GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Instrumentation and Control Engineering

Subject Code : DI04017081

Subject Name : Industrial Data Communication

w. e. f. Academic Year:	2025-26
Semester:	4
Category of the Course:	Professional Elective - II

Prerequisite:	Basic Knowledge of circuits and data communication.
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 and automation.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Identify network on the basis of various network parameters.	R
2	Identify OSI-ISO and TCP/IP network models.	U
3	Configure/Setup guided and unguided medium for various types of data transmission.	A
4	Assign IP address to the network and network component as per the networks.	A
5	Install various types of network devices and other network hardware.	A
6	Troubleshoot problems in hardware/software employed in data communication.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
Unit – I Fundamentals of Industrial Communication .	1.1: Introduction to Computer Networks 1.2: Computer Networks in Instrumentation. 1.3: Components of Computer Networks: 1.3.1: hardware and software 1.3.2: Configuration of various Network topologies and its applications. 1.4: Network Classification Based on 1.4.1: Transmission Technologies: Point- to-point and Broadcast 1.4.2: Based on scale: LAN, WAN, MAN,VPN, Internet 1.4.3: Based on Architecture: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model	9	20
Unit – II Protocol and Serial communication	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 2.3: The TCP/IP Reference Model: Brief functional description of each of the Layer with list of protocols 2.3.1: IP layer Protocols: IPv4 and IPv6 frame Format (Limited to format only) 2.4: Fundamentals of serial communication: Asynchronous vs. synchronous communication. Concepts of signal levels, baud rate, and data format. 2.5: RS-232, RS-422, and RS-485 standards: 2.5.1: Detailed specifications, advantages, and limitations. 2.5.2: Applications in industrial settings, particularly for legacy systems and point-to-point connections. 2.6: Electrical noise and grounding considerations in industrial environments.	10	20

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
Unit – III Network Media and Hardware	3.1: Transmission Media: Unguided and Guided media, Wired and Wireless, UTP, Coaxial and Fiber optical cable 3.2: Types of Connectors: RJ-45, RJ-11, BNC, BNC Terminator, Fiber optic connectors:- Subscriber Channel(SC), Straight Tip(ST), Mechanical Transfer–Registered Jack (MT-RJ) connectors. 3.3: Network Interface Card (NIC), 3.4: ARCNET, 3.5: Ethernet. 3.6: Network connecting devices: Installation, Utilization and application. Repeater, Hub, Bridge, Switch, Router, Gateway, Access point, Wireless Access points. 3.7: Industrial WLAN. (Industrial Wifi) 3.8: Servers introduction : File, Print, Mail, Proxy, Web 3.9: Firewall (protection system)	9	20
Unit – IV Basics of Fieldbus and ProfiBus	4.1: Introduction to Foundation Fieldbus 4.1.1: Concept of decentralized control and distributed I/O. 4.1.2: Benefits over traditional serial communication. 4.2: Wiring and installation practice with Fieldbus 4.2.1: Termination Preparation 4.2.2: Installation of the complete system 4.2.3: Troubleshooting of foundation field bus 4.2.4: Introduction to physical problem 4.2.5: Power problem 4.2.6: Communication problem 4.3: Test equipment for foundation field bus 4.4: Overview of the PROFIBUS family, PROFIBUS DP 4.4.1: Profibus Communication model and frame structure	9	20

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
	4.5: Profibus cable and its types 4.5.1: Profibus to OFC Converter. 4.5.2: OFC to Profibus Converter. 4.6: Troubleshooting of Profibus. 4.7: Industry 4.0 and the IIoT: 4.7.1: Brief overview of emerging trends like the Industrial Internet of Things and its reliance on robust communication. 4.7.2: Role of wireless technologies like Long Range Wide Area Network (LoRaWAN). 4.7.3: IIoT Protocols MQTT and CoAP in brief.		
Unit – V HART, MODBUS and OPC	5.1: Concept of Highway Addressable Remote Transducer (HART) 5.1.1: Wireless HART 5.2: HART and smart Instrumentation 5.3: HART benefits 5.4: Troubleshooting of HART 5.5: Overview of Modbus protocol 5.6: Modbus Protocol: 5.6.1: Modbus RTU and Modbus ASCII variants. 5.6.2: Master-slave architecture and data frame structure. 5.6.3: Implementation using RS-485. 5.7: Modbus TCP/IP: Modbus integration with standard Ethernet. 5.8: Comparison: Serial Modbus vs Modbus TCP/IP 5.9: OPC UA: 5.9.1: Introduction to OPC (Open Platform Communications). 5.9.2: Concept of OPC UA as a platform-independent communication standard. 5.9.3: Application in bridging the gap between IT and OT (Operational Technology).	8	20
	Total	**45**	**100**

SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. required
1	To study different types of transmission medias.	2Hrs
2	Prepare and Test Straight and Cross UTP Cable.	2Hrs
3	Prepare and Test Cross CAT5, CAT6 and RJ11Cable.	4Hrs
4	Configuring Computer modem.	2Hrs
5	Configuring Hub/Switch and Router.	2Hrs
6	Connect computer terminal in various physical topologies and test the data transfer.	4Hrs
7	Prepare detailed report of existing LAN in the Department/Institute	4Hrs
8	Configure static and dynamic IP addresses and Run basic utilities and network commands: ipconfig, ping, tracert, netstat, pathping ,route etc.	4Hrs
9	Configure file server and configure client to file server and use file services.	4Hrs
10	Set access rights and security permissions for user.	2Hrs
11	Setting up wireless network.	2Hrs
12	Connect multiple computers using wireless media.	2Hrs
13	Test the operational Fieldbus Network using Fieldbus tester	2Hrs
14	Select appropriate cable for FF and Profibus network	2Hrs
15	Connect multiple RTUs with ModBUS protocol.	2Hrs
16	Connect HART handheld communicator to HART network	2Hrs

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. required
17	Install and Configure HART point-to-point communication Network	2Hrs
18	Transmit 8 bit digital signal superimposed on 12mA analog signal using HART FSK technique	2Hrs
	Total	46

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare experimental setup	30
2	Operate the equipment setup or circuit	10
3	Follow safe practices measures	20
4	Record observations correctly	20
5	Interpret the result and conclude	20
	Total	**100**

MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Wires, tools and various connectors	2,3
2	Computer and modem.	4

3	Computer, Hub, switch and Router, RTUs, PLC or any other smart instrument used in Instrumentation.	5,6,7,8,9,10
4	Wireless router.	11,12

AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member for assigned student activity.
b) Follow safety practices and procedure in Lab.
c) Realize the importance of engineering for societal development.
d) Develop gradually the engineering mindset in day-to-day observation

SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Realize various topologies using computers and instruments.
b) Give seminar on Internet and cyber security.
c) Prepare a comparative Chart on various types of network.
d) Give seminar wireless communication and its future scopes.

SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:

a) Inspire Student to read books on development and evolution networking, instruct them to take notes in form of summary
b) Prepare a short note on applications of network security in industry.
c) Guide students to make presentation on applications of HART Protocol.
d) List out various models used in data communications along with their advantages and limitations.
e) Guide students to make presentation on applications of Modbus Protocol.

SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
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
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)

SUGGESTED LEARNING WEBSITES

i. www.nptel.iitm.ac.in.
ii. www.isa.org
iii. 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.opc-router.com/what-is-opc-ua/
xv. www.prosoft-technology.com/kb/assets/intro_modbustcp.pdf
xvi. www.thethingsnetwork.org/docs/lorawan/what-is-lorawan/

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