



**C. U. SHAH UNIVERSITY**  
**Wadhwan City**

**FACULTY OF:** - Technology & Engineering

**DEPARTMENT OF:** - Instrumentation & Control Engineering

**SEMESTER:** - VII

**CODE:** - 4TE07IDC1

**NAME:** - Industrial Data Communication

**Teaching & Evaluation Scheme**

| Subject Code | Subject Name                  | Teaching Hours/Week |    |    |       | Credits | Evaluation Scheme/Semester |     |                 |     |           |    |            |             |
|--------------|-------------------------------|---------------------|----|----|-------|---------|----------------------------|-----|-----------------|-----|-----------|----|------------|-------------|
|              |                               | Th                  | Tu | Pr | Total |         | Theory                     |     |                 |     | Practical |    |            | Total Marks |
|              |                               |                     |    |    |       |         | Sessional Exam             |     | University Exam |     | Internal  |    | University |             |
|              |                               |                     |    |    |       |         | Marks                      | Hrs | Marks           | Hrs | Pr/Viva   | TW | Pr         |             |
| 4TE07IDC1    | Industrial Data Communication | 4                   | 0  | 2  | 6     | 5       | 30                         | 1.5 | 70              | 3   | --        | 20 | 30         | 150         |

**OBJECTIVES**

- To acquaint the students with various standards and protocols used for Industrial Data Communication applications.

**PRE-REQUISITE**

- Fundamentals of electronics and communication engineering.

**COURSE OUTLINES**

| Sr. No. | Course Contents   | No. of Hours |
|---------|---|--------------|
| 1.      | <b>Introduction:</b> Modern instrumentation and control systems; Open systems interconnection (OSI) model; Protocols; Standards   | 3            |
| 2.      | <b>Industrial Data Communication Methodology:</b> 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 | 4            |
| 3.      | <b>EIA-232 Interface Standard:</b> major elements of EIA-232, Half-duplex operation of the EIA-232 interface, EIA/TIA-232 revisions, Limitations of EIA-232; <b>troubleshooting:</b> Introduction, Typical approach, Test equipment, Typical EIA-232 problems   | 4            |
| 4.      | <b>EIA-485 Interface Standard:</b> The EIA-485 interface standard, Troubleshooting: Introduction, EIA-485 vs EIA-422, EIA-485 installation, Noise problems, Test equipment  | 4            |
| 5.      | <b>Current loop and EIA-485 converters:</b> The 20 mA current loop, Serial interface converters, Troubleshooting, Troubleshooting converters  | 4            |
| 6.      | <b>Fiber optics overview:</b> Introduction; Applications for fiber optic cables; Fiber optic cable  | 4            |

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|    | 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   |   |
| 7  | <b>Modbus and Modbus Plus Protocols:</b><br><b>I. Modbus Protocol:</b><br><b>General overview; protocol structure; Function codes:</b> 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);<br><b>Troubleshooting:</b> Common problems and faults, Description of tools used, Detailed troubleshooting<br><b>II. Modbus Plus protocol:</b><br><b>General overview; troubleshooting:</b> Common problems and faults, Description of tools used, detailed troubleshooting | 4 |
| 8  | <b>HART Protocol</b><br><b>Introduction to HART and smart instrumentation; HART protocol:</b><br>Physical layer, Data link layer, Application layer; <b>Troubleshooting</b>  | 3 |
| 9  | <b>AS-interface (AS-i)</b><br><b>Introduction; Layer 1 – the physical layer; Layer 2 – the data link layer; Operating characteristics; Troubleshooting</b>   | 3 |
| 10 | <b>DeviceNet overview</b><br><b>Introduction; Physical layer:</b> 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;<br><b>Network power:</b> General approach, Single supply – end connected, Single supply – center connected, Suggestions for avoiding errors and power supply options; <b>System grounding:</b> Signaling; <b>Data link layer:</b> Frame format, Medium access, Fragmentation; <b>The application layer; Troubleshooting:</b>   | 3 |
| 11 | <b>ProfiBus PA/DP/FMS protocol</b><br><b>Introduction; ProfiBus protocol stack:</b> Physical layer (layer 1), Data link layer (layer 2), Application layer, Fieldbus message specification (FMS), Lower layer interface (LLI), Fieldbus management layer (FMA 7); <b>The ProfiBus communication model; Relationship between application process and communication; Communication objects; Performance; System operation:</b> 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; <b>Troubleshooting:</b> Introduction, Troubleshooting tools   | 4 |
| 12 | <b>Foundation Fieldbus</b><br><b>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:</b> Termination preparation, Installation of the complete system; <b>Troubleshooting:</b> Introduction, Power problems, Communication problems, Foundation Fieldbus test equipment   | 4 |

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| 13 | <b>Industrial Ethernet overview</b><br><b>Introduction; 10 Mbps Ethernet:</b> Media systems, Signaling methods, Medium access control, Frame transmission, Frame reception, MAC frame format, IEEE 802.2 LLC, Reducing collisions, Design rules; <b>100 Mbps Ethernet:</b> Introduction, Media access: full-duplex, Auto-negotiation;  | 4 |
| 14 | <b>TCP/IP overview</b><br><b>Introduction:</b> The Internet layer, The host-to-host layer, The process/application layer; <b>Internet layer protocols (packet transport):</b> IP version 4 (IPv4), Address resolution protocol (ARP), ICMP, ICMP datagrams, Routing; <b>Host-to-host layer:</b> End to end reliability – TCP, UDP; <b>Troubleshooting:</b> Introduction, Common problems, Tools of the trade, Typical network layer problems, Transport layer problems | 4 |

### Learning Outcomes

- Students will be able to understand the working, design, implementation and applications of various standards and protocols used for data communication purposes which will be greatly helpful to them if and when they get a chance to work in the actual industrial environments.

### Books Recommended

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