

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:

- Identify network on the basis of various network parameters.
- Identify OSI-ISO and TCP/IP network models.
- Select guided and unguided medium for various types of data transmission.
- Assign IP address to the network and network component as per the networks.
- Install various types of network devices and other network hardware for Field and ProfiBUS.
- 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				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	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 Local Area Network	1a Justify need of Computer Networks in automation. 1b Describe the functions of various components of Computer Networks. 1c Compare 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
	1d Classify computer networks- Based on Transmission, scale, and Architecture. 1e Differentiate LAN, WAN, MAN. 1f Describe configuration of LAN with example. 1g State the applications service offered by WAN. 1h Explain 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 Server over Peer-to-Peer Model
Unit – II Network Devices and Communication Protocol	2a Justify the need of protocol. 2b Explain the need for layer modeling. 2c Describe the functions of each layer of OSI Reference model.	2.1 Basics of Protocol and its need 2.2 Brief functional description of each The OSI-ISO Reference Model layers with list of protocols
	2d Describe the functions of each layer of TCP/IP Reference model. 2e Compare the major features of OSI and TCP/IP model. 2f Explain Format of IP v4 and IPv6 protocol. 2g Explain IP addressing scheme with examples. 2h Describe Domain Name system (DNS).	2.3 The 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) 2.5 Internet addressing: Network addressing, Subnet and subnet masking, gateway addressing, broadcast addressing, dotted decimal notation, loopback addressing 2.6 Domain Name System(DNS): Introduction, mapping to IP addresses
Unit – III Network Media and Hardware	3a Explain characteristics of guided and unguided transmission media. 3b Describe specifications of UTP	3.1 Transmission Media: Unguided and Guided media, Wired and Wireless, UTP, Coaxial and Fiber optical cable

	<p>and coaxial cable.</p> <p>3c Describe specifications of Wired and Wireless.</p> <p>3d Sketch constructional details of UTP and coaxial cable with labels.</p>	
	<p>3e List different types of connectors.</p> <p>3f Describe different connectors with neat sketch.</p> <p>3g List features of different network interface card.</p>	<p>3.2 Types 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</p> <p>3.3 Network Interface Card (NIC), ARCNET, Ethernet.</p>
	<p>3h Explain functions of following network devices: Repeater, Hub, Bridge, Switch, Router, Gateway, Access point, Wireless Access points.</p>	<p>3.4 Network connecting devices: Repeater, Hub, Bridge, Switch, Router, Gateway, Access point, Wireless Access points</p>
	<p>3i List features of different types of Servers.</p>	<p>3.5 Servers introduction : File, Print, Mail, Proxy, Web</p>
<p>Unit – IV Basics of Fieldbus and ProfiBus</p>	<p>4a Discuss benefits of Foundation Fieldbus.</p> <p>4b Sketch waveforms showing Manchester Bi-phase L encoding scheme with four encoding states.</p> <p>4c Sketch waveforms showing use of N+ and N– encoding states.</p> <p>4d Draw OSI model of the FF protocol stack.</p> <p>4e Explain data link layer of Foundation Fieldbus in brief.</p> <p>4f Draw data link layer packet format for Foundation Fieldbus.</p> <p>4g Describe application layer of Foundation Fieldbus in brief.</p> <p>4h Draw the passage of information packets to the physical layer of Foundation Fieldbus.</p> <p>4i List the important points to be considered while preparing termination for Foundation Fieldbus.</p>	<p>4.1 Introduction to Foundation Fieldbus</p> <p>4.1.1 Physical layer and wiring rules</p> <p>4.1.2 Data Link layer</p> <p>4.1.3 Application layer</p> <p>4.1.4 User layer</p>

	<p>4j Draw and explain wiring configuration of Foundation Fieldbus system.</p> <p>4k List the factors need to be known when troubleshooting the power system of an FF system.</p> <p>4l Discuss the communication problems of Foundation Fieldbus.</p> <p>4m State the parameters which can be checked by Foundation Fieldbus test equipment.</p>	<p>4.2 Wiring and installation practice with Fieldbus</p> <p>4.2.1 Termination Preparation</p> <p>4.2.2 Installation of the complete system</p> <p>4.3 Troubleshooting of foundation field bus</p> <p>4.3.1 Introduction to physical problem</p> <p>4.3.2 Power problem</p> <p>4.3.3 Communication problem</p> <p>4.3.4 Test equipment for foundation field bus</p>
	<p>4n Describe the versions (Profibus DP, Profibus FMS and ProfibusPA) of Profibus standard in brief.</p> <p>4o Draw Profibus protocol stack</p> <p>4p List the features of Physical layer of Profibus DP standard.</p> <p>4q Draw and explain in brief about hybrid medium access control scheme of Profibus.</p> <p>4r Differentiate between token passing and polling technique used in Profibus for medium access.</p> <p>4s Describe token passing method of Profibus in brief.</p>	<p>4.4 Introduction to Profibus standard</p> <p>4.5 Profibus protocol stack</p> <p>4.5.1 Physical layer</p> <p>4.5.2 Data Link layer</p> <p>4.5.3 Application layer</p>
	<p>4t State various troubleshooting tools for profibus network and explain any one.</p> <p>4u Explain how the common problems of Profibus DP can be identified.</p>	<p>4.6 Troubleshooting of Profibus</p>
<p>Unit – V HART and MODBUS</p>	<p>5a Write the salient feature of HART protocol which is generally not found in other protocol.</p> <p>5b Discuss the features of HART for smart instrumentation.</p> <p>5c Describe HART protocol in brief.</p> <p>5d Draw and explain HART point-to-point communication.</p> <p>5e Draw and explain HART multi-point communication.</p> <p>5f State the uses of HART handheld communicator.</p> <p>5g Sketch the connection diagram of HART handheld communicator.</p>	<p>5.1 Concept of Highway Addressable Remote Transducer (HART)</p> <p>5.2 HART and smart Instrumentation</p> <p>5.3 HART protocol</p> <p>5.4 HART Physical layer</p>

	<p>5h Show HART protocol implementation of OSI layer model.</p> <p>5i Draw HART data link frame format.</p> <p>5j List the benefits of HART.</p> <p>5k Describe the trouble shooting of HART network in brief.</p>	<p>5.5 HART Data link layer</p> <p>5.6 HART benefits</p> <p>5.7 Troubleshooting of HART</p>
	<p>5l State the limitations of Modbus network.</p> <p>5m State transmission modes used in Modbus and give their short description.</p> <p>5n Draw and explain in brief about format of Modbus message frame.</p>	<p>5.8 Overview of Modbus protocol</p> <p>5.9 Modbus protocol structure</p>
	<p>5o Describe Read coil or digital output status (function code 01) of Modbus with suitable example.</p> <p>5p Describe Read digital input status (function code 02) with suitable example.</p> <p>5q Describe Read holding registers (function code 03) with suitable example.</p>	<p>5.10 Function codes</p> <p>5.10.1 Read coil or digital output Status (function code 01)</p> <p>5.10.2 Read digital input status (function code 02)</p> <p>5.11 Read holding registers (function code 03)</p>

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	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 Andrew S 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.fieldbusinc.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**Faculty Members from Polytechnics**

- **Prof. J.T. Patankar**, I/C HOD(IC), Govt. Polytechnic, Ahmedabad
- **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