GovernmentPolytechnic,Mumbai

(A… …nicallyAutonomousInstitute,GovernmentofMa… …htra)

NameoftheProgramme:Diploma inElectronicsEngineering

TeachingandExaminationScheme(P23) — **With EffectFromAcademicYear:2023-24**

DurationofProgramme:6Semester — **Duration:16WEEKS**

Semester:Fourth — **Scheme: P23**

Sr No	CourseTitle	CourseType	CourseCode	TotalIKS Hrs forSem.	LearningScheme: ActualContactHrs./Week CL	TL	LL	Self-Learning (TermWork+Assignment)	Notional LearningHrs/Week	Credits	AssessmentScheme: Paperduration(hrs.)	Theory FA-TH T1	FA-TH T2	SA-TH Max	Theory Total Max	Theory Total Min	BasedonLL&TL Practical FA-PR Max	FA-PR Min	SA-PR Max PR	SA-PR Max OR	SA-PR Min	BasedOnSelf Learning SLA Max	SLA Min	TotalMarks
1	Internet of Things	AEC	EC 23501		3	-	4	1	8	4	2:30	20	20	60	100	40	25	10	25@	-	10	25	-	175
2	Computer Network	DSC	EC 23110		3	-	2	1	6	3	-	-	-	-	-	-	25	10	-	25@	20	25	-	75
3	Embedded system	DSC	EC 23111		3	-	4	1	8	4	2:30	20	20	60	100	40	25	10	25#	-	10	25	-	175
4	Power Electronics	DSC	EC 23112		3	-	4	1	8	4	2:30	20	20	60	100	40	50	20	25#	-	10	25	-	200
5	Elective-Microwave and RADAR	DSE	EC 23201		3	1	2	-	6	3	2:30	20	20	60	100	40	25	10	-	50@	20	-	-	175
	Artificial Intelligence	GE	EC 23701																					
	Consumer Electronics	DSE	EC 23202																					
6	Linux	AEC	EC 23502		-	-	2	-	2	1	-	-		-	-	-	-	-	-	-	-	-	-	-
7	Project I	INP	EC 23401				2		2	1									-	25@				25
Total					**15**	**1**	**20**	**4**	**40**	**20**					**400**		**150**		**100**	**75**		**100**		**825**

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, FA-Formative Assessment, SA-Summative Assessment, IKS-Indian Knowledge System, SLA-Self LearningAssessment**Legends :**@ InternalAssessment,#ExternalAssessment, *#On LineExamination,@$InternalOnline Examination

Note: 1.FA-THrepresentsmarksoftwoclasstestsof20markseachconductedduringthesemester.

2. Ifcandidateisnotsecuringminimumpassingmarks inFA-PRofanycoursethenthecandidateshallbedeclaredas"Detained"inthatsemester.
3. Ifcandidateisnotsecuringminimumpassingmarks inSLAofanycoursethenthecandidateshallbedeclaredasfailandwillhavetorepeatandresubmitSLAwork.
4. NotionalLearninghoursforthesemesterare(CL+LL+TL+SL)hrs.*15Weeks
5. 1creditisequivalentto30Notionalhrs.
6. *SelflearninghoursshallnotbereflectedintheTimeTable.

CourseCategory: DisciplineSpecificCourseCore(DSC):2,DisciplineSpecificElective(DSE):0,ValueEducationCourse(VEC):1,Intern./Apprenti./Project./Community(INP):0,AbilityEnhancementCourse(AEC):2,SkillEnhancementCourse(SEC):2,GenericElective(GE):0

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CDC Co-ordinator G. P. Mumbai

CDCCordinator, ElectronicsDepartment

HOD, ElectronicsDepartment

CDCIncharge, CDCCell

Principal, G.P.Mumbai

Programme : Diploma in Electronics Engineering (Sandwich pattern)												
Course Code: EC23501					**Course Title: Internet of Things**							
Compulsory / Optional: Compulsory												
Learning Scheme and Credits						**Assessment Scheme**						
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**	**SA-TH (3 Hrs.)**	**FA-PR**	**SA**		**SLA**	**Total**
									PR	**OR**		
3	-	4	1	8	4	40	60	25	25@	-	25	175

Total IKS Hrs. for course: -

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work
4. SA-PR represents the end term practical examination.

I. Rationale:

IoT is responsible for the super-fast evolution of industry 4.0, where the operations are mostly automated thus

eliminating the need for much human intervention. The Internet of Things (IoT) describes the network of physical objects-"things" that are embedded with sensors , softwares and other technologies. IoT devices gather

Information and send it along to a data server where the information is collected, processed and used to make

host of tasks easier to perform. IoT enables the creation of innovative solutions to real world challenges.

II. Industry / Employer Expected Outcome

Develop and implement creative solutions for real time problems that can enhance efficiency, safety and convenience across various domains.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Understand the fundamental concepts of IoT.
CO2	Analyze IoT gateways and microcontrollers.
CO3	Apply sensors and communication protocols to design efficient IoT systems
CO4	Understand the software stack required for developing and managing IoT applications
CO5	Integrate IoT services with cloud computing for scalable data storage, processing, and real-time analytics
CO6	Understand the fundamentals of 3D printing technology and its applications

IV.Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	TLO1.1- Define IoT and understand its history and evolution TLO1.2- Explain the characteristics, architecture, and technology behind IoT systems. TLO1.3- Understand the key design principles and layers of IoT/M2M systems. TLO1.4- Identify and describe the major components of IoT devices.	**Unit 1 – Fundamental of IOT** 1.1 Concept and Definitions of the Internet of Things(IoT)History of IoT.Characteristics, 1.2 Conceptual Framework, Architectural view, technology behind IoT. 1.3 Design Principles for connected Devices:IoT/M2M systems layers and Design standardization, Physical vs logical design, communication technologies, Data Enrichment and consolidation, Ease of Designing and affordability. 1.4 Major Component of IoT Devices(Sensor or Gateway, Cloud, Analytics, User Interface) **Course Outcome:CO1 Teaching Hours:4hrs Marks: 8(R- 2, U-4, A-2)**

2	TLO2.1- Understand the function and importance of IoT gateways in connecting devices, processing data, and facilitating communication within IoT systems. TLO2.2- Gain proficiency in using Arduino microcontrollers to develop and implement IoT applications, understanding their architecture and capabilities.	**Unit 2- IoT Gateway and Microcontroller** 2.1 Know your IoT Gateway 2.2 Embedded Platforms for IoT – Embedded Computing Basics(Block Diagram), 2.3 IoT supported platforms-Arduino and Raspsberry Pi IoT Protocol- MQTT, CoAP,XMPP **Course Outcome:CO2 Teaching Hours:8hrs Marks: 10(R- 4, U-4, A-2)**
3	TLO3.1- Gain a broad overview of various types of sensors, their applications, and their importance in IoT systems. TLO3.2- Understand the fundamental operating principles behind different sensors, including how they detect and measure physical properties. TLO3.3- Acquire skills in calibrating sensors to ensure accurate and reliable measurements in practical applications. TLO3.4- Understand how Bluetooth, WiFi, SPI, USB, UART, I2C is used for short-range wireless communication in IoT devices, including its features, applications, and limitations. TLO3.5- Acquire skills in calibrating sensors to ensure accurate and reliable measurements in practical applications. TLO3.6- Understand how Bluetooth, WiFi, SPI, USB, UART, I2C is used for short-range wireless communication in IoT devices, including its features, applications, and limitations.	**Unit 3 – Sensors and Communication Protocols in IoT** 3.1 Working Principles of Sensors 3.2 Sensor Calibration 3.3 IoT Communication Protocols- Bluetooth, WiFi, SPI, USB, UART, I2C, Bluetooth.ZigBee,RFID,GPS NFC, Ethernet,TCP/IP **Course Outcome:CO3 Teaching Hours:8hrs Marks: 10(R- 2, U-4, A-4)**
4	TLO4.1- Understand the functionalities and features of circuit design software used for creating, simulating, and analyzing electronic circuits in IoT applications. TLO4.2- Learn the fundamentals of block-based programming environments and how they facilitate visual coding for IoT applications, making programming more accessible. TLO4.3- Gain familiarity with integrated	**Unit 4- Software Stack for IoT Application** 4.1 Circuit Designer Overview 4.2 Block Programming 4.3 Python Direct IDE 4.4 Introduction to Python 4.5 Learn Python using Blocks

	development environments (IDEs) for Python, including their features and how they support direct coding and debugging for IoT projects. TLO4.4- Acquire foundational knowledge of Python programming, including its syntax, structures, and use cases in developing IoT applications. TLO4.5- Develop programming skills by using block- based representations of Python code to understand concepts and logic, bridging the gap between visual and text-based programming.	**Course Outcome:CO4 Teaching Hours:9hrs Marks: 12(R- 4, U-4, A-4)**
5	TLO5.1- Understand how IoT harnesses its full potential through effective device connectivity, data management, and integration with cloud services. TLO5.2- Learn how mobile browsers interact with IoT gateways to facilitate communication and data exchange in IoT systems. TLO5.3- Gain insights into how cloud services enable IoT applications by providing scalable storage, data processing, and analysis capabilities. TLO5.4- Acquire the skills to create and set up an Amazon Web Services (AWS) account, essential for leveraging cloud resources for IoT projects. TLO5.5- Learn how to manage and optimize AWS costs effectively to ensure efficient use of cloud resources for IoT applications.	**Unit 5 - IoT Services and Cloud Computing** 5.1 Unlocking power of IoT 5.2 Mobile browser to IoT Gateway Communication 5.3 Cloud Connectivity for IoT Application 5.4 Cloud based Architecture, SaaS , PaaS and IaaS 5.5 How to open AWS account 5.6 AWS Cost Management **Course Outcome:CO5 Teaching Hours:8hrs Marks: 10(R- 2, U-4, A-4)**
6	TLO6.1- Explain the principle of 3D printing. TLO6.2- Explain common basic slicer softwares. TLO6.3- Explain post-processing techniques used in 3D printing.	**Unit 6 – Introduction to 3D printing** 6.1 Basic principle of 3D printing, steps in 3D printing process 6.2 3D printer components and its calibration 6.3 Common basic slicer settings (layer height, fill density, supports, platform adhesion – skirt, brim, raft, shell thickness) 6.4 Post-processing techniques, need of post-processing, steps in post processing **Course Outcome:CO6 Teaching Hours:8hrs Marks: 10(R- 2, U-4, A-4)**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr No	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
1	LLO1.1 - Connect the IR sensor and Servo motor to the IoT Gateway LLO1.2 - Write the application program logic LLO1.3 - Verify the notifications sent to the mobile device on execution of the program LLO1.4 - Decode and understand the science concept/principle behind the sensor construction	Circuit Design for IoT System – Door and Light Automation Solution	2	CO1
2	LLO2.1 - Connect the Keypad and Servo motor to the IoT Gateway LLO2.2 - Write the application program logic LLO2.3 - Verify the notifications sent to the mobile device on execution of the program LLO2.4 - Decode and understand the science concept/principle behind the sensor construction	Block-Based IoT Programming for Home Security Solution (Digital Lock)	2	CO1
3	LLO3.1 - Connect the IR sensor, USB Camera and Buzzer to the IoT Gateway LLO3.2 - Write the application program logic LLO3.3 - Verify the notifications sent to the mobile device on execution of the program LLO3.4 - Decode and understand the science concept/principle behind the sensor construction	Build the IOT Home Security - Security Solution using IR, Camera and Buzzer	2	CO1, CO2, CO3
4	LLO4.1 - Connect the IR sensors and LED (using breadboard) to the IoT Gateway LLO4.2 - Write the application program logic LLO4.3 - Verify the notifications sent to the mobile device on execution of the program LLO4.4 - Decode and understand the science concept/principle behind the sensor construction	Build the Energy Management with Smart Lighting	2	CO1, CO2, CO3, CO4, CO5
5	LLO5.1 - Connect the Soil Moisture sensor, RTC, Solenoid Valve to the IoT Gateway LLO5.2 - Write the application program logic LLO5.3 - Verify the notifications sent to the mobile device on execution of the program LLO5.4 - Decode and understand the science concept/principle behind the sensor construction	Demonstrate a timer based Smart Irrigation Solution	2	CO1, CO2, CO3

6	LLO6.1 - Connect the pH Sensor and TDS sensor to the IoT Gateway LLO6.2 - Write the application program logic LLO6.3 - Verify the notifications sent to the mobile device on execution of the program LLO6.4 - Decode and understand the science concept/principle behind the sensor construction	Build the IOT based Water Quality Testing	2	CO1, CO2, CO3, CO4, CO5
7	LLO7.1 - Connect the PulseOximeter sensor and Led board to the IoT Gateway LLO7.2 - Write the application program logic LLO7.3 - Verify the notifications sent to the mobile device on execution of the program LLO7.4 - Decode and understand the science concept/principle behind the sensor construction	Demonstrate IOT in Healthcare - Smart Pulse Rate and Oxygen Monitoring Solution	2	CO1, CO2, CO3, CO4, CO5
8	LLO8.1 - Connect the Weight sensor, Led board and Buzzer to the IoT Gateway LLO8.2 - Write the application program logic LLO8.3 - Verify the notifications sent to the mobile device on execution of the program LLO8.4 - Decode and understand the science concept/principle behind the sensor construction	Demonstrate IOT in Healthcare - Smart Saline Monitoring Solution	2	CO1, CO2, CO3, CO4, CO5
9	LLO9.1 - Connect the IR sensor and Buzzer to the IoT Gateway LLO9.2 - Write the application program logic LLO9.3 - Verify the notifications sent to the mobile device on execution of the program LLO9.4 - Decode and understand the science concept/principle behind the sensor construction	Demonstrate IOT in Healthcare - Assistive Communication Solution	2	CO1, CO2, CO3, CO4, CO5
10	LLO10.1- Connect the Temperature Sensor, Halleffect sensor, LED board to the IoT Gateway LLO10.2- Write the application program logic LLO10.3- Verify the notifications sent to the mobile device on execution of the program LLO10.4- Decode and understand the science concept/principle behind the sensor construction	Construct IOT in Weather Forecasting - Wind Speed and Humidity Measurement	2	CO1, CO2, CO3, CO4, CO5
11	LLO11.1- Connect the Moisture sensor, Relay, LoRa Hub, LoRa nodes to the IoT Gateway LLO11.2- Write the application program logic LLO11.3- Verify the notifications sent to the	Build IOT in Agriculture - Smart Scalable Farming Solution	2	CO1, CO2, CO3, CO4, CO5

	mobile device on execution of the program LLO11.4- Decode and understand the science concept/principle behind the sensor construction			
12	LLO12.1- Connect the Energy device, Relay to the IoT Gateway LLO12.2- Write the application program logic LLO12.3- Verify the notifications sent to the mobile device on execution of the program LLO12.4- Decode and understand the science concept/principle behind the sensor construction	Create a Smart Energy Monitoring Solution (PF, Energy consumption etc.)	2	CO1, CO2, CO3, CO4, CO5
13	LLO14.1- Connect the USB Camera, Keypad and Servo motor to the IoT Gateway LLO14.2- Write the application program logic LLO14.3- Verify the notifications sent to the mobile device on execution of the program LLO14.4- Decode and understand the science concept/principle behind the sensor construction	Build a Home Security Solution - Digital Lock with Camera	2	CO1, CO2, CO3, CO4, CO5
14	LLO15.1- Connect the Moisture sensor, Solenoid valve to the IoT Gateway LLO15.2- Write the application program logic LLO15.3- Verify the notifications sent to the mobile device on execution of the program LLO15.4- Decode and understand the science concept/principle behind the sensor construction	Build a Agriculture – Smart Irrigation Solution using LoRa protocol	2	CO1, CO2, CO3, CO4, CO5
15	LLO16.1- Connect the IR sensor, Temperature sensor and Motor to the IoT Gateway LLO16.2- Write the application program logic LLO16.3- Verify the notifications sent to the mobile device on execution of the program LLO16.4- Decode and understand the science concept/principle behind the sensor construction	Develop a Home and Building Energy Management - Smart AC	2	CO1, CO2, CO3, CO4, CO5
16	LLO17.1- Connect the Flame sensor and Solenoid valve to the IoT Gateway LLO17.2- Write the application program logic LLO17.3- Verify the notifications sent to the mobile device on execution of the program	Develop a Home and Building Fire Safety Solution	2	CO1, CO2, CO3, CO4, CO5

	LLO17.4- Decode and understand the science concept/principle behind the sensor construction			
17	LLO18.1- Connect the Alcohol sensor, Ultrasonic sensor, Motor and Buzzer to the IoT Gateway LLO18.2- Write the application program logic LLO18.3- Verify the notifications sent to the mobile device on execution of the program LLO18.4- Decode and understand the science concept/principle behind the sensor construction	Build a Transportation and Safety Solution	2	CO1, CO2, CO3, CO4, CO5
18	LLO19.1- Connect the IR sensors and Servo motors to the IoT Gateway LLO19.2- Write the application program logic LLO19.3- Verify the notifications sent to the mobile device on execution of the program LLO19.4- Decode and understand the science concept/principle behind the sensor construction	Create a Public Safety – Smart Crowd Management System	2	CO1, CO2, CO3, CO4, CO5
19	LLO20.1- Connect the Weight sensor, Gas sensor, Flame sensor, Led board, Buzzer, Solenoid valve to the IoT Gateway LLO20.2- Write the application program logic LLO20.3- Verify the notifications sent to the mobile device on execution of the program LLO20.4- Decode and understand the science concept/principle behind the sensor construction	Build a Smart LPG Monitoring Solution	2	CO1, CO2, CO3, CO4, CO5
20	LLO21.1- Connect the IR sensor, Ultrasonic sensor, LED board, Servo motor and Buzzer to the IoT Gateway LLO21.2- Write the application program logic LLO21.3- Verify the notifications sent to the mobile device on execution of the program LLO21.4- Decode and understand the science concept/principle behind the sensor construction	Build a Smart City - Waste Management Solution	2	CO1, CO2, CO3, CO4, CO5
21	LLO22.1- Connect the Moisture sensor, Flow sensor, Ultrasonic sensor and Solenoid valve to the IoT Gateway LLO22.2- Write the application program logic LLO22.3- Verify the notifications sent to the	Build a Home and Building - Water Management Solution (eg. Monitoring flow level, supply	2	CO1, CO2, CO3, CO4, CO5

	mobile device on execution of the program LLO22.4- Decode and understand the science concept/principle behind the sensor construction	automation)		
22	LLO23.1- Connect the IR sensors, Led board and Servo motor to the IoT Gateway LLO23.2- Write the application program logic LLO23.3- Verify the notifications sent to the mobile device on execution of the program LLO23.4- Decode and understand the science concept/principle behind the sensor construction	Develop a Smart City – Smart Parking Management System	4	CO1, CO2, CO3, CO4, CO5

Note: 20out of 22 experiments should be performed in a term for completion of TW

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):

1. Complete any one course related to "Internet of Things" freely available on Infosys Springboard/NPTEL/Spoken Tutorial.
2. Micro project
3. Automatic Street Light- Street Light should automatically ON at evening and automatically OFF at morning. LCD and Serial Monitor shows Light Intensity value on First Line and Status of Street Light on Second Line. USE RGB LED for street Light and use orange color.
4. Home Automation through PC- Design and develop project to control 8 home devices through PC serial monitor, LCD connected on project will shows Status of Devices is on or off. Also show the status of all devices on serial monitor.
5. Motion enabled Room Light- Light present in Room should automatically ON when human motion is detected and automatically OFF in the absence of human motion. LCD and Serial monitor shows appropriate message as
6. "Motion detected! Light ON" and "No Motion! Light OFF" when particular condition fulfilled.
7. Electronic Smart Blind Stick- If someone is in front of blind person, LED and Buzzer should on and LCD will show the message" Obstacle. Be Alert" otherwise LED and Buzzer will remains off and LCD show the message "Safe.. Keep Walking".
8. Electronic Notice Board- Any Message send from Serial Monitor should get displayed on LCD. When new message sends, previous message gets automatically erased and replaced with new message.
9. Assignment
10. Solve Assignment covering all COs given by Course Teacher.

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Fundamental Building Blocks of IOT	2	4	2	8
2	IoT Gateway and Microcontroller	4	4	2	10
3	Sensors and Communication Protocols in IoT	2	4	4	10
4	Software Stack for IoT Application	4	4	4	12
5	IoT Services and Cloud Computing	2	4	4	10
6	Introduction to 3D printing	2	4	4	10
Total					**60**

V1II. AssessmentMethodologies/Tools

Formative assessment (Assessment for Learning)

Rubrics for continuous assessment based on process and product related performance indicators (25 marks)

Summative Assessment (Assessment of Learning)

End term examination, Viva-voce, Workshop performance (25 marks)

IX. 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	SO-1	SO-2	SO-3
CO1	2	1	2	2	1	2	1	1		1
CO2	1	2	2	3	2	2	2			
CO3	1	2	2	3	2	2	2		1	1
CO4	1	2	2	3	2	2	2	1	1	1
CO5	2	2	3	3	2	2	2	1		1
CO6	1		3	3		2		2		
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

X. Suggested Learning Materials / Books

Sr.No	Author	Title	Publisher with ISBN Number
1	Cornel M Amariei	Arduino Development Cookbook	PACKT publishing Ltd. New Delhi, ISBN: 978-1-78398-294-3
2	Arshdeep Bahga, Vijay Madisetti	Internet of Things: A Hands-On Approach	Orient Blackswan New Delhi ,ISBN: 978- 0996025515 628/- 2
3	David Hanes, Gonzalo Salgueiro, Patrick Grossetti	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	Cisco Press ISBN: 978-1-58714-456- 1 599
4	Simen Monk	Raspberry Pi Cookbook	Publisher(s): O'Reilly Media, Inc. ISBN: 9781098130923
5	Agus Kurniawan	Smart Internet of Things projects	PACKT publishing Ltd. New Delhi ISBN:9788131766613

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CDC Co-ordinator
G. P. Mumbai

XI. Learning Websites & Portals

Sr.No	Link / Portal	Description
1	https://github.com/microsoft/IoT-For-Beginners	All practicals
2	https://www.javatpoint.com/difference-between-sensors-and-actuators	Sensors and Actuators
3	https://www.tinkercad.com/learn/circuits?collectionId=O0K87SQL1W5N4P2	Practical using Simulator
4	https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/	Online content of Internet of Things
5	https://hands-on-books-series.com/iot.html	Introduction to IoT
6	https://hands-on-books-series.com/iot.html	Hands on approach on IoT
7	https://www.raspberrypi.org/	Raspberry Pi Hands on tutorial

Note :

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

XII. Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr Anjum Mujawar	Lecturer in Electronics	Vidyalankar Polytechnic, Mumbai
2	Mr Abhijit Patil	Lecturer in Electronics	St Xavier Polytechnic, Mumbai
3	Mr V.Y.Patil	Lecturer in Electronics	Government Polytechnic, Mumbai
4	Mrs. V.K.Jadhav	Lecturer in Electronics	Government Polytechnic, Mumbai

Coordinator
Curriculum Development,
Department of Electronics

Head of Departments
Department of Electronics

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

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CDC Co-ordinator
G. P. Mumbai

Principal
Government Polytechnic, Mumbai

Programme : Diploma in Electronics Engineering (Sandwich pattern)												
Course Code: EC 23110				**Course Title: Computer Network**								
Compulsory / Optional: Compulsory												
Learning Scheme and Credits						**Assessment Scheme**						
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2:30 Hrs.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T1**			**PR**	**OR**		
3	-	2	1	6	3	-	-	-	25	-	25@	25	75

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

Note:
1. FA-PR represents the term work
2. SA-OR represents the end term oral examination.

I. Rationale:

The field of electronics engineering increasingly integrates networked systems, requiring professionals to have a solid foundation in computer networks. This course enables students to understand networking fundamentals, configurations, and troubleshooting, which are critical for developing and maintaining embedded systems, IoT devices, and industrial communication systems.

II. Industry / Employer Expected Outcome:

After completing this course, students will be able to:

1. Install, configure, and troubleshoot small-scale networks in industrial or office environments.
2. Develop and maintain communication systems for IoT and automation projects.
3. Integrate and test network protocols in electronics-based systems.
4. Adapt to evolving networking technologies and standards.

This course gives the important concepts and techniques related to data communication and enable students to maintain and troubleshoot computer networks.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Understand the fundamentals of computer networking, including layered architecture and protocols.
CO2	Learn about physical and wireless communication media, networking hardware, and tools.
CO3	Develop skills in configuring and managing network devices like routers, switches, and firewalls.
CO4	Gain hands-on experience in network setup, troubleshooting, and performance analysis
CO5	Demonstrate the functions of different network components, devices, protocols.

IV Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	TLO1a.Explain the function of the given component in the process of data Communication. TLO1b.Describe the given data transmission method with its frame format TLO1c.Design computer network considering particular topology. TLO1dClassify networks Based on the given parameter.	**Introduction to Computer Networks and its characteristics:** 1.1 Brief history: Voice networks to data networks 1.2 Components of data communication Transmitter, Receiver, Medium, Message, Protocol. Standards, Standard organizations. Basic block diagram of data communication system 1.3 Data Transmission: Serial, Parallel Synchronous, Asynchronous, Isochronous transmission 1.4 Transmission characteristics: Signaling rate, data rate, bit rate, baud rate 1.5 Need of computer networks, Network criteria advantages of networking. 1.6 Network topologies: Mesh, Star, Bus, Tree, Ring and Hybrid topologies Schematic diagram, working, advantages disadvantages and applications 1.7 Network Classification: 1.7.1 Based on Transmission Technology: Point to-point, Multipoint, Broadcast 1.7.2 Based on physical size(scale):PAN, LAN, MAN, WAN, VPN 1.7.3 Based on Architecture: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model. **Course Outcome: CO1 Teaching Hours: 05 hrs**
	TLO2a.Describe the function of the given layer of TCP/IP Reference model.	**Network Models:** 2.1 TCP/IP protocol suite with define protocols in respective Layers: Physical layer, Data Link Layer, Network Layer, Transport Layer, Application Layer

2	TLO2b.Explain the relationship of layers with addresses in TCP/IP. TLO2c.Differentiate between Various addressing schemes in TCP/IP. TLO2d.Describe the functions of the given layer of OSI Reference model	2.2 Addressing in TCP/IP: Physical, logical, Port and specific. 2.3 The ISO-OSI model:Physical layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer **Course Outcome: CO1** **Teaching Hours: 10 hrs**
3	TLO3a. Select the transmission media for transmitting given signal for the given application. TLO3b.Describe the construction of the given cable with labeled sketches. TLO3c.Compare different type of Transmission medium based on given parameter TLO3d.Explain the working of the given type of modem TLO3e.Compare different Switching techniques based on the given parameters.	**Physical layer:** 3.1 Transmission medium: classification based on electromagnetic wave spectrum 3.2 Guided Media -Twisted pair (UTP, STP) cable-connector, Coaxial cable-connector, Fiber-optic cable connector, performance and applications 3.3 Unguided Media-Radio waves, microwaves, Infrared and their applications 3.4 Modems: Classifications: Broadband modem, DSL-ADSL, HDSL, VDSL 3.5 Switching: Circuit-switched networks, Packet switched networks -Datagram approach, Virtual circuit approach. **Course Outcome: CO2** **Teaching Hours:10 hrs**
4	TLO4a.Describe the services Provided by Data Link layer. TLO4b.Explain flow control protocol in the data link layer with justification. TLO4c.Compare Characteristics of given type of Protocol. TLO4d.Select the appropriate protocol for any application	**Data link layer:** 4.1 Data link layer: Flow and Error control 4.2 Flow control: Framing, Flow and control, stop-and-wait protocol 4.3 Overview of important protocols: IP, TCP, UDP, HTTP, FTP, SMTP., UART, I2C (Definition and Practical Applications of each protocol) 4.4 Introduction to wireless protocols: Bluetooth, Zigbee, Wi-Fi.,MQTT (Message Queuing Telemetry Transport),CoAP (Constrained Application Protocol LoRaWAN (Definition and Practical Applications of each protocol) 4.5 Addressing: IPv4 vs. IPv6, subnetting basics. **Course Outcome: CO3** **Teaching Hours : 10 hrs**
5	TLO5a.Justify the function of the given network device. TLO5b.Select appropriate class for given network size. TLO5c.Differentiate between class full and class less addressing.	**Network, Transport, Application layer:** 5.1 Network devices: Repeater, Hub, Bridge, Switches, Router, Gateway 5.2 Network layer Logical addressing: IPv4 Addresses: address space Notations, classful and classless addressing, Network address translation (NAT), IPv6 addresses, Need for IPv6, Structure and address space 5.3 Network layer-Multicast Routing Protocols: Unicast, Multicast and Broadcast routing and applications

	TLO5d.Explain the role of NAT in address depletion. TLO5e.Explain the given type of Routing. TLO5f.Describe the services provided by transport layer/network layer/Application layer.	Transport Layer: Process to process delivery, UDP, RTP and SCTP: ports, format, operation and uses 5.4 Application Layer services: Concept of DNS, FTP. 5.5 Security services: concepts of message and entity security services, Firewall **Course Outcome: CO5** **Teaching Hours : 10hrs**
5	TLO5a.Justify the function of the given network device. TLO5b.Select appropriate class for given network size. TLO5c.Differentiate between class full and class less addressing. TLO5d.Explain the role of NAT in address depletion. TLO5e.Explain the given type Of Routing. TLO5f.Describe the services provided by transport layer/network layer/Application layer.	**Network, Transport, Application layer:** 5.6 Network devices: Repeater, Hub, Bridge, Switches, Router, Gateway 5.7 Network layer Logical addressing: IPv4 Addresses: address space Notations, classful and classless addressing, Network address translation (NAT), IPv6 addresses, Need for IPv6, Structure and address space 5.8 Network layer-Multicast Routing Protocols: Unicast, Multicast and Broadcast routing and applications Transport Layer: Process to process delivery, UDP, RTP and SCTP: ports, format, operation and uses 5.9 Application Layer services: Concept of DNS, FTP. 5.10 Security services: concepts of message and entity security services, Firewall **Course Outcome: CO5** **Teaching Hours : 10hrs**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr No	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
1	LLO1: Study of different Networking Tools like Network and Telecom Crimping Tool / LAN Cable Tester/ Line Tester	Study of different Networking Tools like Network and Telecom Crimping Tool / LAN Cable Tester / Line Tester.	02	CO1
2	LLO2:Simulate the networking Topology of the institute in Packet Tracer	Identify the different types of network topologies in lab.	02	CO1
3	LLO3:Simulate the networking Topology of the institute in Packet Tracer	Connect computers in star topology and test the performance.	02	CO1
4	LLO4:Install a LAN network Using a Hub/ Switch consisting of 6 Computers using Packet tracer.	Install a LAN network Using a Hub/ Switch consisting of 6 computers	02	CO1

5	LLO5:Install devices like Printer / Router/Access Points. Implement Basic Network Commands.	Install devices like Printer / Router /Access Points. Implement Basic Network Commands.	02	CO5
6	LLO6:Assign IP address to the PC connected to the internet	Assign IP address to the PC connected to the internet	02	CO4
7	LLO7:Configure LAN network using CAT5/6 cable and RJ 45 jack outlet Crimping	Configure LAN network using CAT5/6 cable and RJ 45 jack outlet Crimping	02	CO3
8	LLO8:Check and setup network Settings on a computer.	Configure/Test Internet connectivity.	02	CO4
9	LLO9:Check connection using ping command and use IP configuration command	Check connection using ping command and use IP configuration command	02	CO2
10	LLO10:Make cross-wired and straight cables using crimping tools	Make cross-wired and straight cables using crimping tools	02	CO3
11	LLO11:Troubleshoot network using commands including ping, tracert, netsh, ipconfig, and netstat etc.	Troubleshoot network using commands including ping, tracert, netsh, ipconfig, and netstat etc.	02	CO2
12	LLO12:Perform Smart Pulse rate and oxygen monitoring system practical using protocol - I2C.	Perform Smart Pulse rate and oxygen monitoring system practical using protocol - I2C.	02	CO5
13	LLO13:Perform Smart Parking system Practical using Protocol MQTT	Perform Smart Parking system practical using Protocol - MQTT	02	CO5
14	LLO14:Perform practical Application using GPS sensor using Protocol - UART	Perform practical Application using GPS sensor using Protocol - UART	02	CO5
15	LLO15:Perform practical Smart scalable farming system using Protocol - Bluetooth and WiFi	Perform practical Smart scalable farming system using Protocol - Bluetooth and WiFi	02	CO5
16	LLO16:Make a Mini project by using different Network Components	Make a Mini project by using different Network Components	02	CO2
17	LLO17:Do Case study on any one Network service provider company on their Network infrastructure and design	Do Case study on any one Network service provider company on their Network infrastructure and design.	02	CO2

Note: 12 experiments should be performed in a term for completion of TW. Mini project is mandatory.

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): (Minimum 10 Assignment)

1. Configuring a Cisco Wi-Fi Router using Packet Tracer: Set up a network using Cisco Packet Tracer and configure a Wi-Fi router.

2. Building a Simple LAN: Design and implement a Local Area Network (LAN) with multiple devices and test its functionality.
3. Network Security Implementation: Create a project that focuses on implementing basic network security measures like firewalls and encryption.
4. Performance Analysis of Different Network Protocols: Compare the performance of various network protocols (e.g., TCP vs. UDP) under different conditions.
5. Designing a VPN: Develop a Virtual Private Network (VPN) setup and test its security and performance.
6. Implementing Quality of Service (QoS): Design a network that prioritizes certain types of traffic to ensure quality of service.
7. Network Troubleshooting and Diagnostics: Create a project that involves diagnosing and troubleshooting common network issues.
8. Wireless Network Optimization: Optimize a wireless network for better performance and coverage.
9. Network Simulation: Use network simulation tools to model and analyze the behavior of different network topologies.
10. IoT Network Integration: Integrate Internet of Things (IoT) devices into a network and manage their communication.
11. Bluetooth-Based Projects
    a. Bluetooth-Based Smart Lock System
    b. Bluetooth Indoor Navigation
11. UART-Based Projects
    a. UART Temperature Monitoring System
    b. UART Data Logger
12. MQTT-Based Projects
    a. IoT Home Automation System
    b. MQTT Weather Dashboard
12. I2C-Based Projects
    a. I2C-Based Smart Weather Station.
    b. I2C OLED Display Controller
13. LoRa-Based Projects
    a. LoRa-Based Agricultural Monitoring System
    b. LoRa Emergency Alert System.

VII. Specification Table: NA

VIII. Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)
Rubrics for continuous assessment based on process and product related performance indicators. (25 marks)

Summative Assessment (Assessment of Learning)
Viva-voce, Workshop performance (25 marks)

IX. Suggested COs - POs Matrix Form(Electronics Engineering)

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	2	2	2
CO2	3	1	1	3	1	1	2	2	2	2
CO3	3	3	3	3	1	3	1	3	3	3
CO4	3	3	3	3	1	2	1	3	3	3
CO5	1	3	3	2	1	2	1	2	2	2
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

X. Suggested Learning Materials / Books

Sr. No	Author	Title	Publisher
1	Computer Networks	Tanenbaum, A.S	Pearson Education, New Delhi, India Fourth Edition, 2011 ISBN: 9788131787571. Delhi, India
2	Data Communication and Networking	Forouzan, Behrouz A	McGraw Hill, Education Ne 2015; ISBN 978007296775
3	Introduction to Data Communications and Networking	Tomasi, W. Stallings	Pearson Education, New Delhi, India 2007, ISBN: 9788131709306
4	Data Communications and Networks	Godbole, A.S.;Kahate, A	Tata McGraw Hill, New Delhi, India .Second Edition, 2011 ISBN (13) : 978007107770

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CDC Co-ordinator
G. P. Mumbai

XI. Learning Websites & Portals

Sr. No	Link / Portal	Description
1	https://www.youtube.com/watch?v=hAopORgAcbQ	Video lectures on all topics
2	nptel.ac.in/courses/106105082/19	Video lectures on all topics
3	nptel.ac.in/courses/106105082/17	Video lectures on all topics
4	https://www.ics.uci.edu/~magda/Courses/netsys270/ch7	PPTs on all topics
5	http://www.nptel.iitm.ac.in/courses	Different courses on related to Compute network

XII. Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr.S.N.Isal	Director,Techmahoday	Industry Expert Institute Course Expert
2	Dr. Hemant Kasturewale	Hod,Extc and DS,Thakur Engg.college	Academic Expert
3	Mr. A.D. Vikhankar	SL. Grade Lecturer in Electronics	Institute Course Expert
4	Ms. S.H.Sisodiya	Lecturer in Electronics	Institute Course Expert

Coordinator
Curriculum Development,
Department of Electronics
Engineering

Head of Departments
Department of Electronics
Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

Principal
Government Polytechnic, Mumbai

Programme : Diploma in Electronics Engineering (Sandwich pattern)												
Course Code: EC 23111					Course Title: Embedded System							
Compulsory / Optional: Compulsory												
Learning Scheme and Credits						Assessment Scheme						
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (3 Hrs.)	FA - PR	SA		SLA	Total
										PR	OR		
3	-	4	1	8	4	20	20	60	25	25#	-	25	175

Total IKS Hrs. for course: _

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

Note:

1. FA-TH represents total of two class tests of 20 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work
4. SA-PR represents the end term practical examination.

I. Rationale:

Introduce the fundamental concepts of embedded systems, laying a strong foundation for understanding how embedded systems operate, their key characteristics, and their applications in real-world scenarios. Embedded systems are pervasive in modern technology, from household devices to critical infrastructure. Understanding the basics of embedded systems is essential for any future work in this domain, as it covers everything from architecture to applications in everyday life.

II. Industry / Employer Expected Outcome

The embedded systems course is designed to meet the growing demands of the embedded systems industry. Employers and industries that rely on embedded technologies look for individuals who have a strong foundation in both theoretical knowledge and practical application.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Demonstrate a thorough understanding of embedded systems' design, architecture, and applications.
CO2	Design and implement basic embedded systems using ATmega328P microcontroller and Arduino boards.
CO3	Demonstrate the ability to interface various sensors and actuators.
CO4	Analyze memory system architectures, including cache and virtual memory.
CO5	Develop real-time solutions using RTOS principles for practical applications.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	TLO 1a. Understand Embedded Systems Concepts. TLO 1b. **Analyze architectures**: Compare and contrast Von Neumann and Harvard architectures, as well as RISC, CISC. TLO 1c. Evaluate System Characteristics: Explain the characteristics of embedded systems, such as latency, throughput, safety, and power consumption.. TLO 1d. Classify Embedded Systems. TLO 1e. Apply Knowledge to Real-World Scenarios	**1.Basics of Embedded Systems** 1.1 Definition of Embedded System 1.2 Block Diagram of Embedded System 1.3 Embedded System Architectures: Von-Neumann/Harvard, RISC/CISC, DSP 1.4 Characteristics of Embedded Systems: size, performance, flexibility, maintainability, latency, throughput, correctness, processor power, power consumption, safety, NRE cost. 1.5 Classification of Embedded Systems: 1.5.1 Based on Performance of microcontroller: Small scale, medium scale, Sophisticated 1.5.2 Based on performance and functional requirements: Real time, Standalone, Networked, Mobile. 1.6 Applications of Embedded Systems **Course Outcome: CO1** **Teaching Hours: 9hrs** **Marks: 10(R- 2, U-6, A-2)**
	TLO2a. Understand Features and Architecture-Identify the features of the ATmega328P microcontroller and Arduino platforms. TLO2b. Analyze Arduino Uno: Interpret the functional	**2.AVR Microcontroller** 2.1 Features of ATMega 328P Microcontroller and Arduino 2.2 Arduino: open source community 2.3 Arduino boards based on Atmrga328 Microcontroller 2.4 Functional Block Diagram of Arduino Uno 2.5 Functions of each pin of Arduino Uno

2	block diagram and pin configurations of Arduino Uno. TLO2c. Develop Arduino Programs: Write programs in Arduino for basic I/O operations, PWM, random number generation, and serial communication. TLO2d. Implement Communication Protocols:Apply RS232, I²C, and SPI protocols in embedded system applications.	2.6 Arduino Programming 2.6.1 Data types, Variables, Operators 2.6.2 IO functions 2.6.3PWM function 2.6.4 Random Functions 2.6.5 Interrupts 2.6.6 Serial Communication:RS232, I²C, SPI **Course Outcome: CO2 Teaching Hours :10hrs** **Marks: 12(R- 4, U-4, A-4)**
3	TLO3a. Understand the components and functionality of Arduino IDE. TLO3b. Develop and execute Arduino sketches using The setup and loop structures. TLO3c. Interface basic input/output devices like LEDs, LCDs, and relays TLO3d. Implement sensor integration for environmental and motion data. TLO3e. Control motors (DC, servo, stepper) for robotic applications.	**3.Arduino Uno IDE and Interfacing** 3.1 Introduction to Arduino IDE- Overview of the Arduino Integrated Development Environment (IDE), Features of Arduino IDE. Components of Arduino IDE, Menu Bar: Provides access to tools, sketches, and preferences. Code Editor: Area to write and edit code. Message Area: Displays errors, warnings, and other messages during compilation, Output Console: Shows detailed logs for compiling and uploading, Toolbar Buttons: Verify: Check the code for errors, Upload: Upload the code to the Arduino board, New, Open, Save: Manage sketches, Serial Monitor: Debugging via serial communication. 3.2 Arduino Sketch Structure-Setup Function, loop Function. 3.3 Basic IO Interfacing-LED, LCD, Relay Sensors: Humidity, Temperature, Ultrasonic, PIR, GAS sensor, Light Sensor (LDR). 3.4 Motors: DC, Servo, Stepper **Course Outcome: CO3 Teaching Hours :10hrs** **Marks: 16(R- 4, U-6, A-6)**
4	TLO4a. Understand the architecture and functionality of memory systems in embedded devices. TLO4b. Differentiate between various memory technologies and their applications. TLO4c. Recognize the role and	4. **System Memory and Peripherals** 4.1 Memory System Architecture 4.1.1 Cache Memory, Virtual Memory 4.1.2 Memory Management Unit 4.1.3 Address translation 4.2 Memory Technologies 4.2.1 SRAM, DRAM 4.2.2 ROM, EPROM, E²PROM, NVROM

	significance of peripherals like watchdog timers and DMA controllers in embedded systems. TLO4d. Implement basic configurations of peripherals for system robustness and efficiency	4.3 Peripheral Devices 4.3.1 Watchdog Timer 4.3.2 DMA Controller **Course Outcome: CO4** **Teaching Hours :6hrs** **Marks: 6(R- 2, U-4, A--)**
5	TLO5a. Differentiate between GPOS and RTOS. TLO5b. Understand the architecture and functionality of an RTOS, focusing on MicroC/OS-II. TLO5c. Develop and manage tasks, semaphores, and communication mechanisms. TLO5d. Handle synchronization and prevent deadlocks in real-time systems. TLO5e. Design time-critical applications using RTOS features like scheduling and task delay.	**5. Real Time Operating System** 5.1 Types of Operating Systems: General purpose, RTOS, Soft/Hard RTOS 5.2 Architecture of an RTOS- MicroC/OS-II 5.2.1 Foreground/Background Systems. 5.2.2 Resources. 5.2.3 Multitasking. 5.2.4 Tasks-Task states, Creating a Task, Deleting a Task. 5.2.5 Kernels. 5.2.6 Schedulers. 5.2.7 Non-Preemptive Kernels. 5.2.8 Preemptive Kernels. 5.2.9 Deadlock (or Deadly Embrace). 5.2.10 Semaphore Management and mail box. 5.2.11 Time Management-Delaying a Task. **Course Outcome: CO5** **Teaching Hours :10hrs** **Marks: 16(R- 4, U-6, A-6)**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr No	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
1	**LLO a.** Understand the Arduino Environment **LLO b.** Familiarity with Programming Workflow	To study of Arduino IDE	2	CO3
2	**LLO a.** Understand the Concept of Sensor Data Acquisition. **LLO b.** Configure USB Serial Communication.	To study sensor information acquisition in Arduino IDE using USB serial interface.	2	CO3
3	**LLO a.** Control LED Behavior **LLO b.** Understand LCD Module Basic.	To interface LED and LCD module with Arduino.	2	CO3
4	**LLO a.** Understand the Working Principle of Humidity Sensors	To interface Humidity sensor module with Arduino.	2	CO3

	LLO b. Connect the Humidity Sensor to Arduino.			
5	**LLO a.** Understand the Working Principle of LM35 Temperature Sensor. **LLO b.** Read Temperature Data Using Arduino	To interface temperature sensor module(LM-35) with Arduino.	2	CO3
6	**LLO a.** Connect the Ultrasonic Sensor to Arduino **LLO b.** Use the pulseIn() Function. **LLO c.** Display Distance Data on the Serial Monitor	To interface Ultrasonic sensor module with Arduino.	2	CO3
7	**LLO a.** Use Digital Input to Detect Motion. **LLO b.** Display Motion Detection Status on the Serial Monitor.	To interface PIR sensor module with Arduino.	2	CO3
8	**LLO a.** Read Gas Concentration Data. **LLO b.** Display Gas Concentration on the Serial Monitor.	To interface GAS sensor module with Arduino.	2	CO3
9	**LLO a.** Understand Relay Triggering and Switching **LLO b.** Use Digital Output to Control Relay	To interface Relay module with Arduino.	2	CO3
10	**LLO a.** Understand the Working Principle of Stepper Motors. **LLO b.** Control Stepper Motor Speed and Direction	To interface stepper motor module with Arduino.	2	CO3
11	**LLO a.** Connect the Servo Motor to Arduino **LLO b.** Control Servo Motor Position Using Arduino.	To interface Servo motor module with Arduino.	2	CO3
12	**LLO a.** Learn How to Create Tasks in MicroC/OS-II. **LLO b.** Write Task Entry Functions	To create and delete task using MicroC/OS-II	2	CO5
13	**LLO a.** Learn the Functionality of Semaphores in MicroC/OS-II. **LLO b.** Create and delete Semaphores in MicroC/OS-II.	To create and delete semaphore using MicroC/OS-II	2	CO5

14	**LLO a.** Learn the Importance of Task Timing.	To create Delay in the task.	2	CO5
15	**LLO a.** Create, delete and sending message to a Mailbox in MicroC/OS-II	To Create, Delete Mailbox and sending message to mailbox.	2	CO5

Note: 10 to 12 experiments should be performed in a term for completion of TW

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): (Minimum 10 Assignments)

1. Assignment based on Basics of Embedded Systems-Define of Embedded System, Block diagram, Differentiate: RISC and CISC, Von-Neumann/Harvard Architecture, Characteristics and classification of Embedded Systems.
2. Assignment based on Features of ATMega 328P Microcontroller and Arduino, Functional Block Diagram of Arduino Uno, Functions of each pin of Arduino Uno and programming.
3. Assignment based on memory-Classification, management.
4. Micro projects
   1. LED Blink (Basic)
   2. Temperature Monitoring System
   3. Humidity Sensor with LCD Display
   4. Ultrasonic Distance Meter
   5. PIR Motion Detection
   6. Automatic Street Light
   7. Digital Thermometer with LCD
   8. Simple Digital Voltmeter
   9. IR Remote Control for LED
   10. Simple Home Automation System
   11. Servo Motor Control with Potentiometer
   12. LCD Clock (Real-Time Clock)
   13. Temperature and Humidity Display with Web Interface
   14. Smart Plant Watering System
   15. Traffic Light Control System

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Embedded Systems	2	6	2	10
2	AVR Microcontroller	4	4	4	12
3	Arduino Uno IDE and Interfacing	4	6	6	16
4	System Memory and Peripherals	2	4	-	06
5	Real Time Operating System	4	6	6	16
	Total				**60**

VI1I. Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)

Rubrics for continuous assessment based on process and product related performance indicators (25 marks)

Summative Assessment (Assessment of Learning)

End term examination, Viva-voce, Workshop performance (25 marks)

IX. 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 and Practices for Society, Sustainability Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CO1	3	-	-	-	-	-	2	1	-	1
CO2	3	-	-	2	-	-	2	-	-	-
CO3	3	3	3	2	2	-	2	-	1	1
CO4	3	-	-	-	-	-	2	1	1	1
CO5	3	3	3	2	2	-	2	1	-	1
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

X. Suggested Learning Materials / Books

Sr. No	Author	Title	Publisher
1	Raj Kamal	Embedded Systems: Architecture, Programming and Design	McGraw Hill Education, 3rd Edition, 2017
2	David Russell	Introduction to Embedded Systems: Using ANSI C and the Arduino Development Environment	McGraw-Hill, 2010
3	Frank Vahid, Tony Givargis	Embedded Systems Design: A Unified Hardware/Software Introduction	Wiley, 2002
4	Jean J. Labrosse	MicroC/OS-II-The Real-Time Kernel	CMP Books-3rd Edition

XI. Learning Websites & Portals

Sr. No	Link / Portal	Description
1	www.arduino.cc	Basics of Arduino
2	https://projecthub.arduino.cc	All projects
3	https://all3dp.com	arduino-project
4	https://researchguides.dartmouth.edu	arduino-project
5	https://projecthub.arduino.cc/	Simulation of Topics
6	http: //en.wikipedia.org/wiki	arduino-project
7	https://nevonprojects.com/	arduino-project
8	https://www.slashgear.com	arduino-project

XII. Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr.Anjum Mujawar	Selection grade Lecturer in Electronics	Vidyalankar Polytechnic,wadala, Mumbai
2	Mr Abhijit Patil	Lecturer in Electronics	Xaviers Polytechnic,Mumbai
3	Mr Vivek Yograj Patil	Lecturer in Electronics	Government Polytechnic, Mumbai
4	Mrs. Archana D Kalyankar	Lecturer in Electronics	Government Polytechnic, Mumbai

Coordinator
Curriculum Development,
Department of Electronics Engineering

Head of Departments
Department of Electronics Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

Principal
Government Polytechnic, Mumbai

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CDC Coordinator
G. P. Mumbai

Programme : Diploma in Electronics Engineering (Sandwich pattern)												
Course Code : EC23112	**Course Title : Power Electronics**											
Compulsory / Optional: Compulsory												
Learning Scheme and Credits						**Assessment Scheme**						
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2:30 Hrs.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
3	-	4	01	8	4	20	20	60	50	25#	-	3	200

Total IKS Hrs. for course: -

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

Note:

1. FA-TH represents an two class tests of 20 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work
4. SA-PR represents the end term practical examination.

I. Rationale:

It is necessary for the students to study and apply the basic principles, analyse and troubleshoot simple circuits like controlled rectifier, light dimmer, battery charger etc. To acquire this level of understanding, the basic knowledge of power semiconductor devices and circuit is essential. This Course is one of the core subject which is deals with construction, working principle, application of power semiconductor devices as well as it deals with some sophisticated power electronics systems and complex circuits such as choppers, inverters etc. Which helps students to work in industrial environment.

II. Industry / Employer Expected Outcome:

The course is designed to have a strong understanding of power electronics circuits, including the ability to design, analyze, and implement circuits involving components such as SCRs, MOSFETs, IGBTs, and diodes in real-world applications like motor control, power conversion, and lighting systems.

III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1	Understand the construction, working principles, and characteristics of power semiconductor devices.
CO2	Analyze various SCR triggering methods, protection circuits, and commutation techniques.
CO3	Design controlled rectifier circuits for different load conditions and analyze their waveforms,
CO4	Understand operation and Analyze characteristics of various chopper types,
CO5	Analyze and design single-phase inverter circuits, and understand their classification,

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's)aligned to CO's	Topics / Sub-topics
1	**TLO1a.** Develop an in-depth understanding of power semiconductor devices, their construction, operation, and characteristics. **TLO1b.** Analyze and interpret the functional role of each device in practical applications. **TLO1c.** Acquire the ability to design and explain basic industrial circuits utilizing power electronics components.	**Power Semiconductor Devices:** 1.1 SCR introduction 1.1.1 Construction, symbol, working principle and V-I characteristics. 1.1.2 Definitions: Holding current, latching current, firing angles, conduction angle and break over voltage. 1.2 Thyristor Family Devices: Construction, symbol, working principle, V-I characteristics and application 1.2.1 TRIAC 1.2.2 Power MOSFET 1.2.3 IGBT 1.3 Triggering Devices: Construction, symbol, working principle, V-I characteristics and application. 1.3.1 DIAC 1.3.2 UJT 1.4 Industrial Circuits: Circuit diagram and working principle 1.4.1 Light dimmer using TRIAC 1.4.2 Battery charger using SCR **Course Outcome: CO1** **Teaching Hours :10 hrs** **Marks: 12 (R- 4, U-4, A-4)**

2	**TLO2a.** Develop an understanding of various SCR turn-on methods and their significance in power electronics. **TLO2b.** Analyze the design and operation of gate trigger circuits and protection mechanisms. **TLO2c.** Gain knowledge about natural and forced commutation methods and their role in turning off SCRs.	**SCR Turn ON, Protection circuits and SCR Turn OFF methods** 2.1 SCR turn on methods. 2.2 Gate trigger circuits: Circuit diagram, working principle, waveforms. 2.2.1 Resistance triggering circuit 2.2.2 R-C triggering circuit 2.2.3 UJT triggering using pulse transformer 2.3 Protection circuits: Circuit diagram, working principle. 2.3.1 dv/dt protection 2.3.2 di/dt protection 2.4 Natural commutation: circuit diagram & working principle 2.5 Forced commutation: circuit diagram & working principle. 2.5.1 Type A 2.5.2 Type B 2.5.3 Type C 2.6 Gate drive Circuits for IGBT **Course Outcome: CO2** **Teaching Hours: 8 hrs** **Marks: 12 (R-4, U-6, A-2)**
3	**TLO3a.** Develop a thorough understanding of control techniques used in rectifier circuits and their effect on output performance. **TLO3b.** Gain the ability to design and analyze single-phase rectifier circuits for various load conditions. **TLO3c.** Evaluate the role of freewheeling diodes in improving rectifier performance and reducing losses.	**Controlled Rectifier** 3.1 Control Techniques:- Phase angle control (Firing angle control), Extinction angle control, Pulse width Modulation (PWM) control 3.2 Single-phase half wave controlled rectifiers with resistive load, inductive load (with and without freewheeling diode): Circuit diagram, working principle, waveforms. 3.3 Single-phase half wave controlled rectifiers with resistive load, inductive load (with and without freewheeling diode): Circuit diagram, working principle, waveforms. 3.4 Single-phase full wave (bridge configurations) controlled rectifiers with resistive load and inductive load (with and without freewheeling diode): Circuit diagram, working principle, waveforms, Effect of freewheeling diodes 3.5 Electric drives 3.5.1 Single phase semiconverter drives 3.5.2 Single phase Full Converter drives **Course Outcome: CO3** **Teaching Hours : 8 hrs** **Marks: 12 (R-4, U-4, A-4)**

4	**TLO4a.** Develop a understanding of chopper circuits, their classification, and applications. **TLO4b.** Analyze the operation of different chopper types through circuit diagrams, working principles, and waveforms. **TLO4c.** Compare various chopper configurations in terms of functionality, operational quadrants, and typical applications.	**Chopper** 4.1 Introduction, classification, basic chopper circuit diagram and working. 4.2 Types of chopper: Circuit diagram, working principle and waveforms 4.2.1 Step up chopper (Boost converter) using SCR. 4.2.2 Step down chopper (Buck converter) using SCR. 4.2.3 First quadrant or class A chopper. 4.2.4 Second quadrant or class B chopper. 4.3 A.C. Choppers: Circuit diagram, working principle and waveforms 4.4 Output Voltage Control Strategies for d.c. Choppers 4.4.1 Time-ratio control 4.4.2 Current limit Control 4.5 Source filters in Choppers: **Course Outcome: CO4** **Teaching Hours : 10 hrs** **Marks: 12 (R- 4 , U- 4 , A-4)**
5	**TLO5a.** Understand the fundamental principles and classification of inverters based on different operational characteristics. **TLO5b.** Analyze the working principles and waveforms of various inverter configurations, **TLO5c.** Develop the ability to compare different inverter types and choose appropriate configurations for specific applications.	**Inverter** 5.1 Introduction. Classification of inverters according to nature of input source, method of commutation, connection of thyristor and commutating component. 5.2 Types of inverters: Working principle and operation 5.2.1 Series inverter 5.2.2 Parallel inverter 5.3 Single phase SCR bridge Inverter : Circuit diagram , working principle and waveforms 5.3.1 1Ø half bridge inverter 5.3.2 1Ø Full bridge inverter 5.4 Voltage control of single phase inverters 5.4.1 External control of A.C. Output Voltage 5.4.2 External control of D.C. Input Voltage **Course Outcome: CO5** **Teaching Hours : 9 hrs** **Marks: 12 (R- 4, U- 4, A-4)**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr No	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
1	**LLO 1a:** Understand experimental setup of power devices. **LLO1b:** Understand the significance and operation of SCR and TRIAC characteristics.	A. Verify the V-I characteristics of SCR. B. Verify the V-I characteristic of TRIAC	4	CO1
2	**LLO2a:** Understand how SCRs are triggered using an R circuit. **LLO2b:** Learn how the R value influences the firing angle by varying resistance **LLO2c:** Measure the firing angle of the SCR and interpret its effects on circuit performance.	Observe firing angle control of SCR using R triggering method.	4	CO2
3	**LLO3a:** Learn the principles of half-wave Controlled rectification by controlled firing of the SCR. **LLO3b:** Observe and understand how the output waveform changes as the firing angle is varied.	Observe the waveform of half wave controlled rectifier for variable firing angle.	4	CO3
4	**LLO4a:** Learn step-down chopper operation using SCR. **LLO4b:** Learn to observe and analyze waveforms at different points in the circuit, such as the input, output, across the load, and the SCR terminals.	Test waveforms at various points of step up chopper using SCR	4	CO4
5	**LLO5a:** Learn how a TRIAC is used in light dimmer circuits to control the intensity of light	Test light dimmer circuit using Triode for Alternating Current (TRIAC)	4	CO1
6	**LLO6a:** Understanding the working principle of a series inverter, LLO6b: Recognize and understand the function of major components in the circuit, such as SCRs, Commutating Capacitors, Inductors, Diodes, Load.	Trace the series inverter circuit and list the major components of the circuit, sketch the observed waveforms and measure voltage levels.	4	CO5
7	**LLO7a:** Understand experimental setup of power devices. **LLO7b:** Understand the significance	A. Verify the V-I characteristic of power MOSFET.	4	CO1

	and operation of MOSFET and DIAC characteristics	B. Verify the V-I characteristic of DIAC.		
8	**LLO8a:** Understand how SCRs are triggered using an RC circuit. **LLO8b:** Learn how the RC network influences the firing angle by varying resistance and capacitance values **LLO8b:** Measure the firing angle of the SCR and interpret its effects on circuit performance.	Observe firing angle control of SCR using RC triggering method.	4	CO2
9	**LLO9a:** Develop an understanding of rectification principles. **LLO9b:** Understand the influence of firing angle on output voltage, current, and overall circuit performance.	Observe the waveform of full wave controlled rectifier for variable firing angle	4	CO3
10	**LLO10a:** Learn step-down chopper operation using SCR. **LLO10b:** Learn to observe and analyze waveforms at different points in the circuit, such as the input, output, across the load, and the SCR terminals.	Test waveforms at various points of step down chopper using SCR	4	CO4
11	**LLO11a:** understanding the working principle of a parallel inverter, **LLO11b:** Recognize and understand the function of major components in the circuit, such as SCRs, Commutating Capacitors, Inductors, Diodes, Load.	Trace the parallel inverter circuit and list the major components of the circuit, sketch the observed waveforms and measure voltage levels.	4	CO5
12	**LLO12a:** Learn the principle of operation of a battery charger circuit utilizing SCR **LLO12b:** Understand how the SCR regulates charging current.	Test Battery charger circuit using SCR	4	CO1

13	**LLO13a:** Understand the basic working principle of a relaxation oscillator and the role of the Uni-Junction Transistor (UJT) in generating periodic waveforms. **LLO13b:** Understand how the resistor and capacitor values influence the frequency of oscillation(RC time constant)	Observe the output waveforms of relaxation oscillator using Uni- Junction Transistor(UJT)	4	CO2
14	**LLO14a:** Understand the role of various protection circuits in safeguarding SCRs from damage.	Case study on protection circuit of SCR	4	CO2
15	**LLO15a:** Apply critical thinking and problem-solving skills **LLO15b:** preparing the students for future industrial electronics work.	Mini project: Group of two students should prepare PCB with tested circuit mounted on it for any Industrial electronics application circuit. For example. SCR flasher, Emergency lighting system and/or any circuit from practical list.	4	CO1,2 ,3,4,5
			60	

Note: 10 to 12 experiments should be performed in a term for completion of TW

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): (Minimum 10 Assignments)

Group of two students should prepare PCB with tested circuit mounted on it for any Industrial electronics application circuit. and/or any circuit from practical list.

VII. Specification Table:

Unit No.	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Power Semiconductor devices	4	4	4	12
2	SCR Turn ON, Protection circuits and SCR Turn OFF methods	4	6	2	12
3	Controlled Rectifier	4	4	4	12
4	Chopper	4	4	4	12
5	Inverter	4	4	4	12
Total		**20**	**22**	**18**	**60**

VIII. Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)
Rubrics for continuous assessment based on process and product related performance indicators (50marks)

Summative Assessment (Assessment of Learning)

End term examination, Viva-voce, Practical performance (25 marks)

IX. 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	1	3		1	1	2	1	1
CO2	2	1	1	1	1	1	1	2	2	1
CO3	2	1	2	1	1	1	2	2	2	1
CO4	1	1	2	3	2	2	1	2	2	2
CO5	3	3	3	3	3	2	2	3	3	2
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

X. Suggested Learning Materials / Books

Sr. No.	Title	Author, Publisher, Edition and Year of publication	ISBN
1	Power electronics	M. D. Singh & K.B. khanchandani, Mcgraw-hill publishing, 2nd edition 1998	978-0070583894
2	Industrial & power electronics	Harish rai, umesh publication, 1/e edition 2018	978-9386827869
3	Power electronics	P. S. Bimbhra, Khanna publishers; 5th edition 1990	978-8174092793
4	Power electronics	Munammad h. Rashid, Pearson Education., 3nd edition , 2014	978-9332535770

XI. Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. S. N. Isal	Director, Techmahoday Mumbai	Mumbai
2	Mrs. A. M. Ghadge	Lecturer, Electronics Engineering	Government Polytechnic Thane
3	Dr. S. D. Pabale	HoD, Electronics Engineering	Government Polytechnic Mumbai
4	Ms. P. A. Khande	Lecturer, Electronics Engineering	Government Polytechnic Mumbai

Coordinator
Curriculum Development,
Department of Electronics Engineering

Head of Departments
Department of Electronics Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

Principal
Government Polytechnic, Mumbai

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CDC Co-ordinator
G. P. Mumbai

Programme : Diploma in Electronics Engineering (Sandwich pattern)												
Course Code: EC23201			**Course Title: Microwave and RADAR Engineering**									
Compulsory / Optional: Optional												
Learning Scheme and Credits						**Assessment Scheme**						
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2Hrs. 30 min.)**	**FA-PR**	**SA**		**SLA**	**Total**
						T1	**T2**			**PR**	**OR**		
3	1	2	-	6	3	20	20	60	25	-	50@	-	175

Total IKS Hrs. for course: _

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

Note:

1. FA-TH represents total of two class tests of 20 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work
4. SA-OR represents the end term oral examination.

I. Rationale:

Electronic communication plays vital role in our daily life. Now a days modern high capacity telecom networks based on microwave principles mobile communication and radar systems becomes integral part of industry, society and other organizations. This course has been designed to develop skills in the diploma engineers to maintain microwave and RADAR based communication systems

II. Industry / Employer Expected Outcome

The study of Microwave and RADAR Engineering will equip students with specific skills and knowledge that are highly valued by employers and essential for various industries. It will help students to maintain microwave and RADAR based communication systems.

III. Course Outcomes:

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

CO1	Use specified waveguides in microwave communication.
CO2	Use microwave components and microwave test bench setup
CO3	Use relevant microwave semiconductor devices for various applications.
CO4	Interpret RADAR based Systems for range detection.
CO5	Maintain various types of RADAR system for the specified application.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	TLO1a. Need of microwave communication system. TLO1b. Define TEM/TE/TM/HE, cut off frequency of a waveguide, guide wave length, phase velocity, group velocity. TLO1c. Draw and explain dominant mode in rectangular waveguide. TLO1d. Explain the propagation of wave in rectangular waveguide. TLO1e. Compare waveguide and two-wire transmission line.	**1. Fundamentals of Microwave communication and Wave Guide:** 1.1 Introduction to basics of microwave transmission: 1.1.1 Microwave frequency spectrum, band designations and applications of microwave in various fields, 1.2 Comparison of wave guide with two wire transmission line 1.3 Rectangular waveguides: 1.3.1 Propagation of waves through rectangular wave guide, Reflection of waves from a conducting plane, dominant mode, the parallel plane waveguide, cut off wavelength, cut off frequency, group and phase velocity. (Simple numerical) 1.3.2 Rectangular waveguide modes: TE mode, TM mode, TEM mode, field patterns of TE1,0, TE2,0, TE1,1 modes. 1.4 Circular waveguide: 1.4.1 Field patterns for dominant mode, 1.4.2 Advantages and applications of circular waveguide **Course Outcome:CO1 Teaching Hour: 6 Hrs.** **TT 2 Hrs. Marks: 08 (R- 4, U-4, A--)**
2	TLO2a. Draw and explain working of isolator, circulator and gyrator. TLO2b. Explain waveguide bends and corners, Twists. TLO2c. Draw and explain working of H- plane TEE, E-Plane	**2 Waveguide Passive components:** 2.1 Ferrites components: Isolators, circulators and gyrator 2.2 Accessories (Flanges, Rotating coupling, Bends and corners, Taper and Twist). 2.3 Multiple Junctions - E plane, H- plane and Magic

	TEE, E-H Plane TEE. TLO2d. Draw and explain working of Multi-hole directional coupler	Tee junction, Terminators. 2.4 Directional coupler- Two hole directional coupler Working principle and applications, directivity, coupling factor and isolation **Course Outcome:CO2 Teaching Hour: 10 Hrs.** **TT 3 Hrs. Marks: 12 (R- 2, U-6, A-4)**
3	TLO3a. State principle and draw construction of multi cavity (two cavities) klystron, Reflex Klystron amplifier, Travelling wave tube, Magnetron. TLO3b.Draw the construction and working of PIN, IMPATT, Tunnel and Gunn diode. TLO3c. Compare the Two cavity Klystron, Magnetron and TWT.	**3 Waveguide Active components:** 3.1 Microwave tubes: Construction, working principle and applications of 3.1.1 Two cavity Klystron amplifier 3.1.2 Reflex Klystron 3.1.3 Magnetron 3.1.4 TWT. 3.2 Compare the performance of Two cavity Klystron, Magnetron and TWT 3.3 Microwave semiconductor devices: Construction, working principle and applications of 3.2.1 Gunn diode, Gunn diode as an oscillator 3.2.2 IMPATT diode 3.2.3 PIN diode, PIN diode as an amplifier and oscillator 3.2.4 Tunnel diode. **Course Outcome:CO3 Teaching Hour:12 Hrs.** **TT4 Hrs. Marks: 16 (R- 2, U-6, A-8)**
	TLO4.a Describe with relevant sketch functions of the given component of the RADAR system. TLO4.b Calculate the maximum RADAR range for the given data. TLO4.c State the effect on the RADAR range for the given parameters. TLO4.d Explain with relevant sketch the given type of scanning and tracking methods used for RADAR.	**4 RADAR Fundamentals:** 4.1 Basic block diagram of RADAR system. 4.2 RADAR performance factors: 4.2.1 RADAR range equation 4.2.2 Factors influencing max. Range 4.2.3 Effect of noise. 4.3 Basic pulse Radar system: Block diagram and working principle, applications 4.4 Antenna scanning (Definition, types and principle): 4.4.1 Horizontal 4.4.2 Vertical 4.4.3 Helical 4.4.4 Spiral. 4.5 Antenna tracking (Types and principle): 4.5.1 Sequential 4.5.2 Conical 4.5.3 Monopulse **Course Outcome:CO4 TeachingHours: 08Hrs.** **TT3 Hrs. Marks:12 (R-4, U-4, A-4)**

	TLO5.a Explain with relevant sketch working principle of the given type of RADAR. TLO5.b Describe the application of given type of RADAR. TLO5.c Describe with relevant sketch working principle of the given type of display used with RADAR system. TLO5.d Compare CW and Pulsed RADAR for the given parameters.	**5 RADAR Systems** 5.1 Display Methods: 5.1.1 A-Scope 5.1.2 PPI 5.1.3 Automatic target detection 5.2 Doppler Effect: Statement 5.3 Block diagram and working of: 5.3.1 CW Doppler RADAR 5.3.2 FM CW Doppler RADAR 5.3.4 MTI RADAR. **Course Outcome: CO5** **Teaching Hours: 9 Hrs.** **TT 3 Hrs.** **Marks:12(R- 2, U-4, A-6)**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr. No.	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	No. of hrs.	Relevant COs
1	LLO1 Use given microwave test bench setup for writing specifications of Microwave Test Bench and five major Microwave components.	Write specifications of Microwave Test Bench and five major Microwave components.	2	CO1
2	LLO1 Use given microwave test bench setup for measuring characteristics of Reflex Klystron.	Demonstrate characteristics of Reflex Klystron.	2	CO2
3	LLO1 Use given microwave test bench setup for measuring characteristics of microwave E-plane tee	Demonstrate characteristics of microwave tees E-plane.	2	CO2
4	LLO1 Use given microwave test bench setup for measuring characteristics of microwave H-plane tee	Demonstrate characteristics of microwave tees H plane.	2	CO2
5	LLO1 Use given microwave test bench setup for measuring characteristics of microwave E-H plane tee.	Demonstrate characteristics of microwave tees E-H plane.	2	CO2
6	LLO1 Use given microwave test bench to Measure VSWR for the given microwave load	Measure VSWR for the given microwave load	2	CO2
7	LLO1 Use given microwave test bench to Measure attenuation of the given attenuator	Measure attenuation of the given attenuator	2	CO2

8	LLO1	Use given microwave test bench setup for measuring characteristics of Isolators.	Demonstrate characteristics of Isolators.	2	CO2
9	LLO1 LLO2	Use given microwave test bench setup for measuring characteristics of Circulators. Analyze frequency response of it	Demonstrate characteristics of circulators.	2	CO2
10	LLO1	Use given microwave test bench setup for measuring characteristics of Multi hole directional coupler.	Demonstrate properties of Multi hole Directional coupler.	2	CO2
11	LLO1	Test the performance of Gunn Diode for the following aspects i) V-I characteristics	Verify V-I Characteristics of Gunn Diode	2	CO3
12	LLO1	Use Doppler RADAR to detect the maximum range	Use Doppler RADAR to detect the maximum range	2	CO4
13	LLO1	Use freeware/open source simulation tool to perform practical related to RADAR communication.	Use freeware/open source simulation tool/virtual lab to perform practical related to RADAR communication.	2	CO4
14	LLO1	Use RADAR system to measure velocity of the moving object.	Determine the velocity of the moving object with the help of RADAR range.	2	CO5
15	LLO1	Use RADAR system to measure distance travelled by object.	Determine the distance travelled by object with the help of RADAR range.	2	CO5

Note: 10 experiments should be performed in a term for completion of TW

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): NA

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Fundamentals of Microwave communication and Waveguide	4	4	-	08
2	Waveguide Passive components	2	6	4	12
3	Waveguide Active components	2	6	8	16
4	RADAR Fundamentals	4	4	4	12
5	RADAR Systems	2	4	6	12
Total		14	24	22	60

VIII. Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)

Rubrics for continuous assessment based on process and product related performance indicators (25 marks)

Summative Assessment (Assessment of Learning)

End term examination, Viva-voce, Performance (50 marks)

IX. Suggested COs - POs Matrix Form

CO	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PSO- 1	PSO- 2	PSO- 3
CO1	1	2	1	3	3	3	3	3	2	-
CO2	2	2	2	3	3	3	3	3	3	2
CO3	2	1	2	3	3	3	3	3	3	3
CO4	2	3	3	2	3	3	3	3	2	2
CO5	2	2	2	3	2	3	3	3	3	3
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

X. Suggested Learning Materials / Books

Sr. No	Title	Author	Publisher
1.	Microwave Engineering	Gupta, Sanjeev	Khanna Publication, ISBN 978-8174090878
2.	Microwave and RADAR Engineering	Gautam A.K.	SK Kataria Publication, ISBN 978-9330141519
3.	Microwave and RADAR Engineering	M. Kulkarni.	Umesh Publication, ISBN 978-8188114009
4.	Fundamentals of Microwave and RADAR Engineering	Sharma K. K.	S. Chand and Company Pvt. Ltd. ISBN 9788121935371

XI. Learning Websites & Portals

Sr. No.	Link / Portal	Description
1	Microwave Components: www.youtube.com/microwave components and devices	Video Lectures
2	Microwave fundamentals: www.nptlvideos.in/microwave engineering	Free online Video Lectures from IIT Guwahati
3	RADAR: www.youtube.com/ RADARs	Free Video Lectures
4	Microwave: www.learnerstv.com/free-engineering	Free Video Lectures
5	Waveguide: www.academia.edu/waveguide	Link for study material

XII. Academic Consultation Committee/Industry Consultation Committee:

Sr. No.	Name	Designation	Institute/Organization
1	Mr.Sourav Deore	AVI	SPL India PVT.LTD.
2	Dr.G J Joshi	SL. Grade Lecturer.	GP Nashik
3	Mrs. S .V. Bannore	SL. Grade Lecturer	G. P. Mumbai
4	Mrs. T. K. Balsaraf	Lecturer in Electronics	G. P. Mumbai

Coordinator
Curriculum Development,
Department of Electronics Engineering

Head of Departments
Department of Electronics Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

Principal
Government Polytechnic, Mumbai

APPROVED COPY
CDC Co-ordinator
G. P. Mumbai

Programme : Diploma in Electronics Engineering (Sandwich Pattern)												
Course Code: EC23701					**Course Title: Artificial Intelligence**							
Compulsory / Optional: Optional												
Learning Scheme and Credits						**Assessment Scheme**						
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**	**SA-TH (2.30 Hrs.)**	**FA-PR**	**SA**		**SLA**	**Total**
									PR	**OR**		
3	1	2	1	6	3	40	60	25		50@	–	175

Total IKS Hrs. for course: -

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

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

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work
4. SA-OR represents the end term oral examination.

I. Rationale:

Artificial intelligence (AI) makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. The overall research goal of artificial intelligence is to create technology that allows computers and machines to function in an intelligent manner. This course covers fundamentals of AI

II. Industry / Employer Expected Outcome:

Diploma students with Artificial Intelligence (AI) can expect industry outcomes including entry-level roles in data analysis, AI-assisted operations support, quality control, automation development, and software development within sectors like manufacturing, healthcare, finance, e-commerce, and logistics, where they can utilize their AI knowledge to enhance efficiency and decision-making processes, often collaborating with more senior AI specialists.

III. Course Outcomes:

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

CO1	Demonstrate knowledge of building blocks of AI as presented in terms of intelligent agents..
CO2	Analyze the problem as a state space, graph, design heuristics and select different search techniques to solve them.
CO3	Develop intelligent algorithms and intelligent systems .
CO4	Attain the capability to represent various real life problem domains using logic based techniques.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	**TLO 1a.** State concept of AI **TLO 1b.** Compare Human Intelligence and Artificial Intelligence **TLO 1c.** Explain concept of different AI approaches. **TLO 1d.** Explain different subfields in AI	**Introduction to Artificial Intelligence (AI):** 1.1 Artificial Intelligence : Concept of AI, Goals of AI. 1.2 Comparison of Human intelligence and artificial intelligence. 1.3 Computational Intelligence: Definition, Concept and methods (list only) 1.4 Components of AI systems, Techniques used in AI. 1.5 AI approaches :The turning test approach, cognitive modelling approach, Rational agent approach . 1.6 Subfields in AI. **Course Outcome:CO1 Teaching Hours:8hrs. Marks: 8 (R-2, U-4, A- 2)**
2	**TLO 2a.** State concepts of Agents and Environments in AI. **TLO 2b.** State and explain different types of agents. **TLO 2c.** State properties of Environments **TLO 2d.** Explain PEAS representation of an agent **TLO 2e.** Explain the concept of NLP and state its importance.	**Agents and Environments:** 2.1 Agent: Definition and Concept. 2.2. Types of agents: Simple reflex agents, model based reflex agents, goal based agents, learning agents, reactive goal cased, utility based. 2.3 Nature of Environments used in AI. 2.4 Properties of Environment. 2.5 PEAS representation of an agent 2.6 Natural language processing (NLP) Concept and importance. **Course Outcome: CO1 Teaching Hours :8hrs Marks: 10(R- 4, U-4, A-2)**

3	**TLO3.a** Explain general problem solving methods. **TLO3.b** Explain control strategies in problem solving and characteristics of problems. **TLO3.c** Explain Breadth first search with algorithm. **TLO3.d** Explain algorithm of hill climbing method. **TLO3.f** Explain different searches such as Beam and Tabu search. **TLO3.e** Explain IDDFS method	**Search Algorithms:** 3.1 General problem solving Production System (with water Jug example) 3.2 State Space representation and search with example of 8 puzzle problem 3.3 Control strategies used in Problem solving, Characteristics of Problems 3.4 Search algorithm terminology: uninformed search strategies - Breadth first search with algorithm 3.5 Informed(Heuristic)search strategies-Hill climbing method and its algorithm 3.6 Beam search, Tabu search 3.7 Finding Optimal Paths: Branch and Bound, Divide and Conquer approaches 3.8 Game playing: Min-max algorithm, AlphaBeta Algorithm, Tic-tac-toe 3.9 Problem solving: Iterative Deepening depth first search (IDDFS) **Course Outcome:CO2 Teaching Hours:14hrs** **Marks: 16(R- 4,U-8, A-4)**
4	**TLO 4a.** Explain concept of planning with space search. **TLO 4b.** Explain different types of planning. **TLO 4c.** Explain concept of forward and backward chaining. **TLO 4d.** Explain Bayes theorem and belief networks. **TLO 4e.** Compare forward and backward chaining.	**Planning and Logic :** **4.1** Planning 4.1.1 Introduction to planning. 4.1.2 Planning with state space search. 4.1.3 Planning and constraint satisfaction: Domains, forward and backward search, goal stack planning, plan space planning, Graphplan, Constraint stack planning, plan space planning, Graphplan, Constraint propagation. 4.2 Logic : 4.2.1 Propositional and First order logic 4.2.2 Forward and backward chaining 4.2.3 Conditional probability, Joint probability, Bayes Theorem, Belief networks and simple inference in Belief Networks **Course Outcome:CO3 Teaching Hours:8hrs** **Marks: 14(R- 6, U-4, A-4)**
5	**TLO 5a.**State concept of machine Learning **TLO5 b.**Explain use of machine learning in deep learning. **TLO 5c.**Explain real life application of ML. **TLO 5d.**Explain real life application of NLP.	**Applications of AI:** 5.1 Introduction to Machine learning. 5.2 Introduction to deep learning. 5.3 Use of machine learning in deep learning. 5.5 Introduction to NLP 5.6 Real life application of ML and NLP **Course Outcome: CO4 Teaching Hours:7 hrs** **Marks: 12(R- 2, U-4, A-6)**

V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr No	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
1	**LLO a.** Interpret use of intelligent system using PEAS **LLO b.** Design intelligent system using PEAS. **LLO c.** Interpret /define problem with state space representation.	Tutorial exercise for a) Design of intelligent system using PEAS b) Problem definition with state space representation	4	CO1
2	**LLO a.** Interpret Beam search algorithm. **LLO b.** Design Beam search algorithm.	Implementation of Beam search algorithm	4	CO2
3	**LLO a.** Interpret Tabu search algorithm. **LLO b.** Design Tabu search algorithm.	Implementation of Tabu search algorithm	4	CO2
4	**LLO a.** Interpret depth search algorithm. **LLO b.** Design depth search algorithm.	Implementation of depth search algorithm	4	CO2
5	**LLO a.** Interpret Min-Max algorithm. **LLO b.** Design Min-Max algorithm..	Implementation of Min-Max algorithm	4	CO2
6	**LLO a.** Interpret Divide and Conquer algorithm. **LLO b.** Design Divide and Conquer algorithm.	Implementation of Divide and Conquer algorithm	4	CO2
7	**LLO a.** Interpret Tic-tac-toe algorithm. **LLO b.** Design Tic-tac-toe algorithm.	Implementation of Tic-tac-toe algorithm	4	CO2
8	**LLO a.** Interpret AlphaBeta algorithm. **LLO b.** Design AlphaBeta algorithm.	Implementation of AlphaBeta algorithm	4	CO3
9	**LLO a.** Interpret Bayes' Belief Network algorithm. **LLO b.** Design Bayes' Belief Network algorithm.	Implementation of Bayes' Belief Network	4	CO3

10	**LLO a.** Interpret working of AI based humanoid self-driving car.	Case study on AI based humanoid self-driving car	4	CO4
11	**LLO a.** Interpret use of AI in the finance sector.	Case study on AI in finance sector	4	CO4
12	**LLO a.** Interpret use of AI in medical applications.	Case study on AI in medical applications.	4	CO4

Note: 10 to 12 experiments should be performed in a term for completion of TW

VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): NA

VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Introduction to Artificial Intelligence (AI)**	2	4	2	8
2	**Agents and Environments**	4	4	2	10
3	**Search Algorithms**	4	8	4	16
4	**Planning and Logic**	6	4	4	14
5	**Applications of AI**	2	4	6	12
	Total	**18**	**24**	**18**	**60**

VIII.Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)

- Rubrics for continuous assessment based on process and product related performance indicators (25 marks)

Summative Assessment (Assessment of Learning)

- End term examination, Viva-voce, Workshop performance (50 marks)

IX. 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	2	1	-	-	-	-	1	2	3
CO2	3	3	1	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	2	3	3
CO4	3	3	3	3	3	-	3	2	3	3
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

X. Suggested Learning Materials / Books

Sr. No	Author	Title	Publisher
1	Stuart Russell and Peter Norvig	Artificial Intelligence : Modern Approach	Pearson education; 3rd edition; 2015
2	Elaine Rich, Kevin Knight, Shivshankar B Nair	Artificial Intelligence	McGraw Hill; 3rd edition, 2017
3	Deepak Khemani	A first course in Artificial Intelligence	McGraw Hill; 1st edition, 2017
4	A classical approach Artificial Intelligence	M. C. Trivedi	Khanna Publishing House; 2nd edition; 2018

XI. Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr.Sumit More	Manager	Shapoorji pallonji fin. Ltd
2	Dr. Hemant Kasturewale	Head of department (Extc & DS)	Thakur Engineering College.
3	Smt.Namrata Wankhede	Lecturer in Informatiom Technology	G.P.Mumbai
4	Smt.Padavi T.Y	Lecturer in Electronics Engineering	G.P.Mumbai

Coordinator
Curriculum Development,
Department of Electronics Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

APPROVED COPY

CDC Co-ordinator
G. P. Mumbai

Head of Departments
Department of Electronics Engineering

Principal
Government Polytechnic, Mumbai

Programme : Diploma in Electronics Engineering (Sandwich pattern)													
Course Code: EC23202			**Course Title: Consumer Electronics**										
Compulsory / Optional: Optional													
Teaching Scheme and Credits						**Assessment Scheme**							
						FA-TH		**SA-TH (2Hrs. 30 min.)**	**FA-PR**	**SA**		**SLA**	**Total**
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**T1**	**T2**			**PR**	**OR**		
3	1	2	-	6	3	20	20	60	25	--	50@	-	175

Total IKS Hrs. for course: -

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

Note:

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work
4. SA-OR represents the end term oral examination.

I. Rationale:

The Consumer Electronics curriculum is designed to provide students with a comprehensive understanding of the essential technologies and systems used in everyday electronic appliances and devices. With rapid advancements in technology, particularly in areas like smart devices, automation, and energy efficiency, there is a growing need for skilled professionals capable of designing, troubleshooting, and maintaining these systems.

The curriculum aims to:

- Equip students with foundational knowledge of consumer electronic devices such as air conditioners, refrigerators, washing machines, microwave ovens, digital cameras, and more.
- Develop hands-on skills in troubleshooting and maintaining electronic systems.
- Foster an understanding of modern trends such as smart home technologies, energy efficiency, and advanced communication systems (e.g., drones and wireless technologies).
- Prepare students for industry roles that demand both theoretical knowledge and practical expertise in managing consumer electronics products and services.

III. Course Outcomes:

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

CO1	Demonstrate knowledge of building blocks of AI as presented in terms of intelligent agents..
CO2	Analyze the problem as a state space, graph, design heuristics and select different search techniques to solve them.
CO3	Develop intelligent algorithms and intelligent systems .
CO4	Attain the capability to represent various real life problem domains using logic based techniques.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	**TLO1a.** Understand the components of a Hi-Fi amplifier through its block diagram. **TLO1b.** Explain how a Hi-Fi amplifier processes low-level signals into high-quality, distortion-free audio output. **TLO1c.** Understand the block diagram of a typical PA system, Identify the core components such as microphones, amplifiers, mixers, equalizers, and speakers. **TLO1d.** Discuss the signal flow from input (microphone) to output (speakers) and how it is controlled. **TLO1e.** Explain the components and setup of a home theatre system, including AV receivers, speakers, and subwoofers. **TLO1f.** Learn systematic approaches to identify and fix issues in audio systems. Understand common problems like no sound, distortion, feedback, and connection faults. **TLO1g.** Use tools such as multimeters, signal generators, and oscilloscopes to diagnose and resolve faults.	**Audio Systems** 1.1 Hi Fi amplifier: 1.1.1 Block diagram 1.1.2 Working principle 1.2 Public address (PA) system: 1.2.1 Block diagram 1.2.2 Working principle 1.2.3 Speaker impedance matching and characteristics 1.3 Home theatre system. 1.4 Trouble shooting procedure of audio systems. **Course Outcome:CO1 Teaching Hours:5hrs** **TL:1hrs Marks: 08 (R- 4 U-4, A-0)**

II. Industry / Employer Expected Outcome

Upon completion of this course, students will be well-prepared to meet the demands of the consumer electronics industry. The outcomes are aligned with the skills required for working in understanding design, troubleshooting, and service sectors.

1. **Consumer Electronics Design and Development**:

Understanding of modern control systems used in smart appliances, leading to innovation in connected home technologies and IoT-enabled devices.

2. **Product Lifecycle Management**:

Knowledge of the manufacturing processes and able to evaluate the reliability, quality, and sustainability of consumer electronic products to meet industry standards.

3. **Repair and Troubleshooting Expertise**:

Proficiency in diagnosing and repairing faults in a wide range of household appliances, such as air conditioners, refrigerators, microwaves, and washing machines.

4. **Consumer Electronics Services and After-Sales Support**:

Ability to offer expert customer support and after-sales service for various consumer electronic appliances.

Skill in upgrading and maintaining home appliances with modern technologies, ensuring they remain relevant and competitive in the market.

5. **Drones and Emerging Technologies**:

Understanding of drone technology and its application in industries such as agriculture, defense, weather forecasting, and industrial inspection.

III. Course Outcomes:

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

CO1	Demonstrate a clear understanding of the fundamental components of audio systems.
CO2	Describe the working principles and troubleshoot color TV systems
CO3	Understand the working principles and the advancements in technologies used color TV systems
CO4	Identify and Troubleshoot common faults in electronic appliances like air conditioners, refrigerators, washing machines, and microwave ovens.
CO5	Understand the anatomy and components, Identify different types of drones and their applications in industries such as agriculture, defense, and industrial inspection.

IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	**TLO1a.** Understand the components of a Hi-Fi amplifier through its block diagram. **TLO1b.** Explain how a Hi-Fi amplifier processes low-level signals into high-quality, distortion-free audio output. **TLO1c.** Understand the block diagram of a typical PA system, Identify the core components such as microphones, amplifiers, mixers, equalizers, and speakers. **TLO1d.** Discuss the signal flow from input (microphone) to output (speakers) and how it is controlled. **TLO1e.** Explain the components and setup of a home theatre system, including AV receivers, speakers, and subwoofers. **TLO1f.** Learn systematic approaches to identify and fix issues in audio systems. Understand common problems like no sound, distortion, feedback, and connection faults. **TLO1g.** Use tools such as multimeters, signal generators, and oscilloscopes to diagnose and resolve faults.	**Audio Systems** 1.1 Hi Fi amplifier: 1.1.1 Block diagram 1.1.2 Working principle 1.2 Public address (PA) system: 1.2.1 Block diagram 1.2.2 Working principle 1.2.3 Speaker impedance matching and characteristics 1.3 Home theatre system. 1.4 Trouble shooting procedure of audio systems. **Course Outcome:CO1 Teaching Hours:5hrs TL:1hrs Marks: 08 (R- 4 U-4, A-0)**
2	**TLO 2a.** Explain the block diagram and Key principles of television systems, including aspect ratio, interlace scanning, and resolution. **TLO 2b.** Describe vestigial sideband transmission, bandwidth requirements for color signals, and signal compatibility. **TLO 2c.** Illustrate the working of a color TV camera and its operational principles. **TLO 2d.** Explain the functioning of a color TV picture tube and its role in	**Fundamentals of Televisions** 2.1 Block diagram of TV: Aspect ratio, image continuity, interlace scanning, scanning periods-horizontal and vertical, vertical and horizontal resolution. 2.2 Vestigial side band transmission, bandwidth for color signal, characteristics of color signal, compatibility. 2.3 Color TV Camera: 2.3.1 Block diagram 2.3.2 Working principle (Vidiocon). 2.4 Color TV Picture Tube: 2.4.1 Block diagram

	image reproduction. **TLO 2e.** Understand the block diagram and functions of a color TV transmitter. **TLO 2f.** Understand troubleshooting procedures for a color TV transmitter. **TLO 2g.** Describe the block diagram and operational functions of a color TV receiver. **TLO 2h.** Perform troubleshooting, analyze specifications, and compare color TV systems.	2.4.2 Working principle. 2.5 Color TV Transmitter: 2.5.1 Block diagram 2.5.2 Function of each block. 2.6 Troubleshooting procedure of Color TV Transmitter 2.7 Block diagram and Function of each block of Color TV receiver: 2.8 Troubleshooting/ Specification/ Comparative analysis for different sets of Television. **CourseOutcome:CO2 Teachinghours:10hrs TL:3hrs Marks:14(R-4,U- 4, A- 6)**
3	**TLO3.a** Explain the working principle of LED and LCD televisions. **TLO3.b** Understand the block diagram of cable television and describe the functions of its components. **TLO3.c** Understand the block diagram of a Direct-to-Home (DTH) receiver, including its indoor and outdoor units. **TLO3.d** Explain the working principle, block diagram, applications, and installation steps of Closed-Circuit Television (CCTV) systems. **TLO3.e** Analyze the block diagram and working principle of Smart TVs and their integration with modern technology.	**LED Television and Cable Television.** 3.1 LED and LCD Television: 3.1.1 Working principle. 3.2 Cable Television: 3.2.1 Block diagram and function of all the blocks 3.4 Direct to Home Receiver (DTH): 3.4.2 Receiver block diagram 3.4.3 Indoor and outdoor unit. 3.5 HDTV: 3.5.1 Development of HDTV 3.6 CCTV: 3.6.1 Working principle 3.6.2 Block diagram 3.6.3 Applications 3.6.4 Installation steps. 3.7 Smart TV: 3.7.1 Block diagram 3.7.2 Working principle. **CourseOutcome:CO3 Teaching Hours: 10hrs TL:3hrs Marks:14(R-4,U-6, A-4)**
4	**TLO4.a** Understand the block diagram, working principle, and basic troubleshooting steps of air conditioners. **TLO4.b** Explain the block diagram, working principle, and troubleshooting methods for refrigerators. **TLO4.c** Describe the block diagram and working principle of a photocopier. **TLO4.d** Understand the types, block diagram, wiring, safety	**Consumer Electronics Appliances** 4.1 Air Conditioners: 4.3.1 Block diagram 4.3.2 Working Principle 4.3.3 Basic troubleshooting steps 4.2 Refrigerators: 4.2.1 Block diagram 4.2.2 Working Principle 4.2.3 Basic troubleshooting steps 4.3 Photocopier:

	instructions, and electrical specifications of microwave ovens. **TLO4.e** Analyze the block diagram, types (automatic and semi-automatic), and troubleshooting procedures for washing machines. **TLO4.f** Understand the electrical specifications and operation of washing machines. **TLO4.g** Explain the components, picture processing, picture storage, and electrical specifications of digital cameras and camcorders. **TLO4.h** Identify and describe the role of pickup devices in digital cameras and camcorders.	4.3.1 Block diagram 4.3.2 Working principle 4.4 Microwave Oven: 4.4.1 Types 4.4.2 Block diagram 4.4.3 Wiring and safety instructions and electrical specifications. 4.5 Washing Machine: 4.5.1 Block diagram of washing machine 4.5.2 Electrical specifications 4.5.3 Types of washing machine: Automatic, Semi-automatic 4.5.4 Trouble shooting procedure. 4.6 Digital Camera and Cam coder: 4.6.1 Pickup devices 4.6.2 Picture processing and picture storage 4.6.3 Electrical specifications. **Course Outcome:CO4 Teaching Hours: 10hrs; TL: 4hrs Marks:12(R- 4,U-4, A-4)**
5	**TLO5.a** Explain the recent trends in drone technology and its advancements. **TLO5.b** Identify and describe the key hardware and software components of drones, including their functions. **TLO5.c** Understand the anatomy of drones and the role of each component, such as propellers, motors, flight controllers, and GPS modules. **TLO5.d** Understand the evolution and key features of drones across various generations. **TLO5.e** Classify the different types of drones based on design, functionality, and application.	**Drone and its applications:** 5.1 Introduction 5.1.1 Resent trends in Drone technology 5.1.2 Components of Drones (Hardware and Software) 5.1.3 Anatomy of drones (Propellers, Brushless motor, Landing gears, Electronic speed controllers, flight controller, receiver, transmitter GPS module battery camera) 5.2 Drone features and Evolution 5.3 Types of drones 5.4 Use cases 1. Defense 2. Weather forecast 3. Industry 4. Agriculture (any one case study in detail) **Course Outcome:CO5 Teaching Hours:10hrs TL:4hrs Marks:12(R- 2,U-6,A-4)**

IV. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

Sr. No.	Practical / Tutorial / Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles / Tutorial Titles	No.of hrs.	Relevant COs
1	LLO1 Develop skills to identify and troubleshoot faults in colour TV trainer kits. LLO2 Gain proficiency in using diagnostic tools like multimeters	To identify and rectify faults in colour TV trainer kits. a) No colour b) Red colour only, c) Green colour only d) No	02	CO2

	and oscilloscopes. LLO3 Enhance understanding of colour TV circuitry for fault rectification.	sound.		
2	LLO1 Identify and diagnose faults in different sections of an LED television receiver, such as the power supply and display unit.	Test the various sections of LED Television receiver.	02	CO3
3	LLO1 Develop practical skills in diagnosing common faults in residential air conditioning units LLO2 Troubleshooting and repairing air conditioning systems, focusing on safety protocols, tools, and techniques for effective fault resolution.	Analyzing and Fixing Faults in Residential Air Conditioning Units	02	CO4
4	LLO1 Develop practical skills in diagnosing common faults refrigerator systems, including issues with the compressor, thermostat, and cooling circuits.	Analyzing and Fixing Faults in Refrigerator.	02	CO4
5	LLO1 Understand the fundamental components and cycles (wash, rinse, spin) of an automatic washing machine LLO2 Analyze the energy and water consumption during different washing cycles and apply troubleshooting techniques to identify and resolve common operational issues in automatic washing machines.	To interpret and demonstrate the Operation of an Automatic Washing Machine	02	CO4
6	LLO1 Use a multimeters to accurately measure and analyze voltage levels at various test points in the horizontal section of a colour TV receiver. LLO2 Identify and troubleshoot common issues in the horizontal section of a colour TV receiver	Testing voltage at various test points at horizontal sections of colour TV receiver.	02	CO2
7	LLO1 Use multimeters to accurately measure and analyze voltage levels at various test points in the horizontal section of a colour TV receiver. LLO2 Identify and troubleshoot common issues in the vertical section of a colour TV receiver.	Testing voltage at various points of vertical section of colour TV receiver.	02	CO2

8	LLO1 Use multimeter to test various test points of colour TV receiver. a) Chroma section b) Picture Tube.	Testing various test points of colour TV receiver. a) Chroma section b) Picture Tube.	02	CO2
9	LLO1 Install and configure key components of a CCTV system, including cameras, monitors, and recording devices. LLO2 Troubleshooting common issues during CCTV installation and optimize the system for effective surveillance and security monitoring.	Installation and Configuration of a CCTV Surveillance System	02	CO3
10	LLO1 Suggest the remedy for the following faults in given colour TV: a) Faults in SYNC separator. B) Faults in video amplifier.	Fault Diagnosis and Remedies for SYNC Separator and Video Amplifier in a Colour TV"	02 02	CO2 CO2
11	LLO1 Measure voltage levels to sketch composite video signal at different stages of TV receiver	Measurement of Voltage Levels and Sketching the Composite Video Signal at Different Stages of a TV Receiver"		
12	LLO1 To test and measure voltage at various sections of LED TV receivers.	To test the various sections of LED television receiver.	02	CO3
13	LLO1 Suggest the remedy for the following faults in given colour TV: a) Faults in HSYNC section b) Fault in VSYNC section	Testing various test points of the following faults in given colour TV: a) Faults in HSYNC section b) Fault in VSYNC section.	02	CO3
14	LLO1 Test the magnetron, capacitor, and transformer. LLO2 Measure voltage at various stages.	Demonstration of working of Microwave oven.	02	CO4
15	LLO1 Test the recording, playback, and zoom functions. LLO2 Measure power and signal continuity	To test the various functions of Camcoder.	02	CO4
16	LLO1 Analyze screen resolution, refresh rate, backlight technology, power consumption, and lifespan.	A case study: Compare LED and LCD TV on the basis of specifications, working etc.	02	CO3
	LLO1 Understand the fundamental working principles of drones and their components.	A case study: The Application of Drones in Agricultural Monitoring or any other as per suggestion given by faculty	02	CO5

	LLO2 Learn how drones are used in agriculture to monitor crop health, optimize irrigation, and detect problems such as pests or diseases.			

Note: 10 experiments should be performed in a term for completion of TW

V. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): NA

VI. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Audio Systems	4	4	-	08
2	Fundamentals of Televisions	4	4	6	14
3	LED Television and Cable Television.	4	6	4	14
4	Consumer Electronics Appliances	4	4	4	12
5	Drone and its applications	2	6	4	12
Total		18	24	18	60

V1I.Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)

Rubrics for continuous assessment based on process and product related performance indicators (25 marks)

Summative Assessment (Assessment of Learning)
End term examination, Viva-voce, Performance (50 marks)

VIII. Suggested COs - POs Matrix Form

CO	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PSO- 1	PSO- 2	PSO- 3
CO1	2	3	2	2	1	-	2	2	3	2
CO2	1	2	2	3	-	-	1	2	2	-
CO3	2	3	2	3	1	-	2	2	3	2
CO4	1	-	-	1	-	3	2	2	1	1
CO5	3	3	3	1	1	2	1	3	3	2
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

IX. Suggested Learning Materials / Books

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Consumer Electronics	Bali, S.P. Pearson education, India, Delhi, 2007	9788131717592
2	Audio Video systems principles, maintenance and troubleshooting.	Gupta, R.G. Mc-graw hill, New Delhi, India 2010	9780070699762
3	Audio Video systems: principle practices and troubleshooting.	Bali, Rajeev, Bali,S. P. Khanna book publishing Co.(P) Ltd. Delhi,2014	9788187522058
4	Trouble shooting electronic equipment	R. S. Khandpur, Tata McGraw hill	9780071477314
5	Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation	Daniel Tal, Jon Altschuld	9781119545880

X. Learning Websites & Portals

Sr. No.	Link / Portal	Description
1	https://www.youtube.com/watch?v=8HG7efTMj78	Link for study material
2	https://www.electronicrepairguide.com/led-tv-repair-basic .html	Link for study material
3	https://www.computer-pdf.com/tutorials-computer-repair-and-maintenance	Link for study material
4	https://www.thespruce.com/refrigerator-repair-guide-4153173	Link for study material

XI. Academic Consultation Committee/Industry Consultation Committee:

Sr. No.	Name	Designation	Institute/Organization
1	Mr.S.N.Isal	Director	Techmahoday
2	Dr. Hemant Kasturewale	Hod,Extc	Thakur Engg.college
3	Ms. A. J. Barbole	Lecturer in Electronics	G. P. Mumbai
4	Ms. T. K. Balsaraf	Lecturer in Electronics	G. P. Mumbai

Coordinator
Curriculum Development,
Department of Electronics
Engineering

Head of Departments
Department of Electronics
Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

Principal
Government Polytechnic, Mumbai

APPROVED COPY
CDC Co-ordinator
G. P. Mumbai

Programme: Diploma in Electronics Engineering (Sandwich pattern)													
Course Code: EC23401	**Course Code: Project 1**												
Compulsory / Optional: Compulsory													
Learning Scheme and Credits						**Learning Scheme and Credits**							
CL	**TL**	**LL**	**SLH**	**NLH**	**Credits**	**FA-TH**		**SA-TH (2:30 Hrs.)**	**FA-PR**	**SA**		**SLA**	**Total**
						UT 1	**UT1**			**PR**	**OR**		
-	-	2		2	1	-	-	-	25	-	25@	-	50

Total IKS Hrs. for course: -

Abbreviations: CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

Note:

1. FA-PR represents the term work
2. SA-PR represents the end term practical examination.

I. Rationale:

An engineer or technician has to carry out variety of tasks & face problems and situations in his professional life. He has to convey his ideas, communicate with people. Effective presentation of ideas, thoughts and information becomes a requisite skill for him/her.

The student should be aware about the concepts, fundamentals, objectives and essential hardware and software required for the execution of project.

The involvement of student in the Project based Seminar course will help him to plan and prepare the related topic by searching information from various sources, interact with others, analyse the information, document the content and present.

II. Industry / Employer Expected Outcome:

This course is to be taught and implemented with the aim to develop in the student, the course outcomes (COs) leading to the attainment of following industry identified outcome expected from this course:

To understand and present the implementation strategy of industry/society need based projects.

III. Course Outcomes:

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

CO1	To suggest and discuss ideas through project based seminar
CO2	To collect data, information, literature from various resources
CO3	develop planning of seminar activities
CO4	To develop skills to communicate the problems and solutions
CO5	To develop skill to prepare reports and presentation

IV. Course Content Details:

Activity No.	1. Activities
1	Briefing and discussion about selection for project based seminar topics in class.
2	Search project based seminar topics and approval of project topic by Project Guide from searched topics.
3	Collection of data and literature for project based seminar through: Internet/industrial visits/Journals/Books/EBooks etc.
4	Preparation of synopsis/report of seminar topic: print draft copy
5	Submission of seminar synopsis to guide (Printed copy)
6	Discuss with the Project Guide about preparation of seminar document
7	Preparation of project based seminar by the students
8	Editing and revising the project based seminar document
9	Submission of Hard copy & Soft copy of project based seminar report and power point presentation to Project Guide
10	Seminar Presentation to Project Guide, department faculty members andstudents

The above listed activities related to Project Based Seminar should be discussed with the ProjectGuide time-to-time throughout the semester and finally present the Seminar work.

S No	Suggestive topics for Project topic in Electronics Engineering
1	IoT and Smart Systems
2	Wind-Solar Hybrid Power System
3	Digital Notice Board Using Arduino
4	Pick and Place Robotic Arm
5	RFID-Based Attendance System
6	Heart Rate Monitoring System
7	Automatic Hand Sanitizer Dispenser
8	Smart Waste Management System
9	Environment Monitoring System
10	Disaster Alert System
11	Voice-Controlled Wheelchair
12	Obstacle Detection for Visually Impaired
13	E-bike speed controller systems
14	Solar wireless electric vehicle charging system
15	Any other topic related to electrical engineering

***Key considerations**

- **Industry Relevance**: Focus on projects related to IoT, renewable energy, or automation, as they are in demand.
- **Feasibility**: Choose projects manageable within the resources and timeline of diploma students.
- **Interdisciplinary Approach**: Encourage collaboration with peers from other disciplines like computer science or mechanical engineering.
- **Topics of Project based seminars will vary as per requirements of particular program**

V. Learning Resources:

Magazines, Journals, Papers: National & international Reference Books, Internet, Previous seminars, Text Books, Codes of Practices e. g. IS Codes, Video Cassettes, Audio Cassettes, Compact Discs, Charts, Transparencies, Software, Models, Industrial visits, expert lectures/workshops

VI. Guidelines for Seminar:

• Submission of Seminar Document:

- The student shall get the seminar draft approved from Guide and complete final document.
- Each student shall prepare two hard copies of final seminar document and retain one copywith student and submit one hard copy along with soft copy for department.
- The structure of the seminar document shall be as per the following format: Certificate / Acknowledgement / Index / Introduction / Detailed content / Conclusion / References.
- The seminar report shall be of minimum 10 pages and max. 20 pages with 1.5-line spacing.Font: New Times Roman, left margin 3 cm, right margin 1.5 cm, top margin 2 cm, bottom margin 2 cm, header & footer 1.5 cm, page numbers, size of font 12 pt, paragraphs left andright justified. It should be certified by seminar Guide and Head of department.

• Evaluation of Seminar:

Evaluation of seminar will consist of Progressive Assessment, Presentation

Progressing Assessment:

a. Progressive assessment will be based on attendance, searching of various seminar topics, selection of title, collection of data from internet, Journals, Literatures, organization of data and preparation of document.

VII. Assessment Methodologies/Tools

Formative assessment (Assessment for Learning)
Documentation of Seminal report (25marks)

Summative Assessment-(Assessment of Learning)
Presentation and discussion based on Project topic (25 Marks)

VIII. 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		
CO2	3		1		1		1			
CO3	3		1			1	1		1	
CO4	3				1		1	1		1
CO5	3			1		1	1	1		
Legends: - High:03, Medium:02, Low:01, No Mapping: --										

IX.Academic Consultation Committee/Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr Sourav Deore	Industry Expert	AVI-SPL India Private Limited
2	Mr. Anjum Mujavar	SL Grade Lecturer	Vidyalankar Polytechnic Mumbai
3	Mr. A. D. Vikhankar	SL Grade Lecturer	Government Polytechnic, Mumbai
4	Mr. R. M. Ingle	SL Grade Lecturer	Government Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Electronics Engineering

Head of Department
Department of Electronics Engineering

I/C, Curriculum Development Cell
Government Polytechnic, Mumbai

Principal
Government Polytechnic, Mumbai

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CDC Co-ordinator