

**Government Polytechnic, Mumbai**  
(Academically Autonomous Institute, Government of Maharashtra)  
Programme : Diploma in Instrumentation Engineering (Sandwich Pattern)

Learning and Assessment Scheme (P-23)  
Duration of Programme : 6 Semester  
Semester : Fifth

With Effect From Academic Year : 2023-24  
Duration : 16 WEEKS  
Scheme : P-23

Sr. No.	Course Code	Course Title	Course Type	Total IKS Hrs. For Sem.	Learning Scheme					Credits	Paper Duration (Hrs.)	Assessment Scheme												Total Marks	
					Actual Contact Hrs./Week			Self-Learning (Term Work + Assignments) Hrs./Week	Notional Learning Hrs./Week			Theory			Based on LL & TL				Based On Self-Learning						
					CL	TL	LL					SLH	NLH	FA-TH		SA-TH	Total		FA-PR		SA-PR		SLA		
								T1	T2					Max	Min		Max	Min	Max	Min	Max	Min			
					Max	Max							PR	OR											
1	IS23110	Industrial Automation	DSC	--	3	--	4	1	8	4	2:30	20	20	60	100	40	25	10	25#	--	10	25	--	175	
2	IS23111	Analytical Instrumentation	DSC	--	3	--	2	1	6	3	2:30	20	20	60	100	40	25	10	--	--	--	25	--	150	
3	IS23112	Biomedical Instrumentation	DSC	--	4	--	2	--	6	3	2:30	20	20	60	100	40	25	10	--	25#	10	--	--	150	
4	IS23701	Elective -II	Database Management	IDE	--	3	--	2	1	6	3	2:30	20	20	60	100	40	25	10	--	--	--	25	--	150
	IOT based instrumentation		IDE																						
	Artificial Intelligence		IDE																						
5	IS23607	Maintenance of Instruments & Systems	SEC	--	1	--	4	1	6	3	--	--	--	--	--	50	20	50#	--	20	25	--	125		
6	IS23504	Management & Entrepreneurship development	AEC	--	1	--	2	1	4	2	--	--	--	--	--	25	10	--	--	--	25	--	50		
7	IS23401	Project	INP	--	--	--	2	2	4	2	--	--	--	--	--	25	10	50#	--	20	25	--	100		
<b>Total</b>				--	<b>15</b>	--	<b>18</b>	<b>7</b>	<b>40</b>	<b>20</b>	<b>10</b>	<b>80</b>	<b>80</b>	<b>240</b>	<b>400</b>	<b>160</b>	<b>200</b>	<b>80</b>	<b>125</b>	<b>25</b>	<b>60</b>	<b>150</b>	--	<b>900</b>	

**Abbreviations:** CL-Classroom Learning, TL-Tutorial Learning, LL- Laboratory Learning, FA-Formative Assessment, SA-Summative Assessment, IKS-Indian Knowledge System, SLA - Self Learning Assessment

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

**Note:**

1. FA-TH represents addition of two-20 marks class tests conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course, then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course, then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+TL+LL+SL) hours X 16 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \*Self-learning hours shall not be reflected in the Time Table.

**Course Category:** Discipline Specific Core Course (DSC): 3, Discipline Specific Elective (DSE):0, Value Education Course (VEC):0, Intern. /Apprentice. /Project /Community (INP):1, Ability Enhancement Course (AEC): 1, Skill Enhancement Course (SEC): 1, Interdisciplinary Elective (IDE): 3

**Department Coordinator,**  
Curriculum Development,  
Dept. of Instrumentation Engineering

**Head of Department,**  
Dept. of Instrumentation Engineering

**In-Charge**  
Curriculum Development Cell

**Principal,**  
Government Polytechnic Mumbai

<b>Programme: Diploma in Instrumentation Engineering (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code:IS23110</b>						<b>Course Title: Industrial Automation</b>							
<b>Compulsory/Optional: Compulsory</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
3	--	4	1	8	4	20	20	60	25	25#	--	25	175

Total IKS Hrs. for course: 00 Hrs.

**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:**@InternalAssessment, # External Assessment, \*#Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-TH represents addition of two class tests 20 marks each conducted during the term.
2. FA-PR represents tutorial/practical term work of 25 Marks.
3. SLA represents self-learning Assessment of 25 Marks.
4. SA-TH represents the end term theory examination of 60 Marks.
5. SA-PR represents the end term Oral examination of 25 Marks

**I. Rationale:**

Now a days PLC & SCADA system are used in most of the industries for automation. PLCs are designed to withstand harsh industrial environments and can be easily programmed and reprogrammed. PLCs provide real-time control and monitoring of industrial processes, enabling quick responses to changes. SCADA systems provide a centralized platform for monitoring and controlling multiple industrial processes. SCADA systems enable remote control and monitoring of industrial processes, reducing the need for on-site personnel. The knowledge of PLC & SCADA system is essential to the instrumentation diploma holder. This course is introduced with the view that the students of instrumentation must be familiar with PLC & SCADA systems and their application in industries.

**II. Industry/Employer Expected Outcome:**

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

“Develop and Maintain Industrial Automation systems.”

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

CO1	Identify the role of different component of the given PLC
CO2	Use the given PLC instruction for developing an application
CO3	Understand the operation of SCADA system
CO4	Develop industrial application using PLC & SCADA



<b>3</b>	<b>TLO3.1</b> Explain benefits of SCADA <b>TLO3.2</b> Draw block diagram of SCADA <b>TLO3.3</b> State the role of each element in SCADA <b>TLO3.4</b> Different tags in SCADA <b>TLO3.5</b> Create MIMIC diagram for given application <b>TLO3.6</b> Create trends, alarms for given tag in SCADA	<b>Unit-III SCADA</b> 3.1 SCADA: Introduction to SCADA, typical block diagram- operation, Role of RTU, MTU, Communication interface, HMI, benefits of SCADA and Applications 3.2 Various editors of SCADA and their function (channel, node, tag database, tag monitor, display, library, alarm setup, alarm log viewer) 3.3 Tags-types (Analog, Digital, String, Derived), Display- Mimic diagram (Concept), assigning animation to display, Trends –Real & Historic. 3.4 Creating Tag database and Mimic diagram for simple applications (On-off of lamp, Start stop of motor, Level indicator, Motor speed)	
<b>Course Outcome: CO3</b>		<b>Teaching Hours:07 hrs.</b>	<b>Marks: 09</b>
<b>4</b>	<b>TLO4.1</b> Prepare I/O List and I/O address for given application <b>TLO4.2</b> Draw ladder diagram for given application <b>TLO4.3</b> Prepare tag list and Tag database for given application <b>TLO4.4</b> Draw MIMIC diagram for given application	<b>Unit-IV Industrial applications of SCADA and PLC</b> 4.1 PLC Application 4.2 Batch Process control 4.3 Redundant Diesel genset control 4.4 Bottle filling plant control 4.5 Water distribution system 4.6 Traffic light control 4.7 Elevator control (I/O List, I/O Address, I/O type, Ladder diagram, Tag database, Mimic diagram)  ( 70% weightage on PLC Application & 30% on SCADA applications) <b>Note : This unit will be preferably taught by Industry person/Alumni of Government Polytechnic Mumbai</b>	
<b>Course Outcome: CO4</b>		<b>Teaching Hours: 09 hrs</b>	<b>Marks: 12</b>

#### 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	<b>LLO1.1</b> Understand different PLC 's in lab	Familiarization with PLC Lab	02	CO1
2	<b>LLO2.1</b> Build ladder diagram to verify OTL & OTU Instruction <b>LLO2.2</b> Test & Troubleshoot ladder diagram.	Lamp ON-FF using OTL & OUT instruction	02	CO2
3	<b>LLO3.1</b> Build ladder diagram to verify AND, OR & NOT gate <b>LLO3.2</b> Test & Troubleshoot ladder diagram	Basic Logic function AND gate, OR gate, NOT gate using ladder Logic.	02	CO2
4	<b>LLO4.1</b> Build ladder diagram to verify NAND & NOR gate <b>LLO4.2</b> Test & Troubleshoot ladder diagram	Basic Logic functions NAND gate, NOR gate, using ladder Logic.	02	CO2

5	<b>LLO5.1</b> Build ladder diagram to verify EX-OR & EXNOR gate <b>LLO5.2</b> Test & Troubleshoot ladder diagram	Basic Logic function EX-OR gate, EXNOR gate, using ladder Logic.	02	CO2
6	<b>LLO6.1</b> Build ladder diagram to verify Logical AND & OR instruction <b>LLO6.2</b> Test & Troubleshoot ladder diagram	Ladder Logic for Logical AND & OR instruction	02	CO2
7	<b>LLO7.1</b> Build ladder diagram to verify Logical NOT & XOR instruction <b>LLO7.2</b> Test & Troubleshoot ladder diagram	Ladder Logic for Logical NOT & XOR instruction	02	CO2
8	<b>LLO8.1</b> Build ladder diagram to verify TON Instruction <b>LLO8.2</b> Test & Troubleshoot ladder diagram	Ladder Logic for Traffic light Control System and test it through PLC using Ton instruction	02	CO2/CO 4
9	<b>LLO9.1</b> Build ladder diagram to verify TOF instruction <b>LLO9.2</b> Test & Troubleshoot ladder diagram	Ladder Logic for Traffic light Control System and test it through PLC using TOF instruction	02	CO4
10	<b>LLO10.1</b> Build ladder diagram to verify RTO instruction <b>LLO10.2</b> Test & Troubleshoot ladder diagram	Develop a Ladder Logic for Traffic light Control using RTO instruction	02	CO4
11	<b>LLO11.1</b> Build ladder diagram to verify CTU instruction <b>LLO11.2</b> Test & Troubleshoot ladder diagram	Ladder Logic for counting the objects using CTU.	02	CO2
12	<b>LLO12.1</b> Build ladder diagram to verify CTD instruction <b>LLO12.2</b> Test & Troubleshoot ladder diagram	Ladder Logic for counting the objects using CTD.	02	CO2
13	<b>LLO13.1</b> Build ladder diagram to Verify ADD & SUB Instruction <b>LLO13.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify ADD & SUB Mathematical Instruction	02	CO2
14	<b>LLO14.1</b> Build ladder diagram to Verify DIV instruction <b>LLO14.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify DIV Mathematical Instruction	02	CO2
15	<b>LLO15.1</b> Build ladder diagram to Verify MUL Instruction <b>LLO15.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify MUL Mathematical Instruction	02	CO2
16	<b>LLO16.1</b> Build ladder diagram to Verify EQU & NEQ Instruction <b>LLO16.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify EQU & NEQ comparison Instruction	02	CO2
17	<b>LLO17.1</b> Build ladder diagram to Verify LES & LEQ Instruction <b>LLO17.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify LES & LEQ comparison Instruction	02	CO2
18	<b>LLO18.1</b> Build ladder diagram to Verify GRT & GEQ Instruction <b>LLO18.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify GRT & GEQ comparison Instruction	02	CO2
19	<b>LLO19.1</b> Build ladder diagram to Verify LIM & SCP Instruction <b>LLO19.2</b> Test & Troubleshoot ladder diagram	Ladder Logic to Verify LIM & SCP Instruction	02	CO 2
20	<b>LLO20.1</b> Build ladder diagram to Verify given application <b>LLO20.2</b> Test & Troubleshoot ladder diagram	Implementing given application using ladder diagram	02	CO4

21	<b>LLO21.1</b> Configure RSVIEW 32	Configuration of RSVIEW 32 to create project	02	CO3
22	<b>LLO22.1</b> Create tag for given application <b>LLO22.2</b> Test Tag	Creation of analog, digital tags and addressing of these tags in SCADA for given application	02	CO 3
23	<b>LLO23.1</b> Create animation for given application <b>LLO23.2</b> Test Animation	Creation and configuration of Animation in SCADA for given application.	02	CO 3
24	<b>LLO24.1</b> Create Alarm for given application <b>LLO24.2</b> Test Alarm	Creation and configuration of alarms in SCADA for given application	02	CO 3
25	<b>LLO25.1</b> Create application using SCADA <b>LLO25.2</b> Test Application	Implementing given application using SCADA	02	CO 4

**Note: Minimum 20 experiments are compulsory and should be chosen such that all COs will be covered.**

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

##### Micro Project:

1. **Automatic street light controller:** Prepare a PLC based system to control the street light as per the intensity of natural light.
2. **Automatic agriculture irrigation system:** Prepare a PLC based system to control drip irrigation.
3. Prepare a PLC and SCADA based system to open or close the prototype railway gate automatically.
4. Prepare a PLC based system for prototype automatic car parking system
5. Prepare a PLC based system for prototype automatic car washing system.
6. Troubleshoot the Faulty Equipment/ Kit available in automation Laboratory.

#### VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Introduction to PLC	5	4	2	11
2	Instruction set and Programming	6	8	14	28
3	SCADA	4	3	2	09
4	Industrial applications of SCADA and PLC	-	-	12	12
<b>Total Marks</b>		<b>15</b>	<b>15</b>	<b>30</b>	<b>60</b>

#### VIII. Assessment Methodologies/Tools:

##### Formative assessment (Assessment for Learning)

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

**Summative Assessment (Assessment of Learning)**

- Rubrics for assessment based on laboratory process and product related performance indicators. (25 Marks)
- End of the term theory examination. (60 Marks)

**IX. Suggested COs-POs Matrix Form:**

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

Legends:- High:03, Medium:02, Low:01, No Mapping: --

**X. Suggested Learning Materials/Books:**

Sr. No.	Title	Author, Publication, Edition and Year of Publication	ISBN NO.
1	Programmable Logic Controller	Jadhav V. R., Khanna publishers, New Delhi, 2017	9788174092281
2	Programmable logic controllers	Petruzella F., Tata-McGraw Hill India, New Delhi, Fourth edition, 2010,	9780071067386
3	Programmable logic controllers and Industrial automation-An introduction	Madhuchhanda Mitra, Samarjit Sen Penram International Publication, New Delhi, 2015, Fifth reprint,	9788187972174
4	Introduction to Programmable logic controllers	Dunning, G. Thomson /Delmar learning, New Delhi, 2005,	9781401884260
5	Supervisory control and Data acquisition	Boyar. S. A. ISA Publication New Delhi (4 <sup>th</sup> edition)	9781936007097
6	Programmable logic controllers	Hackworth, John; Hackworth. Federic PHI Learning, New Delhi 2003	9780130607188
7	Industrial automation and Process control	Stenerson, Jon PHI Learning, New Delhi	9780130618900

8	Practical SCADA for Industry	Bailey, David, Wright, Edwin Newnes (an imprint of Elsevier) international edition,2003	0750658053
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**XI. Learning Websites & Portal:**

Sr. No.	Link/Portal	Description
1	www.fossee.com	Simulation software
2	www.logixpro.com	Simulation Software
3	www.plctutor.com	---
4	www.ellipse.com	---
5	PLC lecture:- <a href="https://www.youtube.com/watch?v=pPiXEfB02qo">https://www.youtube.com/watch?v=pPiXEfB02qo</a>	video
6	PLC tutorial: -http://users.isr.ist.utl.pt/-jag/aulas/api13/docs/API I C3 3 ST.pdf	---

**XII. Academic Consultation Committee/Industry Consultation Committee:**

Sr. No.	Name	Designation	Institute/Organization
1	Mr. Avinash Mane	Sr. Project Engineer (Automation Trainer)	IPCS Global, Mumbai
2	Mr. Vijay Suryawanshi	Lecturer in Instrumentation	Govt Polytechnic Pen
3	Mr. S.G. Thube	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai
4	Mr. Uday B Shinde	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai

<b>Programme: Diploma in Instrumentation Engineering (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code: IS23111</b>						<b>Course Title: Analytical Instrumentation</b>							
<b>Compulsory / Optional: Compulsory</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
3	--	2	1	6	3	20	20	60	25	--	--	25	150

Total IKS Hrs. for course: 00 Hrs.

**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, \*# Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-TH represents addition of two class tests 20 marks each conducted during the term.
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4. SA-TH represents the end term theory examination of 60 Marks.

**I. Rationale:**

Analytical instrumentation involves a multidisciplinary approach covering instruments used in medical, drugs and pharmaceutical, petroleum, chemical, water treatment, dairy, environmental pollution monitoring etc. for qualitative and quantitative analysis of given sample. The fundamental knowledge of this course will enable the student to select appropriate instrument for analysis of given sample. The objective of the course is to understand the working principle and operation of analytical instruments

**II. Industry / Employer Expected Outcome:**

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

“Understand the working principle and operation of analytical instruments.”

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

CO1	Select the relevant analytical instruments for given sample/product.
CO2	Illustrate the various techniques and methods of different types of Spectrometers and Nuclear magnetic resonance (NMR).
CO3	Select appropriate Chromatography techniques for Gas Chromatography (GC) and Liquid Chromatography (LC).
CO4	Explain analytical instruments used to analyze industrial gases.
CO5	Explain analytical instruments to monitor environment pollutants.

## IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	<p><b>TLO1.1</b> Draw block diagram of Analytical Instrument and explain the function of each block.</p> <p><b>TLO1.2</b> Categorize analytical instrument based on property of analyte.</p> <p><b>TLO1.3</b> Classify a given analytical instrument based on working principle.</p> <p><b>TLO1.4</b> Explain the use of various elements in a given analytical instrument.</p>	<p><b>Unit - I Basics of Analytical Instrumentation</b></p> <p>1.1 Analytical Instrument: Block diagram, Functions of each block</p> <p>1.2 Properties of Analytes and techniques used in Analytical Instrument</p> <p>1.3 Classification of Analytical Instruments: Spectral, Electro-analytical, Separation method (Introduction to each method)</p> <p>1.4 Elements of Analytical Instruments: Radiation Sources- Incandescent lamp, Discharge lamp, LASER; Filters- Optical filters, Absorption Filters; Monochromators -Prism, Grating</p>
<p><b>Course Outcome: CO1</b> <b>Teaching Hours: 06 hrs.</b> <b>Marks:08</b></p>		
2	<p><b>TLO2.1</b> Explain Interaction of Electromagnetic Radiations with the Matter.</p> <p><b>TLO2.2</b> Explain the working principle of a given Colorimeter with neat diagram along with its applications.</p> <p><b>TLO2.3</b> Illustrate the working principle of a given Spectrophotometer with neat diagram along with its applications.</p> <p><b>TLO2.4</b> Explain the working principle of a given Flame photometer / NMR Spectrometer with neat diagram along with its applications.</p>	<p><b>Unit - II Spectrophotometry and NMR Techniques</b></p> <p>2.1 Interaction of Electromagnetic Radiations with the Matter, Beer Lambert's Law</p> <p>2.2 Colorimeter- Principle, types and applications - Single Beam photometer, Double Beam photometer</p> <p>2.3 Spectrophotometer: Principle, types and applications - Single Beam spectrophotometer, Double Beam spectrophotometer</p> <p>2.4 Flame photometer: Principle, types and applications - Single channel, Atomic Absorption Flame photometer</p> <p>2.5 Nuclear magnetic resonance (NMR) - Principle, Construction, working and applications</p>
<p><b>Course Outcome: CO2</b> <b>Teaching Hours: 10 hrs.</b> <b>Marks:14</b></p>		
3	<p><b>TLO3.1</b> Classify the chromatograph based on different mechanism.</p> <p><b>TLO3.2</b> Select the Chromatograph for analyzing the given sample.</p> <p><b>TLO3.3</b> Differentiate between LC and HPLC.</p> <p><b>TLO3.4</b> Explain the working principle of a given Mass spectrometer with neat diagram along with its applications</p>	<p><b>Unit - III Chromatography</b></p> <p>3.1 Chromatography - Principle, Classification (Based on - Mechanism of separation, Type of mobile Phases, Shape of Chromatography Bed)</p> <p>3.2 Gas Chromatography (GC): Principle, basic parts of GC and applications</p> <p>3.3 Liquid Chromatography (LC): Principle, working and applications of LC and High-performance liquid chromatography (HPLC)</p> <p>3.4 Mass Spectrometer: Principle, working, applications and types of Mass Analyzers in Mass Spectrometry (MS) - Time of flight type, Magnetic type, (GCMS)</p>
<p><b>Course Outcome: CO3</b> <b>Teaching Hours: 10 hrs.</b> <b>Marks:14</b></p>		

<b>4</b>	<p><b>TLO4.1</b> Justify the use of given type of electrode for measurements of particular parameter.</p> <p><b>TLO4.2</b> Explain the working principle of Blood gas analyzer with neat diagram along with its applications.</p> <p><b>TLO4.3</b> Illustrate the working principle of Infrared gas analyzer</p> <p><b>TLO4.4</b> Explain the working principle of Thermal Conductivity analyzer</p> <p><b>TLO4.5</b> Explain the working principle of Paramagnetic Oxygen Analyzer Explain the given pH Measurement Methods.</p>	<p><b>Unit - IV Industrial gas Analyzer</b></p> <p>4.1 Electrodes: Working and application of Glass, Calomel, pO<sub>2</sub>, pCO<sub>2</sub></p> <p>4.2 Blood gas Analyzer- Block diagram, Function of each block, measurement of pH, pCO<sub>2</sub>, pO<sub>2</sub></p> <p>4.3 Infrared gas Analyzer: Principle, Block Diagram, Working, Applications</p> <p>4.4 Thermal Conductivity Analyzer: Principle, Block Diagram, Working, Applications</p> <p>4.5 Paramagnetic Oxygen Analyzer - Principle, Block Diagram, Working, Applications</p> <p>4.6 pH Measurement Methods - Indicator methods</p>	
<b>Course Outcome: CO4</b>		<b>Teaching Hours: 10 hrs</b>	<b>Marks:14</b>
<b>5</b>	<p><b>TLO5.1</b> Analyze the impact of pollutants on environment by stating the need of analysis.</p> <p><b>TLO5.2</b> Classify the pollutant based on the concentration of gas in the environment.</p> <p><b>TLO5.3</b> Choose Conductivity method for SO<sub>2</sub> measurement.</p> <p><b>TLO5.4</b> Select Chemiluminescence / CO Laser for measurement of Nitrogen Oxides.</p> <p><b>TLO5.5</b> Explain the working principle of Conductivity meter for Ozone measurement.</p>	<p><b>Unit - V Environmental Pollution Monitoring System</b></p> <p>5.1 Necessity of monitoring pollutants for environmental sustainability</p> <p>5.2 Representation of concentration of gases</p> <p>5.3 Gas pollutants - Types, Concentration and Measurement techniques (Carbon monoxide measurement using Gas chromatography) of various gas pollutants</p> <p>5.4 SO<sub>2</sub> measurement using Conductivity method</p> <p>5.5 Nitrogen Oxides measurement using i) Chemiluminescence (ii) CO Laser</p> <p>5.6 Ozone measurement using Conductivity meter</p>	
<b>Course Outcome: CO5</b>		<b>Teaching Hours: 09 hrs</b>	<b>Marks:10</b>

#### 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	<b>LLO1.1</b> Identify the elements of analytical instruments in your laboratory	Identification of elements of Analytical Instruments	02	CO1
2	<b>LLO2.1</b> Use Colorimeter to measure absorbance/ transmittance of a given sample	Measurement of absorbance and transmittance using Colorimeter	02	CO2
3	<b>LLO3.1</b> Measure absorbance/transmittance of a given sample using Spectrophotometer	Measurement of absorbance and transmittance using Spectrophotometer	02	CO2
4	<b>LLO4.1</b> Determine the content of a given sample using Flame photometer	Measurement of content using Flame photometer (Video/animation)	02	CO2
5	<b>LLO5.1</b> Interpret the NMR spectroscopy of a given sample.	Demonstration of NMR spectroscopy (Video/animation)	02	CO2

6	<b>LLO6.1</b> Use Gas chromatograph for separation of given sample contents	Separation of contents using Gas chromatography (Video/animation)	02	CO3
7	<b>LLO7.1</b> Use HPLC chromatograph for separation of a given sample content	Demonstration of separation of contents using High performance liquid chromatography (Video/animation)	02	CO3
8	<b>LLO8.1</b> Separate the given sample contents using GCMS	Demonstration of GCMS for separation of sample contents (Video/animation)	02	CO3
9	<b>LLO9.1</b> Measure pH values of a given sample.	Measurement of pH value using pH meter	02	CO4
10	<b>LLO10.1</b> Use IR gas analyser to analyse a given gas sample.	Analysis of gas sample using IR gas analyzer	02	CO4
11	<b>LLO11.1</b> Analyze thermal conductivity of a given gas sample using gas analyzer.	Analysis of gas sample using Thermal conductivity gas analyzer	02	CO4
12	<b>LLO12.1</b> Measure the concentration of oxygen using Oxygen analyzer	Measurement of concentration of oxygen analyzer	02	CO4
13	<b>LLO13.1</b> Measure pO <sub>2</sub> /pCO <sub>2</sub> using Blood gas analyzer.	Demonstration of Blood gas analyzer for measurement of pO <sub>2</sub> , pCO <sub>2</sub> (Video/animation)	02	CO4
14	<b>LLO14.1</b> Measure conductivity of a given sample using conductivity meter	Measurement of conductivity using conductivity meter	02	CO5
15	<b>LLO15.1</b> Detect O <sub>3</sub> gas using Ozone detector	Demonstration of O <sub>3</sub> gas detection using Ozone detector (Video/animation)	02	CO5
16	<b>LLO16.1</b> Use Chemiluminescence analyzer for measurement of Nitrogen Oxides	Demonstration of Nitrogen Oxides measurement using Chemiluminescence analyzer.	02	CO5

**Note: Minimum 12 experiments are compulsory and should be chosen such that all COs will be covered.**

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

##### Micro Project:

- Measure pH of given water samples (drinking water, sewage water, Sea water etc.) with the help of pH testing strips and prepare a report on it.
- Build an analogous model showing internal construction of Gas Chromatography/ Liquid Chromatography/ Colorimeter/ Spectrophotometer/ Flame Photometer.
- Report on Beer Lambert's Law using virtual lab/ video animation
- Build a Prism Monochromators and prepare a report on it

##### Visit:

- Visit pathology laboratories to observe different analysis carried out there and prepare a report on it.
- Visit a PUC (Pollution under control) center and observe the measurement of pollutants concentration in environment and prepare a report on it.
- Visit a Chemical industry to observe operation of Analytical instruments and prepare a report on it.
- Visit a standard Chemical Laboratory, to observe operation of Analytical instruments and prepare a report on it.

**Assignment:**

- Prepare a report based on internet survey of advanced analytical equipment's - Bilirubin testing equipment, Dairy testing solutions, Clinical Osmometers, Anaerobic jar systems.
- Prepare a report on safety precautions to be followed to operate various analytical equipment.
- Prepare a case study which illustrates the calibration problem and solution of Analytical Instrument.

**VII. Specification Table:**

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Analytical Instrumentation	4	2	2	<b>08</b>
2	Spectrophotometry and NMR Techniques	4	6	4	<b>14</b>
3	Chromatography	4	6	4	<b>14</b>
4	Industrial gas Analyzer	4	6	4	<b>14</b>
5	Environmental Pollution Monitoring System	3	4	3	<b>10</b>
<b>Total Marks</b>		<b>19</b>	<b>24</b>	<b>17</b>	<b>60</b>

**VIII. Assessment Methodologies/Tools:****Formative assessment (Assessment for Learning)**

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

**Summative Assessment (Assessment of Learning)**

- End of the term theory examination. (60 Marks).

**IX. Suggested COs - POs Matrix:**

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

Legends: - High:03, Medium:02, Low:01, No Mapping: --

**X. Suggested Learning Materials / Books:**

Sr. No.	Title	Author, Publication, Edition and Year of Publication	ISBN NO.
1	Handbook of Analytical Instruments	Khandpur R.S. McGraw Hill Education, 3rd edition , 2015	9789339221355
2	Analytical Instrumentation	Liptak B. G. CRC Press, 1st edition 2018	9781351466516
3	Instrumental Methods of Analysis	Hobart H. Willard; Lynne L. Merritt; John A. Dean; Jr. Frank A. Settle, CBS Publishers, 6th edition, 1986	9788123909431
4	Instrumental Methods of Chemical Analysis	Galen W. Ewing McGraw-Hill Inc.US; 3rd edition,1969	9780070198517
5	Introduction to Instrumental Analysis	Robert D. Braun BSP Books, 2022	9789381075920
6	Principles of Instrumental Analysis	Skoog, Douglas - Holler, F. - Crouch, Stanley Cengage Learning, 7th edition,2017	9781305577213
7	Instrumental Methods of Chemical Analysis	Dr. G. R. Chatwal , S.K. Anand, Hph publication, 2011	9789390244577

**XI. Learning Websites & Portals:**

Sr. No.	Link / Portal	Description
1	<a href="https://nptel.ac.in/courses/104105084">https://nptel.ac.in/courses/104105084</a>	NOC: Analytical chemistry, IIT Kharagpur
2	<a href="https://archive.nptel.ac.in/courses/104/108/104108078/">https://archive.nptel.ac.in/courses/104/108/104108078/</a>	Principles and Applications of NMR Spectroscopy.
3	<a href="https://mas-iiith.vlabs.ac.in/List%20of%20experiments.html">https://mas-iiith.vlabs.ac.in/List%20of%20experiments.html</a>	Verification of Beer Lambert's Law.
4	<a href="https://vlab.amrita.edu/index.php?sub=2&amp;brch=190">https://vlab.amrita.edu/index.php?sub=2&amp;brch=190</a>	Spectrophotometry
5	<a href="https://censb06-iiith.vlabs.ac.in/List%20of%20experiments.html">https://censb06-iiith.vlabs.ac.in/List%20of%20experiments.html</a>	NMR spectroscopy, IR spectroscopy, Mass spectroscopy.
6	<a href="https://photon-science.desy.de/facilities/petra_iii/e308646/e310494/index_eng.html">https://photon-science.desy.de/facilities/petra_iii/e308646/e310494/index_eng.html</a>	Virtual Laboratory for Instrumental Analysis (VIA).
7	<a href="https://nptel.ac.in/courses/103108100">https://nptel.ac.in/courses/103108100</a>	Modern Instrumental Methods of Analysis, IISc Bangalore
8	<a href="http://www.digimat.in/nptel/courses/video/102107028/L16.html">http://www.digimat.in/nptel/courses/video/102107028/L16.html</a>	Low-pressure liquid chromatography (LPLC) and high-performance liquid chromatography (HPLC)
9	<a href="https://www.youtube.com/watch?v=64Hl_TPrO94">https://www.youtube.com/watch?v=64Hl_TPrO94</a>	Introduction to Chromatography II by NPTEL IIT KHARAGPUR

Sr. No.	Name	Designation	Institute/Organization
1	Mr. Abhinav Sharma	Deputy Engineer	Toyo Engineering Ind. Pvt. Ltd. Mumbai
2	Dr. S.R. Shiledar	Assistant Professor	GCOE Yavatmal
3	Ms. K. U. Waghmare	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai
4	Mr. K. U. Dawane	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai

<b>Programme: Diploma in Instrumentation Engineering (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code: IS23112</b>						<b>Course Title: Biomedical Instrumentation</b>							
<b>Compulsory / Optional: Compulsory</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
4	--	2	--	6	3	20	20	60	25	--	25#	--	150

Total IKS Hrs. for course: 00 Hrs.

**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, \*# Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-TH represents addition of two class tests 20 marks each conducted during the term.
2. FA-PR represents tutorial/practical term work of 25 Marks.
3. SA-TH represents the end term theory examination of 60 Marks.
4. SA-OR represents the end term Oral examination of 25 Marks

**I. Rationale:**

The field of biomedical instrumentation deals with patient monitoring and diagnostic purposes in health care systems. This field is growing in a very fast pace. Advanced, complex and precision biomedical instruments are being used in most of the hospitals. This course will enable the diploma instrumentation graduates to develop skills to maintain biomedical instruments. Thus, they will be employable in hospitals as well as in biomedical instruments manufacturing and service industries.

**II. Industry / Employer Expected Outcome:**

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

"Troubleshoot the biomedical instruments/equipment used in health care system following safety measures."

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

CO1	Explain physiology of human body.
CO2	Identify the electrodes for different bio signals generated by human body organs with a suitable recorder
CO3	Measure various vital signs of human body organ using suitable biomedical devices.
CO4	Explain noninvasive diagnostic and life support system for human health care.
CO5	Analyze electrical hazards due to shocks and leakage currents in biomedical instruments.

## IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	<p><b>TLO1.1</b> Draw a block diagram representation of Man-Instrumentation system and explain each block.</p> <p><b>TLO1.2</b> State various issues encountered while measuring various physical parameters.</p> <p><b>TLO1.3</b> Classify the types of human physiological systems.</p> <p><b>TLO1.4</b> Explain with neat labelled sketch the function of various human physiological systems.</p>	<p><b>Unit-I Human physiological systems</b></p> <p>1.1 Man-instrument system: Block diagram and working</p> <p>1.2 Challenges in measuring living systems: Motion artifacts, noise, patient variability etc.</p> <p>1.3 Types of physiological system of human body.</p> <p>1.4 Overview of physiological systems: Cardiovascular, respiratory, nervous systems</p> <p>1.5 Cardiovascular system: Internal structure of heart, electrical conduction system, heart sound, importance of cardiac output</p> <p>1.6 Respiratory system: Physiology, mechanism of breathing, lung volumes and capacities</p> <p>1.7 Nervous system: Neuron structure &amp; function, structure of brain, functions of cerebrum, cerebellum, medulla oblongata, thalamus, hypothalamus, spinal cord, Neuronal communication</p>
<b>Course Outcome: CO1</b>		<b>Teaching Hours: 11 hrs.</b>
<b>Marks: 11</b>		
2	<p><b>TLO2.1</b> Explain the action and resting potential of a cell with neat diagrams and waveform.</p> <p><b>TLO2.2</b> Identify the types of bioelectrodes along with their application.</p> <p><b>TLO2.3</b> Explain constructional details of given electrode.</p>	<p><b>Unit-II Bioelectric signals and Bioelectrodes</b></p> <p>2.1 Bio-Electric Potential: Resting and Action Potentials- Concept, schematic diagrams, waveform.</p> <p>2.2 Introduction to typical bioelectric signals e.g. ECG, EEG, EMG, ERG, EOG, and EGG.</p> <p>2.3 Electrode Theory- Electrode electrolyte interface with schematic diagram, Nernst equation</p> <p>2.4 Bio-Electrode: Construction and diagram of various electrodes used for measuring Electrocardiograph (ECG), Electroencephalograph (EEG) and Electromyograph (EMG).</p> <p>a) Microelectrodes</p> <p>b) Surface electrodes: Suction- cup electrode, disposable electrode, Floating type electrode, Metal disc electrode</p> <p>c) Needle electrodes.</p>
<b>Course Outcome: CO2</b>		<b>Teaching Hours: 08 hrs.</b>
<b>Marks: 08</b>		
3	<p><b>TLO3.1</b> Explain the 12-lead configuration used in ECG recording.</p> <p><b>TLO3.2</b> Compare unipolar and bipolar leads.</p> <p><b>TLO3.3</b> Identify the suitable recorder used for given bioelectrical signal measurement</p>	<p><b>Unit-III Biomedical Recorders</b></p> <p>3.1 Electrocardiograph: - Block diagram, description.</p> <p>3.2 ECG waveform with labels Explains relating cardiac activity of the heart.</p> <p>3.3 Einthoven's triangle: - Basic explanation with lead placement</p> <p>3.4 Bipolar and unipolar leads: - 12-lead system and wearable ECG leads</p> <p>3.5 Electro-encephalograph: - block diagram, description</p>



		6.4 Precaution to minimize electric shock hazards & leakage current.
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Course Outcome: CO5

Teaching Hours: 04 hrs.

Marks: 04

**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	<b>LLO1.1</b> Identify various parts of circulatory system of human body. <b>LLO1.2</b> Demonstrate the function of circulatory system of human body.	Identification of parts of circulatory systems using physical model /animation	02	CO1
2	<b>LLO2.1</b> Identify various parts of respiratory system. <b>LLO2.2</b> Explain the process of respiration inhuman body.	Identification of parts and function of respiratory system through physical model /animations	02	CO1
3	<b>LLO3.1</b> Identify various parts of nervous system. <b>LLO3.2</b> Explain function of various parts of nervous system.	Identification of various parts of nervous system using physical model /animations	02	CO1
4	<b>LLO4.1</b> Identify various Bio-electrodes used for measuring various physical parameters.	Identification of various ECG, EEG, EMG electrodes.	02	CO2
5	<b>LLO5.1</b> Obtain Electrocardiogram using 12 lead ECG signals on virtual lab.	Simulate 12 lead ECG signals using virtual lab.	02	CO2
6	<b>LLO6.1</b> Simulate Electromyogram signal on virtual lab.	Use virtual lab to plot the EMG.	02	CO2
7	<b>LLO7.1</b> Simulate Electroencephalogram signal on virtual lab. <b>LLO7.2</b> Observe the lead placement of EEG.	Use virtual lab to plot the EEG.	02	CO2
8	<b>LLO8.1</b> Use BP measuring machine and note down the observations.	Measurement of blood pressure using sphygmomanometer.	02	CO3
9	<b>LLO9.1</b> Use pulse oximeter to measure oxygen saturation in blood stream.	Measure oxygen saturation in blood stream using pulse oximeter.	02	CO3
10	<b>LLO10.1</b> Observe heart sound using phonocardiogram	Phonocardiogram using phonocardiograph machine	02	CO3
11	<b>LLO11.1</b> Defibrillate the fibrillated heart using simulation software.	Defibrillation of fibrillated heart using simulation software	02	CO4
12	<b>LLO12.1</b> Observe the functioning of heart using artificial pacemaker. (video presentation) <b>LLO12.2</b> Observe the safety measures followed.	Demonstration of functioning of heart using artificial pacemaker.(video presentation)	02	CO4
13	<b>LLO13.1</b> Observe the working of X-ray machine. (hospital visit/ video demonstration)	Use video program to understand the working of X-RAY machine.	02	CO4
14	<b>LLO14.1</b> Observe the working of ultrasonography machine. (hospital visit/ video demonstration)	Use video program to understand the working of Ultrasonography.	02	CO4

15	<b>LLO15.1</b> Observe the working of MRI machine. (hospital visit/ video demonstration) <b>LLO15.2</b> Observe safety measures used.	Demonstration of functioning of MRI machine (hospital visit/ video demonstration )	02	CO4
16	<b>LLO16.1</b> Observe the working of CT scan machine. (hospital visit/ video demonstration) <b>LLO16.2</b> Observe safety precautions.	Demonstration of functioning of CT scan machine (hospital visit/video demonstration)	02	CO4
17	<b>LLO17.1</b> Identify the general effects of electric current on human body	Prepare a chart of General effects of electric current on human body	02	CO5

**Note: Minimum 12 experiments are compulsory and should be chosen such that all COs will be covered.**

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

### Micro Project:

1. Collect electrodes for different biomedical measurements and plot their responses
2. Visit a hospital and prepare report on instruments used in hospital along with pictures.
3. Collect ECG reports of different persons and list the abnormalities found in ECG.
4. Develop a Model of any one physiological system of Human being
5. Develop animation of any one physiological system of Human being.
6. Prepare a general specification detail of CT scan machine, MRI machine.
7. Prepare a general specification detail of ultrasonography machine.
8. Prepare a general specification detail of any therapeutic device.
9. Compare different imaging techniques.
10. Prepare a report on Internet of Things Based Patient Health Monitoring System Using Wearable Biomedical Device

## VII. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Human physiological systems	4	4	3	11
2	Bioelectric signals and Bioelectrodes	2	4	2	08
3	Biomedical Recorders	2	4	6	12
4	Measurement of Vital Signs	2	3	6	11
5	Diagnostic, Life-Support Systems and IoT Devices	2	5	7	14
6	Electrical safety	2	2	--	04
<b>Total Marks</b>		<b>14</b>	<b>22</b>	<b>24</b>	<b>60</b>

## VIII. Assessment Methodologies/Tools:

### Formative assessment (Assessment for Learning)

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)

### Summative Assessment (Assessment of Learning)

- Rubrics for assessment based on laboratory process and product related performance indicators. (25

- End of the term theory examination. (60 Marks)

**IX. Suggested COs - POs Matrix Form:**

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

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	Handbook of biomedical instrumentation	R. S. Khandpur McGraw Hill Education Third edition (2014)	978-9339205430
2	Introduction to biomedical equipment technology	Carr Joseph J. Brown J.M Pearson Education 4 <sup>th</sup> edition (2002)	978-8177588835
3	Biomedical instrumentation measurements.	Leslie P Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson Education India; 2 edition (2015)	978-9332556911
4	Medical instrumentation application & design	John G. Webster John Wiley & Sons 4th edition ( 2009)	978-0471676003

**XI. Learning Websites & Portals**

Sr. No.	Link / Portal	Description
1	<a href="https://www.youtube.com/enter+topic+name">https://www.youtube.com/enter "topic name"</a>	---
2	<a href="https://medlineplus.gov/encyclopedia.html">https://medlineplus.gov/encyclopedia.html</a>	---
3	<a href="https://bmi-iitr.vlabs.ac.in/List%20of%20experiments.html">https://bmi-iitr.vlabs.ac.in/List%20of%20experiments.html</a>	Biomedical Instrumentation lab IIT Roorkee
4	<a href="https://joshferge.com/Defibrillator-Simulator/Tutorial?testnum=1&amp;user=undefined">https://joshferge.com/Defibrillator-Simulator/Tutorial?testnum=1&amp;user=undefined</a>	Defibrillator simulator
5	<a href="https://www.intuz.com/blog/iot-in-remote-patient-monitoring">https://www.intuz.com/blog/iot-in-remote-patient-monitoring</a>	Enhancing Health Care with IoT-Enabled Remote Patient Monitoring

**XII. Academic Consultation Committee/Industry Consultation Committee:**

Sr. No.	Name	Designation	Institute/ Organization
1	Mr. Shrikant More	Managing Director	Easy fit Devices Pvt. Ltd.
2	Ms. V. K. Pawar	Lecturer in Instrumentation	Govt. Polytechnic, Karad
3	Mr. U.B. Shinde	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai
4	Mrs. S.T. Shinde	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai



<b>Programme : Diploma in Instrumentation Engineering</b>													
<b>Course Code: IS23701</b>						<b>Course Title: Database Management system</b>							
<b>Compulsory / Optional: Optional</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA- PR	SA-		SLA	Total
						T1	T2			PR	OR		
3	--	2	1	6	3	20	20	60	25	--	--	25	150

Total IKS Hrs. for course: 00 Hrs

**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, \*# Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-TH represents addition of two class tests 20 marks each conducted during the term.
2. FA-PR represents tutorial/practical term work of 25 Marks.
3. SLA represents self-learning Assessment of 25 Marks.
4. SA-TH represents the end term theory examination of 60 Marks.

**I. Rationale**

Database management system creates stores and manages a large amount of data which can be used by different software applications. In comparison to file processing systems, use of this system increases efficiency of business operations and reduces overall costs. For Developing and managing efficient and effective database applications it requires understanding the fundamentals of database management systems, techniques for the design of databases, and principles of database administration. The course focuses on the fundamentals of database management systems and the recent developments.

**II. Industry / Employer Expected Outcome**

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

‘To encourage students to develop DBMS concepts that should proficiently solve real-world problems, enhancing decision- making, design and innovation with precision and efficiency.’

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

CO1	Understand fundamental concepts of database.
CO2	Design normalized database using Entity Relationship modeling approach.
CO3	Understand transaction processing in Database System.
CO4	Develop and manage Database using SQL commands and constraints.
CO5	Understand database backup and recovery techniques & Write PL/SQL code, create functions and procedures, apply triggers on database.

## IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's.	Topics / Sub-topics
1	<p><b>TLO 1.1</b> Understand the basic concepts of database systems.</p> <p><b>TLO 1.2</b> Understand the concept of data abstraction.</p> <p><b>TLO 1.3</b> Understand the concept of data independence.</p> <p><b>TLO 1.4</b> Describe overall structure of DBMS.</p> <p><b>TLO 1.5</b> Describe different data models.</p>	<p><b>Unit-I Database System Concepts</b></p> <p>1.1 An Introduction to Database: Data, Database, Database Management Systems, 2.1 advantages of DBMS over file processing system, Applications of DBMS</p> <p>1.2 Data abstraction, Data dictionary, Instance and schema.</p> <p>1.3 Data Independence: Logical and Physical Data Independence</p> <p>1.4 Overall structure of DBMS: Components of DBMS, DBMS system Architecture, Database Users, functions of Database Administrator.</p> <p>1.5 Data Modeling: Relational, Hierarchical, Network models</p>
<p><b>Course Outcome : CO1</b>                      <b>Teaching Hours: 05 hrs.</b>                      <b>Marks: 08</b></p>		
2	<p><b>TLO2.1</b> Design database using E-R model.</p> <p><b>TLO2.2</b> Understand data relationships using the concepts of EER model.</p> <p><b>TLO2.3</b> Learn functional dependency in BMS.</p> <p><b>TLO2.4</b> BMS.</p> <p><b>TLO2.5</b> Design normalized database using different normal forms.</p>	<p><b>Unit-II Database Design</b></p> <p>2.1 Database Design Using E-R Model</p> <p>2.1.1 Data Modeling Using the E-R Model:</p> <ul style="list-style-type: none"> <li>• Entity, Entity Sets-Weak, Strong Entity Set</li> <li>• Relationship sets</li> <li>• Types of attributes</li> <li>• Mapping Cardinalities</li> <li>• Shortcomings of E-R Model.</li> </ul> <p>2.1.2 Enhanced ER (EER) model:</p> <ul style="list-style-type: none"> <li>• Subclass, super class, Specialization and Generalization</li> <li>• Case studies: EER model for Bank, library, education, organization, hotel management, hospital management.</li> </ul> <p>2.2 Relational Database Design:</p> <p>2.2.1 Dependencies:</p> <ul style="list-style-type: none"> <li>• Functional dependencies</li> <li>• Armstrong's axioms for FD's</li> <li>• Closure of a set of FD's</li> </ul> <p>2.2.2 Normalization:</p> <ul style="list-style-type: none"> <li>• Need of Normalization: Data redundancy, Insert, Update and Delete anomalies</li> <li>• Normal Forms : 1NF, 2NF, 3NF, BCNF</li> </ul>
<p><b>Course Outcome : CO2</b>                      <b>Teaching Hours: 06 hrs.</b>                      <b>Marks: 10</b></p>		



	database users. <b>TLO5.3</b> Learn to manage database	5.3 Authorization: Assign and revoke privileges 5.4 Database Backup: Types of failures, causes of failure, Create backup of database 5.5 Database Recovery Techniques
<b>Course Outcome : CO4</b>		<b>Teaching Hours:06 hrs.</b>
<b>Marks: 10</b>		
<b>6</b>	<b>TLO6.1</b> Understand PL/SQL programming environment <b>TLO6.2</b> Learn control structures in PL/SQL. <b>TLO6.3</b> Learn exception handling in PL/SQL <b>TLO6.4</b> Learn to work with data using cursors <b>TLO6.5</b> Learn the concepts of functions and stored procedures in PL/SQL. <b>TLO6.6</b> Learn database triggers.	<b>Unit- VI PL/SQL Programming</b> 6.1 Introduction of PL/SQL 6.1.1 PL/SQL Block Structure 6.1.2 PL/SQL execution environment 6.1.3 PL/SQL data types 6.1.4 Advantages of PL/SQL 6.2 Control Structure: Conditional Control, Iterative Control, Sequential Control 6.3 Exception Handling: Predefined Exception, User Defined Exception. 6.4 Cursor: 6.4.1 Implicit and Explicit Cursors 6.4.2 Declare, open and close Cursor 6.4.3 Fetching a record from Cursor, Cursor for loops, parameterized Cursor 6.5 Functions: Create, Execute and Delete functions. 6.6 Stored Procedures: Create, Execute and Delete Stored Procedures. 6.7 Database Triggers: 6.6.1 Use of Database Triggers 6.6.2 Types of Triggers 6.6.3 Creating Trigger, Deleting Trigger
<b>Course Outcome : CO5</b>		<b>Teaching Hours : 0 8 hrs.</b>
<b>Marks: 10</b>		

#### 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	<b>LLO1.1</b> Install open-source database product.	Install any open-source database Product like My SQL.	2	CO1
2	<b>LLO1.2</b> Execute DDL operations on table	Create a New Database and Perform Following DDL operations: a) Create table b) Alter the table c) Rename Table d) Drop the table.	2	CO2
3	<b>LLO1.3</b> Execute DML operations on table.	Create a New Database and Perform Following DML operations: Create a table, Insert values in the table, Update table, Delete contents of the table	2	CO2

4	<b>LLO1.4</b> Apply different clauses on table	Create a table and apply following clauses on it: Where, Having, Group by, Order by clause	2	CO3
5	<b>LLO1.5</b> Apply different integrity constraints on table.	Create table and apply constraints such as NOT NULL, UNIQUE, CHECK, DEFAULT, PRIMARY KEY, FOREIGN KEY on the table	2	CO4
6	<b>LLO1.6</b> Execute different built-in functions	Implement the following Functions in SQL a) Date functions b) Time functions c) String functions d) Aggregate functions.	2	CO5
7	<b>LLO1.7</b> Perform DML operations on data using View.	Write SQL code for creating of View and perform operations Insert, Modify, Delete records through view, Delete the View.	2	CO5
8	<b>LLO1.8</b> Execute Join operations on tables.	Implement Inner Join, Outer Join and Self-Join operation on tables.	2	CO3
9	<b>LLO1.9</b> Execute DCL and TCL commands	Execute DCL commands: Grant, Revoke. Execute TCL commands: Commit, Rollback, Save point.	2	CO4
10	<b>LLO1.10</b> Create indexes on table.	Create different types of indexes on table.	2	CO4
11	<b>LLO1.11</b> Execute PL/ SQL program using different control structures.	Write a PL/SQL programs using control structures: if then else, for loop, while loop.	2	CO5
12	<b>LLO1.12</b> Write PL/ SQL program for cursors	Write a PL/SQL code to implement implicit and explicit cursors.	2	CO5
13	<b>LLO1.13</b> Write PL/ SQL program for Exception handling.	Write a PL/SQL programs based on Exception Handling (Predefined and User-defined Exceptions).	2	CO5
14	<b>LLO1.14</b> Write PL/SQL program for Function and procedure.	Write a PL/SQL code create Procedures and Functions.	2	CO5
15	<b>LLO1.15</b> Write PL/SQL program for triggers.	Write a PL/SQL programs to create triggers on a database.	2	CO5

**Note: Minimum 12 experiments are compulsory and should be chosen such that all COs will be covered.**

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

1. Survey on various database systems.
2. Design E-R diagram for different database systems: Hospital/Bank/Education/Library etc.
3. Design Normalized database for: Hospital/Bank/Education/Library etc.
4. Apply trigger for different conditions.

**VII. Specification Table:**

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Database System Concepts	04	04	--	<b>08</b>
2	Database Design	02	04	04	<b>10</b>
3	Relational Data Model	04	--	10	<b>14</b>
4	Transaction Processing	--	04	04	<b>08</b>
5	Database Security	04	06	--	<b>10</b>
6	PL/SQL Programming	--	04	06	<b>10</b>
<b>Total</b>		<b>14</b>	<b>22</b>	<b>24</b>	<b>60</b>

**VIII. Assessment Methodologies/Tools Formative assessment (Assessment for Learning)****Formative assessment (Assessment for Learning)**

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

**Summative Assessment (Assessment of Learning)**

- End of the term theory examination. (60 Marks)

**IX. Suggested COs - POs Matrix Form:**

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

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	Database System concepts	Abraham Silberschtz, Henry Korth& S. Sudarshan, Tata McGraw Hill International, 6 <sup>th</sup> Edition , 2015	9789332901384
2	Fundamentals of Database Systems	Ramez/ Navathe, Shamkant B. Elmasri, Pearson Education, 6 <sup>th</sup> Edition , 2010	9780136086208
3	Database Management Systems	Gupta G. K. , Tata McGraw Hill Education Private Limited 2011	9780071330077
4	Teach Yourself SQL/PL SQL Using Oracle 8i and 9i with SQLJ	Ivan Bayross, BPB publication,2003	9788176566919

**XI. Learning Websites & Portals:**

Sr. No.	Link / Portal	Description
1	www. google.com	---
2	https://www.w3schools.com/	---
3	<a href="http://www.youtube.com/watch?v=IoL9Ve2SRwQ&amp;list=">http://www.youtube.com/watch?v=IoL9Ve2SRwQ&amp;list=</a>	---

**XII. Academic Consultation Committee/Industry Consultation Committee:**

Sr. No.	Name	Designation	Institute/ Organization
1	Mr. M.D. Bharti	Director	MDB Electro soft Pvt. Ltd Amravati
2	Ms. S.P. Rangari	Lecturer in Computer Engineering	Government Polytechnic Yavatmal
3	Mrs. Vrushali A. Patil	Lecturer in Computer Engineering	Govt. Polytechnic, Mumbai
4	Mr. M. K. Kulkarni	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai

<b>Programme: Diploma in Instrumentation Engineering (Sandwich Pattern)</b>													
<b>Course Code: IS23702</b>						<b>Course Title: IoT Based Instrumentation</b>							
<b>Compulsory / Optional: Optional</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
										PR	OR		
3	--	2	1	6	3	20	20	60	25	--	--	25	150

Total IKS Hrs. for course: 00 Hrs.

**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, \*# Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-TH represents addition of two 20 marks class tests conducted during the term.
2. FA-PR represents tutorial/practical term work of 25 Marks.
3. SLA represents self-learning Assessment of 25 Marks.
4. SA-TH represents the end term theory examination of 60 Marks.

**I. Rationale:**

The convergence of the Internet of Things (IoT) and instrumentation technologies is rapidly transforming industries ranging from manufacturing and healthcare to agriculture and smart cities. Traditional instrumentation is evolving beyond standalone systems to become intelligent, connected, and data-driven. This transformation necessitates a new generation of engineers and technologists who understand both the principles of measurement systems and the integration of these systems within IoT frameworks. This course is designed to equip students with the essential knowledge and practical skills required to develop and deploy IoT-enabled instrumentation systems.

**II. Industry / Employer Expected Outcome:**

The aim of this course is to help the student to achieve the following industry identified outcome through various learning experiences:

“Develop and maintain the IoT based applications for industries.”

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

CO1	Interpret the architecture of Internet of Things (IoT).
CO2	Select IoT system for given application development.
CO3	Manage IoT communication for data handling.
CO4	Interpret RTO system and its role in IoT systems.
CO5	Implement different IoT based applications





## IV. 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	<b>LLO1.1</b> Study enabling technologies of IoT.	Foundational enabling technologies of IoT	02	CO1
2	<b>LLO2.1</b> Establish a connection between the Node MCU- ESP32 and a computer using appropriate cables and drivers. <b>LLO2.2</b> Install and configure Arduino IDE for Node MCU programming.	Installation and configuration of Arduino IDE for Node MCU ESP32	02	CO2
3	<b>LLO3.1</b> Interface LED and switch with Node MCU to turn ON and OFF LED.	Interfacing LED and Switch with Node MCU	02	CO2
4	<b>LLO4.1</b> Control relay operation using Node MCU and IR sensor.	Interfacing relay and IR sensor with Node MCU	02	CO2
5	<b>LLO5.1</b> Measure and display humidity and temperature using DHT 11 and Node MCU.	Interfacing Humidity/temperature sensor with Node MCU	02	CO2
6	<b>LLO6.1</b> Temperature measurement using LM35 sensor and Node MCU.	Interfacing LM35 Sensor with Node MCU	02	CO2
7	<b>LLO7.1</b> Motion detection using PIR sensor and Node MCU.	Interfacing PIR Sensor with Node MCU	02	CO2
8	<b>LLO8.1</b> Configure Node MCU to connect to a Wi-Fi network and troubleshoot connectivity issue.	Connecting Node MCU to Wi-Fi network	02	CO3
9	<b>LLO9.1</b> Use HTTP protocol to send sensor data from Node MCU to a web server (use any cloud service).	Data Transmission from Node MCU to Web Server	02	CO3
10	<b>LLO10.1</b> Set up MQTT communication to publish and subscribe to topics using Node MCU.	Implementation of MQTT Protocol with Node MCU	02	CO3
11	<b>LLO11.1</b> Measure data from LDR to monitor light intensity and transmit it to cloud. <b>LLO11.2</b> Control intensity of LED according to the data received from cloud. (use any cloud service).	Monitoring and controlling light intensity using Node MCU	02	CO3
12	<b>LLO12.1</b> Write simple code for performing two tasks parallelly using RTOS	Rtuin /Duin/ FreeRTOS or any other free RTOS for Arduino and test simple looping program	02	CO4
13	<b>LLO13.1</b> Design a smart home system control the lights, Fans and Locking system. <b>LLO13.2</b> Develop the code for smart control of Saline Monitoring Solution system.	Implementation of IoT enabled Smart Home applications	02	CO5
14	<b>LLO14.1</b> Design a smart Saline Monitoring Solution system. <b>LLO14.2</b> Develop the code for smart control of Saline Monitoring Solution system.	Implementation of IoT in Healthcare - Smart Saline Monitoring Solution System	02	CO5
15	<b>LLO15.1</b> Design a Healthcare - Assistive Communication Solution system. <b>LLO15.2</b> Develop the code for smart Healthcare-	Demonstrate IOT in Healthcare - Assistive Communication Solution	02	CO5

	Assistive Communication Solution system.			
16	<b>LLO16.1</b> Design a Smart Irrigation Solution system. <b>LLO16.2</b> Develop the code for Smart Irrigation Solution system.	Demonstrate a timer based Smart Irrigation Solution	02	CO5
17	<b>LLO17.1</b> Design a Smart Parking Management system. <b>LLO17.2</b> Develop the code for Smart Parking Management system.	Demonstrate a Smart Parking Management System	02	CO5
18	<b>LLO18.1</b> Design a Smart Packaging System. <b>LLO18.2</b> Develop the code for Packaging System.	Demonstrate a Smart Packaging System	02	CO5

**Note: Minimum 12 experiments are compulsory and should be chosen such that all COs will be covered.**

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

##### Microprojects: -

1. Interface a glucometer with Node MCU to measure glucose level and display it to Web Server.
2. Prepare a report of IoT based remote patient Monitoring system (case study).
3. Develop IoT based Smart parking system for your institute using Node MCU.
4. Develop IoT Based IPL Scoreboard using Node MCU to Display Live Score using Cricket API.
5. Develop IoT based robotic prototype.

#### VI. Specification Table:

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Basics of Internet of Things (IoT)	4	6	2	12
2	Fundamentals of Node MCU	2	4	6	12
3	IoT Communication Protocol	4	4	4	12
4	Real Time Operating System	2	6	4	12
5	Applications of IoT	--	4	8	12
<b>Total Marks</b>		<b>12</b>	<b>24</b>	<b>24</b>	<b>60</b>

#### VII. Assessment Methodologies/Tools:

##### Formative assessment (Assessment for Learning)

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

##### Summative Assessment (Assessment of Learning)

- End of the term theory examination. (60 Marks)

## VIII. Suggested COs - POs Matrix Form:

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

Legends: - High:03, Medium:02, Low:01, No Mapping: --

## IX. Suggested Learning Materials / Books

Sr. No.	Title	Author, Publication, Edition and Year of Publication	ISBN NO.
1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, Cisco Press, 1st edition, 2017	9781587144561
2	Sams Teach Yourself Arduino™ Programming in 24 Hours	Richard Blum, Sams Publishing, 1st edition, 2014	9780672337123
3	Introduction to IoT	Sudip Misra, Anandarup Mukherjee, Arijit Roy, Cambridge University Press, 1st edition, 2021	9781108842952
4	An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications	Rahul Dubey, Cengage India Private Limited, 1st edition, 2018	9789353501020
5	Embedded Systems: Architecture, Programming and Design	Raj Kamal, McGraw-Hill Education India, 2 <sup>nd</sup> edition, 2009	9780070151253

## X. Learning Websites &amp; Portals:

Sr. No.	Link / Portal	Description
1	<a href="https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0130009449730539521875_shared/overview">https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0130009449730539521875_shared/overview</a>	IoT Platform

2	<a href="https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01329474210427699229893_shared/overvie">https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01329474210427699229893_shared/overvie</a>	"Mastering IoT with Arduino". Infosys Spring board online course for ThinkSpeak
3	<a href="https://www.arduino.cc/en/software">https://www.arduino.cc/en/software</a>	Arduino IDE software
4	<a href="https://www.tinkercad.com/projects?subject=arduino&amp;sort=views">https://www.tinkercad.com/projects?subject=arduino&amp;sort=views</a>	Arduino projects on Tinkercad
5	Introduction to Internet of Things - Course (nptel.ac.in)	Complete coverage of IoT
6	<a href="https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384301295320268828657_shared/overvie">https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384301295320268828657_shared/overvie</a>	IoT Automation with ESP8266 with Projects
7	<a href="https://www.guru99.com/iot-tutorial.html">https://www.guru99.com/iot-tutorial.html</a>	IoT Tutorial: Introduction to Internet of Things (IoT Basics)
8	<a href="https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0130009449730539521875_shared/overview">https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0130009449730539521875_shared/overview</a>	IoT Platform

### XI. Academic Consultation Committee/Industry Consultation Committee:

Sr. No.	Name	Designation	Institute/Organization
1	Mr. Mudassar Khopatkar	Chief Executive Officer	PCE Consultants & Engineers LLP, Andheri (E)
2	Mr. Sanjay Rajput	Lecturer in Instrumentation Engg.	Government Polytechnic, Ratnagiri
3	Dr. B. B. Sul	Head of Department, Instrumentation Engg.	Government Polytechnic, Mumbai
4	Mr. Firoz S. Bagwan	Lecturer in Instrumentation Engg.	Government Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai

<b>Programme: Diploma in Instrumentation (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code: IS23703</b>						<b>Course Title: Artificial Intelligence</b>							
<b>Compulsory/Optional: Optional</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
3	--	2	1	6	3	20	20	60	25	--	--	25	150

**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, \*#Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-TH represents addition of two class tests 20 marks each conducted during the term.
2. FA-PR represents tutorial/practical term work of 25 Marks.
3. SLA represents self-learning Assessment of 25 Marks.
4. SA-TH represents the end term theory examination of 60 Marks.

**I. Rationale:**

Artificial Intelligence technologies are now attractive tool to improve the various domain related to Instrumentation, system identification and control. Artificial intelligence (AI) makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. Instrumentation engineers deal with field of automation, decision making efficiencies, to facilitate predictive maintenance, enhance process optimization, and boost overall system performance.

**II. Industry/Employer Expected Outcome:**

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

Design intelligent systems capable of performing human-like tasks in sensing, analysis, and control.

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

CO1	Learn the basic knowledge of Artificial Intelligence (AI).
CO2	Demonstrate knowledge of building blocks of AI as presented in terms of intelligent agents.
CO3	Analyze the problem as a state space, graph, design heuristics and select different search techniques to solve them.
CO4	Develop intelligent algorithms and intelligent systems.
CO5	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	<b>TLO1.1</b> Understand the basic concepts of AI.	<b>Unit-I Introduction to Artificial intelligence (AI)</b> 1.1 Artificial intelligence definition 1.2 Goals of AI 1.3 History of AI 1.4 Applications of AI
<b>Course Outcome: CO1                      Teaching Hours: 07 hrs.                      Marks: 08</b>		
2	<b>TLO2.1</b> Study AI environments <b>TLO2.2</b> Learn the structure and types of AI Agents. <b>TLO2.3</b> Understand the need and importance of Agents in AI.	<b>Unit-II Agents and Environments</b> 2.1 Agent terminology 2.2 Structure of intelligent agents 2.3 Types of agents-simple reflex agents, Model based reflex agents, Goal based agents 2.4 Nature of environments, properties of environments 2.5 PEAS representation for an agent
<b>Course Outcome: CO2                      Teaching Hours: 08 hrs.                      Marks: 10</b>		
3	<b>TLO3.1</b> Learn various Search techniques in Artificial Intelligence. <b>TLO3.2</b> Implement Search Techniques.	<b>Unit-III Search Techniques</b> 3.1 Heuristic search: Best first search, Hill Climbing 3.2 Beam search, Tabu search 3.3 Finding Optimal Paths: Branch and Bound, Divide and Conquer approaches 3.4 Problem Decomposition: Goal Trees, 3.5 Game playing: Min-max algorithm, Alpha Beta Algorithm, Tic-tac-toe 3.6 Problem solving: Iterative Deepening depth first search (IDDFS)
<b>Course Outcome: CO3                      Teaching Hours: 10 hrs.                      Marks: 14</b>		
4	<b>TLO4.1</b> Learn concepts of Planning used in AI. <b>TLO4.2</b> Apply logic theorems in AI.	<b>Unit-IV Planning and Logic</b> 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, goals tack planning, plan space planning, Graph plan, Constraint stack planning, plan space planning, Graph plan, 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

<b>Course Outcome: CO4</b>		<b>Teaching Hours: 10 hrs</b>	<b>Marks: 14</b>
<b>5</b>	<b>TLO5.1</b> Understand notion of machine learning, deep learning and NLP. <b>TLO5.2</b> Correlate machine learning and deep learning. <b>TLO5.3</b> Learn use of ML and NLP.	<b>Unit-V Applications</b> 5.1 Introduction to Machine learning 5.2 Introduction to deep learning 5.3 Use of machine learning in deep learning 5.4 Introduction to NLP 5.5 Real life application of ML and NLP  <b>Note : This unit will be preferably taught by Alumni of Government Polytechnic Mumbai</b>	
<b>Course Outcome: CO5</b>		<b>Teaching Hours: 10 hrs</b>	<b>Marks: 14</b>

#### 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	<b>LLO1.1</b> Identify problem definition for intelligent system.	Problem definition with state space representation.	02	CO1
2	<b>LLO2.1</b> Design of intelligent system using PEAS	Design of intelligent system using PEAS. Eg. i) Automated Taxi Driver ii) Medical Diagnosis System	02	CO2
3	<b>LLO3.1</b> Demonstration of searching algorithms.	Implementation of Tic-tac-toe algorithm	02	CO3
4	<b>LLO4.1</b> Learn the use of Instrumentation & AI to real life applications	Case study on AI based humanoid self-Driving car	02	CO4
5	<b>LLO5.1</b> Identify use of AI in Health Care applications.	Case study on AI in medical applications.	02	CO5
6	<b>LLO6.1</b> Demonstration of Beam search algorithms.	Implementation of Beam search Algorithm	02	CO2
7	<b>LLO7.1</b> Demonstration of Min-Max search algorithms.	Implementation of Min-Max algorithm	02	CO2
8	<b>LLO8.1</b> Demonstration of Logic theorem.	Implementation of Bayes' Belief Network	02	CO3
9	<b>LLO9.1</b> Demonstration of Logic theorem.	Implementation of Alpha Beta algorithm	02	CO3
10	<b>LLO10.1</b> Identify use of AI in Finance applications.	Case study on AI in finance sector	02	CO5
11	<b>LLO11.1</b> Demonstration of Tabu search algorithms.	Implementation of Tabu search Algorithm	02	CO2
12	<b>LLO12.1</b> Demonstration of Depth search algorithms.	Implementation of depth search Algorithm	02	CO2
13	<b>LLO13.1</b> Demonstration of Bayes' belief network.	Implementation of Bayes' belief network	02	CO4

**Note: First five experiments are compulsory and rest at least 07 from remaining should cover so that all Cos are covered during lab learning.**

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

1. Predictive maintenance model using sensor data.
2. Traffic sign recognition using computer vision.
3. Weather prediction model using historical data.
4. Healthcare: AI can be used for diagnostics, drug discovery, and personalized medicine.
5. Predicting Credit card Approval: Forecast credit approvals with machine learning.
6. Autonomous Robot Navigation: Develop a robot that can navigate through an environment autonomously using sensors and AI algorithms, an application in robotics and AI.
7. Smart Agriculture System using AI: Develop an AI system that optimizes crop yield and monitors farm conditions, applying AI in agriculture.
8. AI in Telemedicine for Patient Monitoring: Create a telemedicine system that uses AI to monitor patient health and alert doctors to potential issues.
9. AI for Environmental Monitoring and Protection: Create an AI system for monitoring environmental parameters and predicting ecological changes.
10. AI for Waste Sorting and Management: Develop an AI system that automates waste sorting, contributing to efficient waste management and recycling processes.

**VII. Specification Table:**

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Introduction to Artificial intelligence	02	04	02	08
2	Agents and Environments	02	06	02	10
3	Search Techniques	04	06	04	14
4	Planning and Logic	02	08	04	14
5	Applications	02	06	06	14
<b>Total Marks</b>		<b>12</b>	<b>30</b>	<b>18</b>	<b>60</b>

**VIII. Assessment Methodologies/Tools:****Formative assessment (Assessment for Learning)**

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

**Summative Assessment (Assessment of Learning)**

- End of the term theory examination. (60 Marks)

**IX. Suggested COs-POs Matrix Form:**

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

Legends:- High:03, Medium:02, Low:01, No Mapping: --

**X. Suggested Learning Materials / Books:**

Sr. No.	Title	Author, Publication, Edition and Year of Publication	ISBN NO.
1	Artificial Intelligence: A modern Approach	Stuart Russell and Peter Norvig; Pearson education, 3 <sup>rd</sup> edition, 2015	9789332543515
2	Artificial Intelligence	Elaine Rich, Kevin Knight, Shivshankar B Nair, McGraw Hill, 3 <sup>rd</sup> edition, 2017	9780070087705
3	A first course in Artificial Intelligence	Deepak Khemani; McGraw Hill, 1 <sup>st</sup> edition, 2017	9781259029981
4	A classical approach Artificial Intelligence	M.C. Trivedi, Khanna Publishing House; 2 <sup>nd</sup> edition; 2018	9788190698894
5	Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow Concepts, Tools, and Techniques to Build Intelligent Systems	Aurélien Géron; O'Reilly, USA, 3 <sup>rd</sup> Edition 2022	9781098125974
6	Artificial Intelligence	John Paul Mueller, Luca Massaron and Stephanie Diamond; John Wiley and Sons Inc. 3 <sup>rd</sup> Edition 2025	9781394270712

**XI. Learning Websites & Portals:**

Sr. No.	Link/Portal	Description
1	<a href="http://nptel.ac.in/courses/106106126">nptel.ac.in/courses/106106126</a>	--
2	<a href="https://www.javatpoint.com/artificial-intelligence-tutorial">https://www.javatpoint.com/artificial-intelligence-tutorial</a>	--
3	<a href="https://www.tutorialride.com/artificial-intelligence/artificial-intelligence-tutorial.htm">https://www.tutorialride.com/artificial-intelligence/artificial-intelligence-tutorial.htm</a>	--
4	<a href="https://course.fast.ai/">https://course.fast.ai/</a>	Fast.ai Deep Learning
5	<a href="https://www.coursera.org/learn/ai-for-everyone">https://www.coursera.org/learn/ai-for-everyone</a>	AI For Everyone – Andrew Ng
6	<a href="https://www.coursera.org/learn/machine-learning">https://www.coursera.org/learn/machine-learning</a>	Machine Learning with Python
7	<a href="https://www.elementsofai.com">https://www.elementsofai.com</a>	Elements of AI (Beginner Friendly)
8	<a href="https://instrumentationtools.com/ai-projects/">https://instrumentationtools.com/ai-projects/</a>	AI Based Project

**XII. Academic Consultation Committee/Industry Consultation Committee:**

Sr. No.	Name	Designation	Institute/Organization
1	Mr. Nilay Bhatnagar	Designated Director	Ramarpan Creations LLP, Goregaon (E), Mumbai
2	Ms. Sayyed Shabana	Lecturer in AI/ML	B.V. Polytechnic, Vasai, Thane
3	Mrs. Neha Vachhani	Lecturer in Computer Engg.	Government Polytechnic, Mumbai
4	Dr. B.B. Sul	HOD Instrumentation Engg.	Government Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai

<b>Programme: Diploma in Instrumentation (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code: IS23607</b>						<b>Course Title: Maintenance of Instruments and Systems</b>							
<b>Compulsory / Optional: Compulsory</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
1	--	4	1	6	3	--	--	--	50	50#	--	25	125

Total IKS Hrs. for course: 00 Hrs

**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, TH- Theory, PR- Practical, T1- Class Test One, T2- Class Test Two.

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

**Note:**

1. FA-PR represents tutorial/practical term work of 50 Marks.
2. SA-PR represents the end term external practical examination of 50 Marks
3. SLA represents Self-Learning Assessment of 25 Marks.

**I. Rationale:**

Maintenance of instruments and control systems ranging from simple gauges to complex distributed control systems is vital in any process industry. This course aims to develop various technical skills such as preventive maintenance, calibration and troubleshooting of instruments which will help the instrumentation diploma holder to effectively upkeep the instruments and control systems in the work place.

**II. Industry / Employer Expected Outcome:**

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

“Maintain the instruments and control systems in process industries”.

**III. Course Outcomes (COs):** Students will be able to achieve and demonstrate the following COs upon completion of course.

CO1	Select appropriate maintenance and troubleshooting techniques for instrumentation systems
CO2	Maintain field instruments in a process industry.
CO3	Maintain control loops implemented in a process industry.
CO4	Calibrate given temperature and pressure measuring instruments.
CO5	Calibrate given flow, level measuring instruments and final control elements

## IV. Course Content Details:

Unit No.	Theory Learning Outcomes (TLO's) aligned to CO's	Topics / Sub-topics
1	<p><b>TLO1.1</b> Identify the instrument maintenance and troubleshooting tools.</p> <p><b>TLO1.2</b> Explain the given maintenance technique used for field instrument maintenance.</p> <p><b>TLO1.3</b> Explain the given troubleshooting technique used for field instrument troubleshooting.</p> <p><b>TLO1.4</b> Prepare format of maintenance work order.</p>	<p><b>Unit - I Maintenance and Troubleshooting of Instrumentation Systems</b></p> <p>1.1 Maintenance: need of instruments/control systems maintenance, types of maintenance - preventive, predictive, corrective maintenance, breakdown, and emergency, Introduction of CAPA (Corrective &amp; Preventive Action).</p> <p>1.2 Troubleshooting: maintenance versus troubleshooting, basic troubleshooting techniques- logical analysis, divide and conquer, remove and conquer, built in diagnostics</p> <p>1.3 Functions of instrumentation maintenance department</p> <p>1.4 Instrument maintenance tools and their usages</p> <p>1.5 Maintenance work order/job report card format and maintenance record system</p>
<p><b>Course Outcome: CO1</b>                      <b>Teaching Hours: 03 hrs.</b>                      <b>Marks: --</b></p>		
2	<p><b>TLO2.1</b> Prepare preventive maintenance plan and schedule of given field instruments.</p> <p><b>TLO2.2</b> Write the procedure to carry out PM of given field instrument as per checklist.</p> <p><b>TLO2.3</b> Elaborate the troubleshooting procedure of given field instrument.</p>	<p><b>Unit-II Preventive Maintenance and Troubleshooting of Field Instruments</b></p> <p>2.1 Preventive maintenance (PM)- elements, role of instrument maintenance technician/engineer, PM plan and schedule, safety and health practices-PPE, Isolation methods, and Introduction of MSDS (Material Safety and Data Sheet)</p> <p>2.2 Preventive maintenance checklists and troubleshooting guidelines - temperature, pressure, flow, level measuring instruments/transmitters, load cell, linear variable differential transformer (LVDT), pressure switch, level switch</p> <p>2.3 Preventive maintenance checklists and troubleshooting guidelines - control valves, actuators, current to pressure (I/P) converter, pressure to current (P/I) converter, electro-pneumatic valve positioner, pressure regulator cum filter, alarm annunciator, indicators</p>
<p><b>Course Outcome: CO2</b>                      <b>Teaching Hours: 03 hrs</b>                      <b>Marks: --</b></p>		
3	<p><b>TLO3.1</b> Describe the troubleshooting procedure of 4-20 mA current loop transmitter</p> <p><b>TLO3.2</b> Describe the troubleshooting procedure of given PID-based process control loop</p> <p><b>TLO3.3</b> Elaborate the troubleshooting procedure of given control</p>	<p><b>Unit-III Preventive Maintenance and Troubleshooting Process Control Loops</b></p> <p>3.1 Introduction of Loop Calibrator &amp; HART Calibrator</p> <p>3.2 Troubleshooting a 4-20 mA current loop of transmitter</p> <p>3.3 Troubleshooting PID-based process control loop</p> <p>3.4 Troubleshooting of control panel, Control</p>

	<p>panel</p> <p><b>TLO3.4</b> Elaborate the PM and troubleshooting procedure of given process controller in temperature/ pressure/ level/ flow control loop</p> <p><b>TLO3.5</b> Elaborate the PM and troubleshooting procedure of PLC.</p>	<p>Panel GA Diagram for Troubleshooting</p> <p>3.5 Preventive maintenance and troubleshooting of process controller- PID controller in any one control loop- temperature/pressure/level/flow control loop</p> <p>3.6 Preventive Maintenance Checklist and troubleshooting of PLC</p>
<b>Course Outcome: CO3                      Teaching Hours: 03 hrs                      Marks: --</b>		
4	<p><b>TLO4.1</b> Identify appropriate calibration standards and equipment.</p> <p><b>TLO4.2</b> Describe the steps for calibration of temperature measuring instrument PT- 100/ thermocouple by fixed point cell/ comparison method.</p> <p><b>TLO4.3</b> Describe the steps for calibration of pressure gauges using dead weight tester.</p>	<p><b>Unit - IV Introduction to Temperature and Pressure Calibration</b></p> <p>4.1 Calibration: need of calibration, types of calibration standards, traceability concept, field and bench calibration, individual instrument and loop calibration, National Accreditation Board for Testing and Calibration Laboratory (NABL) accredited certificate cum report</p> <p>4.2 Temperature calibration: temperature standards, fixed point cell and comparison methods, standard temperature sources, calibration of temperature measuring instruments- bimetallic thermometer, PT100, thermocouples, pyrometers, temperature switches</p> <p>4.3 Pressure calibration: pneumatic/ hydraulic dead weight tester, pneumatic comparator with master pressure gauge, multi-function calibrator, pressure gauges, electronic and smart pressure transmitters, LVDT, strain gauge, load cell type pressure transmitter</p>
<b>Course Outcome: CO4                      Teaching Hours: 03 hrs                      Marks: --</b>		
5	<p><b>TLO5.1</b> Describe the steps for calibration of pressure or temperature transmitters using multi-function calibrator.</p> <p><b>TLO5.2</b> Explain the procedure for calibration of smart transmitter using HART communicator.</p> <p><b>TLO5.3</b> Explain the procedure for calibration of control valve-actuator and its auxiliary components.</p>	<p><b>Unit -V Introduction to Flow and Level Calibration and Calibration of Final Control Elements</b></p> <p>5.1 Flow calibration: gravimetric, volumetric, master flowmeter methods, calibrating liquid/ gas flowmeters - turbine, ultrasonic, mass flowmeters, positive- displacement flowmeter, rotameter, Introduction of Square Root Extractor for Flow Calibration, Flow Calibration Software &amp; Flow Calibration Skid</p> <p>5.2 Calibration of level instruments: differential pressure cell type, capacitance type, ultrasonic type level transmitters</p> <p>5.3 Calibration of control valves, actuators, current to pressure (I/P) converter, pressure to current (P/I) converter, electro-pneumatic valve positioner</p>
<b>Course Outcome: CO5                      Teaching Hours: 03 hrs                      Marks: --</b>		

## 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
01	<b>LLO1.1</b> Identify the functions and usage of given instrument maintenance and troubleshooting tools.	Instrument maintenance tools	2	CO1
02	<b>LLO2.1</b> Select maintenance technique for given field instrument.	Maintenance techniques for field instruments	2	CO1
03	<b>LLO3.1</b> Select troubleshooting technique for given field instrument.	Troubleshooting techniques for field instruments	2	CO1
04	<b>LLO4.1</b> Prepare format of maintenance work order/job report card.	Preparation of maintenance work order format/job report card	2	CO1
05	<b>LLO5.1</b> Design preventive maintenance plan and schedule for given laboratory field instruments.	Designing of preventive maintenance plan and schedule for laboratory field instruments	2	CO2
06	<b>LLO6.1</b> Demonstrate the safety precautions and health practices during maintenance.	Safety and health practices during maintenance	2	CO2
07	<b>LLO7.1</b> Prepare PM checklist for given temperature measuring instrument. <b>LLO7.2</b> Carry out PM of given temperature measuring instrument.	Preventive maintenance of temperature measuring instrument	2	CO2
08	<b>LLO8.1</b> Prepare PM checklist for given flow measuring instrument. <b>LLO8.2</b> Carry out PM of given flow measuring instrument.	Preventive maintenance of flow measuring instrument	2	CO2
09	<b>LLO9.1</b> Prepare PM checklist for given pressure measuring instrument. <b>LLO9.2</b> Carry out PM of given pressure measuring instrument.	Preventive maintenance of pressure measuring instrument	2	CO2
10	<b>LLO10.1</b> Prepare PM checklist for given control valve with actuator. <b>LLO10.2</b> Carry out PM of given control valve with actuator.	Preventive maintenance of control valve with actuator	2	CO2
11	<b>LLO11.1</b> Prepare PM checklist for given current to pressure (I/P) converter. <b>LLO11.2</b> Carry out PM of given current to pressure (I/P) converter.	Preventive maintenance of current to pressure (I/P) converter	2	CO2
12	<b>LLO12.1</b> Prepare PM checklist for given electro-pneumatic valve positioner. <b>LLO12.2</b> Carry out PM of given electro-pneumatic valve positioner.	Preventive maintenance of electro-pneumatic valve positioner	2	CO2

13	<b>LLO13.1</b> Troubleshoot the given nonworking/ faulty pressure measuring instrument.	Troubleshooting of pressure measuring instrument	2	CO2
14	<b>LLO14.1</b> Troubleshoot the given nonworking/ faulty temperature measuring instrument.	Troubleshooting of temperature measuring instrument	2	CO2
15	<b>LLO15.1</b> Troubleshoot the given nonworking/ faulty flow measuring instrument.	Troubleshooting of flow measuring instrument	2	CO2
16	<b>LLO16.1</b> Troubleshoot the given nonworking/ faulty control valve with actuator.	Troubleshooting of control valve with actuator	2	CO2
17	<b>LLO17.1</b> Troubleshoot a 4-20 mA current loop of given transmitter.	Troubleshooting of 4-20 mA current loop of transmitter	2	CO3
18	<b>LLO18.1</b> Troubleshoot given PID-based temperature/ pressure/ level/ flow control loop.	Troubleshooting of PID-based control loop	2	CO3
19	<b>LLO19.1</b> Prepare PM checklist of given process controller. <b>LLO19.2</b> Troubleshoot given process controller.	Preventive maintenance and troubleshooting of process controller in temperature/ pressure/ level/ flow control loop	2	CO3
20	<b>LLO20.1</b> Prepare PM checklist of given control panel <b>LLO20.2</b> Troubleshoot given panel /PLC	Preventive maintenance and troubleshooting of control panel /PLC	2	CO3
21	<b>LLO21.1</b> Use fixed point cell/comparison method to calibrate PT-100.	Calibration of PT-100	2	CO4
22	<b>LLO22.1</b> Use fixed point cell/comparison method to calibrate thermocouple.	Calibration of thermocouple	2	CO4
23	<b>LLO23.1</b> Calibrate Temperature Switches	Calibration of temperature switches	2	CO4
24	<b>LLO24.1</b> Use dead weight tester/ pneumatic comparator to calibrate pressure gauge.	Calibration of pressure gauge	2	CO4
25	<b>LLO25.1</b> Use multifunction calibrator for testing and calibration of given pressure/ temperature transmitter.	Calibration of pressure/ temperature transmitter by using multifunction calibrator	2	CO4
26	<b>LLO26.1</b> Use gravimetric/ volumetric method to calibrate the given rotameter.	Calibration of rotameter	2	CO5
27	<b>LLO27.1</b> Use master flowmeter to calibrate the given flowmeter/ flow transmitter.	Calibration of flowmeter/ flow transmitter	2	CO5
28	<b>LLO28.1</b> Calibrate the given control valve with actuator.	Calibration of control valve	2	CO5
29	<b>LLO29.1</b> Calibrate the given current to pressure (I/P) converter.	Calibration of current to pressure (I/P) converter	2	CO5

30	<b>LLO30.1</b> Use HART communicator for calibration of smart transmitter.	Calibration of smart transmitter	2	CO5
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**Note:**

- **Minimum 20 experiments are compulsory and should be chosen such that all COs will be covered.**
- Judicial mix of LLOs is to be performed to achieve desired outcomes.

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

**Assignments:**

1. Prepare a PM checklist in excel sheet for LVDT through online survey.
2. Prepare a power point presentation on maintenance and troubleshooting techniques.
3. Prepare a PM checklist in excel sheet for control valve through online survey.
4. Prepare a PM checklist in excel sheet for industrial weighing scale through online survey.
5. Prepare a report on PM and troubleshooting of field instruments through library handbooks

**Micro Projects**

1. Prepare a report on PM and troubleshooting guidelines for industrial process control loops through survey.
2. Prepare a report on different calibration standards and their ranges that are used during calibration of pressure/temperature/flow instruments in a NABL approved calibration laboratory.
3. Prepare a report on safety and health practices followed during maintenance in any one of the
4. industries- chemical, petrochemical, fertilizer, cement, pharmaceutical, sugar mill, power plants.
5. Prepare NABL approved calibration report cum certificate through industrial/online survey.
6. Prepare a report on functions of instrumentation maintenance department by industrial survey.
7. Prepare maintenance work order/job report card through industrial/service center survey.
8. Repair non-working instruments in laboratory and prepare a detailed maintenance report.
9. Repair a 4-20 mA current loop of transmitter in the laboratory.

**Note:**

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

**VII. Specification Table: ---NA--****VIII. Assessment Methodologies/Tools:****Formative assessment (Assessment for Learning)**

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)

- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

### Summative Assessment (Assessment of Learning)

- Rubrics for assessment based on laboratory process and product related performance indicators. (25 Marks)

### IX. Suggested COs - POs Matrix Form:

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

Legends: - High:03, Medium:02, Low:01, No Mapping: --

### X. Suggested Learning Materials / Books:

Sr. No.	Title	Author, Publication, Edition and Year of Publication	ISBN NO.
1.	Maintenance of Instruments & Systems: Practical Guides for Measurement and Control	Lawrence D. Goettsche, International Society of Automation, Second Edition, 2005	9781643312392
2.	Calibration: A Technician's Guide	Mike Cable, International Society of Automation, 2005	9780876640852
3.	Fundamentals of Test Measurement Instrumentation	Keith R. Cheatle, International Society of Automation, 2006	9781556179146
4.	Troubleshooting: A Technician's Guide	William L. Mostia, Jr., P. E., The Instrumentation, Systems and Automation Society, 1999	9781556179631
5.	Engineering Maintenance: A Modern Approach	B. S. Dhillon, CRC Press, 2002	9781587161421
6.	Lessons In Industrial Instrumentation 1/3	Tony R Kuphaldt, Samurai Media Limited, 2017	9789888407088

## XI. Learning Websites &amp; Portals:

Sr. No.	Link/Portal	Description
1	<a href="https://instrumentationtools.com/basics-of-4-20ma-current-loop/">https://instrumentationtools.com/basics-of-4-20ma-current-loop/</a>	Basics of 4-20mA current loop
2	<a href="https://www.fluke.com/en-us/products/calibration-tools/ma-loop-calibrators">https://www.fluke.com/en-us/products/calibration-tools/ma-loop-calibrators</a>	For calibration and troubleshooting of 4-20mA control loop.
3	<a href="https://plccom-coep.vlabs.ac.in/exp/pneumatic-current-converter">https://plccom-coep.vlabs.ac.in/exp/pneumatic-current-converter</a>	Calibration and fault finding of pneumatic to current converter.
4	<a href="https://plccom-coep.vlabs.ac.in/exp/current-pneumatic-converter">https://plccom-coep.vlabs.ac.in/exp/current-pneumatic-converter</a>	Calibration and fault finding of current to pneumatic converter.
5	<a href="https://www.yokogawa.com/us/library/videos/references-videos/factory-instrument-calibration-and-service-before-after">https://www.yokogawa.com/us/library/videos/references-videos/factory-instrument-calibration-and-service-before-after</a>	Maintenance (service) and calibration
6	<a href="https://www.fluke.com/en-in/learn/blog/calibration/calibrating-hart-pressure-transmitter">https://www.fluke.com/en-in/learn/blog/calibration/calibrating-hart-pressure-transmitter</a>	Use of HART communicator for calibrating a HART based smart pressure transmitter.
7	<a href="https://plccom-coep.vlabs.ac.in/exp/alarm-annunciator/simulation.html">https://plccom-coep.vlabs.ac.in/exp/alarm-annunciator/simulation.html</a>	Design an alarm annunciator.
8	<a href="https://www.devarinc.com/wp-content/uploads/Troubleshooting-a-4-20mA-loop.pdf">https://www.devarinc.com/wp-content/uploads/Troubleshooting-a-4-20mA-loop.pdf</a>	Troubleshooting a 4-20 mA loop.
9	<a href="https://www.getmaintainx.com/blog/what-is-preventative-maintenance">https://www.getmaintainx.com/blog/what-is-preventative-maintenance</a>	Preventive maintenance
10	<a href="https://automationforum.co/how-to-troubleshoot-a-control-valve-and-how-to-do-the-preventive-maintenance-of-the-control-valve/">https://automationforum.co/how-to-troubleshoot-a-control-valve-and-how-to-do-the-preventive-maintenance-of-the-control-valve/</a>	Troubleshooting and preventive maintenance of the control valve.
11	<a href="https://law.resource.org/pub/in/bis/S05/is.13122.1.1993.pdf">https://law.resource.org/pub/in/bis/S05/is.13122.1.1993.pdf</a>	IS 13122 (Part 1) -1993 : Indian standard transmitters for use in industrial process control systems - specification
12	<a href="https://law.resource.org/pub/in/bis/S05/is.10189.1.1982.pdf">https://law.resource.org/pub/in/bis/S05/is.10189.1.1982.pdf</a>	IS 10189 (Part I)-1982 : Indian standard specification for industrial process control valves- part I general requirements and tests
13	<a href="https://archive.nptel.ac.in/courses/108/105/108105064">https://archive.nptel.ac.in/courses/108/105/108105064</a>	Control valve operation
14	<a href="https://plctt-coep.vlabs.ac.in/List%20of%20experiments.html">https://plctt-coep.vlabs.ac.in/List%20of%20experiments.html</a>	Process loop component for transmitter.
15	<a href="https://plcip-coep.vlabs.ac.in/List%20of%20experiments.html">https://plcip-coep.vlabs.ac.in/List%20of%20experiments.html</a>	Process loop components for the current and pneumatic converters.
16	<a href="https://plchla-coep.vlabs.ac.in/List%20of%20experiments.html">https://plchla-coep.vlabs.ac.in/List%20of%20experiments.html</a>	Process loop components for the high low selector and alarm annunciator.

**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:**

<b>Sr. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Institute/Organization</b>
1	Mr. Prajyot Shingari	Officer Maintenance	Avesta Pharma Pvt. Ltd., Vikramgad, Palghar
2	Mrs. Rupali Thakare	Lecturer in Instrumentation	Govt. Polytechnic, Pen
3	Ms. K. U. Waghmare	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai
4	Mr. Shivaji G. Thube	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

**Coordinator**  
**Curriculum Development,**  
**Department of Instrumentation Engg.**

**Head of Department**  
**Department of Instrumentation Engg.**

**Incharge**  
**Curriculum Development Cell**  
**Government Polytechnic, Mumbai**

**Principal**  
**Government Polytechnic, Mumbai**

<b>Programme: Diploma in Instrumentation Engineering (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code: IS23504</b>						<b>Course Title: Management &amp; Entrepreneurship development</b>							
<b>Compulsory / Optional: Compulsory</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
1	-	2	1	4	2	--	--	--	25	--	--	25	50

**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,\*# Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-PR represents tutorial/practical term work of 25 Marks.
2. SLA represents self-learning Assessment of 25 Marks.

**I. Rationale:**

Diploma pass out students are normally placed at the supervisory or Junior Engineer level when they go to industries. They have immense opportunities in manufacturing, trading, and service and consultancy enterprise. These subjects give knowledge of managing organizations effectively and provide scope for diploma engineer as an entrepreneur creates a new idea of project & implement it to opens up many employment opportunities. This course deals with different aspects of management, which helps to skillful manage the changed environment in the industry

**II. Industry / Employer Expected Outcome:**

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

“Prepare plan to manage organization properly and identify business opportunities that suit you.”

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

CO1	Understand the different business types and management functions
CO2	Explain organization structure, finance and inventory management
CO3	Discuss the project and industrial safety rules & act
CO4	Identify the entrepreneurship development process for society
CO5	Illustrate SSI, various types of support system for an entrepreneur.





		strength & weakness determine strategy to deal with each competitor.		
9	<b>LLO9.1</b> Prepare case study on entrepreneur/Businessman	A Case study on entrepreneur/Businessman	02	CO4
10	<b>LLO10.1</b> Write report on session discussion for successful entrepreneur.	Make a live conversation with an entrepreneur raise the issue of your interest pertaining to various aspects of entrepreneurship and make a report on it.	02	CO4
11	<b>LLO11.1</b> Find Breakeven point for your business idea	Find our Break-even Analysis of your business, describe how many units you sell to break even & you think of way to lower the breakeven point.	02	CO3
12	<b>LLO12.1</b> Write report on biography of entrepreneur	Study of biography of successful entrepreneur indicating milestone achievement, summarize important trails	02	CO4
13	<b>LLO13.1</b> Write report on market requirement of product	Prepare market strategy for your product/service	02	CO3
14	<b>LLO14.1</b> Prepare list of agencies support to business	Collect the information from Library /internet for government agencies for business improvement.	02	CO5
15	<b>LLO15.1</b> Understand Business strategy and growth.	Make Report on Industry visit for study of business / entrepreneurship	02	ALL
16	<b>LLO16.1</b> Write sources of capital and budget.	Use internet or library to find out different sources of capital and budgets	02	CO2

**Note: Minimum 12 experiments are compulsory and should be chosen such that all COs will be covered.**

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

##### **Assignment/ Activities for Specific Learning:**

1. Prepare report on any success story of Business person
2. Survey on internet to find different government agencies for financial support and write report.
3. Visit nearest any SSI write report.
4. Identify strength and Weakness of your business plan using SWOT analysis

#### **VII. Specification Table: ---NA---**

#### **VIII. Assessment Methodologies/Tools:**

##### **Formative assessment (Assessment for Learning)**

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ activities based on process and product related performance indicators (25 Marks)

## IX. Suggested COs - POs Matrix Form:

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

Legends: - High:03, Medium:02, Low:01, No Mapping: --

## X. Suggested Learning Materials / Books:

Sr. No.	Title	Author, Publication, Edition and Year of Publication	ISBN NO.
1	Industrial Engineering and Management	Dr. O. P. Khanna, Dhanpat Rai & Sons., New Delhi, 1980	9788189928353
2	Industrial Management	Rustom S. Davar, Vikas publication, 1999	9780706999051
3	Industrial Management	Jhamb & Bokil, Everest Publication, Pune. 2013	9788176602044
4	Organization & Management R	R. D. Aggarwal, Tata McGraw hill	9780074515068
5	Entrepreneurship Development	Preferred By Colombo plan staff college of technical education, Tata Mc Graw Hill Publishing co. ltd. New Delhi, 1998	---
6	A Manual on Business opportunity Identification & Selection	J.B. Patel, S.S. Modi, EDI study material, Ahmedabad, Gujarat	---
7	A Hand book of New Entrepreneurs	J.B. Patel, S.S. Modi, EDI study material, Ahmedabad, Gujarat	---
8	New Initiative in Entrepreneurship Education & Training	J.B. Patel, S.S. Modi, EDI study material, Ahmedabad, Gujarat	---
9	Dynamics of Entrepreneurial Development & Management-	Vasant Desai, Himalaya Publishing House	

**XI. Learning Websites & Portals:**

Sr. No.	Link / Portal	Description
1	<a href="https://ndl.iitkgp.ac.in/">https://ndl.iitkgp.ac.in/</a>	All
2	<a href="http://www.scribd.com">www.scribd.com</a>	All
3	<a href="https://nptel.ac.in">https://nptel.ac.in</a>	All
4	<a href="http://www.slideshare.net.com">www.slideshare.net.com</a>	All
5	<a href="https://www.nabard.org">https://www.nabard.org</a>	Government Schemes

**XII. Academic Consultation Committee/Industry Consultation Committee:**

Sr. No.	Name	Designation	Institute/Organization
1	Mr. Harshal Katdare	Technical quality manager	Perfect instrumentation Pvt Ltd. Thane
2	Mr. Sachin Chauhan	Lecturer in Instrumentation	Govt. Polytechnic, Jintur
3	Dr. B.B. Sul	HOD in Instrumentation	Govt. Polytechnic, Mumbai
4	Ms. Kavita Waghmare	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
Department of Instrumentation Engg.

Head of Department  
Department of Instrumentation Engg.

Incharge,  
Curriculum Development Cell  
Government Polytechnic, Mumbai

Principal  
Government Polytechnic, Mumbai

<b>Programme: Diploma in Instrumentation Engineering (E&amp;C) (Sandwich Pattern)</b>													
<b>Course Code: IS23401</b>						<b>Course Title: Project</b>							
<b>Compulsory / Optional: Compulsory</b>													
<b>Learning Scheme and Credits</b>						<b>Assessment Scheme</b>							
CL	TL	LL	SLH	NLH	Credits	FA-TH		SA-TH (2:30 Hrs.)	FA-PR	SA-		SLA	Total
						T1	T2			PR	OR		
--	--	2	2	4	2	--	--	--	25	50#	--	25	100

**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, \*# Online Examination, @\$ Internal Online Examination

**Note:**

1. FA-PR represents tutorial/practical term work of 25 Marks.
2. SA-PR represents the end term Oral examination of 50 Marks
3. SLA represents self-learning Assessment of 25 Marks.

**I. Rationale:**

In the rapidly advancing field of technology, it is essential for diploma holders to develop the ability for lifelong self-learning. This subject is designed to equip students with skills to identify and use various sources of technical information and apply self-study techniques for project development and report writing. It provides a strong foundation in measurement, control systems, fault diagnosis, testing, cost estimation, material procurement, fabrication, and manufacturing processes. By combining theoretical knowledge with practical skills, the subject prepares students for supervisory roles in industry. It also encourages entrepreneurship by enabling them to start and manage small-scale enterprises in the instrumentation field.

**II. Industry / Employer Expected Outcome:**

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

" Apply and Execute solutions for real field problems effectively as a team within a given time frame and present report."

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

CO1	Apply skills and knowledge gained in previous semesters to address complex engineering problems.
CO2	Conduct surveys and research to develop solutions or products that promote lifelong learning.
CO3	Test the developed project model and critically evaluate its performance.
CO4	Demonstrate effective communication skills by presenting the project or product through oral and written formats.

**IV. General guidelines for PROJECT WORK:**

1. The Project- problems must be related to the Programme or may be interdisciplinary, based on the industry expected outcomes.
2. The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
3. Project titles are to be finalized in co-ordination/consultation with the faculty mentor. However, faculty may form a team of students as per specific roles- Literature survey/data collection, data Analysis, model/prototype developers, testers. Study type project is NOT advisable.
4. Project must be assigned to a group of 3-4 students under the guidance of identified faculty mentor.
5. Students are required to prepare a prototype/working model/software of the Project and simultaneously prepare a report.
6. Students shall Submit One Hard copy and one soft copy each of Project Report and soft-copy of the project code or the working model.
7. Students must maintain a project execution diary having the progress steps and details. The concerned faculty should check the diary on a weekly basis and accordingly interact with students based on the progress shown and keep proper record with feedback if any.
8. Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and similar applicable domains
9. The evaluation of project work at final oral examination should be done jointly by the internal and external examiners. The guide should be internal examiner for oral examination. The external examiner should be from the related area of the concerned project. He/ She should have minimum of five years of experience at institute level or industry.

**V. Typographical instructions/guidelines for Project report writing**

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

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

- i) The project report, the title page should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

## VI. Project Report

On completion of the project work, every student will submit a project report which should cover the following points:

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

Chapter-1 Introduction (background of the Industry or User based Problem/Task)

Chapter-2 Literature Survey (to finalize and define the Problem Statement)

Chapter-3 Scope of the project

Chapter-4 Methodology/Approach, if any

Chapter-5 Details of designs, working and processes

Chapter-6 Results and Applications

7. Conclusion

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

### NOTE:

1. Project report must contain only relevant and short mentioned – technology or platform or tools used. It must be more focused on project work carried out and its implementation.
2. No. of copies of seminar report to be prepared = S+2, where S is no. of students in group.)

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

1. Prepare a Synopsis report on their project topic before the end of the term and give presentation on it.
2. Prepare a technical paper based on the completed work in project head.
3. Participate in co-curricular activities like Technical Paper presentation competition, publication under the guidance of project guide.

**Note :** Project guide will decide to conduct one or more activities from above.

**IX. Assessment Methodologies/Tools:****Formative assessment (Assessment for Learning)**

- Rubrics for continuous assessment based on attendance, process and product related performance indicators. (25 Marks)
- Rubrics for continuous assessment of self-learning assignments/ micro project/ activities based on process and product related performance indicators. (25 Marks)

**Summative Assessment (Assessment of Learning)**

- Rubrics for assessment based on laboratory process and product related performance indicators. (50 Marks)

**X. Suggested COs - POs Matrix Form**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Outcomes (POs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools, Experimentation	PO-5 Engineering Practices For Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO - 1	PSO - 2
CO1	3	--	--	--	--	3	3	1	1
CO2	--	3	--	--	1	3	3	2	1
CO3	--	--	3	3	--	3	3	3	3
CO4	--	--	--	--	--	3	3	3	3
Legends: - High:03, Medium:02, Low:01, No Mapping: --									

**XI. Academic Consultation Committee/Industry Consultation Committee:**

<b>Sr. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Institute/Organization</b>
1	Mr. Prasad Vitkar	Director	Acumen Tech -Sol Pvt. Ltd, Turbhe, Thane
2	Mr. Santosh Kamble	Assistant Professor	Electronic and Computer Science Shah and Anchor kutchhi Engg college
3	Mr. F. S. Bagwan	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai
4	Mrs. S.T. Shinde	Lecturer in Instrumentation	Govt. Polytechnic, Mumbai

Coordinator,  
Curriculum Development,  
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