GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

COURSE TITLE: CONTROL INSTRUMENTATION SYSTEM

(Code: 3341701)

Diploma Programmes in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	4th semester

1. RATIONALE

In the present industrial scenario, it is desired that instrumentation diploma engineers be able to identify, classify, troubleshoot and maintain the different Control Instrumentation Systems. They are required to implement the planned Plant Control Instrumentation Systems. Therefore, this course has been designed so that students may learn to build, test and wire the different types of Control Instrumentation Systems for Process Application.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency

- learn to types of control system, modes of control action, response of control system and stability of control system for Process Application

3. Course Outcomes:

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

I. Identify different types of control system
II. Determine transfer functions of simple systems by various methods
III. Determine stability of control systems using frequency response analysis (Bode plot/Polar plot/ Nyquist criteria).
IV. Use stability criteria (Routh, Hurwitz criteria) for system stability determination.
V. Analysis of simple system by time response method (up to second order & step input only)
VI. Interpret modes of control action.

4. Teaching and Examination Scheme

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment**.**

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I INTRODUCTION TO CONTROL SYSTEMS	1a. Define: Plant, Process, System, Control system, Servo system, Open loop control system, closed loop control system. 1b. Classify types of control system. 1c. Explain open loop control system with block diagram and example. 1d. Explain closed loop with block diagram and example. 1e. Compare open loop and closed loop system. 1f. Define transfer function. 1g. Derive Transfer Function for simple one tank and two tank level system. 1h. Obtain mathematical model of simple mechanical and electrical system. 1i. Compare differential equations for the mechanical translational system, mechanical rotational system and series/parallel electrical system and prepare table for analogous quantities in force- torque and voltage/current analogy. 1j. Define block diagram. 1k. List rules for block diagram reduction. 1l. Derive T.F. of a single loop closed loop control system. 1m. State Mason's gain formula.	1.1. Control System. 1.2. Open Loop and Closed Loop Control System 1.3. Transfer function 1.4. Mathematical model of simple mechanical and electrical control system and analogy. 1.5. Block diagram Algebra. 1.6. Signal Flow Graph.

Unit	Major Learning Outcomes	Topics and Sub-topics
	1n. Derive transfer function from given simple signal flow graph.	
Unit – II **TIME RESPONSE ANALYSIS OF CONTROL SYSTEM.**	2a. List and draw Standard test signals. 2b. Explain Standard test signals with their equations. 2c. Define time response, transient response, steady state response. 2d. Define Characteristic equation, Order of the system and Type of the system. 2e. Explain time response of 1 st order system with unit step input. 2f. Explain time response of 2 nd order system with unit step input. 2g. Draw time response of second order system with unit step input and define following terms- delay time t_d, rise time t_r, peak time t_p, maximum overshoot Mp, settling time ts.. 2h. Describe steady state error and error constant of control system for step, ramp, parabolic input and type-0, 1, 2 systems.	2.1. Standard test signals. 2.2. Time response. 2.3. Time Response of first order system to step input. 2.4. Time Response of second order system to step input. 2.5. Time Response specifications of the second order system. 2.6. Steady-state errors and error constants
Unit – III **CONCEPT OF STABILITY**	3a. Describe concept of stability. 3b. Classify Control system stability according to location of the roots of characteristic equation (poles of the system). 3c. State necessary conditions for stability. 3d. State Routh-Hurwitz Criteria for stability. 3e. Determine stability of given characteristic equation using Routh-Hurwitz Criteria. 3f. Describe concept of root locus in brief	3.1. Stability 3.2. Routh-Hurwitz Criteria for stability. 3.3. Introduction to Root Locus Concept.

Unit	Major Learning Outcomes	Topics and Sub-topics
	3g. State the rules for construction of Root Locus.	
Unit – IV **FREQUENCY RESPONSE ANALYSIS**	4a. Describe concept of Polar plot in brief. 4b. Describe concept of Bode plot in brief. 4c. Define gain margin and phase margin. 4d. State Nyquist stability statement. 4e. Describe concept of Nyquist stability criteria in brief.	4.1. Polar plot 4.2. Bode plot 4.3. Gain Margin & Phase Margin 4.4. Nyquist Stability Criterion.
Unit – V **MODE OF CONTROL ACTION**	5a. Define Process terminologies 5b. Classify modes of control action. 5c. Explain two positions, Multi position, P, I, D and composite mode control action. 5d. Sketch output for various modes of control action for step changes only. 5e. Compare various modes of control action. 5f. Define feed forward, cascaded control, Spilt range control and Ratio control system.	5.1. Process terminologies: process equation, process load, process lag, self regulation, measurement lag, control lag, transportation lag, dead time, cycling 5.2. Discontinuous and continuous modes control action 5.3. Concept of Two position ,Multi position control action 5.4. Concept of P, I, D, P+I, P+D, P+I+D mode of control action. 5.5. Introduction to feed forward, cascaded, Spilt range, Ratio control system.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	INTRODUCTION TO CONTROL SYSTEMS	12	7	10	4	21
II	TIME RESPONSE ANALYSIS OF CONTROL SYSTEM	10	6	6	2	14
III	CONCEPT OF STABILITY	06	4	08	2	14
IV	FREQUENCY RESPONSE ANALYSIS	06	4	4	2	10
V	MODE OF CONTROL ACTION	08	2	4	5	11
	Total	42	23	32	15	70

Legends: R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills **(Outcomes in cognitive, psychomotor and affective domain)** so that students are able to acquire the competencies. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain*

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	Identify various control parameters viz. set point, controlling variable, actuating signal, controlled variable, manipulated variable etc. in a given control loop.	02
2	I	Identify various blocks of a given open loop system.	02
3	I	Identify various blocks of a given closed loop system	02
4	I	Convert an open loop system in to a closed loop and observe the difference in output using control simulator.	02
5	I	Obtain mathematical model for a single tank system and compare the same with control simulator derived.	02
6	I	Obtain mathematical model for two non-interacting tank system and compare it with control simulator derived.	02
7	I	Obtain mathematical model for two interacting tank system and compare it with control simulator derived.	02
8	I	Obtain transfer function of given electrical systems.	02
9	I	Obtain transfer function of given mechanical systems.	02

10	I	Obtain equivalent voltage analogous system (series electrical system) from given mechanical translational motion system (mass-spring-dashpot).	02
11	I	Obtain equivalent current analogous system (parallel electrical system) from a given mechanical translational motion (mass-spring-dashpot) system.	02
12	I	Obtain equivalent voltage analogous system (series electrical system) from given mechanical rotational motion system.	02
13	I	Obtain equivalent current analogous system (parallel electrical system) from given mechanical rotational motion system.	02
14	I	Derive transfer function for a given block diagram using control simulator.	02
15	I	Derive transfer function using signal flow graph with control simulator.	02
16	II	Observe output of first order system with control simulator. Compare it with theoretical output and find out reasons if there is any difference.	02
17	II	Observe output of second order system with control simulator. Compare it with theoretical output and find out reasons if there is any difference.	02
18	II	Compare various parameters of time response and frequency response for given system using control simulator.	02
19	II	Calculate Kp, Kv, Ka error constant for a given type -0 system .	02
20	II	Calculate Kp, Kv, Ka error constant for a given type -1 system..	02
21	II	Calculate Kp, Kv, Ka error constant for a given type -2 system.	02
22	II	Calculate t_d, t_r, t_p, M_p, t_s, e_{ss} for a given second order system.	02
23	III	Find out roots of a given transfer function and decide stability.	02
24	III	Determine stability for various system using Hurwitz criteria.	02
25	III	Determine stability for various system using Routh criteria.	02
26	IV	Obtain root locus for a given system using control simulator.	02
27	IV	Obtain bode plots for a given system using control simulator and calculate gain margin and phase margin.	02
28	IV	Observe the effect of increasing and decreasing gain margin and phase margin for given system using control simulator.	02
29	IV	Obtain nyquist plot for a given system using control simulator.	02
30	IV	Obtain polar plot for a given system using control simulator.	02
Total			**60**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- Do analysis of First & Second Order Control System using various free control simulators.
- Develop simple program for different control actions.
- Use Internet Surfing relevant to Automation & Control Systems.
- Prepare Presentation on given topics.

9. SPECIAL INSTRUCTIONAL STRATEGIES

i. Visit to Industries.

ii. Use Free Simulators Software for teaching / learning activities.

iii. Show Video/Animation Films relevant to Automation & Control System.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Control Systems Engineering	Nagrath & Gopal	New Age International
2.	Linear Control System	B.S.Manke	Khanna publication
3.	Feed back Control Systems	Dr. S D. Bhide & Barapte	Tech max Publication
4.	Control Systems Engineering	S.K. Bhattcharya	Pearson Education
5.	Process Control Instrumentation Technology	C.D. Johnson	PHI
6.	Automatic Control system	Syed Hasan Saeed	S.K. Kataria &Sons

B) List of Major Equipment/ Instrument with Broad Specifications

- Process Control Trainer
- Process control simulator

B) List of Software/Learning Websites:

MATLAb,
Labview

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. Z. Shyara**, Sr. Lecturer, IC, A.V.P.T.I. Rajkot
- **Prof. R. J. Dhruv** , Sr. Lecturer, IC, A.V.P.T.I., Rajkot
- **Prof. N. B. Mehta**, Sr. Lecturer, IC, GP, AHMEDABAD
- **Prof. R. P. Raiyani**, I/C Head, Christ Polytechnic Institute Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.
- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Department of Electrical and Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PROGRAMMABLE LOGIC CONTROLLER AND DISTRIBUTED CONTROL SYSTEM
(Code: 3341702)

Diploma Program in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	4th Sem

1. RATIONALE

Different logical process automation is used for optimum controlling of the process parameters and hence Diploma Engineers should be able to maintain them. This requires that they should know very well about logical control action fundamentals. Hence this curriculum has been designed so that the students will be able to explain the construction, working and applications of various logical control strategies for automation.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- O**perate and Maintain programmable logical controllers and distributed control system.**

3. COURSE OUTCOMES

i. Identify logical process control in automation (PLC and DCS based automation).
ii. Connect the PLC peripherals with the PLC for logical functioning.
iii. Develop basic PLC programmmes.
iv. Maintain PLC.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit
ESE - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Logical Process control in automation	1a. Describe different process control techniques. 1b. Explain the working of data logger, DDC, SCADA. 1c. Justify need of automation in industry.	1.1. Introduction to process control 1.2. Continuous Process Control 1.3. Discrete-state Process Control 1.4. Composite Process Control 1.5. Data logger, DDC, SCADA 1.6. Scope of automation in industry.
Unit – II PLC architecture	2a. Draw Block diagram of PLC. 2b. Describe PLC architecture. 2c. Explain the working of PLC. 2d. List the steps to configure the PLC. 2e. List out peripherals for PLC 2f. Draw basic symbols used for PLC. 2g. Describe selection criteria for PLC. 2h. State advantages and Disadvantages of PLC. 2i. List out PLC applications in industries and automation systems.	2.1. Introduction to PLC 2.2. Configuration of PLC(components for modularized PLC) 2.3. Architecture of PLC 2.4. Working of PLC 2.5. PLC peripherals 2.6. PLC symbols 2.7. Selection criteria of PLC 2.8. Advantages and disadvantages of PLC 2.9. PLC applications
Unit – III PLC peripherals and wiring	3a. Identify analog input /output module for PLC. 3b. Identify digital input /output module for PLC. 3c. Describe analog input /output module. 3d. Describe digital input /output module. 3e. Explain and Interface analog/digital input/output module (including wiring) with PLC. 3f. Draw connection diagram to	3.1. Analog input/ output module 3.2. Digital input/ output module 3.3. Switching devices (level, pressure, flow, temperature, timer, proximity switch). 3.4. PLC input/output connection. 3.5. PLC power connection (wiring). 3.6. Isolated and non isolated input/output wiring to PLC.

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	connect the switching devices with PLC. 3g. Describe the isolation technique. 3h. Draw the Isolated and non-isolated input wiring to PLC. 3i. Explain the Isolated and non isolated input wiring to PLC.	
Unit – IV Basic PLC programming	4a. Describe general programming procedure. 4b. List special key board and display functions of hand-held programmer 4c. List the steps to upload ON-line, OFF-line program by hand-held programmer 4d. List the steps for Programming sequence of PLC. 4e. Describe the legal (proper) / illegal (improper) PLC ladder diagram 4f. List the important scanning considerations for PLC. 4g. List the corrective steps to be taken in case of PLC operational fault. 4h. Develop Relay based logical functions. 4i. List out different types of PLC Programming languages. 4j. Develop Ladder logic for NOT, AND, OR, NAND, Ex-OR, Ex-NOR logic. 4k. Develop ladder logic for given Boolean algebraic equation. 4l. Develop Ladder logic for holding contact. 4m. Develop ladder logic for simple and complex branching	4.1. Introduction to General PLC Programming Procedures. 4.1.1 Programming equipment- Hand held programmer *4.1.2* Programming sequence 4.1.3 PLC Ladder Diagrams 4.1.4 Process scanning consideration 4.1.5 PLC operational fault. 4.2. NOT ,AND, OR, NAND, NOR, Ex-OR, Ex-NOR logic. 4.3. PLC Programming languages. 4.4. Boolean algebraic equation. 4.5. Holding (latching relay) contact. 4.6. Branching and complex branching ladder rung. 4.7. Temperature control using ladder logic.

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	ladder rung. 4n. Develop ladder logic for ON-OFF temperature control using timer and limit switches.	
Unit – V Distributed Control System (DCS)	5a. Explain concept of DCS. 5b. Draw Hierarchy of DCS. 5c. Describe Hierarchy of DCS. 5d. List functions of each level of DCS. 5e. Describe functions of each level of DCS. 5f. State Strengths and limitations of DCS. 5g. Explain network topology for DCS. 5h. Describe different display of DCS.	5.1. Introduction to DCS. 5.2. History of DCS. 5.3. Concept of DCS. 5.4. Hierarchy of DCS. 5.5. Functions of each level of DCS. 5.6. Network topology for DCS. 5.7. Display organization (Monitoring facilities) for DCS.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Logical Process control in automation	04	01	02	04	07
II	PLC architecture	08	02	04	08	14
III	PLC peripherals and wiring	08	02	04	08	14
IV	Basic PLC programming	12	03	06	12	21
V	Distributed Control System	10	02	04	08	14
Total		**42**	**10**	**20**	**40**	**70**

Legends: R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
1.	I	Identify continuous, discrete control and composite control system.	2
2.	I	Connect direct digital control for a process.	2
3.	I	Connect data logger to a process.	2
4.	I	Identify components of SCADA.	2
5.	II	Prepare PLC specification for given situation for automation.	2
6.	II	Identify various modules and component of PLC hardware.	2
7.	III	Assemble various modules and component of PLC to make a PLC system.	2
8.	III	Wire given level control system for automation.	2
9.	III	Wire given temperature control system for automation.	2
10.	III	Wire given flow control system for automation.	2
11.	IV	Use relay as a switch to make circuit ON.	2
12.	IV	Implement NOT, AND & OR logic using relay(s).	2
13.	IV	Implement NAND & NOR logic using relay(s).	2
14.	IV	Implement EX-OR & EX-NOR logic using relay(s).	2
15.	IV	Identify programming formats and proper construction of ladder diagrams of given PLC.	2
16.	IV	Build NOT, AND & OR logic using ladder diagram with the help of PLC.	2
17.	IV	Build NAND & NOR logic using ladder diagram with the help of PLC.	2
18.	IV	Build EX-OR & EX-NOR logic using ladder diagram with the help of PLC.	2
19.	IV	Develop ladder diagram to prepare latching relay.	2
20.	IV	Develop ladder to switch ON motor for given condition	2
21.	IV	Develop ladder diagram for given level control system using	2

		level switch	
22.	IV	Develop ladder diagram for given temperature control system using temperature switch	2
23.	IV	Develop ladder diagram for given flow control system using flow switch	2
24.	V	Identify various level of distributed control system	2
25.	V	Indentify various display of distributed control system	2
26.	V	Connect personal computers in network using ring topology	2
27.	V	Connect personal computers in network using star topology	2
Total hours			54

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i. Assemble PLC power supply PLC, Input / Output module on mounting rack.
ii. Wire automatic level control system using various components.
iii. Wire automatic temperature control system using various components.
iv. Wire automatic flow control system using various components.
v. Connect personal computer using star topology.
vi. Connect personal computer using ring topology.

9. SPECIAL INSTRUCTIONAL STRATEGIES

i. **V**isits to Industries.
ii. Use free simulators for PLC programming in the class when teaching.
iii. Video films/animation films on working of different type automatic system such as PLC, DDC, SCADA and DCS, from YouTube and other resources.
iv. Mini project.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1	Programmable logic Controllers Principles and applications	John w. Webb Ronald A Reis	PHI Learning,
2	Programmable logic Controllers Programming methods and applications	John R Hackworth Frederick D. Hackworth Jr.	Pearson
3	Process Control Principles and applications	Surekha Bhanot	Oxford University press
4	Instrumentation engineer's handbook	B.G Liptak	Chilton Book Co., Philadelphia
5	Process control Instrumentation technology	Curtis D Johnson	PHI pvt. Ltd.

B) List of Major Equipment/ Instrument with Broad Specifications

i. Electrical tool kit
ii. Multi-meter
iii. Master PLC with Power supply and Hand held PLC programmer (touch screen teach pendent).
iv. Slave PLC with Power supply and Hand held PLC programmer.
v. 24 analog input module (8 analog input module 3NO.)
vi. 24 analog output module (8 analog output module 3NO.)
vii. 24 digital input module (8 digital input module 3 NO.)
viii. 24 digital output module (8 digital output module 3 NO.)
ix. level switches
x. temperature switches
xi. flow switches
xii. 3" conveyor system operated 12V DC motor with digital shaft encoder
xiii. Proximity switches (Inductive, Optical, motion, light etc.)
xiv. 12 V DC motor with digital shaft encoder
xv. PLC based Automatic bottle filling plant
xvi. Flow, temperature, level control setup for PLC based automation using Flow, temperature, level switches.

C) List of Software/Learning Websites

i. www.control.com
ii. www.wikipedia.org
iii. www.youtube.com
iv. www.ourinstrumentationgroup.com
v. www.googlebooks.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R. P. Merchant** HOD IC Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. A. K. Bilakhia** Lecturer IC Engineering, Govt. Polytechnic, Gandhinagar
- **Prof**. **N. B. Mehta** Lecturer IC Engineering, Govt. Polytechnic, Ahmedabad
- **Prof. S. K. Raval**, Lecturer IC Engineering, Govt. Polytechnic, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.
- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Department of Electrical and Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

COURSE TITLE: PROCESS INSTRUMENTATION-I

(Code: 3341703**)**

Diploma Programmers in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	4th semester

1. RATIONALE

In the present industrial scenario, role of the process instrumentation is becoming more important day by day. More advanced, precise and complex instrumentations are being employed in the industry. Diploma engineers should therefore be able to identify, classify, troubleshoot and maintain the different process instrumentation systems. Therefore, this course has been designed so that students will learn to build, test and wire the different types of process instrumentation required for processing plants mainly for the process parameter such as pressure, flow, speed, humidity / moisture.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Operate and Maintain different types of process instrumentation systems.**

3. COURSE OUTCOMES:

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Observe and obtain the accurate reading of process instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
ii. Correlate between Different types of pressure.
iii. Specify instrumentation for a given Pressure, flow, speed, moisture / Humidity application.
iv. Identify, describe and calibrate major instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
v. Describe the purpose and function of process instrumentation of Pressure, flow, speed, moisture / Humidity in a process plant.
vi. Identify the main installed instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
vii. Identify sub components of the main instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
viii. Draw schematic diagram of process instrumentation for Pressure, flow, speed, moisture / Humidity in a process plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment**.**

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Introduction to measurement	1a. Define Measurement & state its types. 1b. State and explain unit system. 1c. Define Error. 1d. List types of error. Explain each. 1e. List standards of measurement. 1f. Give importance of standards of measurements.	1.1 Introduction to Measurement. 1.2 Fundamental and derived units. 1.3 Error classification. 1.4 Standards of measurements.
Unit – II Pressure Measurement Techniques	2a. State importance of pressure measurement in process industries. 2b. Enlist and define different types of pressure. 2c. List out different pressure measuring units and show relations among them. 2d. Explain working principle and construction for various pressure measuring devices with neat sketch and also with its merits and demerits. (2.4 to 2.8). 2e. List applications for pressure devices (2.4 to 2.10). 2f. Describe pressure switch with schematic diagram. 2g. Describe dead weight tester with schematic diagram. 2h. Explain Pressure Transmitter with neat schematic diagram./block diagram.(2.11 to2.13).	2.1. Pressure measurement. 2.2. Types of pressure: static, dynamic, absolute, differential, atmospheric, gauge pressure, vacuum. 2.3. Pressure units. 2.4. Manometers : U type, well type, inclined type, ring type, Float type, Barometer 2.5. Pressure sensing elements :Bellows, Diaphragm, Bourdon Tube 2.6. Electrical pressure sensors: - LVDT type, strain gauge, Piezo electric type, Capacitance type. 2.7. Optical type Pressure Transducer. 2.8. Vacuum sensors:-Thermal Conductivity gauge, Pirani Gauge, Ionization Gauge, McLeod's gauge. 2.9. Pressure switch. 2.10. Dead weight tester. 2.11. Pneumatic Differential pressure transmitter 2.12. Electronic differential pressure transmitters: - Capacitive and Strain Gauge

Unit	Major Learning Outcomes	Topics and Sub-topics
		type. 2.13.Smart/Intelligent Pressure Transmitter.
Unit – III Flow Measurement Techniques	3a. State importance of flow measurement in process industries. 3b. Define terminologies and characteristics for flow measurement (3.2) 3c. Define Reynolds's number. 3d. Enlist and define different types of Flow (Turbulent and Laminar Flow) 3e. Derive Bernoulli's theorem with flow equation for incompressible fluids. 3f. Explain pressure profile through orifice plate drawing schematic diagram. 3g. Enlist units of flow measurement. 3h. Classify flow measuring methods. 3i. Factors consideration for flow meter selection. 3j. Explain detail construction for Orifice plate, flow nozzle, Venturi tube. Pitot tube. 3k. Explain working principle and construction for target flow meter. 3l. Explain working principle with construction for various flow measuring devices (3.6 to 3.13). 3m. List out merits and demerits of flow measuring devices.(3.5 to 3.13). 3n. List out applications of flow measuring devices.(3.5 to 3.13) 3o. Enlist types of venturi tube. 3p. State the rules for Installation of head flow meters. 3q. Enlist types of flow switch. 3r. Describe flow switch. 3s. Explain Differential Pressure type flow Transmitter with neat schematic diagram./block diagram. 3t. State need of Square root extractor in flow measurement.	3.1. Introduction to flow measurement. 3.2. Flow measurement terminologies: specific gravity, density, viscosity, compressibility, effect of pressure and temperature on flow measurement. 3.3. Measurement of flow rate in closed pipe using Bernoulli's theorem. 3.4. Turbulent and Laminar Flow, Reynolds's number. 3.5. Differential Flow sensing elements: Orifice plate, flow nozzle, Venturi tube. Pitot tube, Target. 3.6. Variable area meter: Rotameter. 3.7. Magnetic flow meters. 3.8. Ultrasonic flow meters. 3.9. Turbine flow meter. 3.10. Thermal flow meter. 3.11. Vortex flow meter. 3.12. Mass flow meter. 3.13. Positive displacement meters: Piston cylinder type, Nutating disc, Rotating vane. 3.14. Flow switches. 3.15. Flow transmitters (Pneumatic and Electronic).

Unit	Major Learning Outcomes	Topics and Sub-topics
	3u. Enlist calibration methods for flow measurement.(liquid, gas)	
Unit – IV SPEED Measurement Techniques	4a. Define speed with units and classify it. 4b. List and explain speed measurement methods (4.2to4.5). 4c. List industrial application of tachometers.	4.1. Introduction to Speed measurement. 4.2. Mechanical tachometer: Revolution Counter, Resonance. 4.3. Electrical tachometer: D.C. tachometer, A. C. tachometer, Induction sensor tachometer, Magnetic tachometer (Eddy current). 4.4. Optical method: photo electric method. 4.5. Stroboscopic tachometer.
Unit – V Moisture And Humidity Measurement Techniques	5a. Define Moisture and Humidity with units. 5b. Define terminologies for humidity: relative humidity, absolute humidity, dew point, specific humidity, and hygrometer. 5c. Importance of moisture and humidity measurement in process industries. 5d. Explain different hygrometer with schematic diagram (5.2 to 5.6).	5.1. Introduction to Moisture and Humidity. 5.2. Wet and dry bulb type hygrometer. 5.3. Hair hygrometer method 5.4. Thin film capacitance type hygrometer method. 5.5. Electrolytic hygrometer method 5.6. Infrared absorption hygrometer method.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to measurement	**04**	**2**	**4**	**1**	**07**
II	Pressure Measurement Techniques	**12**	**6**	**10**	**5**	**21**
III	Flow Measurement Techniques	**16**	**8**	**14**	**6**	**28**
IV	Speed Measurement Techniques	**05**	**2**	**3**	**2**	**07**
V	Moisture And Humidity Measurement Techniques	**05**	**2**	**3**	**2**	**07**
	Total	**42**	**20**	**34**	**16**	**70**

Legends: R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	II	Measure a given unknown pressure using U-tube Manometer.	02
2	II	Measure a given unknown pressure using Well-type Manometer.	02
3	II	Measure Pressure Measurement using C-type Bourdon Tube Pressure Gauge.	02
4	II	Measure Pressure Measurement using Bellows type Pressure Gauge.	02
5	II	Measure Pressure Measurement using Diaphragm type Pressure Gauge.	02
6	II	Test and calibrate a given pressure gauge using Dead Weight Tester.	02
7	II	Measure Pressure Measurement using LVDT type Pressure Transducer.	02
8	II	Measure Pressure Measurement using Strain Gauge type Pressure Transducer.	02
9	II	Measure Pressure Measurement using Peizo-electric type Pressure Transducer.	02
10	II	Measure Pressure Measurement using Capacitance type Pressure Transducer.	02
11	II	Test and Calibrate Capacitive type Differential Pressure Transmitter.	02
12	II	Identify electrical contact configurations used in pressure switches.	02
13	II	Demonstrate the operation of pressure switch.	02
14	III	Measure Flow using Orifice Plate.	02
15	III	Measure Flow using Flow Nozzle.	02
16	III	Measure Flow using Venturi Tube	02
17	III	Measure Flow using Pitot Tube.	02
18	III	Measure Flow using Rotameter.	02
19	III	Measure Flow using Magnetic Flow meter.	02
20	III	Measure Flow using Vortex Flow meter.	02
21	III	Measure Flow using Turbine Flow meter.	02
22	III	Measure Flow using ultrasonic Flow meter.	02
23	IV	Measure Speed using Mechanical Tachometer.	02
24	IV	Measure Speed using A.C. Tachometer.	02

25	IV	Measure Speed using D. C. Tachometer.	02
26	IV	Measure Speed using Magnetic Tachometer.	02
27	V	Measure Humidity using Hair Hygrometer.	02
28	V	Measure Humidity using Wet & Dry Bulb Hygrometer.	02
29	V	Measure Humidity using Thin film Capacitance Hygrometer.	02
30	V	Measure Humidity using Electrolytic Hygrometer.	02
31	V	Measure Humidity using Infrared Absorption Hygrometer.	02
Total			**62**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- Industrial Visit for students (chemical industries, petroleum industries, production industries)
- Small technical projects based on theory topic.

9. SPECIAL INSTRUCTIONAL STRATEGIES

Videos/Animation for different devices should be shown.
Seminar on relevant topics.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Process Measurement and Analysis	B. G. Liptak	I.S.A
2.	Industrial Instrumentation	D. P. Eckman	Wiley Eastern Limited
3.	Industrial Instrumentation	S.K. Singh	Tata Mc Graw Hill
4.	Mechanical Measurements	D. S. Kumar	Metropolitan Book Company
5.	Process Instrumentation and Control	A.P.Kulkarni	Nirali Prakashan
6.	Mechanical and Industrial measurements	R.K. Jain	Khanna publication
7.	Industrial Instrumentation	K. Krishnaswamy and S. Vijayachitra,	New Age International Publication.

B) List of Major Equipment/ Instrument with Broad Specifications

- Function generator(sine, square, triangle etc. with frequency range 10 Hz to 100 kHz)
- DC power supply (-30 →0→+30 V with at least 1A current capacity)
- Measuring equipments like CRO (preferably dual channel, 20Mhz)
- Multi meter
- Electrical tool kit.
- Circuit/Trainer board/ Demonstration modules of Manometers
- Dead Weight Tester,
- Pressure Switches,
- Pressure Gauges,
- Strain Gauge type Pressure Transducer
- Capacitance type Pressure Transducer

- LVDT type Pressure Transducer
- Electronic differential pressure transmitters
- Pneumatic Differential pressure transmitter
- Smart/Intelligent Pressure Transmitter
- Universal Calibrator
- Air Compressor
- Pirani Gauge
- Ionisation Gauge
- Different types of Flow Elements like Orifice
- Venturi Tube
- Flow Nozzle
- Pitot tube flow trainer.
- Rotameter
- Magnetic Flow Meter
- Ultrasonic Flow Meter
- Flow Trasmitters
- Flow Totalizers
- Flow counter.
- Flow Switches.
- Contact & Non-contact type Tachometers
- A.C. Tachometer
- D. C. Tachometer
- Magnetic Tachometer
- Photoelectric Tachometer
- Stroboscopic Tachometer.
- Hair Hygrometers
- Wet & Dry Bulb Hygrometers.
- Electrolytic Hygrometers.
- Infrared Absorption Hygrometer.

B) List of Software/Learning Websites

i.http://en.wikipedia.org/wiki/Pressure_measurement
ii.http://www.ni.com/white-paper/13034/en/
iii.http://www.omega.com/literature/transactions/volume3/pressure.html
iv.http://en.wikipedia.org/wiki/Flow_measurement
v.http://www.pc-education.mcmaster.ca/Instrumentation/flow.htm

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R. J. Dhruv** Sr. Lecturer , A.V.P.T.I. Rajkot
- **Prof. S. Z. Shyara** Sr. Lecturer , A.V.P.T.I. Rajkot
- **Prof. R. P. Raiyani** I/C H.O.D I.C Christ Polytechnic Institute, Rajkot
- **Prof. H. P. Patel** Lecturer, Government Polytechnic, Ahmedabad.

Coordinator and Faculty Members from NITTTR Bhopal

- Prof. **(Mrs.) Susan S. Mathew,** Associate Professor**,** Department of Electrical and Electronics Engineering.
- Prof. **Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: BIOMEDICAL INSTRUMENTATION
(Code: 3341704)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	4th semester

1. RATIONALE

The use of Biomedical instruments are increasing day by day in health care. Now days 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. Hence this course has been designed to develop some of the basic skills in operation, test and maintenance of various biomedical instruments.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Operate and calibrate biomedical instruments.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Operate biomedical instruments used in hospital
ii. Calibrate biomedical instruments used in hospital
iv. Test different biomedical instruments used in hospital
v. Understands different bio signals / potentials

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Fundamentals of Medical Instruments	1a. List the Sources of biomedical signals. 1b. Explain generation of bio-potential in human body. 1c. Draw and explain generalized block diagram of medical instrumentation system. 1e. Describe the features of the ECG/ EEG/ EMG/Defibrillator electrodes drawing schematic diagram. 1f. Explain the different types of medical transducers used in medical instruments for Body temperature, Blood pressure, and respiration rate. 1g. Explain the working of the indirect blood pressure measurement instrument (sphygmo-manometer). 1h. Classify medical instruments based on different principles with Application Viz - (diagnostic, therapeutic, Imaging, analytical) , Physiological parameter and bio-potential , Biological system , Different departments in the hospital.	1.1 Fundamentals of medical instrumentation. ▪ Sources of biomedical signals ▪ Generalized medical instrumentation block diagram. ▪ Medical electrodes - ECG,EEG,EMG , Defibrillator ▪ Medical transducers: Body temperature, Blood pressure, respiration rate 1.2 Classification of Medical instruments based on: • Application - (diagnostic, therapeutic, Imaging, analytical) • Physiological parameter and bio-potential • Biological system • Different departments in the hospital
Unit – II Biomedical Recorders	2a. Describe working principle of Electrocardiograph with a block diagram. 2b. Drawing a ECG waveform with labels describe relating cardiac activity of the heart. 2c. Explain bipolar and unipolar leads used for ECG measurements. 2d. Explain Einthoven's triangle. 2e. Explain working of phono-cardiograph. 2f. Describe 10-20 electrode placement method used for EEG. 2g. Explain working principle of Electro encephalograph. 2h. Draw block diagram and describe the working principle of EMG. 2i. Drawing block diagram explain bio- feedback instrumentation.	2.1 Electro-cardiograph(ECG) machine • ECG block diagram • Bipolar and unipolar leads • Phono-cardiograph 2.2 Electro-encephalograph (EEG). • 10-20 electrode placement system • EEG readout device 2.3 Electro-myograph (EMG) machine. 2.4 Bio-feedback Instrumentation

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – III Medical Imaging Equipments	3a. List and explain characteristics of x-ray. 3b. Explain generation of an X-ray. 3c. Describe working of an X-ray machine with block diagram. 3d. Describe working of a CT scan machine with block diagram. 3e. List properties of ultrasound and its applications in medical instrumentation. 3f. Draw block diagram and describe working of an ultrasonic foetal monitor. 3g. List the types of Transducers used in Ultrasonic foetal monitor. 3h. Describe working of an echo-encephalography machine with block diagram. 3i. Describe working of an echo-cardio graph machine with block diagram. 3j. Describe working of a colour Doppler ultrasound machine with block diagram.	3.1 X-ray machine. 3.2 CT-Scan machine. 3.3 Properties of ultrasound 3.3 Ultrasonic foetal monitors. 3.3 Echo-encephalography. 3.4 Echo-cardiograph. 3.5 Colour Doppler ultrasound machine.
Unit– IV Surgical & Therapeutic Instruments	4a. Describe working of an electro-surgery machine with block diagram and the safety precautions to be taken. 4b. Describe working of a Hemo-dialysis machine with block diagram. 4c. Describe working of a Muscle Stimulators machine with block diagram. 4d. Describe working of a Defibrilator Machine with block diagram and the safety precautions to be taken. 4e. Describe the electrodes of a Defibrilator Machine with diagram.	4.1 Electro-surgery machine (cautery) 4.2 Hemo-dialysis machine 4.3 Muscle stimulators 4.4 Defibrilator Machine
Unit – V Medical Laboratory Instruments	5a. List the pathological (clinical) test Instruments for medical diagnosis. 5b. Draw the block diagram and describe working of a blood cell counter with schematic diagram. 5c. Draw the block diagram and describe working of a bio-chemistry analyzer. 5d. Draw the block diagram and describe working of an auto analyzer. 5e. Draw the block diagram and describe working of a blood gas analyzer.	5.1 Types of test •Blood cell • Bio chemistry 5.2 Blood Cell Counter 5.3 Bio chemistry analyzer. 5.4 Auto analyzer. 5.5 Blood gas analyzer.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Medical Instruments	10	02	04	08	14
II	Biomedical Recorders	08	02	04	08	14
III	Medical imaging equipments	08	02	04	08	14
IV	Surgical & Therapeutic instruments	08	02	04	08	14
V	Medical Laboratory Instruments	08	02	04	08	14
Total		**42**	**10**	**20**	**40**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical/exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Approx Hrs.
1.	I	Identify ECG electrodes & Patient cable	2
2.	I	Identify EEG electrodes & Patient cable	2
3.	I	Identify EMG electrodes	2
4.	I	Measure blood pressure using sphygmomanometer.	2
5.	I	Measure respiration rate using respiration rate-meter.	2
6.	I	Measure body temperature using analog and digital thermometer.	2
7.	II	Identify various leads selector network of ECG machine	2
8.	II	Obtain Lead –I, II, III, aVr , aVl , V1 … v6 type of ECG.	2
9.	II	Calibrate & maintain ECG machine.	2
10.	II	Obtain EEG of patient using EEG machine.	2
11.	II	Demonstrate the Performance of EMG.	2
12.	II	Demonstrate the performance of Electro surgery – cautery machine.	2
13.	II	Demonstrate the performance of EEG machine	2
14.	II	Demonstration of Phono-cardiograph machine.	2
15.	III	Have a handle on different controls of X-ray machine.	2
16.	III	Calibrate X-ray machine.	2
17.	III	Demonstration of CT-scan machine.	2
18.	III	Demonstration and operation of Ultra sonic machine along with transducer & patient cable.	2
19.	III	Identify ultra sound probes for sonography machine.	2
20.	IV	Maintain different electrodes for Electro-surgery machine (cautery).	2
21.	IV	Demonstrate various cutting modes of Electro-surgery machine. (cautery)	2
22.	IV	Identify parts of Hemo-dialysis machine.	2
23.	IV	Demonstrate operation of Muscle Stimulators.	2
24.	V	Demonstrate operation of Blood Cell Counter.	2
25.	V	Demonstrate operation of Bio chemistry analyzer.	2
26.	V	Demonstrate operation of Auto analyzer.	2
Total hours			52

8. SUGGESTED LIST OF STUDENT ACTIVITIES Following is the list of proposed student activities like: i. Prepare presentation on relevant topics.

ii. Prepare chart/model on relevant topic.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Visits to Industries/ Hospital.

ii. Use bio simulators in the class when teaching.

iii. Video films/animation films on working of different types of bio-medical instruments. iv. Mini project.

10. SUGGESTED LEARNING RESOURCES A) List of Books

S. No.	Title of Book	Author	Publication
1.	Handbook of biomedical instrumentation	R. S. Khandpur	Tata McGraw Hill, New Delhi
2.	Introduction to biomedical equipment technology	Carr Joseph J.,Brown J.M	Pearson education, New Delhi
3.	Biomedical instrumentation measurements.	Lesli P Cromwell, Fred J. Weibell, Erich A. Pfeiffer	PHI Learning, New Delhi
4.	Medical instrumentation application & design	John G. Webster, Editor	John Wiley and Sons, New Delhi
5.	Medical Electronics	A. G. Patil	Excel Book, New Delhi

B) List of Major Equipment/ Instrument with Broad Specifications

i. Heart rate monitor cum ECG trainer

ii. 12 lead ECG simulator

iii. Respiration-rate monitor

iv. Electro-myograph trainer

v. Phono-cardiograph trainer

vi. Blood pressure measurement trainer

vii. Sphygmomanometer

viii. Bio-Electrodes for (ECG/EEG/EMG)

ix. Ultra sound probes

x. Ultrasound machine trainer

xi. Electro cautery machine

xii. Muscle simulator

xiii. Electronic / electrical assorted tool kit

C) List of Software/Learning Websites

i. http://phet.colorado.edu/en/simulations/category/biology

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J.T.Patankar** H.O.D. (I/C) IC Engineering, Govt. Polytechnic, Ahmedabad.
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- **Prof. M. M. Shah** lecturer IC Engineering, AVPTI, Rajkot.
- **Prof. S. K. Raval** lecturer IC Engineering, Govt. Polytechnic, Ahmedabad.

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GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

COURSE TITLE: INSTRUMENTATION SIMULATION PRACTICES

(Code: 3341705)

Diploma Programmes in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	4th semester

1. RATIONALE

In the present industrial scenario, diploma engineering students should be able to understand, simulate, analyze and troubleshoot the prevalent Process Control Systems in the industry. They are required to foresee the effects of changes in the various process parameters on the system behavior before actual implementation of the Plant Control System. Therefore, this course has been designed so that students can familiarize with various simulation software tools to build and simulate the different types of Control Systems for Process Application.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- Simulate **different types of Instrumentation Control Systems for Process Application.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Use instrumentation simulation software for Interactive Process Control Simulation.
ii. Do System Analysis to understand the system behaviour.
iii. Generate plots for outputs of different process automation control loop system for step and ramp input.
iv. Simulate different control action on given control system.
v. Install process and control instrumentation Simulating and Analyzing software.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
0	0	4	4	0	0	40	60	100

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

NA

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS

NA

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	**Practical Exercises** (Outcomes' in Psychomotor Domain)	**Approx Hrs. required**
1.	Install process and control instrumentation Simulating and Analyzing softwares and familiarize with the system requirements and essential features/specifications of the software in use.	02
2.	Simulate basic instruments viz indicators for a simple process loop.	02
3.	Simulate basic instruments viz recorders for a simple process loop.	02
4.	Simulate basic instruments viz indicator, recorder and controller for a simple process loop.	02
5.	Determine poles and zeros of given first order transfer function.	02
6.	Obtain poles and zeros of given second order transfer function.	02
7.	Develop mathematical model for a single process parameter of a tank system.	02
8.	Simulate P -control action on a given system for given step/ramp input and set point. Obtain the effect on output varying Kp of the system.	02
9.	Simulate I -control action on a given system for given step/ramp input and set point. Obtain the effect on output varying Ki of the system.	02

S. No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Approx Hrs. required
10.	Simulate P+I -control action on a given system for given step/ramp input and set point. Obtain the effect on output varying K_p and K_i of the system.	02
11.	Simulate P+D -control action on a given system for given step/ramp input and set point. Obtain the effect on output varying K_p and K_d of the system.	02
12.	Simulate P+I+D -control action on a given system for given step/ramp input and set point. Obtain the effect on output varying K_p, K_d, and K_i of the system.	02
13.	Simulate a simple feedback loop for process parameter and obtain output varying set points.	02
14.	Simulate simple feed forward loops for process parameter to obtain output varying set points.	02
15.	Simulate simple cascade loops for process parameter to obtain output varying set points.	02
16.	Simulate simple ratio loops for process parameter to obtain output varying set points.	02
17.	Simulate simple split range loops for process parameter to obtain output varying set points.	02
18.	Simulate a simple instrumentation process loops to obtain output varying generating disturbance.	02
19.	Simulate simple instrumentation continuous process loops to obtain output generating disturbance in a previous sub process.	02
20.	Simulate simple bio-medical signal measuring loops to obtain output in the form of indicator and recorder.	02
21.	Simulate flow control loop using process control simulator.	02
22.	Simulate pressure control loop using process control simulator.	02
23.	Simulate On-Off level control system using process control simulator.	02
24.	Simulate interacting level system using process control simulator.	02
25.	Simulate non-interacting level system using process control simulator.	02
26.	Simulate On-Off temperature control system using process control simulator.	02
27.	Simulate various characteristic of control valve.	02
28.	Simulate control valve using different characteristic co-efficient.	02
29.	Simulate control valve to find rangeability.	02
Total Hours		58

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i. Study of First and Second Order Control System using various free control simulators.

ii. D e v e l o p simple simulated instrumentation control process system for different control actions strategies.

iii. Prepare Presentation on given topics.

9. SPECIAL INSTRUCTIONAL STRATEGIES

i. Use Free Simulators Software for teaching / learning activities.

ii. Show Video/Animation Films relevant to Process Automation and Control System.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1	A Guide to MATLAB: For Beginners and Experienced Users	Ronald L. Lipsman, Jonathan Rosenberg	Cambridge University Press
2	Getting Started With Matlab 7: A Quick Introduction For Scientists And Engineers	Rudra Pratap	Oxford University press, New Delhi
3	LabVIEW 7 Express Student Edition	Robert Bishop	PHI Learning, New Delhi
4	LabVIEW™ Basics II Course Manual PDF	Worldwide TechnIcal Support and Product Information ni.com	National Instruments Corporate Headquarters 11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel

B) List of suggested Software/Learning Websites:

i. MATLAB,
ii. SCILAB
iii. Prosim
iv. PSpice
v. LabVIEW
vi. Chemical Process simulator
vii. Electronics Workbench
viii. www.mathworks.in
ix. www.ni.com
x. www.edx.org
xi. www.coursera.org
xii. www.ocwconsortium.org

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. M. N. Mulchandani** Sr. Lecturer in IC, AVPTI, Rajkot.
- **Prof. H. P. Patel**, Lecturer in IC, GP Ahmedabad.
- **Prof. N. B. Mehta,** Sr. Lecturer in IC, GP Ahmedabad.
- **Prof. S. K RAVAL**, Lecturer in IC, GP Ahmedabad.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. (Mrs.) Susan S. Mathew,** Associate Professor**,** Department of Electrical and Electronics Engineering.
- **Prof. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering.