Program Name	: **Electronics Engineering Programme Group**
Program Code	: **DE/EJ/ET/EN/EX/EQ**
Semester	: **Sixth**
Course Title	: **Computer Networking and Data Communication**
Course Code	: **22634**

1. RATIONALE

Data communication deals with the transmission of digital data through a network. Many applications like Airline Reservations, Railway reservations, e-banking, e-governance, Online Shopping, e-learning can be managed by a single click. Diploma Engineers should be able to select, classify, install, troubleshoot and maintain different industrial data communication networks. This course gives the important concepts and techniques related to data communication and enable students to maintain and troubleshoot computer networks.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain computer network systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Maintain wired computer network topologies.
b. Use the relevant network model for the specified data communication system.
c. Maintain relevant transmission medium and modem for data transmission.
d. Analyze error detection/correction and flow control of data in the data network.
e. Configure the network component and assign IP address.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory						Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.
Legends: *L-Lecture;* **T** *– Tutorial/Teacher Guided Theory Practice;* **P** *- Practical;* **C** *– Credit,* **ESE** *- End Semester Examination;* **PA** *- Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map..
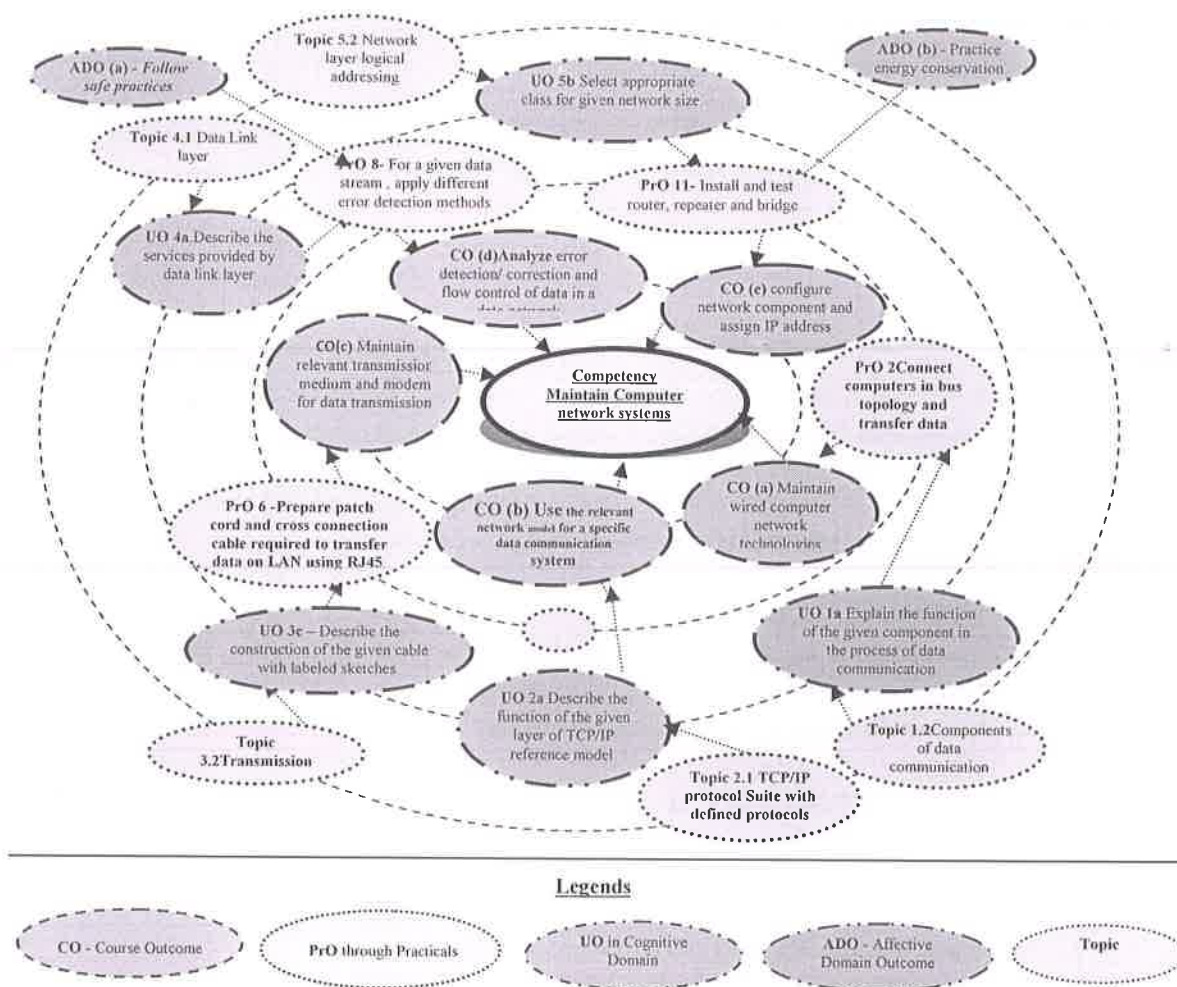
Figure 1 - Course Map

6.   SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Analyse the type of network topology used in your lab and prepare technical specifications for it.	I	02*
2	Connect computers in bus topology and transfer the data.	I	02
3	Connect computers in star topology and test the performance.	I	02*
4	Install/configure/Test Peer to Peer LAN and sharing of resources.	I	02*
5	Configure Point to Point network in laboratory.	I	02
6	Prepare patch cord and cross connection cables, use to connect the devices on the LAN.	III	02*
7	Using a Hub/ Switch Install a LAN network consisting of 6 computers	III	02
8	Locate the error bit in the given data stream by applying the different error detection methods.	IV	02*
9	Correct the error in a given data stream by applying the different error correction methods.	IV	02
10	Use route command to test the performance of the given network.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
11	Install and test Router, Repeater and Bridge	V	02*
12	Assign IP address to the PC connected to the internet.	V	02*
13	Configure/Test Internet connectivity.	V	02*
14	Use FTP protocol to transfer file from one system to another system.	V	02*
15	Install and configure a Firewall for the network security.	V	02
16	Interconnect two PCs using RS232 cable and transfer data as null modem configuration.	V	02
	Total		**32**

Note

i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental setup.	20
2	Setting and operation.	20
3	Safety measures.	10
4	Observation and recording.	10
5	Interpretation of result and conclusion.	20
6	Answer to sample questions.	10
7	Submission of report in time.	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

    a. Follow safety practices.
    b. Practice good housekeeping.
    c. Demonstrate working as a leader/a team member.
    d. Maintain tools and equipment.
    e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

    • 'Valuing Level' in 1st year
    • 'Organizing Level' in 2nd year

- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Client Machines (Computers with windows / Linux and latest configuration) with Printer: Laser jet	1 to 15
2	Network Tool kit: clamping, crimping tool, network tester, line tester	1 to 15
3	Network Accessories: RJ 45, UTP cable, T connector, Optical Fiber, Coaxial Cable, Modem, various connectors, 1000Mbps NIC.	1 to 15
4	UPS system 6KVA online.	1 to 15
5	Router, Repeater, Bridges: Latest configuration	10,11
6	Computer Hub 8/ 16 node with console port	1 to 15
7	Modem – Latest configuration	13
8	Ethernet Switch 4/8/16/24/32	1 to 15
9	LAN Cable (CAT6, CAT5)	1 to 15
10	Coaxial Cable, UTP Cable, STP Cable, Fiber Optic Cable	1 to 15
11	Firewall with high security and high storage	14,15
12	MS office latest version	1 to 15
13	Antivirus Software (online protection with firewall securities)	1 to 15
14	RS 232 cable and connector	16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of Data Communication and network topology	1a. Explain the function of the given component in the process of data Communication. 1b. Describe the given data transmission method with its frame format 1c. Explain the given source of noise and its effect 1d. Design computer network considering particular topology. 1e. Classify networks on the basis of the given parameter.	1.1 **Data communication and its characteristics** 1.2 **Components of data communication** Transmitter, Receiver, Medium, Message, Protocol. Standards, Standard organizations. Basic block diagram of data communication system 1.3 **Data Transmission**: Serial, Parallel Synchronous, Asynchronous, Isochronous transmission 1.4 **Transmission characteristics**: Signaling rate, data rate, bit rate, baud rate 1.5 Need of computer networks, Network criteria, advantages of networking 1.6 **Network topologies**: Mesh, Star, Bus, Tree, Ring and Hybrid topologies - Schematic diagram, working, advantages disadvantages and applications 1.7 **Network Classification:** **Based on Transmission Technologies:**

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		Point to-point, Multipoint, Broadcast **Based on physical size(scale)**: PAN, BAN, LAN, MAN, WAN,VPN **Based on Architecture**: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model.
Unit– II Network Models	2a. Describe the function of the given layer of TCP/IP Reference model. 2b. Explain the relationship of layers with addresses in TCP/IP. 2c. Differentiate between various addressing schemes in TCP/IP. 2d. Describe the functions of the given layer of OSI Reference model.	2.1 **TCP/IP protocol suite** with define protocols in respective Layers: Physical layer, Data Link Layer, Network Layer, Transport Layer, Application Layer 2.2 **Addressing in TCP/IP**: Physical, logical, Port and specific 2.3 **The ISO-OSI model**: Physical layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer.
Unit– III Physical layer	3a. Describe the principle of given multiplexing technique. 3b. Select the transmission media for transmitting given signal for the given application. 3c. Describe the construction of the given cable with labeled sketches. 3d. Compare different types of Transmission medium on the basis of given parameter 3e. Explain with sketches the working of the given type of modem 3f. Compare different Multiplexing/Switching techniques on the basis of the given parameters.	3.1 **Multiplexing**: Basic concept, Frequency-Division Multiplexing, Wavelength-Division Multiplexing, Synchronous Time-Division Multiplexing, Statistical Time- Division Multiplexing 3.2 **Transmission medium**: classification based on electromagnetic wave spectrum 3.3 **Guided Media** -Twisted pair (UTP,STP) cable -connector, Coaxial cable - connector, Fiber-optic cable - connector, performance and applications 3.4 **Unguided Media**-Radio waves, microwaves, Infrared and their applications 3.5 **Modems**: classifications : Broadband modem, DSL –ADSL,HDSL,VDSL 3.6 **Switching**: Circuit-switched networks, Packet switched networks –Datagram approach, virtual circuit approach.
Unit– IV Data link layer	4a. Describe the services provided by Data Link Layer. 4b. Describe the technique of the given error control method with examples. 4c. Explain with sketches the given type of flow	4.1 **Data link layer**: Flow and Error control 4.2 **Error control** : Types of errors : single bit and Burst errors Error detection and correction –Hamming code, linear block code, CRC, checksum 4.3 **Flow control**: Framing, Flow and Error control, Noiseless and Noisy Channels – stop-and-wait protocol, Stop and wait

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	control used in the data link layer with justification. 4d. Compare characteristics of given type of Protocol. 4e. Select the appropriate protocol for error free transmission of given data	ARQ protocol 4.4 **Sliding window protocol**: One bit sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ 4.5 **Point to point Protocol**: service provided by PPP, Frame format PPP and Transition phases of PPP.
Unit– V Network, Transport and Application layer	5a. Justify the function of the given network device. 5b. Select appropriate class for given network size. 5c. Differentiate between class full and class less addressing 5d. Explain the role of NAT in address depletion. 5e. Explain the given type of Routing. 5f. Describe the services provided by transport layer/ network layer/Application layer. 5g. Describe the given type of network security technique.	5.1 **Network devices:** Repeater, Hub, Bridge, Switches , Router, Gateway 5.2 **Network layer Logical addressing**: IPv4 Addresses: address space Notations, classful and classless addressing, Network address translation(NAT), IPv6 addresses, Need for IPv6, Structure and address space 5.3 **Network layer-Multicast Routing Protocols :**Unicast, Multicast and Broadcast routing and applications **Transport Layer**: Process to process delivery, UDP,RTP and SCTP: ports, format, operation and uses 5.4 **Application Layer services**: Concept of DNS, FTP, 5.5 **Network security**: Cryptography: it's Components, Block diagram of symmetric and asymmetric cryptography 5.6 **Security services**: concepts of message and entity security services, Firewall.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Data Communication and network topology	12	02	08	06	16
II	Network Models	08	--	04	08	12
III	Physical layer	08	04	04	06	14
IV	Data link layer	08	-	04	08	12
V	Network, Transport, Application layer	12	02	06	08	16
	Total	**48**	**08**	**26**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note: *This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10.   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. Prepare journals based on practical performed in laboratory.
    b. Follow the safety precautions.
    c. Prepare specifications of a given communication medium.
    d. Test the performance of HUB, Switches, router and Servers.
    e. Library / Internet survey of computer network and data communication.
    f. Prepare power point presentation or animation for understanding different switching networks.
    g. Prepare a presentation on TCP/IP reference model and the OSI reference network model
    h. Visit to any industry to observe the different networks.

11.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

    a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
    b. *'L' in item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
    c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
    d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*..
    e. Video programs/YouTube may be used to teach various topics and sub topics.
    f. Demonstrate students thoroughly before they start doing the practice.
    g. Encourage students to refer different book and websites to have deeper understanding of the subject.
    h. Observe continuously and monitor the performance of students in Lab.
    i. Encourage students to use front/rear panel control of electronic instruments.
    j. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries.
    k. Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12.   SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the *Only one micro-project* is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so

that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three.*

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. A network proposal has to be developed for a bank. The bank has a main office, which is located in London, and has 5 branch offices located at Paris, California, Mumbai ,Dubai and Singapore. The bank has an application server, which is used by its customers across the world for online transactions. All the branches have high speed internet connection. There are approximately 100 users in each of the branch offices and 200 users in the main office.

b. Prepare a proposal to develop a network system that links two branch offices of an organization. The two branches are separated by a distances of 10 Km. Make appropriate assumption while preparing the proposal.

c. Interconnect two PCs using RS232 cable. Write the step by step procedure to transfer a file from one computer to another computer through RS232 link and implement .

d. Prepare a hardware specification required to develop a wireless LAN for a cyber-cafe for 20 users.

e. Develop a Bluetooth network of 5 devices namely laptop, mobile phone, speaker, keyboard, printer (piconet) and transfer files from one device to another. Configure your laptop / mobile as a hot spot for internet access.

f. Prepare a detailed report on application of computer network in a Mall / railway reservation system.

g. Visit a CISCO based laboratory/ any other networking laboratory and prepare a report of the various networking equipments and the networking facility

13.   SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Computer Networks.	Tanenbaum, A.S	Pearson Education, New Delhi, India, Fourth Edition, 2011 ISBN : 9788131787571
2	Data Communication and Networking	Forouzan, Behrouz A	McGraw Hill, Education New Delhi, 2015; ISBN 9780072967753
3	Introduction to Data Communications and Networking	Tomasi, W.	Pearson Education, New Delhi, India, 2007 ISBN : 9788131709306
4	Data and Computer Communications	Stallings, W.	Prentice Hall India,10 th Edition, 2013 ISBN : 9780133506488
5	Data Communications and Networks	Godbole, A.S. ; Kahate, A.	Tata McGraw Hill, New Delhi, India, Second Edition, 2011 ISBN (13) : 9780071077705
6	Computer Networks	Kurose, James F. ; Ross, Keith W.	Pearson Education, New Delhi, India, Third Edition, 2011 ISBN : 9788177588781

S. No.	Title of Book	Author	Publication
7	Data Communications and Computer Networks	ISRD Group	Tata McGraw Hill, New Delhi, India, First Edition, 2006 ISBN (13) : 9780070616820

14. **SUGGESTED SOFTWARE/LEARNING WEBSITES**
   a. https://www.youtube.com/watch?v=hAopORgAcbQ
   b. nptel.ac.in/courses/106105081/2
   c. https://www.ics.uci.edu/~magda/Courses/netsys270/ch1_v1.pp
   d. https://www.ics.uci.edu/~magda/Courses/netsys270/ch2_v1.ppt
   e. https://www.youtube.com/watch?v=gJ5h4_0mllI
   f. https://www.tutorialspoint.com/principles_of_communication/principles_of_communication_multiplexing.htm
   g. https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch08-Multiplexing.pp
   h. https://www.ics.uci.edu/~magda/Courses/netsys270/ch6_1_v1.ppt
   i. https://www.ics.uci.edu/~magda/Courses/netsys270/ch7_1_v1.ppt
   j. nptel.ac.in/courses/106105082/19
   k. nptel.ac.in/courses/106105082/17
   l. http://www.nptel.iitm.ac.in/courses
   m. nptel.ac.in/courses/106106157/52