| PO1 | **Basic scientific knowledge** | Apply the basic mathematical, scientific and engineering concepts appropriate to the discipline of computer science and engineering. |
| --- | --- | --- |
| PO2 | **Problem analysis** | Analyze a problem, identify and define the computing requirements appropriate to its solution. |
| PO3 | **Design / development of solutions** | Design, develop, and evaluate a computer-based system, component or process that meet desired needs within realistic constraints such as public health and safety, cultural, societal, and environmental considerations. |
| PO4 | **Tackling Complex problems** | Design and conduct experiments, as well as analyze and interpret data. |
| PO5 | **Conversant with modern approaches** | Use state-of-the-art techniques, tools and skills necessary for computing practice. |
| PO6 | **The engineer and society** | Include societal, health, safety, legal, and cultural issues and responsibilities with the computing solutions. |
| PO7 | **Environment and sustainability** | Demonstrate the knowledge of sustainable development considering the impact of computing solutions in a global, economic, environmental, and societal context. |
| PO8 | **Ethics** | Apply ethical principles and commit to professional ethics and responsibilities and norms of the computer science and engineering practice. |
| PO9 | **Team work** | Able to function effectively on multi-disciplinary teams to accomplish a common goal. |
| PO10 | **Communication** | Communicate effectively, both written and oral, with a range of audiences. |
| PO11 | **Project management and finance** | Demonstrate knowledge and understanding of the engineering and management principles and apply these to his own work, as a member and leader in a team, to manage projects in multidisciplinary environments. |
| PO12 | **Life-long learning** | Recognize the need for and have the preparation and ability to engage in life-long learning and continuing professional development. |

**Programme Outcomes**

**Course-Plan**

**Spring Semester, 2024**

**School ENGINEERING**

**Department Computer Science and Engineering**

**Course Code CO 218**

**L-T-P-C 3-0-0-3**

**Course Name Data Communication**

**Instructor Dr. Sanjib K. Deka**

**Class Schedule Refer to the Department’s Class timetable**

**Pre-requisites**

The students should have some basic knowledge in programming covered in CO 102

1. **Abstract**:

This course is intended to introduce and provide a good understanding of the basic concepts and the various tools and techniques used in data communication. The course will introduce the layered architecture of computer networks and discuss in details the layers associated with the data communication issues in networks. The characteristics of a variety of data communication media and the various tools and techniques along with the standards used for communication over these media will be introduced in the course. The course will lay the foundation for further study on computer networking.

**2.** **Course Objectives (min 4)**

The overall objective:

(i) Understand the basic technologies behind introductory data communication.

(ii) Implement and test data communication techniques in laboratory.

(iii) Learn about various design framework of data communication features and its working.

(iv) Develop knowledge about interaction of hardware and data communication system software development.

**3. Course Outcomes**

Students who complete the course will have the ability to:

| **COs** | **Statements** | **Blooms Level** |
| --- | --- | --- |
| CO1 | ***Understand*** and ***contrast*** the concept of Signals, Fundamentals of Data communication, OSI & TCP/IP reference models and ***discuss*** the functionalities of each layer in these models. | L2 |
| CO2 | **Discuss** and **Analyse** flow control and error control mechanisms and apply them using standard data link layer protocols, communication channel, channel capacity, distortion and noise, line coding, modulation, multiplexing, switching, communication media. | L3 |
| CO3 | ***Analyze*** and ***apply*** various data encoding techniques for data transmission in physical layer involving signals, communication channel, and channel capacity. | L4 |
| CO4 | ***Explain*** the details of various data link control (DLC), medium access control (MAC) protocols, network layer functions and devices such as gateways, bridges and routers etc. | L2 |
| CO5 | ***Analyze*** the features and operations of various data link control and medium access control protocols, data link layer protocols such as HDLC and PPP. | L4 |

**4. Mapping of Programme and Course Outcome:**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO1** |  | 2 | 1 |  | 2 | 3 |  |  |  | 2 | 2 | 2 | - | - | - |
| **CO2** | 2 | 2 |  |  | 1 |  |  |  |  | 2 | 2 | 2 | - | 1 | - |
| **CO3** | 2 | 2 |  | 2 | 2 |  |  |  |  | 1 | 2 | 2 | - | 1 | - |
| **CO4** |  |  |  |  |  | 3 |  |  |  | 2 |  |  | - | - | 1 |
| **CO5** | 2 | 2 | 2 | 2 | 2 | - | - | - | 2 | 1 | - | 1 | - | - | 1 |

**5. Course Plan**

The module wise objective:

| **Modules** | **Topic** | **Learning Objectives** | **CO mapping** | **Contact hours** |
| --- | --- | --- | --- | --- |
| 1 | Overview, Introduction to Data Communication | To introduce the fundamental definition of Data Communication, Objective of Computer Communication and its application. | CO1 | 4 |
| 2 | Computer Communication and Network Architecture | To learn the concept of reference model, design philosophy, layer, protocol, interface, service concepts and Layered Architecture | CO1 | 6 |
| 3 | Physical Layer | To introduce the synchronization cocepts involving data transmission: signal, communication channel, channel capacity, distortion & noise, line coding; modulation,  Multiplexing, switching, communication media. | CO1, CO2, CO3 | 8 |
| 4 | Medium Assess Control in broadcast networks | To understand the fundamental mechanism of medium access control protocols like ALOHA, CSMA etc, Standard LAN protocol, satellite network, WLAN, LAN switching etc. | CO3, CO4 | 9 |
| 4 | Data link layer | To learn the techniques of Framing, Error control, Data link protocols and their performance, HDLC and PPP protocol. | CO4,  CO5 | 9 |
| 5 | Network layer | To explore the introductory concepts of routing, congestion and deadlock control algorithms, Internetworking issues and devices, gateways, bridges and routers, IP & X.25 protocols. | CO4 | 4 |

**4. Course outline+ suggested reading:**

Overview: Objectives and Applications of Computer Communication.

Computer Communication and Network Architecture: ISO-OSI reference model, design philosophy, layer, protocol, interface, and service concepts. Layer wise functionality.

Physical Layer: Concepts of data transmission: signal, communication channel, channel capacity, distortion & noise, line coding; modulation(analog and digital), modem; multiplexing- FDM, TDM, WDM, CDM etc; OFDM & spread spectrum techniques; switching, communication media—guides & unguided; standard protocols, RS-232C, RS-449, X.21, xDSL, SONET, Frame relay, ATM etc.

Medium Access Control in broadcast networks: ALOHA, CSMA, CSMA/CD, CSMA/CA, token ring, token bus etc, Standard LAN Protocols: (IEEE 802.X), FDDI, satellite networks, LAN switching, VLAN, WLAN, PAN and WiMax.

Data link layer: Framing, Error control techniques, Data link protocols and their performance, HDLC and PPP protocol.

Network layer: Introductory concepts and issue: Routing, Congestion and deadlock control Algorithms, Internetworking issues and devices, gateways, bridges and routers, IP & X.25 protocols.

Laboratory: Generation, testing, of AM, FM, and PM, Transmitter and receiver, PCM codec; Flow control, Error Control and MAC protocols on LAN trainer kit.

**Text Book**

[STA] Stalling, Data and Computer Communication, 8e, PHI (EEE)

[TAN] Tanenbaum A.S., Computer Network, 5e, PHI (EEE)

**Supplementary Books/Texts and Materials**

[FOR] Forouzan B. A, Data Communication and Networking, 5e, Tata McGrawHill

[LEG] Leon-Garcia, Widijaja, I., Communication, 5e, PHI (EEE)

**5. (a)Time-Plan**

| **Tentative Lecturers** | **Topic** | **Content** | **Book** |
| --- | --- | --- | --- |
| 1 | Overview | Objectives and an Overview of the course | STA |
| 2 | Data Communication Network Architecture | ISO-OSI reference model for Computer Communication Network - Design Philosophy, Layer, Protocol, Interface, and Service Concepts, Information Units at Different Layers, Flow of Information, Layer-wise Functionality. TCP/IP Protocol Stack. | TAN |
| 3 – 4 | Data & Signal Concepts | Data & types of data, Analog & digital forms; Signal & Types of signals, Analog & digital forms; Signal characteristics, Signaling element | TAN/  STA |
| Time & frequency domain representation, Spectrum & bandwidth |
| 5 – 6 | Channel Concepts, Transmission Impairments & Channel Capacity | Transfer function of a channel, pass band, bandwidth; Nyquist data rate | TAN |
| Sources of impairment, Attenuation & delay distortion |
| Noise & sources of noise, Distortion |
| Shannon capacity for a noisy channel, Line coding |
| 7 – 9 | Conversion/ Signal Conditioning Techniques | Analog data - Analog signal: Modulation techniques- AM, FM, PM | STA, FOR |
| Digital data – Analog signal: ASK, PSK, FSK, QAM |
| Analog Data – Digital signal: Encoding techniques- PCM, DM, DPCM |
| Digital data – Digital signal: Encoding schemes – unipolar, polar, multi-level, scrambling, block coding |
| 10 – 11 | Transmission Media: Forms & Characteristics | Guided: Twisted pair, coaxial, optical fiber; Unguided: RF- broadcast, point-to-point, cellular, microwave- terrestrial, satellite; infrared | TAN/  STA |
| 12 – 13 | Multiplexing | FDM, WDM, TDM- Synchronous, Asynchronous | STA/ TAN |
| 14 – 15 | Multiplexing examples- Telephone system- Analog, Digital; Digital Technology, Cable modem, Sonet | STA |
| 16 – 17 | Interfacing | Modes of Communication- Parallel & Serial, Simplex, Half-duplex, Full-duplex, Synchronous & Asynchronous.  DTE & DEC interface: RS-232C, Null Modem, X.21. | TAN |
| 18 | Standard Modems |  |
| 19 – 20 | Error Detection & Correction | Types of Errors- Isolated, Burst | TAN |
| Error Detection Techniques- Parity check, Two dimensional parity check, Checksum, Cyclic redundancy check | TAN |
| 21 | Error Correcting Codes | TAN |
| 22 – 24 | Flow & Error Control | Flow Control Techniques: Stop-and-wait, Sliding window | TAN |
| Backward Error Correction(BEC)- Stop-and-waiit ARQ, Go-back-N ARQ, Selective-repeat ARQ | TAN |
| Forward Error Correction(FEC )- Hamming code | FOR |
| 25 – 26 | Data Link Control | Framing, Flow control, Error control, Link management, HDLC | TAN |
| 27 | Data communication through WAN | Issues in WAN, Network topologies, Switching techniques | TAN |
| 28 – 29 | Circuit switching- Switching fabrics- Space division switch- Crossbar switch, Multistage switch;  Time division switch | TAN/ FOR |
| 30 – 32 | Message switching & Packet switching- Store & forward networks, Virtual circuit & Datagram | TAN/ FOR |
| Routing | TAN |
| 33 – 34 | Data communication through LAN | Basic Issues | TAN |
| ALOHA | TAN |
| CSMA, CSMA/CD | TAN |
| Token based: Ring, Bus, FDDI | TAN |
| Polling, Reservation |  |
| 35 – 36 | Standard LAN Protocols (IEEE 802.X),  High speed LAN | TAN |
| 37 – 38 | Wireless LAN Concepts and Protocols - CSMA/CA, Wi Fi, Wi Max. | TAN |
| PAN - Bluetooth |  |
| 39 – 40 | Internetworking | Internetworking Issues & Devices | TAN |
| Internet Protocol(IP) | TAN/ FOR |

**5 (b). Student Evaluation**

| **Sl.no** | **Component** | **Marks** |
| --- | --- | --- |
| 1 | Test : I, II(Mid-term), III | 25+40+25=100 |
| 3 | End-Term | 60 |

**Total : 150**

**6.** **Pedagogy** :

Teaching – learning methods to be used

1. Lectures and Discussions
2. Class Tests & Quizzes
3. Programming Exercises (laboratory), Assignments

**7.** **Expected outcome:** Towards the end of the course the student would

- have overall understanding on underlying concepts, principles, tools, techniques of data communication.

- gather knowledge about interaction of hardware and data communication system software development.

- be able to implement and test some of the fundamental data communication techniques in laboratory.

**Laboratory Assignments / Homeworks**

There will have following basic assignment/homeworks covering topics of DC features using Matlab and Logic Circuit Simulators.

| **Sl No** | **Description/ Purpose** |
| --- | --- |
| 1 | Signal Generation |
| 2 | Signal Manipulation |
| 3 | Autocorrelation Crosscorrelation of Signals |
| 4 | Signal Capturing |
| 5 | AM Demonstration |
| 6 | FM Demonstration |
| 7 | Implementing HDLC protocol features |
| 8 | PSK and QAM Demonstration |
| 9 | Implementing Error Detecting and Error Correcting Codes |
| 10 | OFDM Demonstration |