

GUJARAT TECHNOLOGICAL UNIVERSITY

Instrumentation and Control Engineering

B. E. SEMESTER: VII

Subject Name: **Industrial Data Communication**

Subject Code: **171703**

Teaching Scheme				Evaluation Scheme			
Theory	Tutorial	Practical	Total	University Exam (E)		Mid Sem Exam (Theory) (M)	Practical (Internal)
				Theory	Practical		
4	0	0	4	70	0	30	50

Sr. No	Course Content	Total Hrs.
1.	Introduction: Modern instrumentation and control systems; Open systems interconnection (OSI) model; Protocols; Standards	3
2.	Industrial Data Communication Methodology: Introduction; Common problems and solutions; General comments on troubleshooting; a specific methodology; Grounding/shielding and noise; Sources of electrical noise; Electrical coupling of noise; Shielding; Cable ducting or raceways; Cable spacing, Earthing and grounding requirements; Suppression techniques; Filtering	3
3.	EIA-232 Interface Standard: EIA-232 interface standard (CCITT V.24 interface standard): the major elements of EIA-232, Half-duplex operation of the EIA-232 interface, EIA/TIA-232 revisions, Limitations of EIA-232; troubleshooting: Introduction, Typical approach, Test equipment, Typical EIA-232 problems	3
4.	EIA-485 Interface Standard: The EIA-485 interface standard, Troubleshooting: Introduction, EIA-485 vs EIA-422, EIA-485 installation, Noise problems, Test equipment	3
5.	Current loop and EIA-485 converters: The 20 mA current loop, Serial interface converters, Troubleshooting, Troubleshooting converters	3

6.	Fiber optics overview: Introduction; Applications for fiber optic cables; Fiber optic cable components; Fiber optic cable parameters; Types of optical fiber; Basic cable types: Aerial cable, Underground cable, Sub-aqueous cables, Indoor cables; Connecting fibers: Connection losses, Splicing fibers, Connectors, Connector handling, Optical couplers; Splicing trays/organizers and termination cabinets: Splicing trays, Splicing enclosures, termination in patch panels and distribution frames; troubleshooting: Standard troubleshooting approach, Tools required, Fiber installation rules, Clean optical connectors, locating broken fibers	3
7.	Modbus and Modbus Plus Protocols: I. Modbus Protocol: General overview; protocol structure; Function codes: Read coil or digital output status (function code 01), Read digital input status (function code 02), Read holding registers (function code 03), Reading input registers (function code 04), Force single coil (function code 05), Preset single register (function code 06), Read exception status (function code 07), Loopback test (function code 08), Force multiple coils or digital outputs (function code 0F), Force multiple registers (function code 10); Troubleshooting: Common problems and faults, Description of tools used, Detailed troubleshooting II. Modbus Plus protocol: General overview; troubleshooting: Common problems and faults, Description of tools used, detailed troubleshooting	4
8.	HART Protocol Introduction to HART and smart instrumentation; HART protocol: Physical layer, Data link layer, Application layer; Troubleshooting	3
9.	AS-interface (AS-i) Introduction; Layer 1 – the physical layer; Layer 2 – the data link layer; Operating characteristics; Troubleshooting: Introduction, Tools of the trade	3
10.	DeviceNet overview Introduction; Physical layer: Topology, Connectors - Pluggable (unsealed) connector, Hardwired (unsealed) connection, Mini (sealed) connector, Micro (sealed) connector; Cable budgets; Device taps: Sealed taps, IDC taps, Open style taps, Multiport open taps, Power taps, Cable description: Thick cable, Thin cable specification, Flat cable; Network power: General approach, Single supply – end connected, Single supply – center connected, Suggestions for avoiding errors and power supply options; System grounding: Signaling; Data link layer: Frame format, Medium access, Fragmentation; The application layer;	3

	Troubleshooting: Introduction, Tools of the trade, Fault finding procedures	
11.	ProfiBus PA/DP/FMS protocol Introduction; ProfiBus protocol stack: Physical layer (layer 1), Data link layer (layer 2), Application layer, Fieldbus message specification (FMS), Lower layer interface (LLI), Fieldbus management layer (FMA 7); The ProfiBus communication model; Relationship between application process and communication; Communication objects; Performance; System operation: Configuration, Data transfer between DPM1 and the DP-slaves, Synchronization and freeze modes, Safety and protection of stations, Mixed operation of FMS and DP stations; Troubleshooting: Introduction, Troubleshooting tools	4
12.	Foundation Fieldbus Introduction to Foundation Fieldbus; The physical layer and wiring rules; The data link layer; The application layer; The user layer; Error detection and diagnostics; High-speed Ethernet (HSE); Good wiring and installation practice with Fieldbus: Termination preparation, Installation of the complete system; Troubleshooting: Introduction, Power problems, Communication problems, Foundation Fieldbus test equipment	4
13.	Industrial Ethernet overview Introduction; 10 Mbps Ethernet: Media systems, Signaling methods, Medium access control, Frame transmission, Frame reception, MAC frame format, IEEE 802.2 LLC, Reducing collisions, Design rules; 100 Mbps Ethernet: Introduction, Media access: full-duplex, Auto-negotiation; Gigabit Ethernet: Introduction, Gigabit Ethernet full-duplex repeaters, Gigabit Ethernet design considerations; Industrial Ethernet: Introduction, Connectors and cabling, Deterministic versus stochastic operation, Size and overhead of Ethernet frame, Noise and interference, Partitioning of the network, Switching technology, Active electronics, Fast and gigabit Ethernet, TCP/IP and industrial systems, Industrial Ethernet architectures for high availability; Troubleshooting: Introduction, Common problems and faults, Tools of the trade, Problems and solutions, Troubleshooting switched networks, Troubleshooting fast Ethernet, Troubleshooting gigabit Ethernet	4
14.	TCP/IP overview Introduction: The Internet layer, The host-to-host layer, The process/application layer; Internet layer protocols (packet transport): IP version 4 (IPv4), Address resolution protocol (ARP), ICMP, ICMP datagrams, Routing; Host-to-host layer: End to end reliability – TCP, UDP; Troubleshooting: Introduction, Common problems, Tools of the trade, Typical network layer problems, Transport layer problems	4

15.	Radio and wireless communications overview Introduction; Components of a radio link; The radio spectrum and frequency allocation; Summary of radio characteristics of VHF/UHF; Radio modems: Modes of radio modems, Features of a radio modem, Spread spectrum radio modems; Intermodulation and how to prevent it: Introduction, Intermodulation; Implementing a radio link: Path profile, RF path loss calculations, Transmitter power/receiver sensitivity, Signal to noise ratio and SINAD, Fade margin, Summarization of calculations, Miscellaneous considerations; Troubleshooting	4
-----	--	---

Reference Books:

1. Practical Industrial Data Networks: Design, Installation and Troubleshooting by Steve Mackay, Edwin Wright, Deon Reynders, and John Park; Elsevier Publication
2. Instrument Engineers' Handbook: Process Software and Digital Networks by Bela G. Liptak; CRC Press