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

MANAGEMENT **Course Code : 315301**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315301	MANAGEMENT	MAN	AEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 1 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Justify the importance of management thoughts in Indian knowledge system. TLO 1.2 Describe the importance of management in day to day life. TLO 1.3 Explain Henry Fayol’s principles of management. TLO 1.4 Describe the role of each level of management in its management hierarchy. TLO 1.5 Practice the self management skills for a given situation TLO 1.6 Apply the required managerial skills for a given situation	**Unit - I Introduction to Management** 1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS) 1.2 Management: meaning, importance, characteristics, functions & challenges. 1.3 Introduction to scientific management- Taylor's & Fayol's principles of management 1.4 Levels & functions of management at supervisory level. 1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking 1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership	Presentations Case Study Interactive session Quiz competition Mixed Picture Puzzle

MANAGEMENT **Course Code : 315301**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Identify the appropriate creativity technique for new product development TLO 2.2 Describe the new product development process for a product / service TLO 2.3 Comprehend the importance of various strategic steps Product Management TLO 2.4 Elaborate Agile product management TLO 2.5 Explain the significance of the Project Management TLO 2.6 Describe the various tools of project management	**Unit - II Product, Operations and Project Management** 2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats. 2.2 New product development, change management 2.3 Product Management -meaning, strategic steps for sustainable design of a product 2.4 Agile product management- concept, benefits, principles and manifesto 2.5 Project Management: importance, areas within project management,4Ps and phases 2.6 Tools of Project Management: PERT and CPM, GANTT & Chart Overview of Estimate and Budget	Presentations Case Study Video Demonstrations Presentations Role Play
3	TLO 3.1 Understand the importance of quality management tools TLO 3.2 Explain the importance of various techniques for optimization and waste minimization TLO 3.3 State the importance of ISO quality standards TLO 3.4 Describe ERP TLO 3.5 State the importance of ISO TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage	**Unit - III Management Practices** 3.1 Quality circle, kaizen, Six Sigma, TQM 3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance 3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020 3.4 The overview of ERP along with example 3.5 Service quality and customer/client satisfaction, servicescape	Presentation Case study Interactive session Quiz Video Demonstration Lecture Using Chalk-Board
4	TLO 4.1 Explain the importance of marketing techniques TLO 4.2 Explain the importance of needs, wants and desires in marketing TLO 4.3 Interpret the traditional and digital marketing techniques TLO 4.4 Plan different aspects of an event management	**Unit - IV Marketing Management** 4.1 Marketing management: meaning, significance, Seven P's of Marketing 4.2 Needs, wants and demands in marketing. Customer relationship management 4.3 Types of marketing: traditional and digital marketing 4.4 Event management: types, different aspects of event management, crisis management	Case Study Interactive session based video Role Play Flipped Classroom Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 State the importance of supply chain and logistics management TLO 5.2 Explain the components of supply chain and logistics Management TLO 5.3 Describe the role of information technology in supply chain & logistics management TLO 5.4 State the significance of Human Resource Management TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization TLO 5.6 List the qualities of a successful supervisor	**Unit - V Supply Chain & Human Resource Management** 5.1 The overview of Supply Chain and logistics Management 5.2 Components of Supply Chain and logistics Management 5.3 Role of information technology in supply chain & logistics management 5.4 Overview of Human Resource Management-Meaning,significance,scope and principles 5.5 Recruitment, selection and training of human resources. Chalk Circle 5.6 Qualities of a successful supervisor /team leader and types of leadership	Presentations Video Demonstrations Case Study Collaborative learning Video Demonstrations Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment / Article

- Make a one page note based on a book of management you read.
- Write a short article on inventory management exploring online learning resources.
- Prepare a report on ISO standards applicable to your field. a. IATF 16949-2016 / SLA-TS 16949-2016, - Automotive Industry b. ISO 22000 — Food safety management c. ISO 50001 — Energy management d. ISO/IEC 27001 - Cyber Security e. ISO/DIS 4931-1 - Buildings and civil engineering works
- Prepare a 4 quadrant matrix of time management for managing the tasks.
- Prepare a report on any one software used for Supply Chain and Logistics Management.
- Prepare a GANTT Chart for project management related to your field.

Note Taking

- Watch a Tedx Talk Video on managerial skills and take notes in the form of keywords.

Case Study

- Prepare a case study and discuss the same on following topics a.Self Management Skills b.Six Thinking Hats c.Kaizen d.Quality Circle e.Safety Measures in different organizations related to your field
- Study the recruitment and selection process of any organization related to your field.
- Prepare a case study on management lessons based on life of Chhatrapati Shivaji Maharaj
- Conduct outbound training on managerial skills. Make a video and upload on social media.

Quizes

- Participate in online quizzes related to areas of management .

Assignment

- Workshops to be conducted for students on following topics a. creativity techniques b. time management c. stress management d. negotiation and conflict e. goal setting f. meditation new product development

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Management	CO1	13	8	6	4	18
2	II	Product, Operations and Project Management	CO2	8	2	4	6	12
3	III	Management Practices	CO3	8	4	4	6	14
4	IV	Marketing Management	CO4	8	2	4	6	12
5	V	Supply Chain & Human Resource Management	CO5	8	4	4	6	14
Grand Total				**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- MCQ Based Class Test, Self Learning Activities / Assignment

Summative Assessment (Assessment of Learning)

- Summative Assessment (Assessment of Learning) MCQ based

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3

CO1	1	1	1	-	-	2	3			
CO2	1	3	3	-	1	3	3			
CO3	1	3	1	-	1	1	3			
CO4	1	2	2	-	1	2	3			
CO5	1	1	2	-	1	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A. K. Gupta	Engineering Management	S. Chand, ISBN: 81-219-2812-5, 2007, 2nd Edition
2	O. P. Khanna	Industrial Engineering &management	Dhanpat Rai Publication, ISBN: 978-8189928353, 2018
3	Harold Koontz and Heinz Weinrich	Essentials of Management	Tata McGraw Hill Education ISBN: 9789353168148, 2020, 12th edition
4	E. H. McGrath	Basic Managerial Skills for All	PHI ISBN: 978-8120343146, 2011, 9th Edition
5	Andrew DuBrin	Management Concepts and Cases	Cengage Learning, ISBN: 978-8131510537, 2009, 9th edition
6	K. Dennis Chambers	How Toyota Changed the World	Jaico Books ISBN: 978-81-8495-052-6, 2009
7	Jason D. O'Grandy	How Apple changed the Wolrd	Jaico Publishing House ISBN: 978-81-8495-052-0, 2009
8	Subhash Sharma	Indian Management	New Age International Private Limited ; ISBN-978-9389802412, 2020, 1st edition
9	Chitale, Dubey	Organizational Behaviour Text and Cases	PHI LEARNING PVT. LTD., ISBN: 978-9389347067, 2019, 2nd Edition

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.debonogroup.com/services/core-programs/six-thinking-hats/	Six Thinking Hats
2	https://hbr.org/1981/09/managing-human-resources	HR Management
3	https://theproductmanager.com/topics/agile-product-management/	Agile Product Management
4	https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management	Supply Chain Management
5	https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm	PERT, CPM, GANTT Chart
6	https://www.simplilearn.com/best-management-tools-article	Management Tools
7	https://www.psychometrica.in/free-online-psychometric-tests.html	Psychometric Tests
8	https://www.investopedia.com/terms/e/erp.asp	ERP
9	https://asq.org/quality-resources/quality-management-system	QMS
10	https://testlify.com/test-library/creative-thinking/	Psychometric Tests
11	https://www.mindtools.com/	Management Skills
12	https://www.investopedia.com/terms/d/digital-marketing.asp	Digital Marketing

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MANAGEMENT **Course Code : 315301**

MSBTE Approval Dt. 24/02/2025 **Semester - 5 / 6, K Scheme**

EMERGING TRENDS IN ELECTRONICS **Course Code : 316337**

Programme Name/s	**: Automation and Robotics/ Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg.**
Programme Code	**: AO/ DE/ EJ/ ET/ EX/ IE/ TE**
Semester	**: Sixth**
Course Title	**: EMERGING TRENDS IN ELECTRONICS**
Course Code	**: 316337**

I. RATIONALE

The rapid advancement in electronics is driven by innovations in computing, communication, automation ,technologies such as AI, ML, IoT, quantum computing. Modern manufacturing techniques, including surface mount technology and automated assembly improves production quality and sustainability. Next-generation telecom networks enable faster and more reliable data exchange. This course will help student to acquire knowledge in Emerging trends in electronics.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences: "Acquire knowledge of Emerging Trends in Electronics fields."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select the appropriate processor for a specific type of application.
- CO2 - Suggest the relevant techniques in the electronic system manufacturing process.
- CO3 - Suggest a different telecom network for the given application.
- CO4 - Connect IoT Devices to cloud platforms for data storage and analysis.
- CO5 - Interpret drone component functions, government guidelines, and application areas.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316337	EMERGING TRENDS IN ELECTRONICS	ETE	DSC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

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4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the architecture of given specific modern processors. TLO 1.2 Compare the salient features of ESP32 and ESP8266. TLO 1.3 Establish the relationship between Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL). TLO 1.4 Differentiate between Single Agent and Multi-Agent with examples. TLO 1.5 Compare classical computing with quantum computing with a suitable example.	**Unit - I Advanced Processors and Technology** 1.1 Graphical Processing Unit (GPU): Introduction, features, Overview of processor architecture, superscalar concept, advantages and applications 1.2 ESP 32: features, pin out, Interfacing board, Comparison with ESP 8266 and Arduino Uno, simple programs and applications 1.3 Artificial Intelligence/Machine Learning [AI/ML]: Definitions, applications and advantages of AI, Definition and Types of ML(Machine Learning) such as Supervised, Unsupervised and Reinforcement. Relationship between DL (Deep Learning), ML and AI. Agents in AI: Single Agent and Multi-Agent 1.4 Quantum Computing: Introduction, qubit (quantum bit), comparison of classical versus Quantum systems, Applications of Quantum Computing	Video Demonstrations Presentations Collaborative learning Flipped Classroom

EMERGING TRENDS IN ELECTRONICS **Course Code : 316337**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Compare SMD technology over traditional (through-hole components) technology in terms of size, performance, and manufacturing efficiency. TLO 2.2 Explain the Human-Machine Interface (HMI) concept in smart manufacturing. TLO 2.3 Analyze the role of robotics in smart manufacturing. TLO 2.4 Suggest modern machines of the given specifications for electronic system assembly and manufacturing. TLO 2.5 Evaluate the significance of environmental standards such as EPEAT and RoHS in electronic manufacturing and their impact on sustainability. TLO 2.6 Explain the concept of Open Source Assembly and Testing.	**Unit - II Smart Manufacturing Processes and Tools** 2.1 Surface Mount Technology (SMT): Introduction, characteristics, advantages, applications 2.2 HMI and Robotics in Smart Manufacturing Process : Introduction, functionality, types, benefits, Robotics in Smart Manufacturing: Functionality, benefits, types of Robots: Articulated Robots, Selective Compliance Articulated Robot Arm (SCARA),Autonomous Mobile Robots (AMRs), Cobots. 2.3 Modern Electronic Assembly and Manufacturing Process: Introduction, classification of machines used in electronic assembly, role, features, and specifications of different machines. Pick-and-Place Machine: Working principle and operation, specifications, Automatic Component Insertion Machine: Functionality and working mechanism, advantages over manual component placement. Reflow soldering Method :Overview of soldering techniques in PCB assembly, working principle, stages of the reflow soldering process (Preheating, Soaking, Reflow, Cooling) 2.4 Environmental standards for electronic manufacturing such as: Electronic Product Environmental Assessment Tool (EPEAT) and Restriction of Hazardous Substances (RoHS) standards 2.5 Introduction to Open Source Assembly and Testing (OSAT)	Video Demonstrations Presentations Site/Industry Visit Flipped Classroom
3	TLO 3.1 Explain the function of the given network component. TLO 3.2 Interpret the spectrum used in the present Telecom sector. TLO 3.3 Compare the mobile generations. TLO 3.4 Explain the Multi Protocol Label Switching in NGN core. TLO 3.5 Analyze Fiber to the Home (FTTH) technology, its architecture, and components of Optical Line Termination (OLT) and Optical Network Unit (ONU). TLO 3.6 Assess the effect of Optical Transport Network(OTN) on data transmission.	**Unit - III Next Generation Telecom Network** 3.1 NGN architecture: Features, Functional block diagram, Network components: Media Gateway, Media Gateway Controller, and Application Server 3.2 NGN Wireless Technology: Telecom network Spectrum: Licensed and unlicensed radio bands, Mobile network evolution (3G to 5.5G) and comparative features 3.3 NGN Core: Concepts, features and advantages 3.4 Fiber to the Home (FTTH): Features, architecture and components: Optical Line Termination (OLT) ,Optical Network Unit (ONU) 3.5 Synchronous Digital Hierarchy (SDH), Optical Transport Network(OTN): Introduction, features and applications	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe different IoT architectures and their role in data processing. TLO 4.2 Compare different cloud service providers based on their capabilities and applications. TLO 4.3 Explain how IoT enhances efficiency and automation in different industrial sectors. TLO 4.4 Explain the applications and benefits of Industry 5.0 in smart manufacturing. TLO 4.5 Differentiate between Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), along with their applications across various domains.	**Unit - IV IIoT and Immersive Technologies** 4.1 Internet of Things (IoT): Introduction, functions of Cyber physical system components, architectures, IoT sensor to cloud data routes 4.2 Introduction to Cloud computing, Cloud service providers (AWS, AZURE, GOOGLE Cloud, ThingSpeak), ThingSpeak: Features, collecting and retrieving data from ThingSpeak, applications 4.3 Applications of IoT in Industries: Automotive, Discrete Manufacturing, Telecom and Agro- industries 4.4 Industry 5.0 and Industrial IoT (IIoT): Introduction, evolution from I1.0 to I5.0, applications and benefits of I5.0, Compare I3.0, I4.0 and I5.0, Architecture of I5.0 4.5 Introduction to Immersive Technologies: Overview of Virtual reality (VR), Augmented Reality (AR), Mixed reality (MR) and Extended reality (XR)	Lecture Using Chalk-Board Hands-on Collaborative learning Flipped Classroom
5	TLO 5.1 Classify drones based on structural configuration. TLO 5.2 Describe the functions of different drone components. TLO 5.3 Interpret relevant government drone regulations. TLO 5.4 Identify the utility of drones in the given application.	**Unit - V Drone Systems and Applications** 5.1 Overview of Drone Technologies, Types of Drones: Multi-Rotor, Single-Rotor, Fixed-Wing, Hybrid 5.2 Hardware Components of drones: Frame, Propellers, Motors, Electronic speed controller, Flight controllers, Gimbal, Radio transmitter and receiver, GPS, Camera, Power distribution panel, Landing gears, Sensors: accelerometer, gyroscope and magnetometers, Batteries: lithium polymer and lithium-ion 5.3 Regulations and safety considerations: Category of zones: Red zone, Inner yellow zone, Outer yellow zone, Green zone, DGCA rules and regulations for registration, operation and pilot license of drones 5.4 Drone Applications: Photography, Logistics, Medical, Agriculture, Defence, Surveillance, Disaster management	Presentations Video Demonstrations Model Demonstration Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Develop a simple ESP32-based sensor data logging system and explain the interfacing process.
- Implement a basic IoT-based LED control program using ESP32 and document the code.
- Develop a smart home automation system using an ESP32 microcontroller, allowing users to control home appliances (lights, fans, etc.) via a smartphone using Wi-Fi and a web-based dashboard or mobile app.

- Collect temperature and humidity data using DHT11/DHT22 sensors and send it to an IoT platform like ThingSpeak.
- Use networking tools like Cisco Packet Tracer to simulate MPLS functionality.
- Detect gas leaks using an MQ-6 sensor and send alerts to users via SMS or an IoT platform.
- Use an ultrasonic sensor in dustbins to detect the garbage level and send notifications to the waste collection department.
- Assemble a simple quadcopter using a frame, motors, electronic speed controllers, and a flight controller.

Student Activity

- Prepare a report on Open Source Assembly and Testing (OSAT).
- Prepare a report on automatic electronic components assembly machine.
- Prepare a PowerPoint presentation on upcoming 5G technology.
- Prepare a report on quantum bits (qubits) and their role in quantum processing using diagrams.
- Prepare a PowerPoint presentation on various Government of India schemes related to drones.
- Prepare a report on the application area of different types of drones.
- Prepare a report on the eligibility criteria for Remote Pilot License and the DGCA approved Remote Pilot Training Organizations near your area.
- Create a PowerPoint presentation on GPU architecture and its role in AI and gaming applications.
- Prepare a PowerPoint presentation on the functions of various sensors and actuators used in drones.
- Prepare internet-based reports on real-world applications of AI and ML in different industries.

Assignment

- Compare the working of superscalar processors with real-world examples.
- Explore anti-drone technology.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Advanced Processors and Technology	CO1	10	2	6	8	16
2	II	Smart Manufacturing Processes and Tools	CO2	9	4	4	6	14
3	III	Next Generation Telecom Network	CO3	9	4	4	6	14
4	IV	IIoT and Immersive Technologies	CO4	8	2	4	6	12
5	V	Drone Systems and Applications	CO5	9	4	4	6	14
Grand Total				**45**	**16**	**22**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

Summative Assessment (Assessment of Learning)

- Online MCQ type Exam

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	2	3	3	2	3			
CO2	2	1	2	2	2	1	2			
CO3	2	1	2	2	3	1	2			
CO4	2	2	2	3	2	2	3			
CO5	1	1	2	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Sudhir Warier	The ABC of Fiber Optics Communication	Artech House Publishers ISBN: 978-1630814144
2	David Hanes, Salgueiro Gonzalo, et al.	IoT Fundamentals: Networking Technologies, Protocols and use cases for Internet of Things	Pearson Education ISBN: 978-9386873743
3	Saroj Kaushik	Artificial Intelligence	Cengage Learning India Pvt. Ltd. ISBN: 978-9355730428
4	Dharna Nar, Radhika Kotecha	Drone Technology for Beginners- Learn | Build | Fly Drones	Drone School India and Ane Books Pvt Ltd. ISBN: 978-8197222184
5	Garvit Pandya	Basics of Unmanned Aerial Vehicles : Time to start working on Drone Technology	Notion Press Media Pvt Ltd. ISBN: 978-1637453865
6	Bhushan Patil, Manisha Vohra	Introduction to Extended Reality (XR) Technologies	John Wiley & Sons Inc. ISBN: 978-1119857228
7	Guy A. Boy	The Handbook of Human-Machine Interaction A Human-Centered Design Approach	CRC Press ISBN: 9780367111939

Sr.No	Author	Title	Publisher with ISBN Number
8	S K. Saha	Introduction to Robotics	Tata McGraw-Hill Education ISBN: 978-9355326461

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.rohsguide.com/rohs-faq.htm	RoHS Guide
2	http://www.trai.gov.in/	TRAI official website for Next Generation Network
3	https://www.tec.gov.in/	Technical Enginnering Centre Technical Reports.
4	https://cfdflowengineering.com/working-principle-and-compone nts-of-drone/	Introduction about drone components
5	https://www.twi-global.com/technical-knowledge/faqs/industry -5-0	Industry 5.0
6	https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.20 12-200609-S!!PDF-E&type=items	Next Generation Networks – Frameworks and functional architecture mode
7	https://www.dgca.gov.in/digigov-portal/?page=jsp/dgca/Invent oryList/headerblock/drones/RPAS.html	DGCA Drone rules
8	https://circuitdigest.com/microcontroller-projects/programmi ng-esp32-with-arduino-ide	Programming ESP32 Board with Arduino IDE
9	https://cloud.google.com/learn/artificial-intelligence-vs-machine-learning	Artificial intelligence (AI) vs. machine learning (ML)
10	https://www.plugxr.com/augmented-reality/ar-vr-mr-xr/	AR vs VR vs MR vs XR – What is the difference?
11	https://www.electronicsandyou.com/electronics-assembly-equip ment-guide.html	Electronic system assembly and machines
12	https://esp32io.com/	ESP 32 Tutorials
13	https://randomnerdtutorials.com/getting-started-with-esp32/	Getting Started with the ESP32 Development Board
14	https://learnesp32.com/videos/course-introduction/course-int roduction	Learn ESP32

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg.**
Programme Code	**: DE/ EJ/ EK/ ET/ EX/ IE/ TE**
Semester	**: Sixth**
Course Title	**: OPTICAL NETWORK AND SATELLITE COMMUNICATION**
Course Code	**: 316332**

I. RATIONALE

Optical networks and satellite communication are the backbone of all high speed communications. The optical networking and satellite communication course is crucial for driving innovative technologies across multiple sectors. This course has been designed to empower diploma engineering students to maintain fiber optics and satellite communication systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attend the following industry/employer expected outcome through various teaching learning experiences.

Maintain optical and satellite communication systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the functions of the various units of optical fiber communication system.
- CO2 - Evaluate the performance characteristics of optical sources and detectors.
- CO3 - Establish analog and digital fiber optic link.
- CO4 - Analyze various parameters influencing performance of transmitted and received signals in satellite communication systems.
- CO5 - Maintain Satellite earth segment.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316332	OPTICAL NETWORK AND SATELLITE COMMUNICATION	ONS	DSC	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Interpret the Electromagnetic Magnetic Spectrum and spot the optical bands used for optical fiber communication. TLO 1.2 Describe the functions of each block in fiber optic communication system. TLO 1.3 Define the given basic optic terms. TLO 1.4 Classify the optical fiber cables based on modes of propagation of light and index profile TLO 1.5 Describe fiber joints, fiber connectors and splices. TLO 1.6 Describe step by step splicing procedure.	**Unit - I Basics of Optical fiber communication** 1.1 Electromagnetic spectrum, optical bands and optical windows, need for optical fiber communication. 1.2 Construction, advantages ,disadvantages and applications of fiber optic cable ,block diagram of optical fiber communication system. 1.3 Definition-Reflection, Refraction, Total Internal Reflection (TIR),Snell's law, Critical angle, Numerical Aperture (NA) , Acceptance angle and Acceptance cone , Light propagation in optical fiber–(Numerical on above concepts) 1.4 Classification of optical fibers-based on modes of propagation of light and index profile, Propagation modes-single mode, multi mode ,mode-field diameter in single-mode optical fiber (SMF) 1.5 Fiber joints, fiber connectors, splices 1.6 Splicing Techniques-Fusion splice,V-groove splice and elastic tube splice	Presentations Video Demonstrations Lecture Using Chalk-Board

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe working principle and characteristics of given optical source. TLO 2.2 Describe the working principle and characteristics of the given optical detector. TLO 2.3 Explain the coherent detection technique used in optical receivers. TLO 2.4 Describe the working of the given optical network component. TLO 2.5 Compare the working of optical amplifiers.	**Unit - II Optical Communication Systems** 2.1 Working principle and characteristics of sources: Edge emitting Light Emitting Diode, Edge emitting Light Amplification by Stimulated Emission of Radiation 2.2 Working principle and characteristics of detectors : PIN photodiode , Avalanche photo diode, Comparison of PIN photodiode and Avalanche photo diode 2.3 Eye diagram, BER ,Q -Factor and Coherent detection in optical receivers 2.4 Couplers, isolators, circulators, Optical routers 2.5 Basic applications and types of optical amplifiers: Erbium -Doped Fiber Amplifiers, Raman Amplifiers, features of Optical network Ethernet standards : IEEE 802.3j,802.3y,802.3z	Lecture Using Chalk-Board Presentations
3	TLO 3.1 Explain dispersion in optical fibers. TLO 3.2 Describe dispersion management and compensation techniques for improved transmission. TLO 3.3 Illustrate the effect of pulse spreading on signal transmission. TLO 3.4 Describe the transmission losses in the optical fiber cable. TLO 3.5 Describe the steps to measure optical parameters using OTDR. No Numerical.	**Unit - III Characteristics of Optical Fiber** 3.1 Dispersion in Optical fiber, types of dispersion 3.2 Dispersion compensation techniques , dispersion measurements - Chromatic Dispersion, Group Velocity Dispersion, Dispersion Slope, Polarization Mode Dispersion 3.3 Pulse spreading and its impact on signal transmission 3.4 Transmission losses in the optical fiber- Insertion loss, Return loss, dispersion loss, coupling loss, attenuation loss, absorption losses, radiation losses and linear scattering losses 3.5 Link power budget, Optical Time Domain Reflectometer (OTDR)-Working Principle.	Lecture Using Chalk-Board Demonstration Presentations
4	TLO 4.1 Describe the types of satellites and their respective functions. TLO 4.2 Explain the phenomenon of limits of visibility and Sun Transit Outage. TLO 4.3 Define the given key satellite communication terms-(latitude, longitude, look angle, elevation angle, station keeping, propagation delay, velocity, and footprint). TLO 4.4 Describe Kepler's law of satellite motion.	**Unit - IV Overview of Satellite Systems** 4.1 Block diagram of Satellite Communication system, Earth segment , Different types of satellites-Active, Passive, geostationary and geosynchronous, Frequency allocation for satellite services-uplink and downlink frequency, Satellite frequency bands 4.2 Different satellite orbits-Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Elliptical Orbit, Geostationary Earth Orbit (GEO) and their comparison , limits of visibility and Sun Transit Outage. 4.3 Basic terminologies used in satellite communication-latitude, longitude ,look angle, elevation angle, station keeping, propagation delay time, velocity and footprint (numerical on Look Angle) 4.4 Kepler's law of satellite motion (three laws), apogee and perigee heights, orbital perturbations, effects of a nonspherical earth shape, atmospheric drag, effect of eclipse on satellite motion.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Hands-on Case Study Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the roles and operations of the subsystem in the satellite earth station. TLO 5.2 Describe various satellite link transmission losses. TLO 5.3 Compute different parameters related to satellite communication using the link power budget analysis. TLO 5.4 Describe the working of the VSAT with the help of a suitable block diagram.	**Unit - V Satellite space segment and space link** 5.1 Block Diagram of Satellite Earth Station, Antenna subsystem,Low Noise Amplifier (LNA),Power subsystem, Telemetry Tracking and Control (TT & C) system, Power Supply subsystem, Attitude Control, Spinning satellite stabilization, Momentum wheel stabilization, Thermal control, Main and auxiliary propulsion subsystem, Transponders:-Single ,double conversion and regenerative type, wideband receiver, input demultiplexer, power amplifier 5.2 Equivalent Isotropic Radiated Power (EIRP), Transmission Losses : Free- space transmission loss, Feeder losses, Antenna misalignment losses, Fixed atmospheric and ionosphere losses, PC- PC communication using Satellite Link , rain attenuation 5.3 Link-Power Budget, System Noise, Carrier-to-Noise Ratio, Combined Uplink and Downlink C/N Ratio, Reliability in satellite System 5.4 Satellite Applications: GPS, VSAT, Meteorology applications.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Hands-on Case Study Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify optical components, cables.	1	* Identification of optical components and cables.	2	CO1
LLO 2.1 Identify core, cladding, and coating of optical fiber.	2	Identification of core,cladding and coating of optical fiber cable.	2	CO1
LLO 3.1 Measure numerical aperture of optical fiber to find the refractive index.	3	* Find numerical aperture of optical fiber.	2	CO1
LLO 4.1 Test the performance of an Avalanche Photodiode (APD).	4	* Test the performance of an Avalanche Photodiode (APD) (Virtual lab can be used in case of non- availability of instruments in the lab)	2	CO2
LLO 5.1 Evaluate the Performance of the given photodiode (detector) using LED as an Optical Source	5	* Analysis of Photodiode Characteristics (Virtual lab can be used in case of non-availability of instruments in the lab)	2	CO2
LLO 6.1 Test the performance of the given photo-diode (Detector) using LASER as an optical source	6	* Measurement of light intensity and photocurrent at various positions for a given photodiode	2	CO2
LLO 7.1 Measure bit error rate (BER) at the optical receiver.	7	Find the bit error rate (BER) at the optical channel receiver.	2	CO2
LLO 8.1 Measure various parameters of the observed eye pattern.	8	* Measurement of various parameters of eye pattern.	2	CO2
LLO 9.1 Measure the power and find the attenuation loss in the given length of optical fiber cable.	9	Measurement of attenuation loss in optical fiber.	2	CO3
LLO 10.1 Measure the bending loss in optical fiber.	10	* Measurement of bending loss of given optical fiber cable.	2	CO3
LLO 11.1 Measure optical power using optical meter.	11	Measurement of optical power using optical meter	1	CO3

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Calculate the Link Power Budget as per equation.	12	* Computation of Link Power Budget for Fiber Optics Using Coding (Use open source simulation software).	2	CO3
LLO 13.1 Determine the rise time budget.	13	* Computation of rise time budget w.r.t fiber optics through coding (Use open source simulation software).	2	CO3
LLO 14.1 Test satellite link operations.	14	* Establishing an Active satellite link and demonstrating link failure operations	2	CO4
LLO 15.1 Create a direct communication link between the Uplink Transmitter and Downlink Receiver using a tone signal .	15	Establish a direct communication link between the Uplink Transmitter and the Downlink Receiver using a tone signal.	2	CO4
LLO 16.1 Establish audio video satellite link between transmitter and receiver	16	Establishing audio video satellite link between transmitter and receiver	2	CO4
LLO 17.1 Establish a link to transmit and receive three separate signals (Audio, Video, Tone).	17	Simultaneous Transmission and Reception of Audio, Video, and Tone/Voice Signals via Satellite Link	2	CO4
LLO 18.1 Test the performance of satellite link by sending telecommand and receive the telemetry Data	18	Evaluating satellite link performance by transmitting telecommands and receiving telemetry data.	2	CO4
LLO 19.1 Interpret the result of the satellite link signal using function generator.	19	Transmission and reception of function generator waveforms through satellite communication link.	2	CO4
LLO 20.1 Estimate satellite Look Angles (Azimuth & Elevation) through coding.	20	* Calculation of Satellite Look Angles (Azimuth & Elevation) Using Coding (Use open source simulation software).	2	CO4
LLO 21.1 Verify Kepler's laws of motion	21	Simulating and validating Kepler's laws of planetary motion using code.(Use any relevant open source software).	2	CO4
LLO 22.1 Estimate Satellite Eclipse Periods	22	Simulation of Satellite Eclipse Periods through coding.(Use open source simulation software).	2	CO4
LLO 23.1 Measure carrier-to-noise ratio (C/N) of established satellite link.	23	* Measurement of the carrier-to-noise ratio (C/N) of the established satellite link.	2	CO5
LLO 24.1 Use RS 232 ports to set up a PC-PC satellite communication link	24	* Establish a direct communication link between two PCs using RS-232 serial ports.	2	CO5
LLO 25.1 Estimate rain attenuation through simulation.	25	* Find rain attenuation through coding (Use open source simulation software).	2	CO5
LLO 26.1 Investigate satellite link budget.	26	* Simulation of satellite link budget through coding (Use open source simulation software).	2	CO5
LLO 27.1 Test the reliability of satellite system.	27	Analysis of reliability in satellite system.	2	CO5
LLO 28.1 Calculate EIRP of any given satellite communication link.	28	* Find EIRP or any given satellite communication link through coding.(Use open source simulation software).	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- The orbit of an earth orbiting satellite has an eccentricity of 0.15 and a semimajor axis 9000 km, determine the apogee. [Assume the earth's radius as 6371 km].
- A fiber has a core diameter of 2 micro meter and its core refractive index is 1.43. The refractive index of cladding is 1.415. Determine : (i) numerical aperture (ii) critical angle (iii) Acceptance angle (iv) Relative refractive index difference.

Student Activities

- Prepare a survey report to compare the technical specifications of different types of optical sources and detectors.
- Prepare a report on splicing techniques used in industry or telecom service providers.
- Prepare the chart to indicate applications of various satellite frequency bands (L,S,C,X,Ku,Ka band).
- Conduct an Internet survey and prepare a detailed report on GPS and its applications.

Visit

- Visit a facility where fiber optics are utilized for communication and various applications ,such as institute LAN, computer networking, remote sensing, the automotive industry, healthcare, decorations and lighting, telecommunication, cable television, mechanical inspections and prepare a report.
- Visit a satellite center or pool lab equipped with a satellite setup and compile a detailed report on its components and their functions.

Micro project

- Build fiber optic lamp to demonstrate total internal reflection and light dispersion.
- Develop a GPS-based speedometer.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Splicing,Cutting and trimming tool of plastic fiber optics cables	1,2,9,10,11
2	Fiber optic cleaning kit	1,2,9,10,11
3	Fiber optic cables	1,2,9,10,11
4	Fiber optic Trainer kit	1,3,7,8,9,10,11
5	Optical fiber power meter	11
6	Desktop computer/Laptop,List of software:MATLAB,SCILAB or any other open source software	12,13,20,21,22,25,26,27,28
7	Spectrum Analyzer-frequency range-2.4 to 2.495 GHzResolution-26 KHz to 3 MHz,resolution BW-58.036 to 812.500 KHz	14,15,16,17,18,19,23

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
8	Satellite Trainer Kit (ST2272)/(STC 24):Uplinking frequency 2414/2432/2450/2468 MHz,4 MHz clock frequency,PIC16F84-8 bit RISC processor based PLL,16 MHz Bandwidth,FM Modulation of Audio and Video 5/5.5/8 MHz Audio and Video Modulation,Detachable Dish Antenna,Radiated Power output 25mW (approx.),4 downlink frequencies 2414/2432/2450/2468 MHz	14,15,16,17,18,19,23
9	RF Signal Generator,9 KHz to 3 GHz,Output Power @ 1 GHz,-127 dBm to +13 dBm AM,FM,PM Analog I/Q Input Pulse,Frequency Modulation-Maximum Deviation @ 1 GHz,20 Hz to 100 KHz	19
10	PC-Processor-dual core @ 2.4 GHz(i5 or i7 Intel processor or equivalent AMD),RAM-4GB,Hard Drive-320 GB 5400 RPM hard drive,OS-win 7/10	24
11	DMM:DC,0-1.5/3 Amp,0-2.5/5 Amp,0-5/10 Amp,0-150/300V,0-250/500V,0-75/150VAC-0-1000V,0-10A	4,5,6
12	Fiber optic cable Tester	4,5,6
13	Lux meter:Display:3 1/2 digit 18mm (0.7")/LCDRanges:1 to 50,000 LUX/Over -input:indication of	4,5,6
14	Power Supply Type:DC,0-30 V, 0-3 A	4,5,6,9,10,11
15	OTDR-Attenuation resolution -0.001BdB,Attenuation measurement linearity 0.05 dB ,Distance measurement accuracy +/- (0.5 + resolution + 5 X 10-5 X L) m	9
16	CRO/Digital storage oscilloscope:60 MHz/100 MHz/200 MHz bandwidth,500MS/s to 1 GS/s real -time sample rate,50 GS/s sample rate for repetative waveforms,High resolution color LCD display	9,10

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Optical fiber communication	CO1	10	2	4	6	12
2	II	Optical Communication Systems	CO2	10	2	6	6	14
3	III	Characteristics of Optical Fiber	CO3	15	4	6	6	16
4	IV	Overview of Satellite Systems	CO4	10	2	4	6	12
5	V	Satellite space segment and space link	CO5	15	2	6	8	16
Grand Total				**60**	**12**	**26**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	2	3	2	2	3			
CO2	3	2	2	3	2	2	1			
CO3	2	1	3	2	1	2	2			
CO4	3	2	3	3	1	1	3			
CO5	1	3	2	1	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Kieser, Gerd	Fiber Optic Communication	Mc Graw Hill Higher Education, New Delhi ,2013, ISBN: 9781259006876,
2	Roddy Dennis	Satellite Communications	Tata McGraw-Hill, New Delhi, fourth edition ,2017 ISBN-13: 978-0070077850
3	G Agrwal	Fiber optic communication System	John Wiley and Sons, New York ,ISBN: 978-1-119-73736-0.
4	Biswanath Mukherjee	Optical Communication Networks	McGraw-Hill,ISBN-13. 978-0070444355
5	Katiyar,Sapna	Satellite Communication	Katson publications,3rd edition 2013,ISBN-978-93-5014-481-7
6	Rao Raja K.N.	Satellite Communication concepts and applications	PHI learning Private limited,New Delhi,second edition 2012,ISBN-978-81-203-4725-0

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=oIurmHsRFSc	NPTEL sessions IIT Mumbai
2	https://oc-iitr.vlabs.ac.in/List%20of%20experiments.html	Virtual Lab for optical communication
3	https://www.youtube.com/watch?v=ougKUUM3hJA&list=PLHj96QRJ0kOhH8xoXXrOgkMf9ZOvjhqYl	NPTEL-NOC IITM video: Fiber Optic Communication Technology
4	https://www.youtube.com/playlist?list=PLgwJf8NK-2e7CDIWsh61eItP9iRw1EIQc	Optical Fiber Communication
5	https://www.youtube.com/watch?v=tu9mW6U6Xmc	NPTEL sessions IIT Mumbai
6	https://www.youtube.com/watch?v=Lis3Bk_guEM	NPTEL sessions IIT Mumbai
7	https://www.youtube.com/playlist?list=PL3rE2jS8zxAxamj-MY7FvzOZkHUALNndQ	Satellite Communication Videos
8	https://youtu.be/n2VeCHetC0I	Simulation of Photodiode
9	https://youtu.be/dZsXqJrZDOQ?si=BWR9hNXMifA44O4r	Bending loss and attenuation loss measurement in optical communication
10	https://youtu.be/jvLmcbxouB4?si=KW-7AUH8x3y9ZZ5l	Measurement of Numerical Aperture

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Sr.No	Link / Portal	Description
11	https://youtu.be/x0SCzP9mt3c?si=Oh0HSXikOM9GWKhl	Determination of the acceptance angle and numerical aperture of a given optical fiber
12	https://youtu.be/bMgU3N1Vuvc?si=n9tx1V8x5DyS2YQc	Measurement of attenuation loss in optical fiber
13	https://youtu.be/4MYfxlVoUoQ?si=H-dVoo9Sw9k58cMG	Measurement of bending loss in optical fiber
14	https://youtu.be/GP39QVYwmNU?si=2AnM1ieV-Dwbj7Iv	How to Read an OTDR Trace - from Corning Cable Systems
15	https://youtu.be/xba2MThR9Ls?si=fr3rgi6om8dYvoXb	Fiber Optic Splicing Guide & Demo
16	https://www.youtube.com/watch?v=oPCmLD3LQk0	Scientech 2272A Satellite Communication Trainer Kit DEMO

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

COMPUTER NETWORK & DATA COMMUNICATION **Course Code : 316338**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg.**
Programme Code	**: DE/ EJ/ ET/ EX/ IE/ TE**
Semester	**: Sixth**
Course Title	**: COMPUTER NETWORK & DATA COMMUNICATION**
Course Code	**: 316338**

I. RATIONALE

Computer Networks and Data Communication is crucial for modern communication services, enabling efficient information exchange and collaboration across devices. Through this course students will be able to select, classify, install, troubleshoot and maintain various data communication networks. This course focuses on enhancing the practical skills such as configuring routers, Modem, Repeaters and switches. Troubleshooting using diagnostic tools and maintaining networks are emphasized. This course includes projects focused on troubleshooting, maintenance, and network security.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

This course aims to help the student to attain the following industry-identified outcomes through various teaching-learning experiences:
Maintain and troubleshoot network devices

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Implement relevant Network Topology
- CO2 - Select relevant network model and Transmission Media for data communication system
- CO3 - Troubleshoot transmission errors and flow control of the data in Data Link Layer
- CO4 - Maintain Network layer and Transport layer
- CO5 - Interprete functions of Application layer and Protocols associated with it

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316338	COMPUTER NETWORK & DATA COMMUNICATION	CND	DSC	4	-	4	2	10	5	3	30	70	100	40	25	10	-	-	25	10	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the role of the given component in the process of data communication. TLO 1.2 State two advantages of computer networking. TLO 1.3 Explain Network devices with its functions in respective layers. TLO 1.4 Describe the given topology with suitable diagram. TLO 1.5 Classify networks based on the transmission technology, physical size and architecture.	**Unit - I Fundamentals of Data Communication and Computer Network** 1.1 Data communication system and its components: Message, Protocol, Transmitter, Medium, Receiver 1.2 Need of computer networks, Network criteria, applications, advantages of networking 1.3 Network devices: Repeater, Hub, Bridge, Switches , Router, Gateway, Modem, NIC, Media Converters 1.4 Network topologies: Mesh, Star, Bus, Tree, Ring and Hybrid topologies, Schematic diagram, working, advantages, disadvantages and applications 1.5 Network Classification: • Based on Transmission Technology: Point to-point, Multipoint, Broadcast • Based on physical size: PAN, BAN, LAN, MAN, WAN, VPN, WLAN • Based on Architecture: Peer to Peer, Client Server	Lecture Using Chalk-Board Collaborative learning Presentations Video Demonstrations Program development tools and simulators

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe the functions of the given layer of OSI reference model. TLO 2.2 Explain four level addressing used in TCP/IP model. TLO 2.3 Compare TCP/IP model and OSI reference model. TLO 2.4 Describe characteristics of the given type of guided transmission media. TLO 2.5 Explain with sketches the working of the given type of modem. TLO 2.6 Compare different Switching techniques.	**Unit - II Network models and Physical layer** 2.1 The OSI Model: Layered Architecture, Encapsulation Layers in OSI Model: Physical Layer, Data-Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer, Functions of each layer 2.2 TCP/IP Protocol Suite: Architecture, Layers in TCP/IP Protocol Suite: Physical Layer, Data-Link Layer, Network Layer, Transport Layer, Application Layer, Functions of each layer 2.3 Introduction to Protocols used in Network model (Enlist names only) 2.4 Addressing in TCP/IP: Physical, Logical, Port and Specific Addresses 2.5 Transmission Media: Guided Media -Twisted pair (UTP, STP) cable, Coaxial cable, Fiber-optic cable Unguided Transmission Media: Radio Waves, Microwaves, Infrared 2.6 Modems : Null Modem, Broadband modem, DSL, ADSL, HDSL, VDSL(working, configuration and the wiring diagram) 2.7 Switching: Circuit-switching, Packet Switching, Datagram approach, Virtual Circuit approach	Lecture Using Chalk-Board Presentations Collaborative learning Video Demonstrations Program development tools and simulators
3	TLO 3.1 Describe Data Link Layer services. TLO 3.2 Describe the technique of the given error control method with examples. TLO 3.3 Generate the CRC code for the given data word. TLO 3.4 Construct the Hamming code for the given data. TLO 3.5 Explain with sketches the given type of flow control used in the data link layer. TLO 3.6 Compare characteristics of given type of data link layer Protocols. TLO 3.7 Select the appropriate protocol for error free transmission of given data.	**Unit - III Data Link Layer** 3.1 Data link layer: Flow and Error control 3.2 Error control: Types of errors-Single bit and Burst errors, Redundancy • Codeword Generation- CRC, Checksum, Hamming code • Error Detection- CRC, Checksum • Error Detection and Correction- Hamming code 3.3 Flow control: Framing, Flow and Error control Protocols: • Noiseless channel: Stop-and-Wait protocol • Noisy channels: Stop and Wait Automatic Repeat Request (ARQ) protocol 3.4 Sliding window protocol: • One Bit Sliding window protocol • Go-Back-N ARQ • Selective Repeat ARQ 3.5 Point to Point Protocol(PPP): Framing and Transition phases of PPP	Lecture Using Chalk-Board Video Demonstrations Collaborative learning Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Select appropriate class for the given network size. TLO 4.2 Differentiate between classful and classless addressing with suitable example. TLO 4.3 Explain the role of NAT in address depletion. TLO 4.4 Describe transport layer services. TLO 4.5 Describe the given type of network security technique. TLO 4.6 Explain functions of firewall.	**Unit - IV Network layer and Transport layer** 4.1 Network layer Logical addressing: • IPv4 Addresses: Address space notations, Classful addressing and Classless addressing, Subnetting, Network Address Translation (NAT) • IPv6 addresses: Need for IPv6, Address space 4.2 Network layer-Multicast Routing Protocols :Unicast, Multicast and Broadcast routing and applications 4.3 Transport Layer: Process to Process delivery, TCP, UDP • Port: Addressing, Format, Operation and uses 4.4 Network security: Cryptography, Components of cryptography, Block diagram of symmetric and asymmetric cryptography 4.5 Security services: Firewalls, Types of Firewall, Packet-Filter Firewall and Proxy Firewall	Lecture Using Chalk-Board Presentations Video Demonstrations Presentations Program development tools and simulators
5	TLO 5.1 Describe functioning of DNS in internet. TLO 5.2 Explain how the working of Simple Mail Transfer Protocol is used for data transfer. TLO 5.3 Describe the importance of Message Access Agent for addressing. TLO 5.4 Explain the steps to transfer files using FTP. TLO 5.5 Explain the working of Telnet for remote logging.	**Unit - V Application Layer** 5.1 Application Layer Protocols: Domain Name System (DNS) architecture, Domain types, DNS name space, Domain name resolution & Mapping to physical addresses 5.2 Electronic Mail • Message Transfer Agent -Simple Mail Transfer Protocol (SMTP) Components, working • Message Access Agent - Post Office Protocol (POP) and Internet Message Access Protocol (IMAP), working 5.3 File Transfer Protocol (FTP), Anonymous FTP 5.4 Remote logging: Telnet	Lecture Using Chalk-Board Presentations Collaborative learning Video Demonstrations Program development tools and simulators

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install packet tracer tools and workspaces. LLO 1.2 Place and connect network devices (PCs, switches and routers).	1	*Installation and introduction of Cisco Packet Tracer	2	CO1
LLO 2.1 Install GNS3 software simulator tools. LLO 2.2 Place and connect network devices (PCs, switches, routers).	2	Installation and introduction GNS3 software simulator tools	2	CO1
LLO 3.1 Analyse the type of network topology used in your lab.	3	Identify the topology used in the computer lab	2	CO1
LLO 4.1 Connect computers in Mesh topology and test the performance.	4	*Simulation of Mesh topology	2	CO1
LLO 5.1 Connect computers in Star topology and test the performance.	5	*Simulation of Star topology	2	CO1
LLO 6.1 Connect computers in Tree topology and test the performance.	6	Simulation of Tree topology	2	CO1
LLO 7.1 Install/configure/Test Peer to Peer LAN and sharing of resources.	7	*Share resources in a computer network	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Set up a basic VPN and Connect remote clients securely using OpenVPN or Windows VPN.	8	Configuring VPN (Virtual Private Network) using simulator	2	CO1
LLO 9.1 Install and test Repeater and Bridge.	9	Installation of Repeater and Bridge	2	CO1
LLO 10.1 Execute TCP/IP network commands: ipconfig ,ping, tracert.	10	*Troubleshoot computer network using given commands	2	CO2
LLO 11.1 Execute TCP/IP network commands: route, netstat, pathping.	11	*Troubleshoot computer network using given commands	2	CO2
LLO 12.1 Prepare a straight patch cord cable to connect the devices in the LAN.	12	*Prepare a standard network straight cable by using crimping tool	2	CO2
LLO 13.1 Prepare cross-connection cables to connect the devices in the LAN.	13	*Create cross-over network straight cable by using crimping tool	2	CO2
LLO 14.1 Capture Protocol Data Unit information of the TCP/IP and OSI Model using network simulator.	14	*Use PDU tool to analyse layers of OSI Model	2	CO2
LLO 15.1 Develop and test ‘C’ program for error detection using Hamming code.	15	Implementation of the Hamming code using c programming language to detect error	2	CO3
LLO 16.1 Develop and test ‘C’ program for error correction using Hamming code.	16	*Implementation of Hamming code using c programming language to correct error	2	CO3
LLO 17.1 Write a ‘C’ program for Cyclic Redundancy Check (CRC).	17	Implement C Program for CRC	2	CO3
LLO 18.1 Configure PPP (Point to Point Protocol) on Cisco packet tracer.	18	*Use PPP Protocol to establish a direct connection between two PCs	2	CO3
LLO 19.1 Capture TCP and UDP packet using CISCO Packet Tracer.	19	Measure types of transmission delays using CISCO Packet Tracer	2	CO4
LLO 20.1 Install and test Modem and Router.	20	Installation of Modem and Router	2	CO4
LLO 21.1 Create IPv6 environment in a small network using simulator.	21	Implement IPv6 addressing scheme on a network	2	CO4
LLO 22.1 Implement Classful Address in a for class A, Class B, Class C network node in CISCO packet tracer.	22	*Implement IP addresses for intranet in Class A, Class B, Class C	2	CO4
LLO 23.1 Configure basic firewall using Windows/Linux.	23	Configuration & Testing of basic Firewall	2	CO5
LLO 24.1 Create FTP Server using network simulation software.	24	*Use the FTP protocol to transfer files from one system to another system.	2	CO5
LLO 25.1 Block/unblock specific ports and test using TELNET.	25	*Use of Packet tracer as packet sniffer	2	CO5
LLO 26.1 Implement SMTP protocol using CISCO packet tracer.	26	*Implementation of SMTP protocol using CISCO packet tracer	2	CO5
LLO 27.1 Capture ARP and ICMP packet Traffic using packet tracer or any similar network simulation software.	27	Filter ARP and ICMP packets Traffic using network simulation software	2	CO5
LLO 28.1 Configure a POP3 protocol in Packet Tracer and Test domain.	28	Configuration of POP3 protocol using CISCO Packet Tracer	2	CO5
LLO 29.1 Configure a web server and access the website using a client PC using CISCO Packet tracer.	29	Configuration of a Web Server (HTTP/HTTPS) using CISCO Packet tracer	2	CO5
LLO 30.1 Configure a DNS server in Packet Tracer and Test domain.	30	*Configuration DNS Server using CISCO Packet Tracer	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Simulation of Data Transmission: Use a network simulator (Cisco Packet Tracer or NS3) to visualize how data packets travel between devices.
- IP Addressing and Subnetting Calculator – Develop a tool that calculates subnet masks, IP ranges, and broadcast addresses for given IPs.
- Wireless Packet Capturing – Use Wireshark to capture and analyze Wi-Fi packets
- Designing a Basic VPN Network Configure a VPN connection between two remote locations. Secure the connection using encryption techniques.
- Install and configure NIC and find MAC Address of Device
- Design a network using any topology and do fault identification
- Network Topology Design – Create different hybrid network topologies using Packet Tracer.

Assignment

- For a trading firm, an organization with 10 users, draw network architecture design of wireless LAN.
- In a particular data transmission system, the data 4 received was 1011010 using 7 bit odd parity hamming code, determine the correct code
- Identify appropriate network topology and network connecting devices for following requirement. Draw network design for proposed network. An organization having its office in a building of 5 floor. Each floor it needs 20 machines. There is one File server. Each floor has 2 print servers to facilitate printer capacity using Tree topology.

Industrial visit

- Industrial visit to BSNL, ISRO, CDAC

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Network Tool Kit: Crimping Tool for RJ-45 connector, 3 in 1 modular crimping tool for RJ-45 UTP CAT-5/CAT-6 Networking Cable,LAN Cutter 8P/6pP/4P All-in-One or similar,Cable Tester/LAN Tester(Specification: Network Cable Tester for LAN RJ-45/CAT5/CAT6 UTP Wire Test Tool or similar)	13,12
2	Network Accessories: RJ45 connector, UTP cable, various connectors,1000Mbps NIC	13,12
3	Printer	7
4	Desktop Computer with basic configuration	All
5	UPS 6 KVA online	All
6	Ethernet Switch- 4/8/16/24/32	All
7	Router-256MB Memory storage capacity, compatible with Desktop and Laptop, Rack Mountable, Wireless Connectivity	All
8	Simulation Software: CISCO Packet Tracer, CORE Network Emulator, GNS3 or any other simulator	All
9	Antivirus Software (online protection with firewall securities)	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Data Communication and Computer Network	CO1	12	4	4	6	14
2	II	Network models and Physical layer	CO2	14	4	4	6	14
3	III	Data Link Layer	CO3	14	2	4	10	16
4	IV	Network layer and Transport layer	CO4	10	4	4	4	12
5	V	Application Layer	CO5	10	4	4	6	14
Grand Total				**60**	**18**	**20**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks each and average of two unit test marks will be considered out of 30 marks.

Laboratory assessment will be for 25 marks.
Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester theory examination will be for 70 marks

Laboratory assessment will be for 25 marks

XI. SUGGESTED COS - POS MATRIX FORM

COMPUTER NETWORK & DATA COMMUNICATION **Course Code : 316338**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	3	3	1	1	2			
CO2	2	-	1	3	1	1	1			
CO3	2	3	2	3	1	1	1			
CO4	-	3	3	3	1	1	1			
CO5	-	-	2	3	1	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Behrouz A. Forouzan	Data Communication and Networking	McGraw-Hill Higher Education ISBN-13 978-0-07- 296775-3
2	Behrouz A. Forouzan	TCP/IP Protocol Suit	McGraw Hill Education ISBN-13 978-0073376042
3	A.S. Tanenbaum	Computer Networks	PRENTICE HALL ISBN-10: 0-13-212695-8 ,ISBN- 13:978-0-13-212695-3
4	Godbole Achyut and Atul Kahate	Data Communications and Networks (2nd Edition)	McGraw Hill Education ISBN-10 9780071077705,ISBN-13 978-0071077705
5	Wayne Tomasi	Introduction to Data communication and Networking	Pearson India ISBN- 978-8131709306

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/106/105/106105082/	NPTEL Course on Data Communication
2	https://www.youtube.com/watch?v=O--rkQNKqls	NPTEL Course on Computer Networks and Internet Protocol
3	https://www.netacad.com/cisco-packet-tracer	Cisco Packet Tracer Software Simulator
4	https://onlinecourses.swayam2.ac.in/cec19_cs07/preview	Swayam course on Computer Networks
5	https://onlinecourses.nptel.ac.in/noc22_ee61/preview	NPTEL Course on Communication Networks
6	https://archive.nptel.ac.in/courses/106/105/106105081/	NPTEL Course on Computer Networks

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE**
Semester	**: Sixth**
Course Title	**: CAPSTONE PROJECT**
Course Code	**: 316004**

I. RATIONALE

Capstone projects in engineering study are considered important as it allow students to integrate and apply the knowledge and skills acquired throughout their academic program and effectively demonstrating their learning of programme by tackling a real-world problem, ultimately keeping them well prepared for the job market. The capstone project is usually the final assignment and plays a vital role in preparing students for the world of work to its practical applications and ability to help hone students' professional knowledge and skills. Normally, capstone projects are developed in collaboration with industries or businesses, providing students with valuable insights. Capstone projects has been considered as an integral part of diploma curriculum. It helps learners to perform and demonstrate skills gained due to early courses of Diploma study independent. Therefore, this is considered as a course of final year/semester study.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Apply professional skills for solving , executing and demonstrating solutions to real-world problems

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Elaborate the identified field problem from the perspective of project work at institute.
- CO2 - Conduct feasibility & viability analysis (using data collection, experiments, Simulation , Coding) to validate required resources, cost, support of the project work.
- CO3 - Apply the acquired knowledge and skills in providing solutions to the real field/industrial problems.
- CO4 - Present Project and its output/ findings / achievements alongwith its exhibits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316004	CAPSTONE PROJECT	CPE	INP	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150

V. General guidelines for PROJECT WORK

- The Project- problems must be related to the programme or may be interdisciplinary, based on the industry expected outcomes.
- The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
- Project titles are to be finalized in co-ordination/consultation with the Faculty mentor. However, faculty may form a team of students as per specific roles- Literature survey/data collection, data Analysts, model/prototype developers, testers, Project managers using IoTs ITES and software /application development. Study type project is NOT advisable.
- Project must be assigned to a group of 3-4 students under the guidance of identified faculty mentor.
- Students are required to prepare a prototype/working model/software of the Project and simultaneously prepare a report.
- Students shall Submit One Hard copy and one Soft copy each of Project Report and soft-copy of the project code or the working model.
- Students must maintain a project execution diary having the progress steps and details. The concerned faculty should check the diary on a weekly basis and accordingly interact with students based on the progress shown and keep proper record with feedback if any.
- Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and similar domains.
- Student shall try to use the national and international standards wherever possible (processes / materials / equipments etc ..)

VI. Project facilitation guidelines:

Once the Project statement has been finalized and allotted to the students, the Faculty Mentor role is very important as guide, motivator, catalyser to promote learning and sustain the interest of the students. At the same time the Faculty Mentor is not expected to guide the students on each step, otherwise it will curb the creativity of the students-group. The Faculty Mentor has to work as a mentor. Following should be kept in mind while facilitating the project at the institute:

1.Project orientation cum -briefing: the project should be relevant to the curriculum of the programme. The project shall be cost effective taking safety aspects, ethical issues, environmental issues and confidentiality as per expectation of industry(if any) into consideration, The work may be industry Sponsored.

2.Information search and data collection: the information and data should be realistic and relevant to the problem /project. Hypothetical data is not to be taken into consideration.

3.Implementation and Monitoring: The project must have important steps /milestones to achieve as per the time frame/action plan prepared by students and faculty. The monitoring mechanism such as daily/weekly dairy (**Format given below)** must be clearly explained and delineated for the students.

VII.Criteria of Assessment /Evaluation of Project work

A. Formative Assessment (FA) criteria

The **Formative Assessment** (FA) of the students for 50 marks is to be done based on following criteria.

Appropriate RUBRICS may be used for assessment

Rubrics for Assessment of the team

Sr.No.	Criteria	Marks
1	Project Selection & Problem definition	05
2	Literature survey and data collection/ Gathering	05
3	Design / concept of project/ Working - Execution of Project	10
4	Stage wise progress as per Action plan/milestone	05
5	Quality Report Writing	05

Rubrics for Individual Assessment

Sr.No.	Criteria	Marks
1	Contribution as a team member	05
2	Depth of Knowledge	10
3	Presentation	05

B. Summative Assessment Criteria

- The summative assessment for 50 marks is to be done and based on following criteria. This assessment shall be done by the faculty mentor and External examiner.

Sr.No.	Criteria	Marks
1	Capstone Project Completion as per plan	10
2	Project related Requirement Analysis & Designing	10
3	Developing a Solution with proper justifications, Teamwork	10
4	Project Report Writing	10
5	Project Presentation	10

(**NOTE :** Team based and Individual performance based summative assessment may include Innovativeness , Technology used , user friendliness , cost effectiveness , society benefits etc..)

SUGGESTED RUBRIC FOR SUMMATIVE ASSESSMENT OF CAPSTONE PROJECT

PROJECT ASSESSMENT				
Project Title:				
Project Assessment Rubric				
Performance	**Excellent**	**Good**	**Fair**	**Poor**
Criteria	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Capstone Project Completion	Excellent **The project is completed as per tasks described in synopsis.**	Good **The project is completed but require minor modifications.**	Fair **The project is completed but require several modifications.**	Poor **The project is not completed as per tasks described in synopsis.**

Project related Requirement Analysis & Designing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Effectively contributed in requirement analysis and designing.	**Partially Contributed in requirement analysis and designing.**	**Attempted to contribute in requirement analysis and designing**	**No contribution in requirement analysis and designing.**
Developing a Solution with proper justifications , Teamwork	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Developed the critical solution modules with Innovation, optimized design and worked very well with the team.	**Developed some solutions with higher complexity and worked well with the team.**	**Attempted to develop few solutions and worked with the team.**	**No contribution in developing a solution and in the team.**
Project Report Writing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Worked very well to submit an excellent project report .	**Worked well to submit the project report with covering all the aspects of a standard report.**	**Tried to submit the project report but standard of report was not satisfactory.**	**No contribution in project report writing.**
Project Presentation	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Presented the project work flawlessly.	**Presented the project work very nice.**	**Presented the project work not so well.**	**Presentation skill is not up to the mark.**
Project Group Members				
ROLL NUMBER/Enrollment Number				
NAME				
Comments (if any)				

NOTE : " These are suggestive rubrics Faculty mentor and external examiner may frame different rubrics as per Programme need and assigned Project work "

C. Self Learning Assessment

Self Learning Assessment **Max Marks -50**

Sr.No.	Criteria	Max Marks	Marks Obtained
1	Project Selection & Problem definition	10	
2	Literature survey and data collection/ Gathering	05	
3	Design / concept of project/ Working - Execution of Project	15	
4	Stage wise progress as per Action plan/milestone/ psychomotor motor skills acquired	10	
5	Quality Report Writing	10	

VIII. CO-PO Mapping

CO-PO mapping will vary project wise and shall be prepared by concerned faculty for the given project

IX. Typographical instructions/guidelines for Project report writing

Following is the suggestive format for preparing the Project report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following.

a. The PROJECT report shall be computer typed (English- British) and printed on A4 size paper.
b. Text Font -Times New Roman (TNR), Size-12 point
c. Subsection heading TNR- 12 point bold normal
d. Section heading TNR- 12 capital bold
e. Chapter Name/ Topic Name – TNR- 14 Capital
f. All text should be justified. (Settings in the Paragraph)
g. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.
h. The training report must be hardbound/ Spiralbound with cover page in black colour. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover [Refer sample sheet (outer cover)]
i. The training report, the title page [Refer sample sheet (inner cover)] should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

X. Project Report

On completion of the project work, every student will submit a project report which should contain the following:
1. Cover Page (as per annexure 1)
2. Title page (as per annexure 2)
3. Certificate by the Guide (as per annexure 3)
4. Acknowledgment (The candidate may thank all those who helped in the execution of the project.)
5. Abstract (It should be in one page and include the purpose of the study; the methodology used.)
6. Table of Contents (as per general guidelines): Detailed description of the project (This should be split in various chapters/sections with each chapter/section describing a project activity in totality).

Chapter–1 Introduction (background of the Industry or User based Problem/Task)
Chapter–2 Literature Survey (to finalize and define the Problem Statement)
Chapter–3 Scope of the project
Chapter–4 Methodology/Approach, if any
Chapter-5 Details of designs, working and processes
Chapter-6 Results and Applications

7. Conclusion
8. References (The listing of references should be typed 2 spaces below the heading “REFERENCES” in alphabetical order in single spacing left – justified. It should be numbered consecutively (in square [ ] brackets, throughout the text and should be collected together in the reference list at the end of the report. The references should be numbered in the order they are used in the text. The name of the author/authors should be immediately followed by the year and other details). Typical examples of the references are given below:

NOTE:
1. Project report must contain only a relevant and short mention – technology or platform or tools used. It must be more focussed on project work and its implementation
2. Students can add/remove/edit chapter names as per the discussion with their guide

Formats

Project Report

"Project Title----------"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

1)Name Of Student	**Enrollment Number**
2)Name Of Student	**Enrollment Number**
3)Name Of Student	**Enrollment Number**
4)Name Of Student	**Enrollment Number**

Are the bonafide on

FOR THE ACADEMIC YEAR

20-----20---

(H.O.D)

(Principal)

(Internal Guide) **(External Examiner)**

Department Name

(If NBA Accredited mention that)
Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

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	Title Page	i
	Certificate of the Guide	ii
	Acknowledgement	iii
	Index	iv
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	List of Figures	vi
	List of Tables (optional)	vii

INDEX

Sr.No.	Chapter	Page No.
1.	Chapter–1 Introduction (background of the Project Problem)	**1**
2.	Chapter–2 Literature Survey (to finalize and define the Problem Statement)	**5**
3.	Chapter–3 Scope of the project	
4	Chapter–4 Methodology/Approach, if any	
5	Chapter-5 Details of designs, working and processes	
6.	Chapter-6 Results and Applications	
7.	REFERENCES	

Note:

***Students can add/remove/edit chapter names as per the discussion with their guide**

Annexure

PROJECT DIARY (Weekly/Daily)

Name of the Student : _____

Name of Guide (Faculty) : _____

Enrollment Number : _____ Semester: _____Project batch Number : _____

WEEK : _____

Date	Activity carried out (Details)	Achievement of mile stone/step as per plan	Remark of Faculty
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Dated Signature of Faculty **Dated Signature of HOD**

MSBTE LOGO INST LOGO

Certificate

This is to certify that

Mr./Ms. *bearing examination seat No.* *has*

Satisfactorily completed his/her ***PROJECT*** *entitled*

Along with his/her batchmates in partial fulfillm ent for the

Diploma Course in

< PROGRAMME NAME>

Of the ***Maharashtra State Board of Technical Education*** *at our Polytechnic during the Academic Year20 -20 .*

The Project is completed by a group consisting of Persons under the guidance of the Faculty Guide

Faculty Name and Signature (Internal)	**Faculty Name and Signature (External if applicable)**	**HOD Name and Signature with Department Stamp**
Date and Time		

AUTOMATION & PLC **Course Code : 316334**

Programme Name/s	**: Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/**
Programme Code	**: EJ/ EK/ ET/ EX**
Semester	**: Sixth**
Course Title	**: AUTOMATION & PLC**
Course Code	**: 316334**

I. RATIONALE

Automation revolutionizes manufacturing by enhancing quality, flexibility, and safety while optimizing costs. To stay ahead, industries are rapidly adopting advanced automation technologies. This course equips learners with the expertise to develop, maintain, and operate sophisticated automation systems, leveraging PLC technology to control diverse industrial processes efficiently.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain the following industry/employer expected outcome through various teaching learning experiences: "Maintain Automation systems."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify different components of automation system.
- CO2 - Interface the given I/O device with PLC module.
- CO3 - Develop ladder logic program for various logic gates and Boolean equations.
- CO4 - Develop ladder logic program for given application.
- CO5 - Use the relevant communication protocol for specific automation system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316334	AUTOMATION & PLC	ATP	DSE	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the benefits of Automation TLO 1.2 Describe the function of components of automation system. TLO 1.3 Compare fixed and modular automation. TLO 1.4 Enlist application areas of automation System. TLO 1.5 Compare tools of Automation System.	**Unit - I Basics of Automation** 1.1 Automation: Features and benefits. 1.2 Hierarchy of automation systems (five layer automation) 1.3 Types of automation system: Fixed, Modular. 1.4 Application areas of automation system. 1.5 Introduction of Automation tools : PLC,HMI, SCADA, DCS, Hybrid Control System (Function and brief introduction)	Lecture Using Chalk-Board Educational Videos Presentations Case Study Site/Industry Visit
2	TLO 2.1 Draw block diagram of PLC and explain functions of each block. TLO 2.2 Describe operating modes of CPU. TLO 2.3 Explain redundancy concept in PLC with neat diagram. TLO 2.4 Classify modular PLC. TLO 2.5 Select the appropriate I/O module for specific application and illustrate the wiring diagram for interfacing field I/O devices with the PLC. TLO 2.6 Explain the sinking and sourcing concept of PLC input output module with neat sketches.	**Unit - II PLC Fundamentals and Interfacing** 2.1 Architecture of PLC: Block diagram, function of each block. 2.2 CPU : Function, Scanning cycle, speed of execution, operating modes of CPU (Programing, RUN / STOP Mode), Memory organization of PLC 2.3 Redundancy in PLC system. 2.4 Types of PLC- Based on connection (fixed, modular) , based on size (small, medium, large) , advantages of PLC system over relay based system. 2.5 I/O Modules: Types(Discrete and Analog), Discrete I/O module: Block diagram, function of each block, Specifications, wiring of I/O devices with PLC . Analog I/O module: Block diagram, function of each block, Specifications, wiring of I/O devices with PLC Comparison of AC and DC Discrete PLC Module(Voltage level, speed, noise immunity applications, common output type and safety) 2.6 Sinking and sourcing concept of I/O modules, selection criteria of PLC.	Lecture Using Chalk-Board Educational Videos Presentations Collaborative learning Flipped Classroom
3	TLO 3.1 Compare PLC programming languages. TLO 3.2 Describe significance of various parts of ladder diagram. TLO 3.3 Specify the proper I/O addressing format for PLC. TLO 3.4 Develop ladder program to test logic gates and boolean equations. TLO 3.5 Develop ladder logic for given process using relay instructions . TLO 3.6 Draw and explain Analog scaling instruction used in PLC .	**Unit - III Basic PLC Programming** 3.1 PLC programming languages: Ladder Diagram Programming, Functional Block diagram, Sequential function chart, Structured text, Instruction list (Introduction and features). 3.2 Ladder logic basics: Structure of ladder logic(Power rails, Rungs, Inputs, Outputs, address notation and tag names) 3.3 Ladder programming instructions: Relay based instructions (NO Contact, NC Contact, Output coil, Set output coil, Reset output coil) , bit set /reset instructions: symbols and working. 3.4 PLC I/O Addressing. 3.5 Ladder logic programs for various logic gates and boolean expressions. 3.6 Ladder logic program examples based on bit/relay instruction.(ON/OFF control ,automatic door opening and closing, sequencing operation ,latching/unlatching) 3.7 Analog signal processing Instruction(Scaling and Normalization)	Lecture Using Chalk-Board Educational Videos Demonstration Presentations Case Study Collaborative learning

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Use appropriate timer instruction to develop ladder program for the given application. TLO 4.2 Use appropriate counter instruction to develop ladder program for the given application. TLO 4.3 Use Logical, Comparison, Data handling instructions to develop ladder program for given application. TLO 4.4 Develop ladder program for the given industrial application. TLO 4.5 Develop PLC sequential function chart for the given industrial application.	**Unit - IV Advanced PLC Programming** 4.1 Timer instruction : ON delay, OFF delay ,Retentive, (Symbol, Status bits, Control word format, timing diagram, working). 4.2 Counter Instruction: Up, Down, Up/Down (symbol, control word format and timing diagram, working). 4.3 Logical, Comparison, arithmetic(mathematical), and Data Handling instructions. 4.4 Ladder logic for industrial application: Automatic Tank Level Control, Sequential motor control, Automatic Bottle filling plant ,Process control, Automatic Car parking, Automatic Traffic light control, Home automation, Objects counter (System design, I/O Listing, Ladder logic) 4.5 Sequential function chart (SFC) programming : Introduction, Structure of SFC, Transition representation ,Types of SFC: (Selection branch ,Simultaneous branch), Sequential functional chart design for object sorting, pick up and place.	Lecture Using Chalk-Board Educational Video Demonstration Presentations Case Study Site/Industry Visit Collaborative learning
5	TLO 5.1 Describe SCADA system architecture in automation system. TLO 5.2 Describe communication protocols used for automation system. TLO 5.3 State benefits of AI in PLC systems. TLO 5.4 Describe steps to share data from PLC to cloud.	**Unit - V Basics of Communication protocols, SCADA and Advancements in PLC** 5.1 Supervisory Control and Data Acquisition (SCADA)- Basic function, Generalized block diagram, function of each block, Interfacing of SCADA with PLC, applications of SCADA. 5.2 Basic communication protocols used in industrial automation: Types of Communication interface , Protocols: PROFINET , MODBUS (RTU and TCP/IP), Profibus DP, Ethernet / IP. Foundation Field Bus, HART (wire and Wireless) 5.3 AI Tools for PLC programming: Introduction ,Benefits ,Applications ,Challenges of AI in PLC systems. 5.4 Cloud PLC: Introduction ,cloud-PLC interconnection , Benefits ,Steps to send data from PLC to cloud.	Lecture Using Chalk-Board Presentations Educational Video Collaborative learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the components of automation system available in laboratory.	1	*Identification of components of automation trainer kit available in the laboratory.	2	CO1
LLO 2.1 Interface input output devices with PLC and test the output for various inputs .	2	*Interface given I/O devices with PLC.	2	CO1 CO2
LLO 3.1 Interface input output devices with PLC and test the output for various inputs in virtual lab.	3	Interface I/O devices with PLC in virtual lab	2	CO1 CO2
LLO 4.1 Test sinking and sourcing concept in discrete I/O module.	4	Sourcing and sinking connection of I/O devices with descrete I/O module.	2	CO2
LLO 5.1 Test functionality of logic gates using ladder diagram.	5	*Test functionality of various logic gates using ladder diagram.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Design 4:1 multiplexer using ladder diagram.	6	*Develop ladder program for 4:1 Multiplexer.	2	CO3
LLO 7.1 Test relay type instructions(NO,NC,output coil etc) using ladder diagram.	7	* Test the functionality of latching using basic relay type instructions in ladder diagram.	2	CO3
LLO 8.1 Test ladder program for sequential ON-OFF control of lamps/ motors.	8	Develop a ladder program for sequential ON-OFF control of lamps/motors.	2	CO3
LLO 9.1 Test ladder program to monitor the temperature of a given liquid using RTD/Thermocouple and PLC (use Analog scaling instruction)	9	*Develop a ladder program to process analog signal.	2	CO3
LLO 10.1 Control the direction of stepper motor using ladder diagram.	10	Develop ladder program to control the direction (Clockwise and Anticlockwise)of stepper motor .	2	CO3 CO4
LLO 11.1 Test ladder program for automatic traffic control using virtual lab.	11	Develop ladder program for traffic light control system using virtual lab simulator	2	CO3 CO4
LLO 12.1 Test ladder program to identify metallic and non-metallic objects.	12	Develop ladder program to sort metalic and non-metalic objects .	2	CO3 CO4
LLO 13.1 Test SFC to identify metallic and non-metallic objects.	13	Develop Sequencial Function Chart (SFC) to sort metalic and non-metalic objects .	2	CO3 CO4
LLO 14.1 Test ladder program for automatic car parking system.	14	*Develop ladder program for automatic car parking system.	2	CO3 CO4
LLO 15.1 Test and compare profibus and profinet network protocol .	15	Interface and test PLC with profibus and profinet network protocol.	2	CO5
LLO 16.1 Develop SCADA graphic screen integrate it with PLC to perform the sequential ON-OFF control of Lamps/motors.	16	*Develop SCADA graphic screen and integrate with PLC to perform the sequential ON-OFF control of Lamps/motors.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Prepare a report on analog I/O module and Digital I/O module.
- Give selection criteria's of I/O modules in automation system.

Industrial Visit

- Visit nearby PLC/SCADA/DCS based process / packaging industry, observe the industrial automation and prepare a report

Micro project

- Automatic Water Level Monitoring and Control

1)Develop ladder program to monitor and maintain the water level in a tank.

2) Prepare I/O list with tags.
3)Draw wiring diagram.
4) Describe Network protocol used
5)SCADA Integration: Display real-time tank levels and control pump operations remotely

- Automatic bottle filling plant

1)Develop ladder program to monitor and maintain the water level in a tank.
2) Prepare I/O list with tags.
3)Draw wiring diagram.
4) Describe Network protocol used
5)SCADA Integration: Display real-time process of automatic bottle filling plant

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Nano PLC, Mini PLC, Micro PLC with analog and Digital I/O, memory, peripheral interfaces, Profinet and Profibus network.	1,2,4,7,5,6,8,10,12,14,13,15,16
2	Input and Output devices for PLC: like Lamp, DC Motor, Proximity sensors, Thermocouple/RTD, Red, green, yellow LEDs, Stepper Motor, limit switches, push button.	1,2,4,7,5,6,8,10,12,14,13,15,16,9
3	Ladder logic simulator : Such as TIA portal/RS Logix/CODESYS/Pico soft Simulator/ EDA tools.	1,2,4,7,5,6,8,10,12,14,13,15,16,9
4	PLC with programming Software and interfacing hardware, user manual, (complete PLC Trainer system)	1,2,4,7,5,6,8,10,12,14,13,15,9
5	SCADA software: Such as Wincc/Eclipse/Factory I/O/Wonder ware /InTouch/Visualization	16
6	Virtual lab simulator.	3,11

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Automation	CO1	6	2	2	4	8
2	II	PLC Fundamentals and Interfacing	CO2	14	4	6	6	16
3	III	Basic PLC Programming	CO3	16	4	6	8	18
4	IV	Advanced PLC Programming	CO4	16	4	6	8	18
5	V	Basics of Communication protocols, SCADA and Advancements in PLC	CO5	8	2	4	4	10
Grand Total				**60**	**16**	**24**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.
- Two offline unit tests are of 30 marks and average of two unit test marks will be consider for out of 30 marks.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	2	1	2	-	2			
CO2	3	1	2	1	2	1	2			
CO3	3	2	2	2	3	1	3			
CO4	2	3	3	3	3	1	3			
CO5	2	3	3	3	2	3	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	John W. Webb & Ronald A. Reis	Programmable Logic Controllers-Principles and Applications	Fifth Edition, Pearson Education India.,Noida ISBN-13- 9789-33-255-512-9
2	Frank D. Petruzella	Programmable Logic Controllers	Fifth Edition, McGraw Hill ,New Delhi ISBN-13 978-9353167271
3	Garry Dunning	Introduction to Programmable Logic Controllers	Edition3 Delmar Cengage Learning , ISBN-13978-1401884260
4	Madhuchhand A Mitra, Samarjit Sen Gupta	Programmable logic controllers and industrial automation an introduction.	Penram international publication, New Delhi, 2015, ISBN: 978-8187972174

Sr.No	Author	Title	Publisher with ISBN Number
5	Rajesh Mehra & Vikrant Vij	PLC & SCADA-Theory and Practice	First Edition University science press ISBN 978-93-81159-11-8

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/tw-79FiRYKA?feature=shared	Introduction to Automation system.
2	https://youtu.be/IAhxYsMi4e8?feature=shared	Introduction of Automation Triangle.
3	https://youtu.be/IAhxYsMi4e8?feature=shared	Automation Pyramid.
4	https://youtu.be/E2WNPXJf-Kw?feature=shared	PLC Introduction.PLC Basics.Components of PLC. Modular PLC. Modules,Input Output.Backplane
5	https://youtu.be/t2rq0lTi8xo?feature=shared	Input Output Modules PLC ?, What is input and output module of PLC?
6	https://youtu.be/zsajTNtxfAE?feature=shared	PLC Ladder programming-1
7	https://youtu.be/mDl46055UN8?feature=shared	PLC Ladder programming - 2
8	https://youtu.be/IRm_tB-irx8?feature=shared	Timers & Counters.
9	https://youtu.be/93PtehIiWKM?feature=shared	Communicating Protocols in automation system
10	https://youtu.be/ShaAt45iMhc?feature=shared	Automation Communication Protocols
11	https://plc-coep.vlabs.ac.in/	Virtual Lab for PLC programming for basic and industrial applications.
12	https://www.ixon.cloud/knowledge-hub/how-to-get-data-from-plc	PLC to Cloud communication

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

DRONE TECHNOLOGY **Course Code : 316335**

Programme Name/s	**: Automation and Robotics/ Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg./**
Programme Code	**: AO/ DE/ EJ/ EK/ ET/ EX/ IE/ TE**
Semester	**: Sixth**
Course Title	**: DRONE TECHNOLOGY**
Course Code	**: 316335**

I. RATIONALE

Drones, or UAVs, are transforming industries and are regulated by rules like the DGCA Drone Rules 2021. Emerging technologies like autonomous flight and AI are expanding drone capabilities. This course will provide a comprehensive knowledge of drone technology and its operations. It will prepare students to work in this field.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching-learning experiences: Maintain various components of Drone System.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Classify different types of Drones.
- CO2 - Interpret drone technology along with its rules and regulations.
- CO3 - State function of Drone system and subsystems.
- CO4 - Test the drone system.
- CO5 - Select drone for a given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316335	DRONE TECHNOLOGY	DRT	DSE	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 2 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe history of Flight and Ancient concepts related to it. TLO 1.2 Describe evolution of UAV technology. TLO 1.3 Explain Drones, types and their applications. TLO 1.4 Explain Drone classification by weight category (as per Drone Rules 2021) . TLO 1.5 Explain terminologies related to Drones . TLO 1.6 Describe Flying area of Drones .	**Unit - I Introduction and Classifications of Unmaned Aerial Vehicle (UAV)/Drones** 1.1 Historical references of ancient flight concepts (IKS) 1.2 Evolution of Drone/UAV technology 1.3 Introduction to Drones : types (fixed,rotary, hybrid) and applications 1.4 Drone classification by weight category (as per Drone Rules 2021) 1.5 Terminologies related to Drones (as per Drone Rules 2021) - UAV (Unmanned Aerial Vehicle), Remote pilot, UAS (Unmanned Aircraft System), RPAS (Remotely Piloted Aircraft System), GCS (Ground Control Station), VLOS (Visual Line of Sight), BVLOS (Beyond Visual Line of Sight), UIN (UAV Identification Number), UAOP (UAV Operations Permit) 1.6 Digital sky platform : Airspace map for zone identification	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
2	TLO 2.1 Describe the operation of basic building blocks of the drone system and subsystem. TLO 2.2 Describe Drone components and its function. TLO 2.3 Explain principles of Flight. TLO 2.4 Explain Drone flying rules, regulations and safety precautions .	**Unit - II Drone Technology - Building blocks, Components, Flight Dynamics, and Regulations.** 2.1 Building blocks of the Drone system and subsystem 2.2 Drone components and its function : frame, motors, propellers, ESC, flight controller, battery, basic Sensors(accelerometer, magnetometer (compass), barometer, GPS),camera, Drone transmitter and receiver, Drone software and firmware 2.3 Principles of flight : lift, thrust, drag, weight, the axis of drone motion (pitch, roll, and yaw), aerodynamic principles that enable flight 2.4 Regulations and safety : Drone flying rules, regulations and their safety precautions (as per Drone rules 2021) governed by DGCA India	Lecture Using Chalk-Board Video Demonstrations Model Demonstration

DRONE TECHNOLOGY **Course Code : 316335**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe the working of Drone motors. TLO 3.2 Demonstrate programming for drone flight control using programming ESC. TLO 3.3 Describe the power management used in Drone . TLO 3.4 Explain the power management system in Drone. TLO 3.5 Describe Propellers and it's type . TLO 3.6 Describe frames and it's type . TLO 3.7 Explain the working of other components associated with Drone.	**Unit - III Drone Motors, Power Systems, and other components** 3.1 Motor: Brushless motor , motor specification, thrust-to-weight ratio, KV ratings and motor selection based on application 3.2 Electronic Speed Controllers (ESC): working principle and specification 3.3 Flight controller: Introduction and working principle 3.4 Power Management: batteries, calculation of flying time based on battery capacity ,the power distribution board 3.5 Propellers and it's type 3.6 Frames and it's type 3.7 Camera, gimble and and role of following sensors in the drone (Gyroscope, Accelerometer, Magnetometer (Compass), Barometer, GPS, Temperature Sensor)	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
4	TLO 4.1 Describe selection criteria for different components used in drone. TLO 4.2 Explain assembly and integration system of drone. TLO 4.3 Describe procedure for Drone operation . TLO 4.4 Explain the maintenance process of Drone	**Unit - IV Drone assembly, operation and maintenance** 4.1 Component Selection : Frame, Motor, Propeller, Power distribution board, Battery, Flight controllers, Transmitter and Receiver, Cameras, and Sensors (Accelerometer, Magnetometer (Compass), Barometer) 4.2 Assembly and Integration: Basic wiring and soldering, assembling components into a functional Drone 4.3 Procedure for Drone operation 4.4 Troubleshooting and Maintenance: Diagnosing and fixing common issues (Power Issues, Connectivity Problems, GPS Issues, Motor and ESC Malfunctions, Propeller Problems, Battery Problems, Camera & Gimbal Issue, Firmware or Software Errors), Maintenance (Pre-flight Maintenance, Post-flight Maintenance, Battery Maintenance, Motor and Propeller Maintenance, Firmware and Software Updates, Regular Inspections) and calibration	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
5	TLO 5.1 Explain the application of Drone in various sector. TLO 5.2 Explain Autonomy and AI concept used in the Drone. TLO 5.3 Explain role of the Drone technology in future.	**Unit - V Drone Applications and Future Trends** 5.1 Applications: Drones in agriculture, construction, logistics, military and cinematography 5.2 Basics of autonomous flight : waypoint navigation, sensor fusion, and machine learning for object detection 5.3 Emerging Trends: Drone swarming, Solar-powered drone, Advanced Sensors used in Drones for Imaging Technology	Lecture Using Chalk-Board Video Demonstrations Model Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

DRONE TECHNOLOGY **Course Code : 316335**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Prepare a report/chart on the history of flight and ancient concepts of aerodynamics(IKS) . LLO 1.2 Prepare of a report/chart on the overview of drones, including their history, types, and applications.	1	Preparation of a report/chart on the history of flight and illustrate the evolution timeline of UAV technology till date	2	CO1
LLO 2.1 Explore Digital sky platform.	2	Exploration of Digital sky platform	2	CO1
LLO 3.1 Identify the zones (Red,Yellow,Green) by using Airspace map for any district and area near the airport.	3	* Identification of zones (Red,Yellow,Green) by using Airspace map for any district and area near the airport	2	CO1
LLO 4.1 Prepare a report/chart on the classification of drones by weight categories and define the related terminologies as per Drone Rules 2021.	4	Preparation of a report/chart on the classification of drones by weight categories and define the related terminologies as per Drone Rules 2021	2	CO1
LLO 5.1 Identify the mechanical components in drones, and describe their specifications and functions.	5	Identification of mechanical components in drones, and describe their specifications and functions	2	CO2
LLO 6.1 Identify electrical components in drones, describing their specifications and functions.	6	*Identification of electrical components in drones, describing their specifications and functions	2	CO2
LLO 7.1 Identify electronic components used in drones, describing their specifications and functions.	7	*Identification of electronic components in drones, describing their specifications and functions	2	CO2
LLO 8.1 Prepare a report/chart on DGCA Regulations & Safety Protocols for Drone Operation .	8	Preparation of a report/chart on DGCA Regulations & Safety Protocols for Drone Operation	2	CO2
LLO 9.1 Plot the Speed-Torque Characteristics of a BLDC Motor used in Drone .	9	Plot the speed-torque characteristics of Drone's BLDC motor	2	CO3
LLO 10.1 Inspect battery pack for bulges and leakage.	10	*Inspection of a battery pack for bulges and leakage	2	CO4
LLO 11.1 Calculate the flying time based on battery capacity.	11	*Calculation of the flying time based on battery capacity	2	CO3
LLO 12.1 Assembling of the quadcopter Drone.	12	*Assemble the quadcopter Drone using the given components	2	CO4
LLO 13.1 Configure and operate the Drone transmitter and receiver.	13	Configuration and operation of Drone transmitter and receiver	2	CO4
LLO 14.1 Test the assembled drone. LLO 14.2 Troubleshoot the assembled drone.	14	*Test the assembled drone	2	CO4
LLO 15.1 Prepare a report/chart on application of Drone technology in Agriculture.	15	*Preparation of a report/chart on application of Drone technology in Agriculture	2	CO5
LLO 16.1 Prepare a report/chart on the application of Drone technology in cinematography.	16	Preparation of a report/chart on the application of Drone technology in cinematography	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Explore and make ppt on current drone regulations (DGCA) and summarize the key safety and operational rules.
- Explore Indian Government schemes related to Drone used in various sectors and tabulate it .
- Create a chart that compares different types of drones (fixed-wing, rotary-wing, hybrid). Include details such as their flight mechanism, uses, and advantages/disadvantages.
- Create a comparison table of popular drone software frameworks like ArduPilot, PX4, and ROS. Highlight their features, advantages, and differences in functionality.
- Create an infographic or chart that shows the key components of a drone (motors, ESCs, flight controller, GPS, sensors). Briefly describe each part's role in the flight system.
- Draw a diagram illustrating the principles of drone flight (lift, thrust, drag, weight). Label the forces and explain how they work together in stable flight.
- Make a chart explaining the Drone policy implemented in India for various applications.

Assignment

- Compare different types of quadcopter frames based on their application (racing frames, photography/videography frames, industrial frames, toy drone frames, fpv frames, heavy-lift frames)
- Explain how Electronic Speed Controller (ESC) calibration is essential for ensuring optimal drone performance. In your answer, discuss the role of ESC calibration in motor performance, throttle range, safety, and battery management. Additionally, explain the potential consequences of failing to properly calibrate the ESC in a drone.
- How is drone technology transforming Indian agriculture? Discuss the role of initiatives like the Kisan Drone Scheme and Namo Drone Didi by the Government of India in accelerating this transformation. Highlight the benefits and challenges of using drones for crop monitoring, spraying, and precision farming, and explore how these advancements are shaping the future of farming in India.
- Compare different types of quadcopter propellers based on their application (racing frames, photography/videography frames, industrial frames, toy drone frames, fpv frames, heavy-lift frames)
- Compare the drone regulations in India with those of other countries (any two) around the world and explain how they differ.
- Compare different types of quadcopter motors based on their application (racing frames, photography/videography frames, industrial frames, toy drone frames, fpv frames, heavy-lift frames)
- Comment on the power vs. speed characteristics of the drone based on the thrust-to-weight ratio and KV rating.
- Drone Maintenance for Agricultural Monitoring Fleet Scenario: You are the lead technician responsible for maintaining a fleet of drones used for agricultural monitoring. The drones are equipped with high-resolution cameras, GPS modules, and autonomous flight systems. Your goal is to ensure their continuous operation and minimize downtime due to maintenance issues. Answer the following questions based on your knowledge of drone maintenance, safety procedures, and preventive measures. Question 1: What daily, weekly, and monthly maintenance tasks should be performed to keep the drones in optimal working condition. Question 2: Explain the importance of calibrating the GPS modules regularly. What steps should be taken to calibrate the GPS system in the drones. Question 3: Describe the procedures you would follow to inspect and maintain the drone’s high-resolution cameras and propellers to prevent any operational issues. Question 4: How would you monitor and maintain the health of the drone batteries to ensure long-duration flights in agricultural fields. Question 5: What emergency procedures should be followed if a drone malfunctions during flight, and how would you ensure the safety of crops and equipment in such cases.
- Drones face significant challenges with weight and battery limitations, which affect their flight time, payload capacity, and overall performance. How can the integration of solar power help overcome these issues. Discuss the potential benefits of solar-powered drones.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer system with internet connectivity.	1,2,3,4,8,15,16
2	Any office software and browser	1,2,3,4,8,15,16
3	Quadcopter Drone Kit	5,6,7,9,10,11,13,12,14
4	Tachometer	9
5	Digital Multimeter	9,10,13,12,14

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction and Classifications of Unmaned Aerial Vehicle (UAV)/Drones	CO1	12	4	4	4	12
2	II	Drone Technology - Building blocks, Components, Flight Dynamics, and Regulations.	CO2	12	4	6	6	16
3	III	Drone Motors, Power Systems, and other components	CO3	12	4	6	6	16
4	IV	Drone assembly, operation and maintenance	CO4	14	2	4	10	16
5	V	Drone Applications and Future Trends	CO5	10	2	4	4	10
Grand Total				**60**	**16**	**24**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning

XI. SUGGESTED COS - POS MATRIX FORM

DRONE TECHNOLOGY **Course Code : 316335**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	1	1	3	1	2			
CO2	2	2	3	3	3	2	3			
CO3	2	2	3	3	3	2	3			
CO4	2	3	3	3	3	2	3			
CO5	2	3	3	3	2	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Ms. Dharna Nar, Dr. Radhika Kotecha	Drone Technology for Beginners: Learn | Build | Fly Drones	Drone School India and Ane Books Pvt Ltd, ISBN : 978-8197222184
2	Aalok Tripathi	DRONE TECHNICIAN THOERY	ARIHANT PUBLICATIONS INDIA LIMITED, ISBN : 978-9364378895
3	Terry Kilby, Belinda Kilby	Make: Getting Started with Drones: Build and Customize Your Own Quadcopter	Shroff Publishers & Distributors Pvt. Ltd, ISBN : 978-9355428899
4	Garvit Pandya	Basics of Unmanned Aerial Vehicles : Time to start working on Drone Technology	Notion Press Media Pvt Ltd, Chennai, ISBN : 978-1637453865
5	Dr Raja Mogili Amirisetty	THE DRONE LAW IN INDIA	Gogia Law Agenency , ISBN : 978-8193978559
6	David McGriffy	Make: Drones - Teach an Arduino to Fly	Shroff Publishers & Distributors Pvt. Ltd, ISBN : 978-9355425188
7	Mr. I.V.S.Yeswanth & Dr. A.V.S.Sridhar Kumar	Fundamentals of Drone Technology	Authors Click Publishing, ISBN : 978-9366652450

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://digitalsky.dgca.gov.in/airspace-map/#/app	A digital sky airspace map is an interactive, real-time representation of airspace boundaries, flight paths, and aviation regulations, often used for flight planning and navigation
2	https://digitalsky.dgca.gov.in/home	Digital Sky Platform is an online portal by the Indian government for managing and regulating the operations of drones in Indian airspace.
3	https://www.dgca.gov.in/digigov-portal/jsp/dgca/homePage/viewPDF.jsp?page=InventoryList/headerblock/drones/Drone%20Rules%202021.pdf	The Drone Rules, 2021, Unmanned Aircraft System Rules, Government of India in the Ministry of Civil Aviation

DRONE TECHNOLOGY **Course Code : 316335**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s	**: Automation and Robotics/ Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics**
Programme Code	**: AO/ DE/ EJ/ ET/ EX/ IE**
Semester	**: Sixth**
Course Title	**: VLSI APPLICATIONS**
Course Code	**: 316340**

I. RATIONALE

VLSI (Very-Large-Scale Integration) design equips aspiring engineers with hands-on experience in both front-end and back-end processes. As a rapidly evolving technology in the industry, VLSI offers vast opportunities for innovation. This course provides students with fundamental skills to develop applications in VLSI using VHDL programming. Additionally, it enables them to utilize FPGA and ASIC chips for design and implement various applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attend following industry/employer excepted outcome through various teaching learning experiences: Develop VLSI-based electronic circuit/component using VHDL.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret CMOS technology circuits and its applications.
- CO2 - Develop digital circuits on CPLD and FPGA devices.
- CO3 - Use VHDL to develop and test digital circuits.
- CO4 - Develop VHDL program for given application.
- CO5 - Interpret VHDL simulation and synthesis.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316340	VLSI APPLICATIONS	VLS	DSE	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe working of MOS transistor as a switch. TLO 1.2 Sketch the given gates using CMOS logic circuits. TLO 1.3 Explain stepwise process of CMOS fabrication. TLO 1.4 Differentiate between the nwell and pwell CMOS. TLO 1.5 Define the given specification/characteristics of CMOS logic family.	**Unit - I Introduction to CMOS Technology** 1.1 MOS Transistor: symbol, characteristics and operation, switch level modes connection, behavior of series & parallel MOS transistor switch, transmission gates and tristate logic 1.2 CMOS fabrication process: Wafer processing, oxidation, epitaxy deposition, ion-implementation, diffusion, metallization, packaging 1.3 Types of CMOS fabrication: nwell, pwell, twin tub process 1.4 Specifications of CMOS logic family: metastability, noise margins, power dissipation, fan-out, skew, figure of merits (Definitions only) and the parameter values 1.5 CMOS circuits for Boolean function	Lecture Using Chalk-Board Presentations Educational Video
2	TLO 2.1 Differentiate between Asynchronous and synchronous logic circuits with the help of suitable examples. TLO 2.2 Explain the Moore and Mealy machine design method with the help of suitable diagram and example. TLO 2.3 Describe the functions of each block of the given type of CPLD, FPGA, ASIC IC. TLO 2.4 Interpret FPGA, CPLA and ASIC parameters.	**Unit - II Advance Programmable Digital Devices (CPLD, FPGA, ASIC)** 2.1 Review of Sequential Logic circuits, comparison of Asynchronous and Synchronous 2.2 Moore and Mealy machine: block diagram, design examples on Moore and Mealy such as counter, sequence detector only 2.3 CPLD: concept, architecture, internal block diagram, applications 2.4 FPGA: concept, block diagram, architecture, applications. differentiate between FPGA and CPLD 2.5 ASIC: concept and design flow	Lecture Using Chalk-Board Presentations Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Differentiate between VHDL and Verilog on the given parameters. TLO 3.2 Optimize VHDL programming steps with its syntax. TLO 3.3 Use basic elements of VHDL programming and develop the simple code for the given function. TLO 3.4 Describe various data types used in VHDL programming with examples. TLO 3.5 Use VHDL operators to develop mathematical expressions.	**Unit - III Introduction to VLSI Design Concepts** 3.1 Hardware Description Languages (HDL): Very High-Speed HDL(VHDL) vs Verilog, and their functionality and comparison 3.2 VHDL: Features, structure and elements of VHDL (entity, architecture, configuration, package, library only definitions) 3.3 Basic Language Elements: Identifiers, VHDL objects: signal, variables and constant (syntax and use) 3.4 VHDL data types: scalar, array, composite, enumerated 3.5 VHDL operators: relational, arithmetic, logical and shift	Lecture Using Chalk-Board Educational Video Presentations
4	TLO 4.1 Compare the VHDL modelling style. TLO 4.2 Develop VHDL program using concurrent statement for the given application. TLO 4.3 Develop VHDL program using sequential statement for given application. TLO 4.4 Implement given combinational and sequential logic circuits using VHDL. TLO 4.5 Develop VHDL test bench code for the given circuit.	**Unit - IV VHDL Programming** 4.1 VHDL Modeling: data flow, behavioral, structural 4.2 Concurrent constructs (when, with) 4.3 Sequential constructs (process, if, case, loop, assert, wait) 4.4 VHDL code for combinational circuits – Logic gates, adder, subtractor, multiplexer, demultiplexer, encoder, decoder, comparator, 4-bit ALU 4.5 VHDL code for Sequential circuits – D, T and JK flip-flop, 4 bit up/down counter, MOD counter, shift registers (4-bit SISO and PIPO) 4.6 Test bench: simple test bench for a combinational circuit (full adder) and sequential logic circuit (D/T flipflop)	Lecture Using Chalk-Board Educational Video Collaborative learning
5	TLO 5.1 Describe the features of the given type of simulator with a suitable example. TLO 5.2 Define the given component in HDL simulation process. TLO 5.3 Prepare flowchart for the HDL design synthesis process. TLO 5.4 Summarize stepwise HDL design flow.	**Unit - V HDL Simulation and Synthesis** 5.1 Types of simulators: event based and cycle based 5.2 Components: Event scheduling, sensitivity list, zero modelling, simulation cycle 5.3 HDL synthesis process: Boolean optimization, flattering, factoring, mapping to gates 5.4 HDL Design flow: RTL simulation, gate-level verification, place and route	Lecture Using Chalk-Board Flipped Classroom Educational Video

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify various blocks of FPGA and CPLD. LLO 1.2 Test the functionality of various pins of FPGA and CPLD.	1	*Identification of internal block and pin configuration of FPGA & CPLD	2	CO2

VLSI APPLICATIONS **Course Code : 316340**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Install relevant EDA (such as Xilinx software) tool for VHDL. LLO 2.2 Check the VHDL libraries installed in VHDL environment.	2	*Installation of EDA tool and the relevant libraries for VLSI code development	2	CO3
LLO 3.1 Test the functionality of basic logic gates using VHDL Data flow model. LLO 3.2 Test the functionality of universal logic gates using VHDL Data flow model.	3	*Develop VHDL code for basic and universal gate for data flow model	2	CO3
LLO 4.1 Test the functionality of basic logic gates using VHDL behavioral model. LLO 4.2 Test the functionality of universal logic gate using VHDL behavioral model.	4	Develop VHDL code for basic and universal gate for behavioral model	2	CO3
LLO 5.1 Test the functionality of half and full adder using VHDL code. LLO 5.2 Test the simulated Test bench waveform.	5	*Realize the half and full Adder on FPGA board	2	CO3
LLO 6.1 Test the functionality of 4:1 multiplexer using VHDL code.	6	*Realize the Multiplexer on FPGA board	2	CO3
LLO 7.1 Test the functionality of 1:8 De-multiplexer using VHDL code.	7	Realize the De-multiplexer on FPGA board	2	CO3
LLO 8.1 Interpret the output of 4:2 encoder using VHDL code.	8	Design 4:2 encoder on FPGA board	2	CO3
LLO 9.1 Interpret the output of 3:8 decoder using VHDL code.	9	Design 3:8 decoder on FPGA board	2	CO3
LLO 10.1 Test the functionality of D flipflop using VHDL code. LLO 10.2 Test the functionality of T flipflop using VHDL code.	10	*Realize the D and T flipflop on FPGA board	2	CO3
LLO 11.1 Test the functionality of 2-bit comparator using VHDL code.	11	Design Comparator on FPGA board	2	CO3
LLO 12.1 Interpret the output of Mod-10 Up counter using VHDL code.	12	Design Up Counter on FPGA board	2	CO3
LLO 13.1 Develop VHDL code for 4-bit Up/Down Synchronous counter and test the circuit on FPGA board..	13	Design Synchronous counter on FPGA board	2	CO3
LLO 14.1 Test the functionality of 4-bit binary to gray code converter & Synthesize using FPGA.	14	Design binary to gray code converter circuit using FPGA board	2	CO3
LLO 15.1 Develop VHDL code for 8-bit Digital to analog converter (DAC) & test the circuit on FPGA board	15	*Design digital to analog converter (DAC) using FPGA board	2	CO4
LLO 16.1 Optimize the VHDL code to rotate stepper motor in clockwise direction.	16	*Design stepper motor Controller using FPGA board	2	CO5
LLO 17.1 Develop VHDL code for 4-bit ALU and simulate it using FPGA.	17	Design of 4-bit ALU/ sequence detector using FPGA board	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Develop the flowchart for simulation used in VHDL.
- Write syntax for concurrent and sequential statements.
- Write test bench code of universal shift register using VHDL.
- Describe architecture of CPLD/FPGA with function of each block.
- Develop flow chart of CMOS IC fabrication in p-well and n-well process.

Micro project

- Build a small ASIC system for your Home /Community.
- Develop four-bit addition/subtraction circuit using VHDL code.
- Develop square wave generator system of frequency = 1 Hz/100Hz
- Develop a VLSI based alarm system when a customer enters into the shop through exits door.
- Build a VLSI based system for vehicle security system.
- Design traffic light system using CPLD/FPGA.
- Design Lift controller system using CPLD/FPGA.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	VLSI trainer kit along with DAC/ADC trainer kit.	15
2	VLSI trainer kit along with stepper motor.	16
3	FPGA trainer kit with Accessories	2,4,5,6,7,8,9,10,11,12,13,14,15,16,17
4	JTAG cable, DMM, Bread board.	3,4,5,6,7,8,9,10,11,12,13,14,15,16,17
5	VLSI trainer kit with accessories such as switches,LED,seven segment display etc.	4,5,6,7,8,9,10,11,12,13,14,15
6	Personal computer with latest configuration.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to CMOS Technology	CO1	12	2	4	8	14
2	II	Advance Programmable Digital Devices (CPLD, FPGA, ASIC)	CO2	10	2	2	6	10
3	III	Introduction to VLSI Design Concepts	CO3	14	4	4	8	16
4	IV	VHDL Programming	CO4	16	4	6	10	20
5	V	HDL Simulation and Synthesis	CO5	8	2	2	6	10
Grand Total				**60**	**14**	**18**	**38**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit test of 30 marks and average of two-unit test will considered for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	1	1	1	2			
CO2	3	2	1	1	1	1	2			
CO3	3	2	2	2	2	2	3			
CO4	3	3	3	3	2	2	3			
CO5	3	3	3	2	2	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Gaganpreet Kaur	VHDL Basics to programming	Pearson Education India, 2011 ISBN: 9788131732113
2	John M. Yarbrough	Digital Logic: Application and Design	C.L Engineering, ISBN: 978 034066756
3	Willian I. Fletcher	An Engineering approach to digital design	Prentice- Hall of India ISBN: 9780132776998
4	Douglas Perry	VHDL programming by example	Tata McGraw-Hill ISBN: 9780070499447
5	Eugene D. Fabricius	Introduction to VLSI Design	McGraw Hill ISBN:9780070199484
6	Sarkar & Sarkar	VLSI design and EDA tools	Scitech Publications (lndia) Pvt Ltd ISBN: 9788183714976

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://docs.amd.com/v/u/en-US/ug1655-ise-documentation	ISE documentation for version 14.7
2	https://web.eecs.utk.edu/~dbouldin/protected/xilinx-ise-quick-start.pdf	ISE quick start tutorial
3	https://www.allaboutelectronics.org/cmos-logic-gates-explained/	Logic gates implementation using CMOS inverter

VLSI APPLICATIONS **Course Code : 316340**

Sr.No	Link / Portal	Description
4	https://www.geeksforgeeks.org/vhdl-very-high-speed-integrated-circuit-hardware-description-language/	VHDL programming.
5	https://nptel.ac.in/courses/117106092	NPTEL- VLSI Design Course

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students