GUJARAT TECHNOLOGICAL UNIVERSITY, GUJARAT

COURSE CURRICULUM
COURSE TITLE: APPLIED INSTRUMENTATION
(COURSE CODE: 3361701)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Sixth

1. RATIONALE

The ultimate success of any plant control system rests on the ability of instrument experts to make proper application of components and system and on the ability of maintenance people to keep them calibrated and work safely. This course is essential in order to prepare future instrumentation personals for these tasks.

2. COMPETENCIES

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies:

- **Operate and maintain different types of instrument air supply systems and plant interlock system.**
- **Select, install and maintain various instrumentation & control systems for various process industries**.

3. COURSE OUTCOMES

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

i Select appropriate instruments according to process application requirement.
ii Utilize instrument drawings during installation and commissioning of plant.
iii Design a plant interlock circuit.
iv Design an instrument air supply system for plant.
v Test and maintain major control loops of cement, textile and power plant.
vi Design, test and maintain major control loops for heat exchanger, chemical reactors and distillation columns.

4. TEACHING AND EXAMINATION SCHEME

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

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Selection, Installation and Commissioning of Instruments.	1a Describe factors affecting for selection of pressure instruments. 1b Describe factors affecting for selection of flow instruments. 1c Describe factors affecting for selection of level instruments. 1d Describe factors affecting for selection of temperature instruments. 1e Describe factors affecting for selection of Control Valves.	1.1 Factors affecting for selection of : 1.1.1 Pressure Instruments 1.1.2 Flow Instruments 1.1.3 Level Instruments 1.1.4 Temperature Instruments 1.1.5 Control Valve
	1f Justify the need for instrumentation related documents listed in topic 1.2.	1.2 Instrumentation related documents : Process flow sheets, Mechanical flow sheets, Instrument index sheet, Loop wiring diagram, Panel drawings and specifications, Plot plans, Installation details
	1g State the checklist of good installation practices. 1h Describe typical checkout procedure for flow transmitter. 1i Describe typical checkout procedure for temperature transmitter. 1j Describe typical checkout procedure for control valve.	1.3 Checklist of good installation practices 1.4 Typical Check out procedure for: - Flow transmitter - Temperature transmitter - Control valve
Unit-II Instrument Air Supply System	2a Describe sizing criteria and pressure level for designing of air supply system. 2b Draw and explain Air supply system for low air requirement. 2c Draw and explain Air supply system for large air requirement.	2.1 Sizing criteria and pressure level for air supply system 2.2 Supply System for low air requirement 2.3 Supply System for large air requirement
	2d Explain construction and working of any one type of positive displacement type compressor. 2e Describe Compressor controls.	2.4 Compressor systems 2.4.1 Positive displacement type 2.4.2 Compressor controls

	2f Justify the need for dryers.(State necessity of dryer) 2g Classify dryers. Explain desiccant dryers in detail. 2h Explain operation of heated type of desiccant dryers. 2i Explain operation of heatless type of desiccant dryers	2.5 Dryers 2.5.1 Types of dryers- Refrigeration and Desiccant(Heated and Heatless) 2.5.2 Necessity of dryers
Unit-III Industrial Control Schemes and Plant Interlocks	3a Describe automatic stop motion control in textile industry 3b Describe Humidity and moisture control in textile industry. 3c Describe Stretch control in textile industry.	3.1 Textile industry 3.1.1 Automatic stop motion control 3.1.2 Humidity and moisture control 3.1.3 Stretch control
	3d Explain kiln temperature control system in cement industry	3.2 Cement Industry - Kiln temperature control
	3e Explain single element Drum level control in thermal power plant. 3f Explain two element Drum level controls in thermal power plant. 3g Explain three element Drum level controls in thermal power plant.	3.3 Thermal power plant 3.3.1 Drum level control- single element, two element and three element.
	3h Justify the need for plant interlocks. 3i Describe the working of any one plant interlock circuit with neat diagram.	3.4 Need for plant interlocks 3.5 Simple plant interlock circuit
Unit-IV Heat Exchanger & Chemical Reactors	4a State and explain heat exchanger variables and draw its symbol. 4b Explain conventional heat exchanger control scheme. 4c Explain Temperature – Pressure cascade loop of heat exchanger. 4d Explain Temperature – Flow cascade loop of steam reboiler.	4.1 Heat Exchanger variables and symbol. 4.2 Conventional Heat Exchanger Control Scheme. 4.3 Temperature-Pressure cascade loop in heat exchanger. 4.4 Temperature-flow cascade loop of steam reboilers.

	4e Draw and Explain Temperature control scheme for chemical reactor. 4f Explain cascade loop scheme for temperature control in chemical reactor. 4g Explain Split range control of multiple coolants in chemical reactor. 4h Explain Reactor pressure control by throttling flow of vent gas.	4.5 Temperature control in a chemical reactor. 4.6 Cascade loop for temperature control in a reactor. 4.7 Split range control of multiple coolants in a reactor. 4.8 Reactor pressure control by vent throttling
Unit-V Distillation Column Schemes	5a List out variables for distillation column. 5b Explain pressure control of Distillation column by throttling condenser water. 5c Explain temperature control of Distillation column by heat control to reboiler. 5d Explain temperature control of Distillation column by reflux flow control. 5e Explain Feed flow control scheme of Distillation column. 5f Explain Cascade control of feed to second column.	5.1 Variables for distillation column operation. 5.2 Distillation column pressure control by throttling condenser water. 5.3 Distillation column temperature control by heat control to reboiler. 5.4 Distillation column temperature control by reflux flow control. 5.5 Feed flow control scheme of Distillation column. 5.6 Cascade control of feed to second column.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS(Theory)

Unit No.	Unit Title	Teaching Hours	Distribution Of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Selection, Installation and Commissioning of Instruments.	12	2	5	11	18
II	Instrument Air Supply System	7	2	4	6	12
III	Industrial Control Schemes and Plant Interlocks	8	2	4	8	14
IV	Heat Exchanger & Chemical Reactors	8	2	4	8	14
V	Distillation Column Schemes	7	2	4	6	12
TOTAL		**42**	**10**	**21**	**39**	**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 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. However, if these practical 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	Practical Exercise (Outcomes in psychomotor domain)	Approx. Hours Required
1	I	Select appropriate pressure instrument.	2
2	I	Select appropriate flow instrument.	2
3	I	Select appropriate level instrument.	2
4	I	Select appropriate temperature instrument.	2
5	I	Select appropriate type of control valve.	2
6	I	Use the checklist of installation of a new instrument taking care of all safety precautions.	2
7	I	Check out a given flow transmitter prior to commissioning.	2
8	I	Check out temperature transmitter.	2
9	I	Check out control valve.	2
10	II	Select proper pressure level and size of compressor for instrument air supply system.	2
11	III	Simulate automatic stop motion control process of textile industry in a simulator.	4
12	III	Simulate Humidity and moisture control of textile industry in a simulator.	4
13	III	Simulate Stretch control of textile industry in a simulator.	4
14	III	Simulate kiln temperature control of cement industry in a simulator.	4
15	III	Simulate single element drum level control system in a simulator.	4
16	III	Simulate two element drum level control system in a simulator.	4
17	III	Simulate three element drum level control system in a simulator.	4
18	III	Program interlocks circuit in plc simulator.	4
19	IV	Simulate Conventional Heat Exchanger Control scheme in a control simulator.	4
20	IV	Simulate Temperature-Pressure cascade loop on steam heater in	4

S. No.	Unit	Practical Exercise (Outcomes in psychomotor domain)	Approx. Hours Required
		a control simulator.	
21	IV	Simulate Temperature-flow cascade loop on steam heater in a control simulator.	4
22	IV	Simulate Temperature control in a chemical reactor in a control simulator.	4
23	IV	Simulate Cascade loop for temperature control of reactor in a control simulator.	4
24	IV	Simulate Split range control of multiple coolants of reactor in a control simulator.	4
25	IV	Simulate Reactor pressure control by vent throttling in a control simulator.	4
26	V	Simulate Distillation column pressure control by throttling condenser water in a control simulator.	4
27	V	Simulate Distillation column temperature control by heat control to reboiler in a control simulator.	4
28	V	Simulate Distillation column temperature control by reflux flow control in a control simulator.	4
29	V	Simulate Feed flow control scheme of Distillation column in a control simulator.	4
30	V	Simulate Cascade control of feed to second column in a control simulator.	4
31	V	Simulate column pressure control scheme in a control simulator.	4
Total Hours			**104**

Note: Perform any of the practical exercises from above list for total of minimum 56 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.

8. SUGGESTED LIST OF STUDENT ACTIVITIES:

i Present a seminar on any one technical topic.
ii Set up practical apparatus on their own during practical under the guidance of faculty.
iii Debate on merits and demerits of current industrial control scheme.
iv Prepare a poster on any one topic from curriculum.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If any):

i Display animation videos of industrial loops.
ii Arrange visit to nearby industry to observe real-time loops.
iii Facilitate the students to set up practical apparatus on their own.
iv Compliment student for his/her work done during the practical in order to motivate him/her by student and Instruct him/her remedies to improve his work if required.
v Arrange expert lectures of instrumentation engineers working in process industries.

10. SUGGESTED LEARNING RESOURCES

A.) Books

Sr No.	Title of Book	Author	Publication
1	Instrument Engineers Handbook	Bela G Liptak	Chilton book company, Radnor, Pennsylvania,3rd edition
2	Applied Instrumentation in the process industries	W G Andrews, H B Williams	Gulf Publishing Company.
3	Chemical Process Industries	R N Shreeve	McGraw-Hill, 3rd edition
4	Chemical Engineering	Dryden	

B.) Major Equipment/Instruments:

i Control Valve
ii Compressor
iii Multimeter
iv Current Source
v Voltage Source,
vi Different types of pressure measuring instruments, Different types of flow measuring instruments,Different types of temperature measuring instruments, Different types of level measuring instruments,
vii Chemical reactor model,
viii distillation column model,
ix Heat exchanger model.

C.) Software/Learning Websites

i books.google.co.in
ii en.wikipedia.org
iii www.britannica.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R J Dhruv**, Sr. Lecturer (I/C HOD) in IC, AVPTI, Rajkot
- **Prof. R. P. Raiyani**, I/C HOD, Christ Polytechnic Institute, Rajkot
- **Prof. (Smt.) S K Raval**, Lecturer in IC, Government Polytechnic, Ahmedabad
- **Prof. M J Dehlvi**, Lecturer in IC , Government Polytechnic, Gandhinagar

Coordinator and Faculty Member from NITTTR Bhopal

- **Dr. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL POWER CONTROL
(COURSE CODE: 3361702)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Sixth

1. RATIONALE

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

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Maintain different types of industrial power control instrumentation system.**

3. COURSE OUTCOMES

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

i. Select relevant power control devices for the given industrial applications.
ii. Troubleshoot AC and DC power control circuits employing power devices.
iii. Troubleshoot inverter, chopper circuits.
iv. Maintain AC and DC drives.
v. Maintain Resistance welding equipment.

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 CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. Power Semiconductor Devices	1a. Describe working of SCR, MOSFET and IGBT with the help of sketches. 1b. Analyze the characteristic curves of SCR, DIAC, TRIAC, PUT, IGBT and MOSFET. 1c. Explain SCR two transistor analogy and derive anode current equation. 1d. Explain the turn ON methods of thyristor (SCR) (triggering methods). 1e. Explain the turn OFF methods of SCR - commutation techniques of SCR. 1f. Describe working of snubber circuit for SCR. 1g. Compare the (features) characteristics of SCR, TRIAC, MOSFET and IGBT.	1.1. Industrial electronics devices :SCR,DIAC,TRIAC,PUT, MOSFET,IGBT 1.2. Triggering methods of SCR 1.3. Commutation techniques of SCR. 1.4. Snubber circuit, freewheeling of SCR.
	1h. Describe construction and working of Opto- Isolators. 1i. Describe construction and working of Opto-SCR.	1.5. Opto electronic devices concept. 1.6. Opto-Isolators, Opto-SCR.
Unit– II Power Converter and Cyclo Converter	2a. Explain working of half and full control bridge converter with resistive load. 2b. Explain working of Half and Full wave control bridge converter with R-L Load.	2.1. Control Converter using SCR.
	2c. Explain the working principle of single phase Bridge Cyclo-converter. 2d. Explain the working principle of single phase Mid-point Cyclo-converter.	2.2. Cyclo-Converter using SCR.
Unit– III Inverters and Choppers	3a. Explain the Principle and working of Series Inverter circuit. 3b. Explain the Principle and working of Parallel Inverter circuit. 3c. Explain the Principle and working of bridge type Inverter circuit.	3.1 Inverters: Series, Parallel and Bridge inverters.
	3d. Explain Basic D.C. chopper circuit. 3e. Explain the working principle of step up Chopper circuits. 3f. Explain the working principle of step down Chopper circuits.	3.2 Chopper: 3.2.1 Classification of chopper. 3.2.2 Step-up. 3.2.3 Step Down.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit IV Industrial Application of Power Electronics Devices	4a. Describe Speed control of D.C. Motor using armature voltage control with circuit. 4b. Describe stator voltage speed control for induction motor with circuit. 4c. Describe stepper motor drive circuit. 4d. Explain application like D.C. static switch, alarm circuit. 4e. Explain circuit diagram for Temperature control using mercury thermostat. 4f. Explain conductive Liquid level control circuit. 4g. Explain Ambient Light control power switch.	4.1 Speed control methods for 4.1.1 D.C motor 4.1.2 Induction motor 4.1.3 Stepper motor 4.2 Industrial Applications. 4.2.1 D.C. static switch. 4.2.2 Alarm circuit. 4.2.3 Temperature control. 4.2.4 Liquid level control. 4.2.5 Ambient Light control
	4h. Describe function of single phase AC power control circuit using DIAC-TRIAC with neat diagram. 4i. Describe function of DC power control circuit using SCR with UJT in triggering circuit with circuit diagram.	4.3 Single phase AC power control using DIAC-TRIAC. 4.4 UJT Triggered SCR power control.
Unit-V Resistance Welding Control	5a. Describe types of Resistance Welding. 5b. Explain the terms related to resistance welding. 5c. Explain duty cycle for resistance welding process. 5d. Explain basic circuit for resistance welding process. 5e. Explain SCR electronic line contactor circuit. 5f. Explain heat control using UJT and SCR. 5g. Explain electronics circuit for weld control sequences. 5h. Describe energy storage welding. 5i. Compare resistance and conventional welding Process.	5.1 Resistance Welding. 5.1.1 Classification: spot, butt, seam, projection, flash. 5.1.2 Duty cycle. 5.1.3 Resistance welding scheme. 5.1.4 Electronics Line contactor. 5.1.5 Heat control circuit. 5.1.6 Sequence Timer. 5.1.7 Energy storage welding. 5.1.8 Comparison of welding methods.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Power Semiconductor Devices	8	6	8	4	18
II	Power converter and Cyclo Converter	8	2	4	8	14
III	Inverters and Choppers	8	2	4	4	10
IV	Industrial Application of Power Electronics Devices	10	4	10	4	18
V	Resistance Welding Control	8	4	4	2	10
	Total	**42**	**18**	**30**	**22**	**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 EXERCISES/PRACTICALS

The practical 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. However, if these practical 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.

Sr. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hours required
1	I	Test V/I Characteristics of SCR.	02
2	I	Test V/I Characteristics of DIAC.	02
3	I	Test V/I Characteristics of TRIAC.	02
4	I	Test Characteristics of Opto-Isolator.	02
5	I	Test Characteristics of power MOSFET.	02
6	I	Test Characteristics of UJT.	02
7	I	Test R-C phase shift control of SCR using UJT.	02
8	I	Test outputs of PUT as relaxation oscillator using MULTISIM.	02
9	I	Test outputs of Class A Load Commutation using MULTISIM.	02
10	I	Test outputs of Class A Load Commutation using physical components.	02

Sr. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hours required
11	I	Test outputs of Class B Resonant Pulse Commutation using MULTISIM.	02
12	I	Verify outputs of Class B Resonant Pulse Commutation using physical components.	02
13	I	Test outputs of Class C Complementary Commutation using MULTISIM.	02
14	I	Test outputs of Class C Complementary Commutation using physical components.	02
15	I	Test outputs of Class D Impulse or Auxiliary SCR commutation using MULTISIM.	02
16	I	Test outputs of Class D Impulse or Auxiliary SCR commutation using physical components.	02
17	I	Test outputs of Class F Line or natural Commutation using MULTISIM.	02
18	I	Test outputs of Class F Line or natural Commutation using physical components.	02
19	II	Test Half control bridge converter.	02
20	II	Test Full control bridge converter.	02
21	III	Test parallel inverter using two SCRs	02
22	III	Test basic operation of series Inverter.	02
23	III	Test chopper circuits with load.	02
24	IV	Test speed control of A.C. Motor using DIAC-TRIAC.	02
25	IV	Test D.C motor speed control using chopper.	02
26	IV	Test alarm circuit using MULTISIM.	02
27	IV	Test D.C Static switch using MULTISIM.	02
28	V	Test Sequential Timer operation using IC-555 for resistance welding process.	02
Total			**56**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Do assignments related theory topics.
iii. Learn troubleshooting techniques and steps to troubleshoot DC motor, AC motor.
iv. Learn troubleshooting steps to troubleshoot inverter.
v. Check the performance of chopper, inverter using simulation software like MATLAB.
vi. Visit industries such as chemical industries, petroleum industries, production industries, manufacturing industries, automobile industries, power Industries etc. and study various instruments used.
vii. Take up a small technical projects based on any advance theory topic.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Show video/animation film to demonstrate the working principles, constructional features, testing and maintenance of different types of power control devices.
ii. Use Flash/Animations to explain the working of different DC, AC and stepper motor.

iii. Arrange Industrial Visit for students (chemical industries, petroleum industries, production industries, Manufacturing industries, Automobile industries, Power Industries)
iv. Ask students to explore internet about recent developments and prepare seminar presentations on relevant topics.
v. Give mini technical projects based on advance theory topics.
vi. Arrange expert lectures of instrumentation engineers working in industries.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Industrial Electronics and Control	Bhattacharya S K and Chatterjee S.	TMH Publication,New Delhi
2.	Power Electronics	Singh M D and Khanchandani K.B.	TMH Publication,New Delhi
3.	Power Electronics And Its Applications	Jain Alok	Penram International Publication, New Delhi
4.	Power Electronics	Bimmhra B S	Khanna Publication,New Delhi
5.	Industrial Electronics And Control	Paul Biswanath	PHI Learning New Delhi
6.	Power Electronics-Devices, Circuits, Systems And Applications	Rai Harish C.	Galgotia Publication,New Delhi

B) Major Equipment/ Instrument with Broad Specifications

i. Function Generator: Sine, square, triangle Wave etc. with frequency range 10 Hz to 100 kHz
ii. DC power supply: -30 →0→+30 V with at least 1A current capacity.
iii. Dual channel CRO: At least 20MHz or higher
iv. Multi meter: Capable of measuring AC and DC current, voltage and resistance.
v. Electrical tool kit: Maintenance of trainer boards.
vi. Circuit/Trainer board/ Demonstration modules: For performing relevant practical's with inbuilt power supply

C) Software/Learning Websites

i. www.nptel.iitm.ac.in.
ii. www.youtube (lectures on Power electronics)
iii. www.howstuffworks.com.
iv. www.alldatasheet.com
v. MATLAB/SIMULINK.
vi. Electronics Work bench.
vii. MULTISIM.
viii. Scilab.
ix. Caspoc.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. Z. Shyara,** Sr. Lecturer, A.V.P.T.I. Rajkot
- **Prof R. D. Sathvara,** Sr. Lecturer, G.P. Gandhinagar
- **Prof. A. M. Patel,** Sr. Lecturer, G.P. Palanpur
- **Prof. H. P. Patel,** Lecturer, G.P. Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. (Mrs.) C.S. Rajeshwari**, Professor and Head, Dept. of Electrical and Electronics Engineering,
- **Dr. Joshua Earnest**, Professor, Dept. of Electrical and Electronics Engineering,

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: DCS AND SCADA
(COURSE CODE: 3361703)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Sixth

1. RATIONALE

In present global scenario of manufacturing, industries are moving towards more and more automation. Small scale and medium scale industries require PLC and SCADA technology, but large scale and very large scale industries require DCS. So, it is very necessary for instrumentation engineers to have knowledge of both DCS and SCADA. So this course attempts to provide basic configurationally knowledge of these technologies to develop operational competency. Hence this course is very important for instrumentation engineers who want to specialize in industrial automation.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Configure and maintain DCS and SCADA system related to instrumentation and control for industrial automation.**

3. COURSE OUTCOMES

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

i. Identify and interpret PI diagram on HMI.
ii. Identify different elements of SCADA.
iii. Interpret the functionality of various elements of SCADA.
iv. Control process parameters of given process using DCS and SCADA

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	2	5	70	30	20	30	150

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 (In Cognitive Domain)	Topics and Sub-topics
Unit – I **DCS Structure** .	1a. Sketch and explain hierarchical architecture of DCS	1.1 DCS architecture
	1b. Explain database organization in DCS with sketch.	1.2 Database organization in DCS
	1c. Identify, explain and select system elements of DCS	1.3 System elements of DCS 1.3.1 Field station 1.3.2 Intermediate station 1.3.3.Central computer station
	1d. Define reliability parameters of DCS and determine Interrelationship between them. 1e. Apply major voting technique to determine reliability of DCS	1.4 Reliability parameters of DCS
	1f. Classify different types of alarms and briefly describe each of them	1.5 Classification of alarms in DCS
Unit– II **HMI IN AUTOMATION**	2a. Sketch and explain in brief basic structure of Automation system.	2.1 Automation system structure
	2b. Determine transfer of control commands for Instrumentation subsystem. 2c. Classify various types of devices connected to Instrumentation subsystem.	2.2 Instrumentation subsystem
	2d. Identify functional steps performed by control subsystem. 2e. Describe interface mechanism to interface control subsystem with other subsystems. 2f. Explain interfacing of control subsystem with Instrumentation subsystem with the help of suitable example. 2g. Explain interfacing of control subsystem with human interface subsystem with the help of suitable example.	2.3 Control subsystem

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	2h. Explain Human Interface subsystem in brief with sketch. 2i. Identify and select active display elements and active control elements of operator panel. 2j. Compare basic approach and mimic approach for the construction of HMI panel. 2k. Sketch interfacing of mimic panel with control subsystem. 2l. State and compare types of mimic panels. 2m. Explain Intelligent operator panel of HMI. 2n. Explain operator station of advanced human interface with suitable example.	2.4 Human Interface subsystem 2.4.1 Operator Panel 2.4.2. Construction of the panel 2.4.3. Interfacing with control subsystem 2.4.4 Types of mimic panels 2.5 Advance Human Interface System 2.5.1.Intelligent Operator Panel 2.5.2. Operator Station 2.5.3. Data logging Station
Unit– III **Introduction to SCADA** .	3a. Define SCADA. 3b. Enumerate application areas of SCADA. 3c. Sketch architecture of SCADA and Describe Major Elements of SCADA. 3d. Compare given automation systems.	3.1 Definition of SCADA 3.2 Application area of SCADA 3.3 Major elements of SCADA 3.4 Advantages and disadvantages of SCADA 3.5 Comparison of SCADA,DCS,PLC and Smart Instrumentation
Unit– IV **Real Time Systems and SCADA Software**	4a. Describe the terms that deal with time response. 4b. Describe real time control for continuous process with suitable example and bar-graph.	4.1 Definition and Introduction of real time control 4.2 Real time control for Continuous process
	4c. Describe master-slave communication access method in brief. 4d. Determine scan interval for SCADA.	4.3 Communication Access and Master-Slave concept 4.4 Determination of Scan Interval
	4e. Describe SCADA software components in brief. 4f. Implement FBD technique on suitable examples. 4g. Compare centralized and distributed processing. 4h. Explain HDLC protocol used in SCADA.	4.5 SCADA software components 4.6 Concept of FBD technique 4.7 Comparison of centralized and distributed processing 4.8 HDLC Protocol

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit– V **SCADA Hardware**	5a. Explain Hardware structure of RTU. 5b. Test the given RTU. 5c. Explain Maintenance procedure of RTU. 5d. List the typical requirements for the RTU system. 5e. Describe ANSI/IEEEC37.1 protocol in brief.	5.1 Remote Terminal Unit (RTU) 5.1.1 Structure of RTU 5.1.1.1.CPU 5.1.1.2.Analog I/O 5.1.1.3.Pulse I/P 5.1.1.4. Digital I/Os 5.1.1.5.Communication Interface 5.1.1.6.Power supply 5.1.1.7.RTU Rack and Enclosure 5.1.2. Test and maintenance of RTU 5.1.3. Requirements for RTU system 5.1.4. ANSI/IEEE C37.1 Protocol
	5f. Explain hardware structure of MTU. 5g. Describe functions of MTU in brief. 5h. Configure MTU with suitable example. 5i. Explain redundancy concept in MTU system.	5.2 Master Terminal Unit 5.2.1. Hardware structure 5.2.2. Functions of MTU 5.2.3. Configuration of MTU 5.2.4. Redundant MTU system

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	DCS Structure	06	07	04	03	14
II	HMI for Automation	10	04	05	05	14
III	Introduction to SCADA	04	02	03	02	07
IV	Real time system and SCADA software	10	03	07	04	14
V	SCADA Hardware	12	07	07	07	21
	Total	**42**	**23**	**26**	**21**	**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 PRACTICALS/EXERCISES

The practical 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. However, if these practical 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.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Approx. Hours Required
1	I	Identify and select system elements of DCS.	2
2	I	Tune the DCS controller by applying suitable PID control algorithm.	2
3	I	Determine the reliability of given DCS system.	2
4	I	Control level and flow of given continuous process using DCS.	4
5	II	Measure temperature and level for the given process using Instrumentation subsystem.	2
6	II	Interface control subsystem with Instrumentation subsystem.	2
7	III	Interface control subsystem with human interface subsystem.	2
8	III	Mount digital panel meter on operator panel.	2
9	III	Mount different types of switches, buzzers and indication lamp on operator panel.	2
10	III	Make necessary connections to interface various devices mounted on control panel. Test the panel by providing appropriate inputs and checking the corresponding outputs.	2
11	IV	Develop SCADA mimic diagram for tank level control	2
12	IV	Develop SCADA mimic diagram for tank pressure control	2
13	IV	Develop SCADA mimic diagram for tank temperature control	2
14	IV	Develop SCADA mimic diagram for flow control in the given process	2
15	IV	Simulate level control system using available SCADA system	2
16	IV	Simulate Pressure control system using available SCADA system	2
17	IV	Simulate Temperature control system using available SCADA system	2
18	IV	Simulate flow control system using available SCADA system	2
19	IV	Control the tank level using available PLC/DCS and SCADA	4

S. No.	Unit No.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Approx. Hours Required
		system. Use On/Off control action	
20	IV	Control continuous level in the tank using PID control action, available PLC/DCS and SCADA system. Show effect of controller tuning on its control performance.	4
21	IV	Control temperature and pressure of the process tank using available PLC/DCS and SCADA system	4
22	IV	Simulate mixing process in the tank using available SCADA system	2
23	IV	Control mixing process in the tank using available PLC and SCADA system	4
24	IV	Simulate bottle filling system using available SCADA system	2
Total Hours			**58**
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Solve different type of numerical problems from different books as possible
iii. List controlling parameters for different process and find how they affect the performance of plant.
iv. Find troubleshooting techniques and steps to troubleshoot DC drives.
Simulate various components of SCADA
v. Analyze the specifications for various types of DCS.
vi. Find practical applications of DCS and SCADA in various industries.
vii. Make list of various industries based on implemented automation system and also specify the sub process if more than one system is implemented.
viii. Check the performance of at least two different types of system using simulation technique.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Show video/animation film on related topic
ii. Arrange a visit to nearby big industry.
iii. Use flash/animations to explain the working of different control devices.
iv. Give mini projects to students.
v. Arrange expert lecture by engineers working in industry on DCS and SCADA technology.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Distributed Computer Control for Industrial	Dobrivoje Popovic and Vijay Bhatkar.	Marcel Dekker Inc.,1990

S. No.	Title of Book	Author	Publication
	Automation		
2.	Overview of Industrial Process Automation	KLS Sharma	Elsevier Publication
3.	Instrumentation Engineer's Handbook Power Electronics	Liptak B.G.	Chilton Book Co., Philadelphia
4.	Practical SCADA for Industry	David Bailey, Edwin Wright	Newnes, (an imprint of Elsevier), 2003
5.	SCADA-Supervisory Control and Data Acquisition System	Stuart A. Boyer	ISA publication (3rd Edition)
6.	Practical Distributed Control System for Engineers and Technicians	----	IDC Technologies
7.	Computer based Industrial Control	Krishnakant.	PHI, New Delhi,5th Edition or latest

B) List of Major Equipment/ Instrument with Broad Specifications

i. Electrical tool kit
ii. Multi-meter
iii. Distributed Control System with at least 2 analog I/O module, 2 digital I/O module, 1 Engineering Configuration unit, 5 operating work stations, LAN with redundant LAN hub/switch and 16 node facility
iv. 24 analog input module (8 analog input module 3NO.)
v. 24 analog output module (8 analog input module 3NO.)
vi. 24 digital input module (8 digital input module 3 NO.)
vii. 24 digital output module (8 digital input module 3 NO.)
viii. level switch
ix. temperature switch
x. flow switch
xi. 3" conveyor system operated 12V DC motor with digital shaft encoder
xii. Proximity switch (Inductive, Optical, motion, light etc.)
xiii. 12 V DC motor with digital shaft encoder
xiv. PLC based Automatic bottle filling plant interfacing with DCS software.
xv. Flow, temperature, level control setup for DCS based automation using Flow, temperature, level switches.

C) List of Software/Learning Websites

i. http://aboutinstrumentation.blogspot.co.uk/2010/12/dcs.html
ii. http://www.instrumentationengineers.org/2012/02/plc-dcs-scada-hmi-for-beginners.html
iii. http://www.eng-tips.com/viewthread.cfm?qid=161284

iv. http://what-instrumentation.blogspot.co.uk/p/difference-between-scada-dcs-and-plc.html

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J.T.Patankar**, HOD IC, Government Polytechnic, Ahmedabad
- **Prof. A.K.Bilkhia**, Sr. Lecturer in IC, Government Polytechnic, Gandhinagar
- **Prof. N.B.Mehta** Lecturer in IC, Government Polytechnic, Ahmedabad
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Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. (Mrs.) C.S. Rajeshwari**, Professor and Head , Dept. of Electrical & Electronics Engineering,
- **Dr. Joshua Earnest**, Professor, Dept. of Electrical & Electronics Engineering,

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL DATA COMMUNICATION
(COURSE CODE: 3361704)

Diploma Programmers in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Sixth

1. RATIONALE

In the present industrial scenario the role of instrumentation is becoming more vital day by day specially in case of industrial automation. More advanced, precise and complex instrumentations are being employed in the industry. These advance instruments requires communication of data from equipment/machines to instruments and vice versa for process and quality control. Diploma engineers should therefore be able to identify, classify, troubleshoot and maintain the different industrial data communication systems employed for instrumentation. Therefore, this course has been designed so that students will be able to test, build, wire and troubleshoot the different types of industrial data communication circuits used for instrumentation like FieldBUS, ProfiBUS network for automation. Thus this course is very important for instrumentation engineers who want to work in industrial automation sector.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Install and maintain hardware of FieldBus, ProfiBus, HART and Modbus Network employed in data communication circuits.**

3. COURSE OUTCOMES

The theory should be taught and practical should be performed in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Identify network on the basis of various network parameters.
ii. Identify OSI-ISO and TCP/IP network models.
iii. Select guided and unguided medium for various types of data transmission.
iv. Assign IP address to the network and network component as per the networks.
v. Install various types of network devices and other network hardware for Field and ProfiBUS.
vi. Troubleshoot problems in hardware/software employed in data communication circuit

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	2	5	70	30	20	30	150

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Local Area Network	1aJustify need of Computer Networks in automation. 1bDescribe the functions of various components of Computer Networks. 1cCompare various computer network topologies.	1.1.Computer Networks in instrumentation 1.2.Components of Computer Networks: hardware and software 1.3.Network topologies: Star, Ring, Bus, Mesh
	1dClassify computer networks- Based on Transmission, scale, and Architecture. 1eDifferentiate LAN, WAN, MAN. 1fDescribe configuration of LAN with example. 1gState the applications service offered by WAN. 1hExplain functions of VPN with example	1.4.Network Classification Based on Transmission Technologies: Point-to-point, broadcast 1.4.1.Based on scale: LAN, WAN, MAN,VPN, Internet 1.4.2.Based on Architecture: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model
Unit – II Network Devices and Communication Protocol	2aJustify the need of protocol. 2bExplain the need for layer modeling. 2cDescribe the functions of each layer of OSI Reference model.	2.1Basics of Protocol and its need 2.2Brief functional description of each The OSI-ISO Reference Model layers with list of protocols
	2dDescribe the functions of each layer of TCP/IP Reference model. 2eCompare the major features of OSI and TCP/IP model. 2fExplain Format of IP v4 and IPv6 protocol. 2gExplain IP addressing scheme with examples. 2hDescribe Domain Name system (DNS).	2.3The TCP/IP Reference Model: Brief functional description of each of the Layer with list of protocols 2.4 IP layer Protocols: IPv4 and IPv6 frame Format (Limited to format only) 2.5Internet addressing: Network addressing, Subnet and subnet masking, gateway addressing, broadcast addressing, dotted decimal notation, loopback addressing 2.6Domain Name System(DNS): Introduction, mapping to IP addresses
Unit – III Network Media and Hardware	3aExplain characteristics of guided and unguided transmission media. 3bDescribe specifications of UTP	3.1Transmission Media: Unguided and Guided media, Wired and Wireless, UTP, Coaxial and Fiber optical cable

	and coaxial cable. 3cDescribe specifications of Wired and Wireless. 3dSketch constructional details of UTP and coaxial cable with labels.	
	3eList different types of connectors. 3fDescribe different connectors with neat sketch. 3gList features of different network interface card.	3.2Types of Connectors: RJ-45, RJ-11, BNC, BNC –T, BNC Terminator, Fiber optic connectors:- Subscriber Channel(SC), Straight Tip(ST), Mechanical transfer – registered jack(MT-RJ) connectors 3.3Network Interface Card (NIC), ARCNET, Ethernet.
	3hExplain functions of following network devices: Repeater, Hub, Bridge, Switch, Router, Gateway, Access point, Wireless Access points.	3.4Network connecting devices: Repeater, Hub, Bridge, Switch , Router, Gateway, Access point, Wireless Access points
	3iList features of different types of Servers.	3.5Servers introduction : File, Print, Mail, Proxy, Web
Unit – IV Basics of Fieldbus and ProfiBus	4aDiscuss benefits of Foundation Fieldbus. 4bSketch waveforms showing Manchester Bi-phase L encoding scheme with four encoding states. 4cSketch waveforms showing use of N+ and N– encoding states. 4dDraw OSI model of the FF protocol stack. 4eExplain data link layer of Foundation Fieldbus in brief. 4fDraw data link layer packet format for Foundation Fieldbus. 4gDescribe application layer of Foundation Fieldbus in brief. 4hDraw the passage of information packets to the physical layer of Foundation Fieldbus. 4iList the important points to be considered while preparing termination for Foundation Fieldbus.	4.1Introduction to Foundation Fieldbus 4.1.1Physical layer and wiring rules 4.1.2Data Link layer 4.1.3Application layer 4.1.4User layer

	4jDraw and explain wiring configuration of Foundation Fieldbus system. 4kList the factors need to be known when troubleshooting the power system of an FF system. 4lDiscuss the communication problems of Foundation Fieldbus. 4mState the parameters which can be checked by Foundation Fieldbus test equipment.	4.2Wiring and installation practice with Fieldbus 4.2.1Termination Preparation 4.2.2Installation of the complete system 4.3Troubleshooting of foundation field bus 4.3.1Introduction to physical problem 4.3.2Power problem 4.3.3Communication problem 4.3.4Test equipment for foundation field bus
	4nDescribe the versions (ProfiBus DP, ProfiBus FMS and ProfiBusPA) of Profibus standard in brief. 4oDraw Profibus protocol stack 4pList the features of Physical layer of Profibus DP standard. 4qDraw and explain in brief about hybrid medium access control scheme of Profibus. 4rDifferentiate between token passing and polling technique used in Profibus for medium access. 4sDescribe token passing method of Profibus in brief.	4.4Introduction to ProfiBus standard 4.5ProfiBus protocol stack 4.5.1Physical layer 4.5.2Data Link layer 4.5.3Application layer
	4tState various troubleshooting tools for profibus network and explain any one. 4uExplain how the common problems of Profibus DP can be identified.	4.6Troubleshooting of Profibus
Unit – V HART and MODBUS	5aWrite the salient feature of HART protocol which is generally not found in other protocol. 5bDiscuss the features of HART for smart instrumentation. 5cDescribe HART protocol in brief. 5dDraw and explain HART point-to-point communication. 5eDraw and explain HART multi-point communication. 5fState the uses of HART handheld communicator. 5gSketch the connection diagram of HART handheld communicator.	5.1Concept of Highway Addressable Remote Transducer (HART) 5.2HART and smart Instrumentation 5.3HART protocol 5.4HART Physical layer

	5hShow HART protocol implementation of OSI layer model. 5iDraw HART data link frame format. 5jList the benefits of HART. 5kDescribe the trouble shooting of HART network in brief.	5.5HART Data link layer 5.6HART benefits 5.7Troubleshooting of HART
	5lState the limitations of Modbus network. 5mState transmission modes used in Modbus and give their short description. 5nDraw and explain in brief about format of Modbus message frame.	5.8Overview of Modbus protocol 5.9Modbus protocol structure
	5oDescribe Read coil or digital output status (function code 01) of Modbus with suitable example. 5pDescribe Read digital input status (function code 02) with suitable example. 5qDescribe Read holding registers (function code 03) with suitable example.	5.10 Function codes 5.10.1 Read coil or digital output Status (function code 01) 5.10.2 Read digital input status (function code 02) 5.11 Read holding registers (function code 03)

6. SUGGESTED SPECIFICATIONTABLE WITH HOURS&MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Local Area Network	08	4	6	4	14
II	Network Devices and Communication Protocol	09	4	6	4	14
III	Network Media and Hardware	09	2	6	6	14
IV	Basics of Fieldbus and ProfiBus	08	4	5	4	14
V	HART and ModBUS	08	4	6	4	14
	Total	**42**	**18**	**30**	**22**	**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**(out comes in psychomotor and affective domain)** so that students are able to acquire the competencies / program out comes. 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 overall development of **Program Outcomes (**as given in a common list at the beginning of curriculum document for this program) 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. Hours Required
1	I	Prepare detailed report of existing LAN in the Department/Institute	04
2	I	Connect computer terminal in various physical topologies and test the data transfer	02
3	II	Install/configure/Test a small wireless network using access points	02
4	II	Install/configure/Test Peer to Peer LAN and sharing of resources	02
5	II	Install/configure/Test Network operating System	02
6	II	Configure/Test Internet connectivity	02
7	II	Install and configure a Firewall for the network security	02
8	II	Check performance of network using ping, trace route commands	02
9	III	Compare performance of various types physical layer Connectors	02
10	III	Compare performance of various types of Transmission media. and Connectors	02
11	III	Prepare and Test Straight UTP Cable	02
12	III	Prepare and Test Cross UTP Cable	02
13	III	Prepare and Test Cross CAT5,CAT6 and RJ11Cable	02
14	III	Install/configure/Test Network Interface Card/port	02
15	III	Install/configure/Test Networking devices	02
16	III	Install/configure/Test small LAN using Hub/switch	02
17	III	Install/configure/Test File Server	02
18	III	Install/configure/Test Print Server	02
19	III	Install/configure/Test Web Server	02
20	IV	Configure the fieldbus wiring	02
21	IV	Prepare the termination for Foundation Fieldbus	02
22	IV	Select appropriate cable for FF and Profibus network	02
23	IV	Prepare D-type connector with built in terminator for	02

		Profibus troubleshooting	
24	IV	Test the operational Fieldbus Network using Fieldbus tester	02
25	V	Transmit 8 bit digital signal superimposed on 12mA analog signal using HART FSK technique	02
26	V	Install and Configure HART point-to-point communication Network	02
27	V	Connect HART handheld communicator to HART network	02
Total Hours			**56**
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED STUDENT ACTIVITIES

i Explore internet and visit websites of reputed companies working in the area of data communication to get knowledge about latest technologies.

ii Prepare small theoretical technical projects.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If any)

i. Show videos/animation for explaining functioning of different devices and systems.

ii. Ask students to explore the internet and prepare presentations on relevant topics and present in class.

iii. Arrange Industrial visit for students to industries having automation such as chemical industries, petroleum industries, production industries, Manufacturing industries, Automobile industries.

iv. Arrange expert lectures by instrumentation engineers working in the area of data communication for automation.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Computer Networks	Tannebaum AndrewS Wetherall David J.	Pearson, New Delhi, 5th Edition, 2011
2.	Data and Computer Communication,	Stallings Williams	PHI Learning, New Delhi (Latest edition)
3.	Computer Networks	Trivedi Bhushan	Oxford University Press, New Delhi 2013
4.	Data Communication and Networking,	Forouzen	Tata McGraw Hill, Education New Delhi (Latest edition)
5.	Practical Industrial Data Networks: Design, Installation and Troubleshooting	Steve Mackay, Edwin Wright, Deon Reynders, John Park	Newnes An imprint of Elsevier
6.	Data Communication Networks	Sharma Sanjay	S.K.Kataria and Sons, New Delhi (Latest edition)

B) Major Equipment/Instrument with Broad Specifications

i Computer Hub 8/ 16 node
ii Router/ Wireless Router
iii Modem 256 / 512 KBS
iv Switch 4/8/16/24/32
v Hart Handheld Communicator
vi Repeater
vii Bridge
viii LAN CABLE (CAT6, CAT5)
ix Coaxial Cable, UTP Cable, STP Cable, Fiber Optic Cable
x HART starter KIT
xi Profibus PA starter KIT

B) Software/Learning Websites

i. www.nptel.iitm.ac.in.
ii. www.isa.org
iii. www.ieee.org
iv. www.pacontrol.com
v. www.ourinstrumentation.com
vi. *www.**profibus**.com*
vii. http://www.siemens.com
viii. http://sine.ni.com/nips/cds/view/p/lang/en/nid/208382
ix. http://www.prosoft-technology.com/Products/Schneider-Electric-In-chassis/PROFIBUS-DP-Master-Network-Interface-Module-for-Quantum
x. *www.rotork.com*
xi. *www.ti.com*
xii. *www.**fieldbus**.org/*
xiii. *www.automation.com/pdf_articles/**fieldbus**.pdf*
xiv. *www.yokogawa.com*
xv. *www.mtl-inst.com*
xvi. *www.ni.com/pdf/manuals/370729a.pdf*
xvii. *www.**fieldbus**-international.com*
xviii. http://ab.rockwellautomation.com/Networks-and Communications/Process/ FOUNDATION-Fieldbus
xix. *www.murrelektronik.com*
xx. *www.**fieldbus**inc.com*
xxi. *www.abb.com*
xxii. *www.mirosoft.com*
xxiii. *www.datalink.com*
xxiv. *www.dax.com*
xxv. *www.cisco.com*

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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- **Prof. A. K. Bilakhia**, Sr. Lecturer(IC), Govt. Polytechnic, Gandhinagar
- **Prof. N.B. Mehta**, Lecturer (IC), Govt. Polytechnic, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest,** Professor, Dept. of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PIC MICROCONTROLLER AND EMBEDED SYSTEMS
(COURSE CODE: 3361705)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control	Sixth

1. RATIONALE

PIC Microcontrollers are being extensively used in the field of Embedded Systems. The students studying this subject are supposed to learn the architecture of a PIC Microcontroller and also get acquainted about their use for control purpose. In addition, the course will provide the knowledge of applications and interfacing of PIC microcontrollers used in the field of instrumentation & control. Thus this course is very useful for instrumentation engineers working in the area of embedded systems.

2. COMPETENCIES

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies:

- **Program PIC microcontroller for data acquisition and processing application.**
- **Interface sensors, transducers, motors, relays, and various input/output devices with PIC microcontroller.**

3. COURSE OUTCOMES (COs)

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

i. Identify and understand function of different blocks of PIC microcontroller.
ii. Develop programs for data transfer, arithmetic, logical and I/O port operations.
iii. Develop programs for PIC18 using “C”.
iv. Develop program for PIC18 Timers, Serial port and Interrupts using “C”.
v. Interface LCD, Keyboard, ADC, DAC, Sensors, Relays, DC motor and Stepper motor with PIC18 microcontroller.

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**	**150**
3	0	2	05	70	30	20	30	

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I PIC Microcontrollers : History, Features and Architecture	1a. Explain evolution of Microcontrollers and Embedded Processors.	1.1 Microcontrollers and Embedded Processors. 1.2 Overview of the PIC18 Family.
	1b. Draw PIC18 PIN connection.	1.3 PIC18 PIN connection.
	1c. Explain PIC18 Registers. 1d. Explain file register allocation between GPR and SFR. 1e. Explain file register's status for the given instructions. 1f. Determine the contents of file registers for the given set of instructions.	1.4 PIC18 Configuration Registers. 1.5 The WREG Register in PIC18. 1.6 The PIC18 File Register and access Bank. 1.7 Use of Instructions with the Default Access Bank.
	1g. Explain PIC18 status register. 1h. Find the status of different flags for the given set of instructions	1.8 PIC18 Status Register.
	1i. Represent data in various number formats. 1j. Explain given directives.	1.9 PIC18 Data Format and Directives.
	1k. Explain program counter.	1.10 The Program Counter and Program ROM Space in the PIC18.
	1l. Explain features of RISC. 1m. Compare Harvard architecture with von Neumann architecture	1.11 RISC Architecture in the PIC18.
Unit– II Classification of Instructions and I/O Port Programming	2a. Explain various arithmetic instructions. 2b. Find the status of flags for a set of given instructions.	2.1 Arithmetic Instructions
	2c. Represent signed numbers in PIC18. 2d. Explain OV flag.	2.2 Signed Number Concepts and Arithmetic Operations
	2e. Explain Logic and compare instructions. 2f. Find the contents of WREG register after executing given instructions.	2.3 Logic and Compare Instructions
	2g. Explain rotate instructions.	2.4 Rotate Instruction and Data Serialization.
	2h. Represent BCD and ASCII codes. 2i. Convert given code.	2.5 BCD and ASCII Conversion.
	2j. List PIC18 conditional Branch instructions. 2k. Explain Loop and nested loop.	2.6 Branch Instructions and Looping.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	2l. Explain CALL, STACK and stack pointer.	2.7 Call Instructions and Stack
	2m. Calculate time delay for the given set of parameters.	2.8 PIC18 Time Delay and Instruction Pipeline.
	2n. Explain alternate functions of Port A, B, C and D. 2o. Explain TRIS register role in inputting and outputting data.	2.9 I/O Port Programming in PIC18.
	2p. Explain single bit instructions. 2q. Develop a short program using bit instructions	2.10 I/O Bit Manipulation Programming.
Unit – III PIC18 Programming in C	3a. Explain data types widely used by PIC18. 3b. Select data type for given variables. 3c. Give factors affecting time delay code size in PIC18.	3.1 Data Types and Time Delays in C.
	3d. Explain bit-addressable I/O programming. 3e. Develop C program.	3.2 I/O Programming in C.
	3f. Explain bit wise logic operators. 3g. Develop C program.	3.3 Logic Operations in C.
	3h. Develop C program.	3.4 Data Serialization in C.
	3i. Explain advantages and disadvantages using program ROM space for data. 3j. Develop C program.	3.5 Program ROM Allocation in C.
	3k. State advantages and disadvantages using data RAM space. 3l. Develop C program.	3.6 Data RAM Allocation in C.
Unit – IV PIC18 Programming in C: Timer, Serial Port and Interrupt	4a. Explain the timers in PIC18. 4b. Develop C program on timers and counters.	4.1 Programming Timers 0, 1, 2 and 3 in C. 4.2 Counter Programming.
	4c. Compare advantages of serial communication over parallel. 4d. Describe serial communication features and main registers used in PIC18.	4.3 Basics of Serial Communication.
	4e. Interface PIC18 with RS232 connector.	4.4 PIC18 connection to RS232.
	4f. Develop a program.	4.5 PIC18 Serial Port Programming in C.
	4g. Explain all interrupts. 4h. Discuss interrupts priority.	4.6 PIC18 Interrupts.
	4i. Develop a program.	4.7 Programming Timer, External Hardware, Serial communication and Port B change

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		interrupts.
Unit – V PIC18 Interfacing : LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor	5a. Describe the functions of the pins of a typical LCD. 5b. Interface an LCD to the PIC18.	5.1 LCD Interfacing
	5c. Interface a 4 x 4 keypad to the PIC18 using "C".	5.2 Keyboard Interfacing
	5d. Explain the process of Data acquisition using 8 and 10 bit serial and parallel ADC. 5e. Program the PIC18's ADC in C.	5.3 ADC Characteristics. 5.4 ADC Programming in the PIC18
	5f. Interface a DAC chip to the PIC18.	5.5 DAC Interfacing
	5g. Interface temperature sensors to the PIC18. 5h. Describe signal conditioning and its role in data acquisition.	5.6 Sensor Interfacing and Signal Conditioning.
	5i. Interface the PIC18 with a relay. 5j. Interface the PIC18 with an opto-isolator.	5.7 Relays and Opto-isolators.
	5k. Interface the PIC18 with a stepper motor. 5l. Program PIC18 to control and operate a stepper motor.	5.8 Stepper Motor Interfacing.
	5m. Interface the PIC18 with a DC motor. 5n. Describe DC motor speed control using PWM.	5.9 DC Motor interfacing and PWM.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARK (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	PIC Microcontrollers : History, Features and Architecture	08	04	04	06	14
II	Classification of Instructions and I/O Port Programming.	10	04	04	06	14
III	PIC18 Programming in C.	07	02	02	06	10
IV	PIC18 Programming in C: Timer, Serial Port and Interrupt.	07	02	04	08	14
V	PIC18 Interfacing : LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor	10	02	04	12	18
	Total	**42**	**14**	**18**	**38**	**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 EXCERCISES / PRACTICALS

The practical 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. However, if these practical 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. Hours Required
1	I	Test Hardware and Software development tool for PIC18.	02
2	I	Check Register and Memory with MPLAB Simulator	02
3	II	Develop and Execute Programs on Arithmetic instructions.	02
4	II	Develop and Execute Programs on Logical and Compare instructions.	02
5	II	Develop and Execute Programs on Rotate instructions and Data Serialization.	02
6	II	Develop and Execute Programs on BCD and ASCII code conversion.	02
7	II	Develop and Execute Programs on branching instructions and Looping.	02
8	II	Develop and Execute Programs on Call instructions.	02
9	II	Develop and Execute Programs on Time delay.	02
10	II	Develop and execute program on I/O Port programming.	02
11	II	Develop and execute programs on single bit manipulation.	02
12	IV	Develop and execute programs on Timers and Counters.	02
13	IV	Develop and execute programs on Serial Communication.	02
14	IV	Develop and execute programs on Different Interrupt handling.	02
15	V	Interface LCD with PIC18.	02
16	V	Interface Keyboard with PIC18.	02
17	V	Interface ADC with PIC18.	02
18	V	Interface DAC with PIC18.	02
19	V	Interface Different Sensors with PIC18.	02
20	V	Interface relay with PIC18.	02
21	V	Interface stepper motor with PIC18.	02
22	V	Interface DC motor with PIC18.	02
23	V	Perform DC motor speed control using PWM with PIC18.	02
Total Hours			**46**

Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.

8. SUGGESTED STUDENT ACTIVITIES

Following are some of the proposed student activities such as:

i. Execute PIC18 "C" programs using microcontroller Development kits.
ii. Verify above programs using simulators.
iii. Interface various peripherals with PIC 18 microcontroller.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange seminar/symposium where student should present on different aspects of PIC Microcontroller
ii. Ask students to do mini projects related to PIC Microcontroller
iii. Arrange expert lecture by engineers having experience of using PIC for instrumentation purposes.

10. SUGGESTED LEARNING RESOURCES

A) Books

Sl. No.	Title of Book	Author	Publication
1.	PIC Microcontroller And Embedded Systems.	Mazidi M. A., McKinlay R. D., Causey D.	Pearson Education International, 2008
2.	PIC Microcontroller	Gaonkar R. S.	Penram International Publishing (India) Pvt. Ltd.
3.	PIC Microcontrollers – Programming in C	Verle Milan	Mikroelektronika, 1st Edition, 2009
4.	PIC Microcontroller	Matic Nebojsa	Mikroelektronika, 1st edition 2008
5.	Embedded C Programming And The Microchip PIC	Barnett R. H., Cox S., O'cull L.	Cengage; Pap/Cdr edition 2003
6.	Design with PIC Microcontrollers	Peatman John B.	Pearson Education

B) Major Equipment/ Instrument with Broad Specifications

1. Computer — capable to support "C" programming and required simulators.
2. PIC 18 Development kit. — With inbuilt power supply, keyboard, LCD displays, ports for interfacing peripheral and memory.
3. Microcontroller based interfacing study cards. — Capable to interface LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor With PIC 18 Development kit.
4. Microcontroller Simulator softwares.

C) Software / Learning Websites

i. www.nptel.com
ii. http://en.wikipedia.org/wiki/PIC_microcontroller
iii. www.microchip.com/pic/
iv. www.engineersgarage.com/articles/pic-microcontroller-tutorial
v. www.best-microcontroller-projects.com/pic-microcontroller.html

vi. www.pic18-simulator-ide.software.informer.com
vii. www.gpsim.sourceforge.net

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. M. V. Dabhi**, I/C HOD (DBM), Government Polytechnic, Gandhinagar.
- **Prof. A. M. Patel**, Lecturer, Government Polytechnic, Palanpur.
- **Prof. (Smt.) S. K. Raval**, Lecturer, Government Polytechnic, Ahmedabad.
- **Prof. M. J. Vadhavaniya**, Lecturer, Government Polytechnic, Gandhinagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: EMBEDED NETWORKS
(COURSE CODE: 3361706)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation And Control	Sixth

1. RATIONALE

Embedded networks are widely used in portable Automatic systems like automobiles, Aeronautics etc. To control speed, autofocus, safety, interconnection and communication of various sensors is necessary. The students studying this course are supposed to learn the concept of real time networking, protocols like CAN, ZIGBEE, MODBUS etc. The course in addition, will provide knowledge of applications and interfacing of embedded networks. Thus this course is an important course for instrumentation engineers working in the area of imbedded instrumentation.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Explain real time embedded systems and embedded networks.**
- **Interface sensors, transducers, motors, relays and various input/output devices with Communication Highway.**

3. COURSE OUTCOMES (COs)

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

i. Identify network types and topologies.
ii. Explain Real Time Operating System (RTOS).
iii. Build Controller Area Network (CAN).
iv. Program Controller Area Network (CAN).
v. Explain Advanced Wireless Networks (ZigBee).

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**	**150**
3	0	2	05	70	30	20	30	

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

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Concept of Networking.	1a. Define Network. 1b. Explain Network types. 1c. Explain Class A, B, C, D networks with their features.	1.1 Need for Networking.
	1d. Explain different Network Topologies. 1e. Discuss advantages and disadvantages of different network topologies.	1.2 Network Topologies.
	1f. Explain OSI reference Model.	1.3 OSI reference Model.
	1g. Explain different types of cables used in Networking with their category description. 1h. Explain Cable connectors used in Networking. 1i. Define Patch cable and Cross over cable. 1j. Discuss factors for the selection of cable.	1.4 Cables used for Networking.
	1k. Define CSMA / CA, CSMA / CD, CSMA / CR. 1l. Discuss applications of CDMA / CA, CSMA / CD, CSMA / CR.	1.5 Concept of CSMA / CA, CSMA / CD, CSMA / CR.
Unit– II Real Time Operating System (RTOS).	2a. Explain concept and characteristics of RTOS. 2b. Explain need of RTOS. 2c. Explain structure of RTOS. 2d. Define multitasking and concurrency. 2e. Explain conditions required for multitasking in RTOS. 2f. Discuss advantages and disadvantages of multitasking in RTOS.	2.1 Introduction to RTOS.
Unit – III Industrial Embedded Networking.	3a. Discuss Serial and Parallel transmission. 3b. Define the given terms.	3.1 Bus System. Terms: Bus line, Bus Subscriber, Gateway, Master / slave controller.
	3c. Give functional description of CAN. 3d. Explain architecture of CAN. 3e. Explain features of CAN. 3f. Compare CAN with OSI model.	3.2 Controller Area Network (CAN).
	3g. Explain each field of CAN data frame.	3.3 CAN data frame.
	3h. Discuss Pinout diagram for DNA – CAN 503. 3i. Discuss CAN Bus wiring. 3j. Explain CAN protocol and standard specifications. 3k. Explain pin assignment of 9 – pole	3.4 Installation of CAN.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	DSUB connector. 3l. Explain pin assignment of 5 – pole combicon connector. 3m. Explain rules for installation of CAN. 3n. Explain isolation in CAN transceiver.	
	3o. Troubleshoot the CAN.	3.5 Troubleshooting of CAN.
	3p. Explain architecture of smart sensors. 3q. Explain various types of smart sensors.	3.6 Introduction to Smart Sensors.
Unit – IV CAN Programming and Applications.	4a. Discuss steps for CAN programming. 4b. Draw flow chart for CAN transmitter. 4c. Draw flow chart for CAN receiver.	4.1 Programming CAN.
	4d. Explain the given applications.	4.2 Applications of CAN: 4.2.1 Auto door locking in automobiles. 4.2.2 Speed Control. 4.2.3 Head light control. 4.2.4 ABS in automobile. 4.2.5 Air Bag control in automobiles.
Unit – V Advanced Wireless Networks.	5a. Explain ZigBee stack architecture. 5b. Describe importance of ZigBee. 5c. Compare ZigBee with other wireless technologies. 5d. Describe ZigBee applications in brief	5.1 Introduction to Zigbee.

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Concept of Networking.	**08**	07	04	03	**14**
II	Real Time Operating System (RTOS).	**06**	03	02	02	**07**
III	Industrial Embedded Networking.	**16**	07	11	10	**28**
IV	CAN Programming and Applications.	**06**	04	06	04	**14**
V	Advanced Wireless Networks	**06**	03	02	02	**07**
	Total	**42**	**23**	**26**	**21**	**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 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. However, if these practical 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. Hours Required
1	I	Debug Local Area Network.	02
2	I	Debug CWAN.	02
3	I	Debug Bus topology.	02
4	I	Identify OSI layers through LAN / CWAN.	02
5	I	Check different cables and connectors.	02
6	I	Install cables for LAN / CWAN.	02
7	II	Develop and Execute Programs for reading data from sensor.	02
8	II	Develop and Execute Programs for writing data to the output device.	02
9	III	Interface CAN 9 – pole DSUB connector.	02
10	III	Interface CAN 9 – pole combicon connector.	02
11	III	Develop a CAN data frame for given conditions.	02
12	III	Troubleshoot error in CAN.	02
13	IV	Develop and execute programs for CAN interfacing.	02
14	IV	Case study – 1. Auto door locking in automobile.	02
15	IV	Case study – 2. Speed Control in automobile.	02
16	IV	Case study – 3. Head light control in automobile.	02
17	IV	Case study – 4. ABS in automobile.	02
18	IV	Case study –5. Air Bag control in Automobile.	02
19	V	Develop wireless program using ZigBee module.	02
Total Hours			**38**
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED STUDENT ACTIVITIES

Following are the proposed student activities such as:

i. Perform various tasks related to Embedded Networks in laboratory.
ii. Perform various practical using simulators in laboratory.
iii. Visit various industries using embedded instrumentation.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange seminar/symposium where student should present on different aspects of embedded networks.
ii. Ask students to do mini projects related to embedded networks.
iii. Arrange expert lecture by engineers having experience of using embedded networks for instrumentation purposes.

10. SUGGESTED LEARNING RESOURCES

A) Books

Sl. No.	Title of Book	Author	Publication
1.	Embedded / Real-Time Systems: Concepts, Design and Programming	Dr. Prasad K. V. K. K.	Dreamtech Press/Wiley India, 2003
2.	Real-Time Systems	Krishna C. M. and Shin K. G.	Mcgraw-Hill,1997
3.	Simple Real Time Operating System	Chowdary Venkateswara	Trafford Publishing, 2007
4.	Understanding and using the controller area network communication protocol	Di Natale, M.Zeng, H.giusto ,P,Ghosal	Springer publication, 2012
5.	Modern Automative technology	James E.Duffy	Goodheart-willcox company 2009
6.	Embedded Networking with CAN and CANopen	Olaf Pfeiffer, Andrew Ayre, Christian Keydel	Copperhill Technologies Corporation, 2008

B) Major Equipment/ Instrument with Broad Specifications

i.	Various Networking Cables and Connectors.	Capable to support "C" programming and required simulators.
ii.	Networking Tools.	With inbuilt power supply, keyboard, LCD displays, ports for interfacing peripheral and memory.
iii.	Simulators.	Capable to interface LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor With PIC 18 Development kit.
iv.	Hardware modules for CAN, ZigBee, MODBUS etc.	

C) Software / Learning Websites

i. http://www.zigbee.org/en/about/faq.asp
ii. http://anideaclub.blogspot.in/2013/04/microcontroller-zigbee.html
iii. www.microchip.com/pic/
iv. www.engineersgarage.com/articles/pic-microcontroller-tutorial
v. www.best-microcontroller-projects.com/pic-microcontroller.html
vi. www.pic18-simulator-ide.software.informer.com
vii. www.gpsim.sourceforge.net
viii. http://inst.cs.berkeley.edu/~ee249/fa08/Lectures/handout_canbus2.pdf
ix. http://www.eecs.umich.edu/eecs/courses/eecs373/Lec/W12Student/373CANpreso.pdf
x. http://www.ueidaq.com/media/catalog/product/pdf/manual/dnx-can-503-manual.pdf
xi. http://www.ecnmag.com/articles/2009/10/isolated-can-transceiver-assures-robust-fieldbus-design
xii. http://www.ti.com/lit/wp/spry200/spry200.pdf
xiii. http://electronicsforu.com/newelectronics/circuitarchives/view_article.asp?sno=840&title%20=%20Electronics+in+Cars&id=11280&article_type=8&b_type=new
xiv. http://guides.machinescience.org/mod/book/view.php?id=706&chapterid=46
xv. http ://www.howstuffworks.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PROJECT- II (WITH SEMINAR)
(COURSE CODE: 3361707)

Diploma Programme in which this course is offered	Semester in which offered
INSTRUMENTATION AND CONTROL	SIXTH

1. RATIONALE:

For a diploma Instrumentation engineer, student expected to gain capabilities of doing independent and group work by carrying out successful project work. For that purpose student expected to learn, define problems, understand the problem, provide alternative solutions to the problems, design, fabricate, implement, test and installation of necessary circuits/system/software to solve the problem. As well as student expected to develop defined soft skills. So that after doing project work student should be confident enough get their employment.

Above mentioned expected outcome may achieved through Project-I, but to further enhance skills, particularly in interfacing area, students should identify and prepare their projects particularly in interfacing Process Instrumentation or Biomedical Instrumentation with various digital computing devices such as microprocessors, microcontroller, Computers, Programmable Logic Controllers, SCADA, DCS etc.

2. COMPETENCE:

The course should be facilitated and implemented, ***with the aim to develop Communicate and lead effectively as well as able to work independently but also collaboratively in multi-disciplinary*** teams by acquiring following skills:

- Hard Skills: Planning, Interpret Technical Specifications, Designing, Fabrication, Implementation, Testing, Installation.
- Soft Skills: Report writing, presentation, Software development/Programming
- Interpersonal Skills: Team work, Communication, Coordination, awareness of market scenario such as costing of components/services.

3. 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	6	6	00	00	60	90	150

4. Course Detail.

Student should carry out one project during the term related to interfacing Process Instrumentation or Biomedical Instrumentation with various digital computing devices such as microprocessors, microcontroller, Computers, Programmable Logic Controllers, SCADA, DCS etc. Project may be pertaining to measurements of process variables and parameters, measurement, control and its interfacing with various Processors.

Guideline to form a group:

Students in group have to identify real life engineering problem from industry, academic institutions, or society. It is necessary to work in a group of minimum two students, individual student is not allowed ***(Reason: every engineering activity is group activity)***. Each group can have maximum four students if project complexity demands.

Guideline for selecting the project idea:

1. Student should read well known technical magazines such as electronics for you, elector-electronics; automate magazine, automation world, and instrument India etc.
2. Project volumes published by electronics for you magazine.
3. Student should refer resource web link given at last.
4. Refer link http://www.techpedia.in/ collaborated by GTU innovation council cell.

Following list of projects are suggested for the guidance of faculties and students:

Sr.No	NAME OF PROJECTS	AREA OF PROJECTS
1.	Home Automation And Security Control Using Microcontroller.	PROCESSOR BASED APPLICATION
2.	Remote controlled Stepper Motor Using Microcontroller	
3.	Ultrasonic Proximity Detector Using Microcontroller	
4.	RFID Based Device Control and Authentication Using PIC Microcontroller	
5.	Beacon Flasher Using Microcontroller	
6.	Line Following Robotic Vehicle Using Microcontroller	
7.	Water Level Controller using 8051 Microcontroller:	

8.	Smart Card For Entry Employee Using Microcontroller	
9.	Password Based Door Lock System Using 8051	
10.	Digital Tachometer Using 8051 Microcontroller	
11.	PLC Based Dc Servo Motor Control System	MEASUREMENTS OF PROCESS VARIABLES AND PARAMETERS AND INTERFACING WITH PLC AND SCADA MISCELLANEOUS
12.	PLC based injection Moulding machine	
13.	PLC based automatic car washing machine	
14.	PLC based Elevator Controller	
15.	PLC based Temperature/Pressure Controller	
16.	Industrial Timer Controller for Multiple Machines using PLC	
17.	Sequential Batch Process using PLC	
18.	Automated Railway Signaling and Monitoring using PLC	
19.	PLC based Coffee Vending Machine	
20.	Automated Door open and close System using PLC	
21.	PLC based automatic bottle filling System	
22.	Water storage and distribution system for pharmaceuticals using PLC and SCADA	
23.	SCADA application of a water steam cycle of a thermal power plant	
24.	Microcontroller-Based Robotics and SCADA Experiments	
25.	SCADA And PLC Based Distribution And Substation Automation	
26.	SCADA System Design And Construction For Real-Time Electrical Parameter Monitoring And Control	
27.	SCADA (Supervisory Control & Data Acquisition) for Remote Industrial Plant	
28.	Simulation approach on step speed control of Induction Motor using Lab View	MEASUREMENTS OF PROCESS VARIABLES AND PARAMETERS AND *INTERFACING WITH COMPUTERS*
29.	Design & Implementation of Smart House Control Using Lab VIEW	
30.	Lab view based instrumentation system for solar-wind hybrid station	
31.	Multi-Device control system using PC	
32.	PC based Temperature Control System	
33.	PC Based Motor Speed Monitoring System	
34.	Ethernet based home/industrial automation	
35.	PC based packing control machine for industrial Application	

Guideline for Report Writing: Every student has to submit their project work detail in project report both in hard copy as well as softcopy (preferable in CD media). Project report should be as per guideline given in the following table.

Chapter No.	Title	Remarks
-	Front page	Compulsory
-	Certificate	Compulsory
-	Acknowledgement	Compulsory
-	Table Of Content	Compulsory
1.	Brief description of project idea	Compulsory
2.	Literature survey	Optional
3.	Block diagram with description	Compulsory
4.	Circuit diagram with description	Compulsory
5.	Programming flow chart and its programme/coding	Optional
6.	PCB layout	Optional
7.	Implementation, Testing and Results	Compulsory
8.	Conclusion	Compulsory
9.	Future scope of work/ Extension of project idea	Optional
10.	Bibliography/ References	Compulsory
11.	Annexure-I (Datasheets of used components)	Compulsory

Note: Suggested guideline for formatting the project report.

1 All pages should have page numbers at center bottom of the page.
2 All text should be in Arial/Times New Roman fonts.
  2.1 Main Title size should be 16
  2.2 Sub Title size should be 14
  2.3 General Text size should be 12

5. SUGGESTED SPECIFICATION TABLE WITH WEEKS.

Phase No.	Phase Title	Working Weeks
I	Literature Survey, Project Identification	2
II	Design	6
III	Implementation	4
IV	Testing and Installation	1
V	Report writing and Presentation	1
	Total	14

6. PROJECT EVALUATION SCHEME:

Evaluation of project should be made as per following guidelines

SR. No.	EVALUATION	WEIGHTAGE
I	Literature Survey, Project Identification	05%
II	Design	35%
III	Implementation	35%
IV	Testing and Installation	10%
V	Project Report	10%
VI	Presentation	05%
	Total	100%

7. SUGGESTED LEARNING RESOURCES:

i **http://www.electronicshub.org/electronics-projects-ideas/**
ii **http://seminarprojects.com/Thread-ece-projects-topics-list-for-final-year-new-ideas**
iii **http://indianengineer.wordpress.com**
iv **http://www.slideshare.net/zettanetworks/final-year-engineering-project**
v **http://www.elprocus.com/final-year-engineering-projects-for-electronics-and-instrumentation-students/**
vi **http://electronicsforu.com/newelectronics/default.asp**
vii **http://www.majesticproject.com/**
viii **http://anedotech.com**
ix **http://www.apexengineeringproject.com**
x **http://1000projects.org**
xi **http://www.ingenstech.com/projects-lists-2013-14/PLC%20SCADA%20Projects%20-%20INPLC.pdf**

8. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- Prof. J.T. Patankar I/C HOD, Government Polytechnic, Ahmedabad
- Prof. M. A. Modi Lecturer , Government Polytechnic, Palanpur.

Faculty Members from NITTTR Bhopal