Government Polytechnic Mumbai

Department of Instrumentation Engineering

P-19 Curriculum

Semester- V

(Course Contents)

GOVERNMENT POLYTECHNIC MUMBAI

(Academically Autonoums Instititute, Government of Maharashtra)

Teaching and Examination Scheme (P19)

With effect from AY 2019-20

Programme: Diploma in Instrumentation Engineering (Sandwich Pattern) **Term / Semester - V**

Course Code	Course Title	Teaching Hours/Contact Hours				Credits	Examination Scheme (Marks)						
							Theory			PR	OR	TW	Total
		L	P	TU	Total		TH	TS1	TS2				
IS19302	Maintenance of Instruments & Systems	3	2	--	5	5	60	20	20	--	25*	--	125
IS19303	Industrial Automation	3	4	--	7	7	60	20	20	50*	--	--	150
IS19305	Biomedical Instrumentation	3	2	--	5	5	60	20	20	--	25*		125
IS19404 IS19405 IS19406	**Elective-II Group** Distributed Control Systems Agriculture Instrumentation Advance Embedded Systems	3	2	--	5	5	60	20	20	--	25*	25	150
IS19501	Industrial Management & Entrepreneurship	3	--	2	5	5	--	--	--	--	25*	25	50
IS19309	Project	--	4	--	4	4	--	--	--	--	50*	50	100
IS19408	Scilab (Spoken tutorial)	--	4 #	--	4 #	4	--	--	--	--	--	--	--
	Total	**15**	**18**	**02**	**35**	**35**	**240**	**80**	**80**	**50**	**150**	**100**	**700**
Total Contact Hours					**35**								

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment)

***** Indicates assessment by External Examiner else internal assessment, **#** indicates Self, on- line learning Mode, **@** indicates on line examination

Note: Duration of Examination--TS1&TS2 -1 hour , TH- 2:30 hours, PR/OR – 3 hours per batch , SCA- Library - 1 hour, Sports- 2 hours, Creative Activity-2 hours

Self, on- line learning Mode through MOOCS /Spoken Tutorials / NPTEL / SWAYAM / FOSSEE etc.

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

In-Charge
Curriculum Development Cell

Head of Departments
Department of Instrumentation Engg.

Principal

Programme :**Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code:**IS19302**				Course Title: **Maintenance of Instruments and Systems**						
Compulsory / Optional: **Compulsory**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**-**	**5**	**60**	**20**	**20**		**25***		**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term

Rationale:

Engineering maintenance is an important sector of economy to improve efficiency & progress of industries. Instrumentation diploma engineers have major role in maintenance of instruments and systems in process and manufacturing industries. Acquiring knowledge of maintenance and calibration of instruments is essential for instrumentation students. This course tends student to gain the various aspects of maintenance and calibration of different instruments and systems used in process and manufacturing industries.

Course Outcomes: Student should be able to

CO1	Select the maintenance /troubleshooting techniques for given field instruments/systems
CO2	Maintain the given field instruments / systems
CO3	Use of calibration method for maintenance and troubleshooting of field instruments/systems
CO4	Explain calibration of various process parameter equipment/system used in industry
CO5	Prepare the maintenance /troubleshooting and calibration reports

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to Maintenance and Troubleshooting** 1.1 Maintenance- Definition, Need for Instruments/Control Systems Maintenance. 1.2 Types of Maintenance: Corrective Maintenance, Preventive, Maintenance and Predictive Maintenance. 1.3 Troubleshooting- Definition, Maintenance versus Troubleshooting 1.4 Basic Troubleshooting Techniques- Logical Analysis, Divide and Conquer, Remove and Conquer, and Built in Diagnostics. 1.5 Maintenance Department Functions 1.6 Job Planning and Scheduling.

	1.7 Typical Maintenance Work Order System (Maintenance Plan-daily/weekly/fortnightly/monthly/quarterly/annually). **Course Outcome:CO1 Teaching Hours :6hrs Marks: 08(R- 2, U-4, A-2)**
2	**Field Instruments Maintenance & Troubleshooting** 2.1 Elements of Preventive Maintenance 2.2 Role of Instrument Maintenance Technicians/Supervisors/ Engineers. 2.3 Safety Practices to be followed while Maintenance and Troubleshooting 2.4 Preventive Maintenance Tips/checklist and Troubleshooting Guidelines for following field instruments 2.4.1 DP Transmitters 2.4.2 Flow Transmitters- Turbine type Flow Meters 2.4.3 RTD /Thermocouple based Temperature Transmitters 2.4.4 Control Valves/Actuator Subsystems. 2.4.5 Current to Pressure (I/P) Converter and pressure(P/I) to current converter 2.4.6 Electro-pneumatic Valve Positioner **Course Outcome:CO2 Teaching Hours :08hrs Marks: 10(R- 2, U-4, A-4)**
3	**Industrial Calibration introduction** 3.1 Calibration –Definition and Need for Instruments Calibration. 3.2 Types of Calibration Standards and Traceability concept 3.3 ISO9000: Requirements of Calibration. 3.4 Individual Instrument Calibration versus Loop Calibration. 3.5 Bench Calibration versus Field Calibration 3.6 Calibration Status Labels and NABL Calibration Reports **Course Outcome: CO3 Teaching Hours :05hrs Marks: 8 (R- 2, U-4, A-2)**
4	**Calibration of Temperature and Pressure Measuring Instruments** 4.1 Temperature Standards and Standard Temperature Sources 4.2 Basic Methods of Temperature Calibration 4.3 Calibration of RTDs and Thermocouples using Fixed-point Method 4.4 Calibration of RTDs and Thermocouples using Comparison Method 4.5 Calibration of Temperature Transmitters using Temperature Simulators. 4.6 Calibration of Temperature Indicators using Temperature Simulators 4.7 Calibration of Pressure Gauges using Pneumatic/Hydraulic Dead Weight Tester (DWT) 4.8 Calibration of Pressure Transmitters using Pressure Calibrators 4.9 Calibration of Electronic Differential Pressure (DP) Transmitter 4.10 Calibration of smart Differential Pressure (DP) Transmitter **Course Outcome: CO4 Teaching Hours :10hrs Marks: 12 (R- 2, U-4, A-6)**
5	**Calibration of Flow and Liquid Level Measuring Instruments** 5.1 Gravimetric and Volumetric Calibration of Liquid Flowmeters 5.2 Volumetric and Gravimetric- PVTt Calibration of Gas Flowmeters 5.3 Calibration of Liquid/Gas Flowmeters using Master Flowmeters 5.4 Calibration of Turbine type Flow Transmitter 5.5 Rotameter Calibration 5.6 Calibration of DP type Level Transmitter in Open/Closed Tanks 5.7 Calibration of Capacitance type Level Transmitter

	5.8 Calibration Air Purge Level Indicator. **Course Outcome: CO4 Teaching Hours:10hrs Marks: 12 (R- 2, U-4, A-6)**
6	**Maintenance and Troubleshooting of PLC AND DCS System** 6.1 Troubleshooting tips of Automation and Process Control loops 6.2 Troubleshoot 4-20 mA Current Loop of 2-Wire/3-Wire Transmitters 6.3 PLC Preventive Maintenance Checklist and troubleshooting 6.4 Distributed Control System (DCS) Maintenance and troubleshooting 6.5 Calibration & Maintenance Report of PLC & DCS **Course Outcome: CO5 Teaching Hours :6hrs Marks: 10 (R- 2, U-4, A-4)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Introduction to Maintenance and Troubleshooting**	2	4	2	8
2	**Field Instruments Maintenance & Troubleshooting**	2	4	4	10
3	**Industrial Calibration introduction**	2	4	2	8
4	**Calibration of Temperature and Pressure Measuring Instruments**	2	4	6	12
5	**Calibration of Flow and Liquid Level Measuring Instruments**	2	4	6	12
6	**Maintenance and Troubleshooting of PLC AND DCS System**	2	4	4	10
	Total	**12**	**24**	**24**	**60**

List of experiments: Total 10-12 experiments(or turns) out of 15 experiments(or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Study of Instrument Maintenance Tools- Identification, Function, Operation and Safety Precautions	2
2	2	CO2	Maintain Field/bench service of an Air Pressure Regulator.	2
3	3	CO3	Calibration of PT-100 or Thermocouple (J / K type).	2
4	4	CO4	Field/bench service given transmitter-Pressure/DP/Temperature	2
5	5	CO4	Calibration of Capacitance type Level transmitter	2
6	6	CO5	Troubleshoot the PLC based control system	2
7	2	CO2	Field/bench service given Current to Pressure (I/P) converter.	2
8	6	CO5	Troubleshoot 4-20 mA Current Loop of 2-Wire/3-Wire Transmitters	2

9	1	CO1	Prepare Preventive Maintenance Plan (Work Order System)-(Daily/weekly/fortnightly/monthly/quarterly/annually)	2
10	2	CO2	Field/bench service given Control valve	2
11	4	CO4	Calibration of Differential Pressure (DP) transmitter for liquid level/flow measurement	2
12	3,4	CO3, 4	Calibration of PT-100 or Thermocouple (J / K type).	2
13	4	CO4	Calibrate a Pressure Gauge with a pneumatic/hydraulic Dead Weight Tester.	2
14	2	CO2	Maintenance &Calibration of Current to Pressure (I/P) converter.	2
15	2	CO2	Maintenance &Calibration of Pressure to current (P/I) converter.	2
16	6	CO5	Describe preventative maintenance of PLC	2
17	ALL	ALL	Industrial Visit (IDEMI or any process industry)	
Total				**30**

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Maintenance of Instruments& Systems: Practical Guides For Measurement And Control	Lawrence D. Goettsche, ISA, 2005	9781556175121
2	Calibration: A Technician's Guide	Mike Cable, ISA, 2005	9781556179129
3	Industrial Process Automation Systems Design and Implementation	B. R. Mehta, Y. J. Reddy Elsevier Publisher, 2014	9780128010983
4	Process Instrumentation –Teacher Edition	Brown A. O., Powler, Malcom, Mid-America Vocational Curriculum Consrotium, Stillwater, Okla, 1989	9781292026015
5	Engineering Maintenance – A Modern Approach	B. S. Dhillon, CRC Press, 2002	9781587161421
6	Maintenance and Troubleshooting Instruction Manuals from Industries		

E-References:

1. https://instrumentationtools.com
2. https://www.instrumentationtoolbax.com
3. https://calibrationawareness.com
4. https://automationforum.co
5. https://automationforum.in

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3	-	-	1	-	-	1	2	1
CO2	2	2	1	2		-	3	2	3
CO3	2	3	1	3	2	-	3	3	3
CO4	3	1	-	2	2	1	3	3	2
CO5	2	-	-	-	1	1	1	2	2

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. T. D. Shinde	Project Engineer	Emerson Process Management Pvt. Ltd.
2	Mr. C.S. Tamkhane	Lecturer in Instrumentation Engg.	Govt. Polytechnic Pen
3	Mr. K.U. Dawane	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai
4	Smt. K. U. Waghmare	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

Head of Department
Department of Instrumentation Engg.

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code: **IS19303**				Course Title: **Industrial Automation**						
Compulsory / Optional: **Compulsory**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30 Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
03	**04**	**-**	**07**	**60**	**20**	**20**	**50***	-	**-**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term

Rationale:

Now a days PLC & SCADA system are used in most of the industries for automation. PLC & SCADA systems are used for monitoring and controlling various plant operations. 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.

Course Outcomes: Student should be able to

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	Explain the topology & protocol in the given application
CO5	Develop industrial application using PLC & SCADA

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to automation and PLC** 1.1 Automation overview, Requirement of automation systems, Architecture of Industrial Automation system 1.2 Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, 1.3 Communication. Advantages of automation 1.4 Introduction of PLC , Block diagram and functions of elements of PLC, Memory organization in PLC, Types of PLC: fixed and modular PLC, Programming devices types, Operation of PLC, Types of Programming Language (Introductory approach) , & Advantages & Disadvantages 1.5 Types of modules: Input modules and output modules : DC module, AC module, Analog Module. (Basic concepts, block diagram, Wiring diagram ,concept of sourcing & sinking) 1.6 PLC Status indicators: Fault, Run, Power, Fault

	1.7 Specifications of PLC **Course Outcome: CO1 Teaching Hours : 06 hrs Marks: 8(R- 4, U-4, A-0)**
2	**PLC Instructions** 2.1 Basic concept of ladder 2.2 Rules of ladder, I/O Addressing 2.3 Classification of PLC instructions (Explanation and examples) 2.3.1 Bit type instructions: XIC,XIO,OTE,OTL,OSR 2.3.2 Logical instructions : OR,AND,NOT,XOR 2.3.3 Comparison instructions: EQU,NEQ,LES,LEQ,GRT,GEQ,LIM 2.3.4 Timer :TON,TOF,RTO, RES 2.3.5 Counter: CTU,CTD, High speed Counter 2.3.6 Math : ADD,SUB,MUL,DIV, 2.3.7 Advanced Math : SCP 2.4 Data files Simple programs to demonstrate the use of above instructions **Course Outcome: CO2 Teaching Hours:15 hrs Marks: 20 (R- 2, U-4, A-14)**
3	**Introduction to SCADA** 3.1 Definition 3.2 Block diagram of SCADA, Operation 3.3 Elements of SCADA: RTU, MTU, Communication interface, HMI 3.4 Benefits of SCADA 3.5 Types of SCADA: Single master single remote, single master multiple control, multiple master multiple control 3.6 Concept of tag, types of tags, Tag addressing 3.7 Concept of mimic diagram 3.8 Concept of Alarm: generation ,types, trend- types **Course Outcome: CO3 Teaching Hours : 06 hrs Marks: 08 (R-4, U- 4, A- 0)**
4	**Communication protocols** 4.1 Network topologies- types : bus, ring, star, protocol 4.2 RS485 - features, working, applications 4.3 HART protocol- concept, features, definition, operation, applications 4.4 Field bus –concept, features, definition, operation, applications 4.5 Ethernet- concept, features, operation, applications **Course Outcome: CO4 Teaching Hours : 09 hrs Marks: 12 (R- 2, U- 4, A- 6)**
5	**Applications programs** 5.1 Batch process Control 5.2 Diesel generator set control 5.3 Drum/Bottle Filling System 5.4 Traffic light control 5.5 Elevator control 5.6 Water distribution system (I/O Addressing, ladder diagram, tag database, mimic diagram for above applications Mimic diagram ,program, device addressing, animation, alarm generation) **Course Outcome: CO5 Teaching Hours : 09 hrs Marks: 12 (R-0, U- 0, A- 12)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Introduction to PLC**	4	4	0	8
2	**PLC Instructions**	2	4	14	20
3	**Introduction to SCADA**	4	4	0	8
4	**Communication protocols**	2	4	6	12
5	**Applications programs**	0	0	12	12
	Total	**12**	**16**	**32**	**60**

List of experiments :Total 10-12 experiments(or turns) out of 15-16 experiments(or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Identify the type of PLC in the lab , PLC component and their role.	04
2	2	CO2	Development of basic logic functions using ladder logic.	04
3	3	CO3	Configuration of RSVIEW 32 In Touch software	04
4	4	CO4	Identify the type of communication network in the lab	04
5	5	CO5	Develop the ladder program and test it : batch process	04
6	6	CO2	Develop ladder diagram to test OTL & OTU instructions	04
7	1	CO2	Develop traffic light control using TON , TOF & RTO instruction	04
8	2	CO2	Develop program for counting the given event using CTU & CTD instruction	04
9	3	CO2	Develop Program to Verify the given comparison instruction	04
10	4	CO2	Develop Program to Verify the given Mathematical Instruction	04
11	5	CO3	Creation of analog, digital tags and addressing of these tags in SCADA for given application	04
12	6	CO3	Creation and configuration of alarms in SCADA for given application	04
13	5	CO3	Observation of trends of variables in SCADA for given application	04
14	6	CO3	Develop ladder logic and graphics for SCADA applications	04
15	5	CO5	Develop application using PLC & SCADA	04
		Total		**60**

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Programmable logic controller	V.R. Jadhav Khanna Publishers , New Delhi,2017	9788174092281
2	Programmable logic controller	Petruzella F.D. Tata- McGraw Hill India, New Delhi, Forth edition 2010	9780071067386
3	Programmable logic controller and industrial automation: An introduction	Mitra, Madhuchandra, Sengupta , Samerjit Penram International Publication, New Delhi	9788187972174
4	Practical SCADA for Industry	Bailey, David; Wright, Edwin Newnes International Edition	9780750658058

E-References:

1. https://automationforum.
2. http://www.hse.gov.uk/
3. http://literature.rockwellautomation.com
4. http://www.pc-education.mcmaster.ca/Instrumentation/go_inst.htm

CO Vs PO and CO Vs PSO Mapping

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

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. Praveen Nalavade	Associate Chief Engineer – Instrumentation & Control Design	Technip FMC
2	Mr. Sanjay Rajput	Lecturer in Instrumentation Engg.	Govt. Polytechnic Jintur
3	Mr. K. U. Dawane	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai
4	Mr. U. B Shinde	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

Head of Department
Department of Instrumentation Engg.

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code: **IS19305**				Course Title: **Biomedical Instrumentation**						
Compulsory / Optional: **Compulsory**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**--**	**25***	**--**	**125**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at midterm and second skill test at the end of the term

Rationale:

The use of biomedical instruments is increasing day by day in health care. Now day's advanced, complex and precision biomedical instruments are being used in most of the hospitals. Diploma Instrumentation engineer are therefore also supposed to know about the biomedical instrumentation fundamentals, it is important as the students may get employment in hospitals where they will have to understand construction working application of different biomedical instruments. This course tends to develop basic skills in operation, test and maintenance of various biomedical instruments.

Course Outcomes: Student should be able to

CO1	Identify the function of physiology of human body
CO2	Illustrate electrodes for different bio signals generated by human body organs with a suitable recorder
CO3	Select biomedical instrument for biomedical parameters measurement
CO4	Demonstrate life support biomedical instruments/imaging instrument for specified application
CO5	Maintain biomedical instruments with electrical safety

Course Content Details:

Unit No	Topics / Sub-topics
1	**Physiological system of human body** 1.1 Man-instrument system:-component block diagram ,working 1.2 Problems encountered in measuring living system. 1.3 Types of physiological system of human body. 1.4 Cardiovascular system:- Internal structure of Heart, Cardiovascular circulation ,heart sounds 1.5 Respiratory system: - physiology, mechanism of breathing, lung volume and capacities. 1.6 Nervous system: - structure and functioning of neuron, structure of brain, neuronal communication.

	Course Outcome: CO1 Teaching Hours :07hrs Marks:10 (R-2, U-4 , A- 4)
2	**Bioelectric signal and Electrodes** 2.1 Resting and action potential-concept, schematic diagrams and waveform 2.2 Introduction to typical bioelectric signals e.g. ECG, EEG, EMG, ERG, EOG, and EGG. 2.3 Electrode theory- Electrode electrolyte interface with schematic diagram 2.4 Electrodes: - Construction and diagram of various electrode used for measuring ECG, EMG, EEG. 2.4.1 Microelectrodes 2.4.2 Surface-electrodes:-Suction cup electrode, Disposable electrode, Floating type electrode, Metal disk type electrode 2.4.3 Needle electrodes **Course Outcome: CO2 Teaching Hours :06hrs Marks:10 (R-2, U-4, A- 4)**
3	**Biomedical Recorders** 3.1 Electrocardiograph:- Block diagram ,description. 3.2 ECG waveform with labels describes relating cardiac activity of the heart. 3.3 Einthoven's triangle. 3.4 Bipolar and unipolar leads used for ECG measurements. 3.5 Electro encephalograph:-working principle. 3.6 Electromyograph:-block diagram, description. **Course Outcome: CO2 Teaching Hours :10hrs Marks:12 (R-2, U-6 , A- 4)**
4	**Biomedical Parameters Measuring Instruments** 4.1 Indirect blood pressure measurement- Sphygmo-manometer 4.2 Respiration rate measurement- Spirometer 4.3 Measurement of heart sound- Phono-Cardiograph. 4.4 Measurement of Oxygen Saturation in Blood Stream and Pulse Rate -Pulse Oximeter (Diagram, construction and working only of above instruments). **Course Outcome:CO3 Teaching Hours :08hrs Marks:10 (R-2, U-2 , A- 6)**
5	**Life support equipment and imaging system** 5.1 Defibrillator:-concept of fibrillation ,Types of defibrillator , DC defibrillator (diagram ,working, output waveform) 5.2 Pacemaker:-Concept of pacemaker, Types of pacemaker-internal and external, working of various pacing modes. 5.3 Ventilators-Basic concept and working 5.4 X-ray: - principle of X rays, block diagram of X ray machine and working 5.5 CAT- principle of CT scan, block diagram, working and applications 5.6 MRI:-basic principle and application 5.7 Ultrasonography:-basic principle and application **Course Outcome: CO4 Teaching Hours :12hrs Marks:14 (R-2, U-6 , A- 6)**
6	**Electrical safety** 6.1 Micro shock & macro shock. 6.2 Effects of leakage current on human body 6.3 Types of leakage current 6.4 Precaution to minimize electric shock hazards & leakage current. **Course Outcome: CO5 Teaching Hours :02hrs Marks:04 (R-2 , U-2 , A- 0)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Physiological system of human body**	02	04	04	10
2	**Bioelectric signal and Electrodes**	02	04	04	10
3	**Biomedical Recorders**	02	06	04	12
4	**Biomedical Parameters Measuring Instruments**	02	02	06	10
5	**Life support equipment and imaging system**	02	06	06	14
6	**Electrical safety**	02	02	--	04
Total		**12**	**24**	**24**	**60**

List of experiments: Total 10experiments(or turns) out of 15 experiments(or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Use video program to understand the working of cardiovascular system.	2
2	2	CO2	Identify ECG, EEG, EMG electrodes.	2
3	3	CO2	Simulate 12 lead ECG signals using virtual lab.	2
4	4	CO3	Measure blood pressure using sphygmomanometer.	2
5	5	CO4	Observe the functioning of DC defibrillator system on virtual lab simulator.	2
6	6	CO5	Prepare a chart of General effects of electric current on human body.	2
7	1	CO1	Use video program to understand the working of nervous system.	2
8	3	CO2	Use virtual lab to plot the EMG.	2
9	4	CO3	Measure respiration rate using spirometer.	2
10	1	CO1	Use video program to understand the working of respiratory system	2
11	5	CO4	Use video program to understand the working of X-RAY machine.	2
12	5	CO4	Use video program to understand the working of MRI.	2
13	5	CO4	Use video program to understand the working of CT scan.	2
14	5	CO4	Simulate pacemaker using virtual lab.	2
15	5	CO4	Use video program to understand the working of Ultrasonography.	2
			Total	**30**

Note: Experiments No. 1 to 6 are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ 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 4th 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

E-References:

1. https://www.youtube.com/enter "topic name".
2. https://www.electronicsandcommunications.com/2019/06/biomedical-engineering.html
3. https://medlineplus.gov/encyclopedia.html
4. https://www.slideshare.net/kerolus/ecg-49879220

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	1	-	-	-	-	-	1	1	-
CO2	2	-	-	2	2	-	2	2	2
CO3	3	-	3	3	2	-	3	3	2
CO4	3	-	3	3	2	-	3	3	2
CO5	3	-	1	-	-	-	2	3	2

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mrs Vaishnavi	Proprioter	Biomedical Solutions
2	Ms. V. K. Pawar	Lecturer in Instrumentation Engg.	Govt. Polytechnic Karad
3	Ms. K.U. Waghmare	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai
4	Mrs. S.T. Shinde	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

Head of Department
Department of Instrumentation Engg.

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code: **IS19404**				Course Title: **Distributed Control Systems**						
Compulsory / Optional: **Optional**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30 Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
03	**02**	**-**	**05**	**60**	**20**	**20**	**-**	**25***	**25**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at midterm and second skill test at the end of the term

Rationale:

In today's competitive production environment, process industries demand a totally integrated control and optimization solution that can increase productivity, reliability, and quality while minimizing cost. Distributed Control System (DCS) is designed to meet these customers' needs. The distributed architecture of DCS reduces impact from loss of system components and ensures production continuity. The component and network redundancy guarantees the operability of critical system and control functions.DCS also ensures operation safety and effectiveness. The DCS advanced solutions deliver operating efficiency improvement, productivity gain. Unit reliability and availability enhancement, and overall cost reduction

Course Outcomes: Student should be able to

CO1	Identify the different components of given DCS
CO2	Describe the role of given module in DCS.
CO3	Classify displays used in DCS
CO4	Understand alarm management system in DCS .
CO5	Develop simple PID control loop with Alarm, control, trends using given DCS system.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to distributed control system(DCS)** 1.1 Introduction to DCS. 1.2 Direct Digital control, centralized computer system, Distributed control. 1.3 DCS Evolution history. 1.4 Generalized DCS architecture and its feature. 1.5 Main difference between PLC and DCS. 1.6 DCS Suppliers and their system name. **Course Outcome: CO1 Teaching Hours :08 hrs Marks: 12(R- 6, U-4, A-2)**

2	**DCS MODULES:** 2.1 Input and output module: Local , Remote, rack mounted. 2.2 Controller Module: 2.3 Power supply module 2.4 Communication Module 2.5 Workstation: Operator and Engineer 2.6 Data Highway and local IO bus 2.7 Redundancy in the DCS (Functions, types and specification as per above modules) **Course Outcome: CO2 Teaching Hours :09 hrs Marks: 12 (R- 2 , U- 4 , A- 6)**
3	**DCS DISPLAYS**: 3.1 Standard Display: Overview display, unit or area Overview display, Group display, Graphics display, trend display, Loop display. 3.2 User -defined display: Plant mimic display, area mimic display, Group mimic diagram and batch control system diagram. **Course Outcome:CO3 Teaching Hours : 09 hrs Marks: 12 (R-2 , U- 4 , A- 6)**
4	**DCS Alarm Management and Database** 4.1 Alarm reporting, types of Alarm generated and acceptance of alarms 4.2 The different types of logs and report that can be configured on DCS system, 4.3 Data history use in logs, reports and trend display. 4.4 The need for different security levels to various operating parameters configuration (Operator, Engineer, supervisor) Organization of system database in one folder on database server **Course Outcome: CO3 Teaching Hours :09 hrs Marks: 12 (R- 2 , U-10- , A-0)**
5	**DCS Programming:** 5.1 Introduction 5.2 DCS Programming Language requirement. 5.3 DCS Programming language(Ladder logic, Functional block diagram Structured text, Sequential flow chart) 5.4 FBD/SFC/Ladder language example 5.5 Example of data acquisition 5.6 Example of Control Logic 5.7 Example of Alarm system **Course Outcome: CO5 Teaching Hours :10 hrs Marks: 12 (R- 0 ,U- 0 , A-12)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Introduction to distributed control system(DCS)**	6	4	2	10
2	**DCS MODULES**	2	4	6	12
3	**DCS DISPLAYS**	2	4	6	12
4	**DCS Alarm Management and Database**	2	10	0	12

5	**DCS Programming**	0	0	12	14
	Total	**12**	**22**	**26**	**60**

List of experiments: Total 10-12 experiments(or turns) out of 15 experiments(or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Preparing URS (User requirement specification)and FRS(Functional requirement specification) for any small Automation process in the lab.	02
2	2	CO2	Understand the Input output module and controller module with detailed specification.	02
3	3	CO3	Study of communication modules with detailed communication protocol.	02
4	4	CO4	Study of Workstation: Operator and Engineer	02
5	5	CO5	Prepare cause and effect document for any small process and develop control logic diagram for the same.	02
6	6	CO2	Prepare small process Graphical representation and display on HMI screen.	02
7	1	CO2	Develop and implement temperature measurement in DCS trainer setup using DCS programming language SFC	02
8	2	CO2	Develop and implement level measurement in DCS trainer setup using DCS programming language SFC.	02
9	3	CO2	Develop and implement Flow measurement in DCS trainer setup using DCS programming language SFC.	02
10	4	CO2	Develop and implement temperature measurement in DCS trainer setup using DCS programming language FBD	02
11	5	CO3	Develop and implement level measurement in DCS trainer setup using DCS programming language FBD.	02
12	6	CO3	Develop and implement Flow measurement in DCS trainer setup using DCS programming language FBD.	02
13	5	CO3	Develop and implement pressure measurement in DCS trainer setup using DCS programming language FBD/SFC.	02
14	6	CO3	Developing and configuring Graphical user interface for any two control loop.	02
15	5	CO5	Develop and implement PID level Control loop in DCS trainer setup using DCS programming language FBD/SFC	02
		Total		

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Instrument Engineers Handbook,Volume3: Process Software and Digital Networks	Bela G. Liptak, Eren CRC Press, Fourth Edition 2016	9781439863435

2	Industrial Process Automation Systems: Design and Implementation	B.R. Mehta, Y. Jaganmohan Reddy Butterworth-Heinemann, 2014	9780128010983
3	Control Systems (DCS): For Engineers and Technicians	IDC Technologies	
4	Industrial Instrumentation & Control Third Edition	Singh S. K. Tata McGraw-Hill Education,2009	9780070262225

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2. https://automationforum.in
3. http://www.hse.gov.uk
4. http://literature.rockwellautomation.com/

CO Vs PO and CO Vs PSO Mapping

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

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr H. K. Kadam	Rtd. HR Manager	RCF Ltd.
2	Mr. Sanjay Rajput	Lecturer in Instrumentation Engg.	Govt. Polytechnic Jintur
3	Mr. S.T. Shinde	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai
4	Mr. U. B Shinde	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

Head of Department
Department of Instrumentation Engg.

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code: **IS19405**				Course Title: **Agriculture Instrumentation**						
Compulsory / Optional: **Optional**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
03	**02**	**-**	**05**	**60**	**20**	**20**	**-**	**25***	**25**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term

Rationale:

Agricultural industries are mostly dependent on nature behaviour. To avoid crop failure, increasing crop quantity and quality, protecting crop, etc is a big challenge for farmers as well as for agro industries. It will be very appropriate to provide knowledge of sensors used in agriculture field, know green house automation schemes and automation associated with agriculture and food processing plants/ systems to instrumentation and control engineers.

Course Outcomes: Student should be able to

CO1	Characterize problems and possible technological solution of agro industries.
CO2	Explain soil properties and sensors used to measure
CO3	Demonstrate continuous and batch process
CO4	Familiarize with current literature in irrigation system associated agricultural instrumentation
CO5	Develop automation scheme for green house

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction** 1.1 Necessity of instrumentation & control for agriculture and food processing 1.2 Remote sensing 1.3 Biosensors in agriculture 1.4 Standard for food quality **Course Outcome: CO1 Teaching Hours : 7 hrs Marks: 10(R- 4, U-4, A-2)**
2	**Soil science and sensors** 2.1 Engineering properties of soil pH, conductivity, resistivity, temperature, soil moisture and salinity, ion concentration measurement. 2.2 Method of soil analysis, permeability & seepage analysis, shear strength, Mohr's circle of stress, active & passive earth pressures.

	2.3 Instrumentation for environmental conditioning of seed germination and growth **Course Outcome: CO2 Teaching Hours : 10 hrs Marks: 14 (R- 2 , U-4, A- 8)**
3	**Food Processing** 3.1 Flow diagram of sugar plant & instrumentation set up for it, 3.2 Flow diagram of fermenter & control (batch process), 3.3 Flow diagram of dairy industry & instrumentation set up for it, 3.4 Juice extraction control process & instrumentation set up for it 3.5 Oil extraction plant and instrumentation set up for it. **Course Outcome: CO3 Teaching Hours : 10 hrs Marks: 14 (R- 2 , U- 4 , A-8)**
4	**Instrumentation in Irrigation** 4.1 Water distribution & management control, 4.2 Auto drip & sprinkler irrigation systems, 4.3 Irrigation canal management systems, upstream & downstream control concept, 4.4 SCADA for DAM parameters & control **Course Outcome: CO4 Teaching Hours : 8 hrs Marks:10 (R- 2 , U-6 , A-2)**
5	**Topic Title: Green-houses & instrumentation** 5.1 Concept & construction of green houses, merits & demerits 5.2 Ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge, carbon dioxide enrichment measurement & control. 5.3 Leaf area length evaportranspiration, temperature, wetness & respiration measurement 5.4 Data logging, electromagnetic radiations photosynthesis, infrared & UV bio sensor methods in agriculture 5.5 Agro-metrological instrumentation weather stations **Course Outcome: CO5 Teaching Hours : 10 hrs Marks:12 (R- 2 , U-6 , A-4)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Introduction**	4	4	2	10
2	**Soil science and sensors**	2	4	8	14
3	**Food Processing**	2	4	8	14
4	**Instrumentation in Irrigation**	2	6	2	10
5	**Green houses & instrumentation**	2	6	4	12
	Total	**12**	**24**	**24**	**60**

List of experiments: Total 10-12 experiments(or turns) out of 15 experiments(or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	To study different bio sensors used in agro automation	02
2	2	CO2	To test soil resistivity moisture and salinity	02
3	3	CO3	To study flow diagram of dairy industry and instrumentation set up	02
4	4	CO4	To study application of SCADA for DAM and irrigation system.	02
5	5	CO5	To study heating cooling and ventilation control in Green house	02
6	6	CO2	To test soil pH, conductivity	02
7	1	CO3	To study juice extraction control set up	02
8	2	CO3	To study flow diagram of sugar industry and instrumentation set up	02
9	3	CO4	To study Auto drip irrigation systems	02
10	4	CO5	To study sprinkler irrigation systems	02
11	5	CO6	To study heating , temperature & humidity control in Green house	02
12	6	CO1	To study flow diagram of Juice extraction control process	02
13	5	CO2	To study UV biosensors in Green house	02
14	6	CO3	Case study on agriculture instrumentation	02
15	5	CO5	Case study on greenhouse instrumentation	02
			Total	**30**

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and Cos.Remaining experiments are to be performed as per importanceof the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Instrumentation handbook-process control	Bela G. Liptak., Published by Chilton, Philadelphia (1969)	9780801955198
2	Process control and instrumentation technology	C.D. Johnson Published by Wiley	9780471057895
3	Principle of Farm Machinery	Kepner, Robert Allen Publisher: Avi Pub. Co Publication Date: 1972	9780870551246
4	Agricultural Engineering	Jack Rudman Published by National Learning Corporation (2004)	9780837339467

5	Environmental Engineering	Jeffrey Jeffrey Peirce Published by Butterworth-Heinemann (2003)	9780750672948
6	Automatic Control for food processing system,	Moreira, Rosana G. Published by Springer (2001)	9780834217812

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3. https://www.eolss.net/Sample-Chapters/C18/E6-43-35-04.pdf
4. https://www.climatecontrol.com/blog/greenhouse-control-systems/
5. https://autogrow.com/your-growing-environment/automated-greenhouse

CO VsPO and CO Vs PSOMapping

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

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. H.K. Kadam	Rtd. HR Manager	RCF Ltd. Chembur
2	Mr S.R. Shiledar	Assistant Prof Instrumentation	Govt college of Engg. Jalgaon
3	Mr. F. S. Bagwan	Lecturer in instrumentation Engg.	Govt. Polytechnic Mumbai
4	Mr.U. B Shinde	Lecturer in instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
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I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code: **IS19406**				Course Title: **Advance Embedded Systems**						
Compulsory / Optional: **Optional**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30 Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
3	**2**	**--**	**5**	**60**	**20**	**20**	**--**	**25***	**25**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term

Rationale:

Embedded systems play a vital role in characterizing, developing as well as creating new processes in automation. They address several requirements of automation and thus enable highly project specific solutions. A new age of automation began with networking as a common place, the total networking of intelligent digital systems. In the future, machines should be able to control each other through new information and communication techniques. Production processes such as production, planning and service should be automatically optimized. The entire process should occur in real time as much as possible in order to achieve a self-organizing production system. This course intends to develop skills to maintain and build the automated and real time systems.

Course Outcomes: Student should be able to

CO1	Comprehend the meaning of embedded system
CO2	Interpret the various communication interfaces
CO3	Develop basic application circuits using Arduino board
CO4	Use memories and peripherals in basic embedded applications
CO5	Interpret the features of Real Time Operating System

Course Content Details:

Unit No	Topics / Sub-topics
1	**Basics of Embedded Systems** 1.1 Definition of Embedded System 1.2 Block Diagram of Embedded System 1.3 Embedded System Architectures: Von-Neumann/Harvard, RISC/CISC, DSP 1.4 Characteristics of Embedded Systems: size, performance, flexibility, maintainability, latency, throughput, correctness, processor power, power consumption, safety, NRE cost, cost 1.5 Classification of Embedded Systems: 1.5.1 Based on Performance of microcontroller: Small scale, Medium scale, Sophisticated 1.5.2 Based on performance and functional requirements: Real time, Standalone, Networked, Mobile

	1.6 Applications of Embedded Systems **Course Outcome: CO1 Teaching Hours : 06hrs Marks: 10 (R-04, U-04, A-02)**
2	**Communication Interfaces** 2.1 Modes of communication: Serial/Parallel, Synchronous/Asynchronous 2.2 Onboard Communication Interfaces: I²C, CAN, SPI, PSI 2.3 External Communication Interfaces: RS232, USB 2.4 Wireless Communication Interfaces: IrDA, Bluetooth, Zigbee (Features and basic principle, difference) **Course Outcome: CO2 Teaching Hours : 09 hrs Marks: 12 (R-02, U-06, A-04)**
3	**AVR Microcontroller** 3.1 Features of ATMega 328P Microcontroller and Arduino 3.2 Arduino: open source community 3.3 Arduino boards based on Atmrga328 Microcontroller 3.4 Functional Block Diagram of Arduino Uno 3.5 Functions of each pin of Arduino Uno 3.6 Arduino Programming 3.6.1 Data types, Variables, Operators 3.6.2 IO functions 3.6.3 PWM function 3.6.4 Random Functions 3.6.5 Interrupts 3.6.6 Serial Communication:RS232, I²C, SPI 3.7 Basic IO Interfacing 3.7.1 Sensors: Humidity, Temperature, Ultrasonic, PIR 3.7.2 Motors: DC, Servo, Stepper **Course Outcome: CO3 Teaching Hours : 13 hrs Marks: 14 (R-02, U-04, A-08)**
4	**System Memory and Peripherals** 4.1 Memory System Architecture 4.1.1 Cache Memory, Virtual Memory 4.1.2 Memory Management Unit 4.1.3 Address translation 4.2 Memory Technologies 4.2.1 SRAM, DRAM 4.2.2 ROM, EPROM, E²PROM, NVROM 4.3 Peripheral Devices 4.3.1 Watchdog Timer 4.3.2 DMA Controller **Course Outcome: CO4 Teaching Hours : 07 hrs Marks: 10 (R-02, U-04, A-04)**
5	**Real Time Operating System** 5.1 Types of Operating Systems: General purpose, RTOS, Soft/Hard RTOS 5.2 Architecture of an RTOS 5.3 Characteristics of an RTOS: Consistency, Scalability, Reliability, Performance, Predictability

	5.4 Tasks, process and threads 5.5 Multiprocessing and Multitasking: Co-operative, Preemptive, Non-Preemptive multitasking 5.6 Scheduling Algorithms: Preemptive, Non-Preemptive, Round Robin 5.7 Interrupt handling, Semaphore, Deadlock **Course Outcome: CO5 Teaching Hours : 10 hrs Marks: 14 (R-02, U-06, A-06)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Basics of Embedded Systems**	04	04	02	10
2	**Communication Interfaces**	02	06	04	12
3	**AVR Microcontroller**	02	04	08	14
4	**System Memory and Peripherals**	02	04	04	10
5	**Real Time Operating System**	02	06	06	14
	Total	**12**	**24**	**24**	**60**

List of experiments: Total 10-12 experiments(or turns) out of 15 experiments(or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Identify the family of given microcontrollers on the basis of IC number and architecture.	2
2	2	CO2	To study sensor information acquisition in Arduino IDE using USB serial interface.	2
3	3	CO3	To interface Humidity/ soil moisture sensor module with Arduino.	2
4	4	CO4	To read and write data in internal E^2PROM memory in Arduino board.	2
5	5	CO5	To study Rtuin OS or Duin OS or any other free RTOS for Arduino and test simple looping program.	2
6	1	CO1	Identify the different blocks and pins on given Arduino development board.	2
7	2	CO2	Interface GSM module with Arduino board using RS 232 interface to send and receive message.	2
8	3	CO3	To implement Voltmeter using Arduino Board.	2
9	4	CO4	To interface external SRAM memory using Arduino board.	2
10	3	CO3	Interface RTC module with Arduino board using I^2C to read time/ date and store data in SRAM.	2
11	4	CO4	To control Motor Speed using Arduino Board.	2
12	3	CO3	Interface Bluetooth module with Arduino board and transfer data to and fro.	2

13	4	CO4	To implement Ultrasonic Range Finder/level controller using Arduino Board.	2
14	4	CO4	To implement LPG Leakage Detector Board.	2
15	4	CO4	To implement Arduino Camera Interface.	2
			Total	**30**

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and COs. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Embedded System Architecture, Programming and Design	Rajkamal, McGraw Hill Education; 3rd edition, 2017	978-9332901490
2	An Embedded Software Primer	David E. Simon, Addison-Wesley Professional, 1st edition, 1999	978-0201615692
3	Introduction to Embedded Systems	Shibu K V, McGraw Hill Education India Private Limited; 2nd edition, 2017	978-9339219680
4	Embedded Systems	B Kanta Rao, Prentice Hall (I), 1st edition, 2011	978-8120340817
5	Embedded System Design	Steve Heath, Newnes, 2nd edition, 2002	978-0750655460
6	Arduino for Beginners: Essential Skills Every Maker Needs	John Baichtal, Que Publishing, 1st edition, 2013	978-0789748836
7	Introduction to Arduino: A piece of cake!	Alan G. Smith, CreateSpace Independent Publishing Platform, 1st edition, 2011	978-1463698348
8	Getting Started with Sensors	Kimmo Karvinen and Tero Karvinen, Maker Media, 1st edition, 2014	978-1449367084

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8. https://www.tutorialspoint.com/arduino/ index.htm
9. https://www.tutorialspoint.com/operating_system/index.htm

CO Vs PO and CO Vs PSO Mapping:

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

Industry Consultation Committee:

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4	Mr. F. S. Bagwan	Lecturer in Instrumentation Engg.	Government Polytechnic, Mumbai

Coordinator,
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Department of Instrumentation Engineering

Head of Department,
Department of Instrumentation Engineering

I/C, Curriculum Development Cell

Principal

Programme :**Diploma in Instrumentation Engineering (Sandwich Pattern)**										
Course Code:**IS19501**				Course Title: **Industrial Management & Entrepreneurship**						
Compulsory / Optional: **Compulsory**										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30Hrs)	TS1 (1 Hrs)	TS2 (1 Hrs)	PR	OR	TW	Total
3	**-**	**2**	**5**	**-**	**-**	**-**	**-**	**25***	**25**	**50**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term.

Rationale:

Diploma pass out students are normally placed at the supervisory or Junior Engineer level when they go to industries. they are act as link between higher management & workers to handle material and machinery to get the targeted output. This subject gives knowledge of managing different resources of the organizations effectively and as an Entrepreneur create a new idea of project & implement it to opens up many employment opportunities. This course deals with different aspects of management, which helps technician to manage the changed environment in the industry.

Course Outcomes: Student should be able to

CO1	Understand the different business types and management functions
CO2	Describe the functions of different departments
CO3	Explain industrial safety rules and act.
CO4	Manage purchase inventory and project
CO5	Develop the awareness about entrepreneurship and collect information of support systems to entrepreneur.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Overview of Business Management Process** 1.1 Definition of Business, 1.2 Types of Business- Service, Manufacturing & Trades 1.3 Globalization: introduction, Advantages & Disadvantages 1.4 Management- Various Definitions 1.5. Levels of Management 1.6. Basic Functions of Management- Planning, Organizing, Staffing, Directing & Controlling 1.7. Fourteen Principles of Management **Course Outcome:CO1 Teaching Hours :08 hrs**

2	**Topic Title: Organizational and Financial Management** 2.1. Organization- Definition and Types 2.2 Forms of Ownership, Proprietorship, Partnership, Joint Stock Company, Co-Operative Society, Government Sector. 2.3 Human Resource Management- Personnel management Definition & Functions. 2.4 Financial Management: Objectives, Capital types and Source of capital 2.5 Budgets: Types of budget, profit & loss account & Balance Sheet **Course Outcome:CO2 Teaching Hours :08 hrs**
3	**Topic Title: Industrial Safety and Management** 3.1. Causes of Accident 3.2. Safety Precautions 3.3. Introduction To: 3.4. Factory Act 1948 3.5. Workmen Compensation Act **Course Outcome:CO3 Teaching Hours :6 hrs**
4	**Topic Title: Materials and Project Management** 4.1. Inventory Management: Definition of Inventory and inventory Control, Objectives of Inventory Control 4.2. ABC Analysis, Graphical Representation 4.3. Economic Order Quantity (E.O.Q.): Graphical Representation and Calculation of E, O.Q. 4.4 Purchasing: Function of Purchasing 4.5 Project Management: Definition and Meaning of Project 4.6 Introduction to C.P.M & P.E.R.T, Preparation Of Network 4.7 Concept of Break-Even Analysis 4.8. Project Risk and Quality Management: Qualitative and Quantitative Analysis of Risks and Quality. **Course Outcome:CO4 Teaching Hours :10 hrs**
5	**Topic Title: Entrepreneurship & Business opportunity** 5.1. Definition of entrepreneur, entrepreneurship 5.2. Characteristics of entrepreneurship 5.3. Functions of entrepreneurship 5.4. Barriers of entrepreneurship 5.5 Identifying trends, opportunities and ideas of Business 5.6 Marketing Concept **Course Outcome:CO5 Teaching Hours:08 hrs**
6	**Topic Title: Scope and Support Systems** 6.1. Trading, Consultancy, Franchises, Service Sectors, Emerging Areas 6.2 Small Enterprises 6.2.1. Definition, Characteristics & Types 6.2.2. Problems Faced by SSI 6.2.3. Industrial Sickness- Causes & Corrective Measures 6.3. Functions & Supportive Institutes (MSME, SIDBI, DICS, SSIB, NSIC, MITCON, TCO's, MIDC) 6.4. Government Agencies **Course Outcome: CO5 Teaching Hours :5 hrs**

Term Work:

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	CO1	Study different Types of Business and List your interest and hobbies and list your business idea related to each interest.	2
2	2	CO2	Study of Different forms of organization and write procedure for training and recruitment	2
3	3	CO3	Make detail survey on Industrial Safety Act, describe any one act with one example	2
4	4	CO4	To represent the purchase Inventory using graphical representation and calculation using EOQ	2
5	5	CO5	Study of biography of successful entrepreneur indicating milestone achievement, summarize important trails.	2
6	6	CO5	Assess yourself as Entrepreneur to achieve success.	2
7	1	CO1	Select one product or service for business and describe how different than others.	2
8	2	CO2	Use internet or library to find out different sources of capital and budgets	2
9	6	CO5	Develop a project on a business opportunity incorporating as per standard format provided under guidelines of concern faculty. Components of project Report: One-page entire project Summary, introduction, project concept, promotors, process & technology, location and infrastructure, plant & machinery required, manpower, Raw Material, Market Survey, cost of project & sources of finance, project profitability, conclusion	4
10	5	CO5	Identify the market for your business, develop questionnaires to conduct primary data research, determine your course of action and determine competitor are, analyze each competitor in terms of price, facility, location, strength & weakness determine strategy to deal with each competitor.	4
11	4	CO4	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.	4
12	5	CO5	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.	2
13	all	all	A Case study on entrepreneur/Businessman	4
14	all	all	Make Report on Industry visit for study of business / entrepreneurship	4
			Total	**30**

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Industrial Engineering and Management	Dr. O. P. Khanna , Dhanpat Rai & Sons., New Delhi, 1980	9788189928353, 9788189928353
2	Industrial Management	Rustom S. Davar, Vikas publication, 1999	9780706999051
3	Industrial Management	Jhamb & Bokil , Everest Publication ,Pune., 2013	978-8176602044

4	Organization& Management	R. D. Aggarwal , Tata Mc'graw 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 How to prepare Project Report	J.B. Patel, D.G. Allampolly, EDI study material, Ahmedabad, Gujarat	----
7	A Manual on Business opportunity Identification &Selection	J.B. Patel, S.S. Modi, EDI study material, Ahmedabad, Gujarat	---
8	A Hand book of New Entrepreneurs	J.B. Patel, S.S. Modi, EDI study material, Ahmedabad, Gujarat	----
9	National Directory of Entrepreneur Motivator & Resource person	S.B. Sareen, H. Anil Kumar, EDI study material, Ahmedabad, Gujarat	----
10	New Initiative in Entrepreneurship Education & Training	J.B. Patel, S.S. Modi, EDI study material, Ahmedabad, Gujarat	---

E-References:

1. https://ndl.iitkgp.ac.in/
2. www. scribd.com
3. www.slideshare.net.com
4. htttps://nptel.ac.in

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	1	1	-	-	1	-	2	1	1
CO2	2	2	-	3	2	1	3	2	3
CO3	2	1	-	-	3	1	1	3	2
CO4	2	1	2	1	2	3	3	2	3
CO5	2	1	1	-	3	2	2	2	3

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr. P.P. Choudhary	Rtd Lecturer in Mechanical Engg. (Six-sigma Master Black belt.)	Govt. Polytechnic Mumbai
2	Mr. B.B. Kulkarni	Rtd Lecturer in Mechanical Engg.	Govt. Polytechnic Mumbai
3	Mr U. B. Shinde	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai
4	Ms. K.U. Waghmare	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

Head of Department
Department of Instrumentation Engg.

I/C, Curriculum Development Cell

Principal

Programme: Diploma in Instrumentation Engineering (Sandwich Pattern)										
Course Code: **IS19309**				Course Title: **Project**						
Compulsory / Optional: **Compulsory**										
Teaching Scheme and Credits				Examination Scheme						
TH	TU	PR	Total	TH (2:30 Hrs)	TS1 (1 Hr)	TS2 (1 Hr)	PR	OR	TW	Total
--	**--**	**4**	**4**	**--**	**--**	**--**	**--**	**50***	**50**	**100**

Rationale:

Diploma holder need to be capable of doing self-Study throughout their life as the technology is developing with fast rate. Student will be able to find out various sources of technical information and develop self-study techniques to prepare a project and write a project report. This subject is intended to teach students to understand facts, concepts and Techniques of measurement, control, its repairs, fault finding and testing, estimation of cost and procurement of material, fabrication and manufacturing of various items used in instrumentation field. This will help the students to acquire skills and attitudes so as to discharge the function of supervisor in industry and can start his own small-scale enterprise.

Course Outcomes: Students will be able to:

CO1	Implement the skills acquired in the previous semesters to solve complex engineering problems
CO2	Survey towards developing a solution/product which helps in life time learning
CO3	Test the designed project model and evaluate its performance
CO4	Communicate effectively in oral or written format to present the working of their project/product

G E N E R A L G U I D E L I N ES:

1. The Project groups of fifth semester will continue the project work in sixth semester and complete project in all respect (fabrication, assembly, development of control logic, implementation, testing, and validation.

2. The group should maintain a logbook of activities. It should have entries related to the work done, problems faced, solution evolved etc., duly signed by respective guide in every week.

3. The guides should regularly monitor the progress of the project work.

4. The project work along with project report should be submitted as part of term work in third year sixth semester on or before the term end date.

5. Project report must be submitted in the prescribed format only. No variation in the format will be accepted.

"Format of Project Report"

Major Contents:

i. Introduction
ii. Literature survey
iii. Detailed Theory: 1) Planning and design
2) Development and Implementation work
3) Methodology
4) Applications
5) Advantages and Disadvantages.
iv. Future scope
v. Conclusion
vi References.

(No. of copies of seminar report to be prepared = S+2, where S is no. of students in group.)

6. 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.

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	3						3	1	1
CO2		3			1		3	2	1
CO3			3	3			3	3	3
CO4						3	3	3	3

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Sagar Tinkhede	Functional Manager	GS E&C Mumbai Pvt Ltd
2	Mr. Tushar Shinde	Project Engineer	Emerson Automation solution Pvt. Ltd.
3	Mr. S.G. Thube	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai
4	Mr. U. B Shinde	Lecturer in Instrumentation Engg.	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of Instrumentation Engg.

Head of Department
Department of Instrumentation Engg.

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Instrumentation Engineering**										
Course Code:IS19408				Course Title: Scilab						
Compulsory / Optional: Compulsory										
Teaching Scheme and Credits				Examination Scheme						
TH	PR	TU	Total	TH (2:30 Hrs)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
--	**4#**	**--**	**4**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill test are to be conducted. First skill test at mid term and second skill test at the end of the term

Course Content Details:

Topics / Sub-topics
1. Introduction to Scilab and its benefits Outline: What is FOSS? Why FOSS ? About Scilab and its benefits Scilab is reliable Use of Scilab in CNES Use of Scilab for space mission analysis and flight dynamics Industrial application
2. Self learning of Scilab through Spoken Tutorials Outline: About Spoken Tutorial Created for self learning Dubbed in all 22 languages Scilab spoken tutorials 25 spoken tutorials on Scilab Side by side learning Spoken tutorial used as ..
3. The amazing resource of Scilab Textbook Companion Outline: Opensource software problem, no good documentation for FLOSS Solution: Textbook companion project Scilab code for standard textbooks Demo of Textbook companion Download Scilab
4. Scilab Lab migration, Toolboxes and Forums Outline: Lab migration Demo of Lab migration on FOSSEE Scilab website Download PDF for lab solution Scilab Toolboxes FOSSEE Optimisation toolbox available on atoms website IEEE paper ..
5. Installing Outline: Installing Show where to download from and how to decide which version to choose (OS and 32/64bit) (www.scilab.org/download) Windows installation (Internet Connection i..
6. Getting Started Outline: Getting Started *Expressions: Show mathematical expressions with numbers *Variables *Diary command *Define symbolic constants. *Basic functions *suppressing output(;) *he..
7. Vector Operations Outline: Vector Operations *Define vector *Calculate length of a vector. *Perform mathematical operations on Vectors such as addition, subtraction and multiplication. *Define a matrix...
8. Matrix Operations Outline: Matrix Operations *Access the elements of Matrix *Determine the determinant, inverse and eigen values of a matrix. *Define special matrices. *Perform elementary row operation.
9. Conditional Branching

Outline: Conditional Branching * 'if' and 'then' with the example * use of the 'else' keyword * use of the 'elseif' keyword * example for select

10. **Iteration**
    Outline: Iteration Explain syntax of 'for' statement- tell that the variable iterates over a list/vector/matrix (or an expression that evaluates to any of these). Give example: ..
11. **Scripts and Functions**
    Outline: Scripts and Functions *Introduction to the file formats in Scilab. *SCRIPT files. *sce versus .sci *Inline functions.
12. **Plotting 2D graphs**
    Outline: Plotting 2D graphs About linspace: linspace is a linearly spaced vector. Plot a simple graph: x=linspace(12,34,10), y=linspace(-.1,2,10), plot(x,y) plot2d Using clf() clear..
13. **Xcos Introduction**
    Outline: Xcos Introduction What is XCOS. What is palette. To collect the blocks from the palette and connect them to construct the block diagram. Set the parameters of different blocks..
14. **File handling**
    Outline: File Handling- Scilab File handling Writing to a file using write() Reading from a file using read() Opening an existing file using mopen() Closing an already opened file usi..
15. **User Defined Input and Output**
    Outline: User Defined Input and Output in Scilab Input Function. mprintf() save() and load() Used to quit scilab midway through calculation and continue at later stage.
16. **Integration**
    Outline: *Develop Scilab code for different Composite *Numerical Integration algorithms *Divide the integral into equal intervals *Apply the algorithm to each interval *Calculate the com..
17. **Solving Non linear Equations**
    Outline: Numerical methods- Solving Non- linear Equations Learn how to solve nonlinear equations using numerical methods Learn Bisection method Learn Secant method Learn h..
18. **Linear equations Gaussian Methods**
    Outline: * Explain Gauss Elimination method algorithm * Explain code for Gauss Elimination method and solve an example using this code * Explain Gauss Jordan method algorithm ..
19. **Linear equations Iterative Methods**
    Outline: 1. Solve system of linear equations using iterative methods 2. Use Jacobi and Gauss Seidel iterative methods 3. Learn how to iterate until we converge at the solution 4. Learn h..
20. **Interpolation**
    Outline: Numerical Interpolation Develop Scilab code for different Numerical Interpolation algorithms Calculate new value of function from given data points
21. **ODE Euler methods**
    Outline: Solving ODEs using Euler Methods 1. Solve ODEs using Euler and Modified Euler methods 2. Develop Scilab code to solve ODEs
22. ODE Applications
    Outline: Solving ODEs using Scilab ode Function Use Scilab ode function Solve typical examples of ODEs Plot the solution
23. Optimization Using Karmarkar Function
    Outline: * About Optimization * Use of Scilab function Karmarkar in Optimization
24. Digital Signal Processing
    Outline: Plotting continuous and discrete sine waves. Plotting step function. Plotting ramp function.
25. Control systems

Outline: 1. Define a continuous time system: second and higher order 2. Response plot for step input 3. Response plot for sine input 4. Bode plot 5. Study numer and denom Scilab function.

26. Discrete systems
    Outline: * Define discrete time system variable z * Define first order discrete time system * Explain ones, flts, dscr, ss2tf functions
27. Calling User Defined Functions in XCOS
    Outline: * Write a squaring function * Use of scifunc block in XCOS * Use of MUX block * Call functions having multiple inputs and outputs
28. Simulating a PID controller using XCOS
    Outline: Simulating a PID controller using Xcos: 1. Modifying firstorder.xcos file to implement a PID controller 2. Closing the loop 3. Setting PID gains and observing its response
29. Developing Scilab Toolbox for calling external C libraries
    Outline: Compiling an external C library Generating shared library Copying the shared library to Scilab Toolbox Interfacing the shared library with Scilab Understanding the important co..
30. Developing Scilab Toolbox for calling Python and its functions
    Outline: About Scithon toolbox About header folder Interfacing between Scilab and Python Files used for starting the python instance and overloaded virtual functions Links to understand.

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