COURSE PACK

SCHEME

The scheme is an overview of work-integrated learning opportunities and gets students out into the real world. This will show what a course entails.

<table>
<tr><td>Course Title</td><td colspan="3">Data Communication and Networking</td><td colspan="3">Course Type</td><td colspan="3">Comprehensive</td></tr>
<tr><td>Course Code</td><td colspan="3">R1UC406B</td><td colspan="3">Class</td><td colspan="3">B.Tech Core and All specialization</td></tr>
<tr><td rowspan="6">Instruction delivery</td><td>Activity</td><td>Credits</td><td>Credit Hours</td><td colspan="4" rowspan="2">Total Number of Classes per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td rowspan="4">Theory</td><td rowspan="4">Tutorial</td><td rowspan="4">Practical</td><td rowspan="4">Self-Learning</td><td rowspan="4">CIE</td><td rowspan="4">SEE</td></tr>
<tr><td>Practical</td><td>1</td><td>1</td></tr>
<tr><td>Self-Learning</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>4</td><td>4</td></tr>
<tr><td>Names Course Coordinators and Instructors</td><td colspan="3">Course Lead: Coordinator:</td><td colspan="6">Dr. Prashant Dixit
Dr. Brijesh Kumar Singh</td></tr>
<tr><td colspan="4">Theory</td><td colspan="6">Practical</td></tr>
<tr><td colspan="4">GUSCSE202332732 Prashant Dixit
GU1213812086 Soumalya Ghosh
GU1213812344 Tarun Kumar
GUSCSE201827199 Swati Sharma
GUSCSE202131437 Aanjey Mani Tripathi
GUSCSE202131600 Arvind Dagur
GUSCSE202131645 Arunendra Mani Tripathi
GUSCSE202231893 Ravi Sharma
GUSCSE202231933 R. Sathiya Priya
Guscse202231934 R. Radhika
GUSCSE202231949 Satheesh Kumar
GUSCSE202232015 Harshvardhan Choudhary
GUSCSE202232019 Brijesh Kumar Singh
GUSCSE202232096 Gurmeet Singh
GUSCSE202232158 Sandeep Bhatia
GUSCSE202232228 Pragya Srivastava
GUSCSE202332280 Ruby Dahiya
GUSCSE202332297 Arvind Panwar
GUSCSE202332318 Manish Verma
GUSCSE202332646 Mukesh Kumar
GUSCSE202332690 Tarun Maini
GUSCSE202332755 Avaneesh Kumar Yadav
GUSCSE202332760 Shobhit Kumar
GUSCSE202433159 S P Ramesh
GUSCSE202433208 Sunder R
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GUSCSE202433471 Geeta Gayatri Behera
GUSCSE202433575 Shilpy Agarwa
GUSCSE202433576 Priyanka Behera
GUSCSE202433709 Rikendra
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GUSCSE202433853 Manish Kumar
GUSCSE202433859 Rani Singh
GUSCSE202534008 Avtar Singh</td><td colspan="6">GUSCSE202332732 Prashant Dixit
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GUSCSE202433859 Rani Singh
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COURSE OVERVIEW

A computer network is a set of computers connected together for the purpose of sharing resources. The most common resource shared today is connection to the Internet. Other shared resources can include a printer or a file server. This course will introduce the student to the basic concepts involved in the design and implementation of a computer networks. This course deals with all the fundamentals of computer network. It deals with various network models, types and OSI layers. This course provides uses of computer network, role of seven OSI layers etc.

PREREQUISITE COURSE

NO

COURSE OBJECTIVES

1. Understand the fundamental concepts of data communications and networking.
2. Identify the basic components/instrument/equipment and their respective roles in data communication system
3. Understand the structure of computer networks, factors affecting computer network deployment.
4. Describe emerging technology in the net-centric computing area and assess their current capabilities, limitations and potential applications.
5. Program and analyse network protocols, architecture, algorithms and other safety critical issues in real-life scenario.

COURSE OUTCOMES(COs)

After the completion of the course, the student will be able to

CO1	Understand fundamental knowledge of data communication, networking principles, network types, switching techniques, and protocol architectures like OSI and TCP/IP.
CO2	Comprehend physical layer concepts, including data and signal types, transmission impairments, data rate limits, modulation techniques, multiplexing, and transmission media.
CO3	Apply error detection and correction techniques, framing methods, data link layer protocols, and multiple access control mechanisms for efficient and reliable data transmission.
CO4	Analyze computer network using concept of IPv4 and IPv6 addressing, subnetting, super netting, NAT, network layer performance, and routing algorithms for efficient data forwarding.
CO5	Evaluate performance of computer network using knowledge of transport layer services, protocols, data traffic management, congestion control mechanisms, and network performance optimization.

BLOOM'S LEVEL OF THE COURSE OUTCOMES

Bloom's taxonomy is a set of hierarchical models used for the classification of educational leaming objectives into levels of complexity and specificity. The learning domains are cognitive, affective, and psychomotor.

COMPREHENSIVE

CO No.	Remember **KL1**	Understand **KL2**	Apply **KL3**	Analyze **KL4**	Evaluate **KL5**	Create **KL6**
CO1	√	√				
CO2	√	√				
CO3	√	√	√			
CO4	√	√		√		
CO5	√	√			√	

PROGRAM OUTCOMES (POs):

PO1:	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2:	**Problem Analysis:** Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).
PO3:	**Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).
PO4:	**Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5:	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).
PO6:	**The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7:	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).
PO8:	**Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9:	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10:	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments..
PO11:	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for: i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).
PSO1:	Have the ability to work with emerging technologies in Computer Science and Engineering requisite to Industry 4.0.
PSO2:	Demonstrate Engineering Practice learned through industry internship and research project to solve live problems in various domains.

COURSE ARTICULATIONMATRIX

The Course articulation matrix indicates the correlation between Course Outcomes and Program Outcomes and their expected strength of mapping in three levels (low, medium, and high).

CO/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	1	-	-	-	-	-	2	1	-
CO2	1	2	1	1	-	-	-		-	-	-	-	1	-
CO3	2	1	2	2	1	1	-	2	-	-	-	2	1	1
CO4	1	2	1	1	1	-	-	2	-	-	-	-	1	1
CO5	2	2	1	2	1	-	-	-	-	-	-	2	1	1

Note: 1-Low, 2-Medium, 3-High

COURSE ASSESSMENT

The course assessment patterns are the assessment tools used both in formative and summative examinations.

Type of Course (B)	CIE			Total Marks		Final Marks
	LAB Work@ + Record	MTE	LAB EXAM*	CIE	SEE	CIE*0.5+SEE*0.5
INTEGRATED	25	50	25	100	100	100

@Lab Work-15 marks + Lab Record-10 marks

*Passing Criteria-30% of marks to be secured in the lab Exam conducted by two examiners (one internal and one external)

COURSE CONTENT

THEORY

Content
Fundamentals of Data Communication and Networking DATA COMMUNICATION: Components, Data Representation, Data Flow (Simplex, half duplex, full duplex) NETWORKS: Network Criteria (Performance, Reliability, Security), Physical Structure (Type of connection, Physical Topology: Mesh, Star, Bus and Ring Topology) NETWORK TYPES: LAN, WAN, MAN, SWITCHING: Circuit-Switched Network and Packet-Switched Network OSI MODEL, TCP/IP Protocol Suite **Physical Layer** DATA AND SIGNALS: Analog and Digital Data, Analog and Digital Signals, Periodic and Nonperiodic Signals, Composite Signals, Bandwidth DIGITAL SIGNALS: Bit Rate, Bit Length, Digital Signal as a Composite Analog Signal, Transmission of Digital Signals TRANSMISSION IMPAIRMENT: Attenuation, Distortion, Noise DATA RATE LIMITS: Nyquist Bit Rate, Shannon Capacity TRANSMISSION MODES: Parallel Transmission, Serial Transmission DIGITAL-TO-ANALOG CONVERSION: ASK, PSK, FSK ANALOG-TO-ANALOG CONVERSION: AM, FM, PM MULTIPLEXING: Frequency-Division Multiplexing, Wavelength-Division Multiplexing, Time-Division Multiplexing GUIDED MEDIA: Twisted-Pair Cable, Coaxial Cable, Fiber-Optic Cable UNGUIDED MEDIA: Radio Waves, Microwaves, Infrared **Data Link Layer:** Introduction of error detection and correction: Types of Errors (Single-bit error and burst error), Redundancy, Detection versus Correction, Coding, Block Coding, Hamming code, Cyclic Codes, Framing, Character and Bit-Oriented Protocols, Simplex and Stop & Wait Protocols, Sliding window protocols, Multiple access protocols: ALOHA, CSMA, CSMA/CD, CSMA/CA **Network Layer** IPv4 ADDRESSES: Address Space, Notations: Binary Notation and Dotted-Decimal Notation, Classful Addressing, Netid and Hostid, Mask, Subnetting and Super netting, Classless Addressing, Network Address Translation (NAT) IPv6 ADDRESSES: Structure, Address Space, Network layer Performance, Routing Algorithm: Distance-Vector Routing Algorithm, Link-State Routing Algorithm **Transport Layer**: Introduction to Transport Layer, Connectionless Versus Connection-Oriented Service: Connectionless Service, Connection Oriented Service, Reliable Versus Unreliable TRANSPORT-LAYER PROTOCOLS: Simple Protocol, Stop-and-Wait Protocol, Go-Back-N Protocol (GBN), Selective-Repeat Protocol DATA TRAFFIC: Average Data Rate, Peak Data Rate, Maximum Burst Size, Effective Bandwidth, Traffic Profiles: Constant Bit Rate, Variable Bit Rate CONGESTION, Network Performance: Delay Versus Load, Throughput Versus Load, CONGESTION CONTROL MECHANISM .

PRACTICAL

Contents	
1	Demonstration and study about different physical equipment used for networking; NIC (Network Interface Card), types of cable, Fiber Optics
2	Demonstration and study different internetworking devices in a computer network; Repeater Bridge, Router, Gateway, Hubs, Switches.
3	To study the working of Basic Networking Commands; hostname, ipconfig, ping, host, telnet, ftp, net, arp, winipcg, nslookup, netstat
4	Installation of Cisco Packet Tracer, and Interface Explanation
5	Design and Simulation of star and bus topology on Cisco Packet Tracer .
6	Design and Simulation of mesh and Ring topology on Cisco Packet Tracer .
7	Creating a simple Topology using a Router in Cisco Packet Tracer
8	Configuring DHCP on a Server in Cisco Packet Tracer
9	Implement bit stuffing and de-stuffing.
10	Write a program for hamming code generation for error detection and correction.

LESSON PLAN FOR THEORY COURSES (40)

L No	T/L	Topics	Skills	Competency
1	T	DATA COMMUNICATIONS: Components, Data Representation	Understanding of network fundamental	Competency in analyzing data communication and networking systems will be developed.
2	T	DATA COMMUNICATIONS: Data Flow (Simplex, half duplex, full duplex)		
3	T	NETWORKS: Network Criteria (Performance, Reliability, Security), Physical Structure (Type of connection)		
4	T	NETWORKS: Physical Structure (Physical Topology: Mesh, Star, Bus and Ring Topology)		
5	T	NETWORK TYPES: LAN, WAN, MAN		
6	T	Switching (Circuit-Switched Network and Packet-Switched Network)		
7	T	OSI Model		
8	T	TCP/IP Protocol Suite		
9	T	DATA AND SIGNALS: Analog and Digital Data, Analog and Digital Signals, Periodic and Nonperiodic Signals	Understanding and comprehension of type of signals and inter conversion	Competency in signal analysis, data transmission techniques, and selecting appropriate transmission media for efficient communication will be developed.
10	T	Composite Signals, Bandwidth		
11	T	DIGITAL SIGNALS: Bit Rate, Bit Length, Digital Signal as a Composite Analog Signal		
12	T	DIGITAL SIGNALS: Transmission of Digital Signals		
13	T	TRANSMISSION IMPAIRMENT: Attenuation, Distortion, Noise		
14	T	DATA RATE LIMITS: Nyquist Bit Rate, Shannon Capacity		
15	T	TRANSMISSION MODES: Parallel Transmission, Serial Transmission		
16	T	DIGITAL-TO-ANALOG CONVERSION: ASK, PSK, FSK		
17	T	ANALOG-TO-ANALOG CONVERSION: AM, FM, PM		
18	T	MULTIPLEXING: Frequency-Division Multiplexing, Frequency-Division Multiplexing, Time-Division Multiplexing		

19	T	GUIDED MEDIA: Twisted-Pair Cable, Coaxial Cable, Fiber-Optic Cable		
20	T	UNGUIDED MEDIA: Radio Waves, Microwaves, Infrared		
21		Introduction of error detection and Correction: Types of Errors (Single-bit error and burst error), Redundancy, Detection versus Correction, Coding	Understanding of key responsibilities of data link layer such as framing, flow control, error control, and media access control.	Competencies in error detection and correction, ensuring data integrity and managing network access efficiently.
22		Block Coding		
23	T	Hamming code and related numerical		
24	T	Cyclic Codes		
25	T	Framing, Character and Bit-Oriented Protocols		
26	T	Simplex and Stop & Wait Protocols, Sliding window protocols		
27	T	Multiple access protocols: ALOHA, CSMA, CSMA/CD, CSMA/CA		
28	T	IPv4 ADDRESSES: Address Space, Notations: Binary Notation and Dotted-Decimal Notation	skills in configuring IPv4 and IPv6, and troubleshooting network layer issues	competencies in IP addressing, subnetting, network layer management, routing algorithms, and optimizing network performance competencies in IP addressing, subnetting, network layer management, routing algorithms, and optimizing network performance
29		Classful Addressing, Netid and Hostid, Mask, Subnetting and Super netting, Classless Addressing, Network Address Translation (NAT)		
30		IPv6 ADDRESSES: Structure, Address Space		
31		Network layer Performance		
32		Distance-Vector Routing Algorithm, Numerical Based on Distance-Vector Routing Algorithm		
33		Link-State Routing Algorithm, Numerical Based on Link-State Routing Algorithm		
34		Unicasting, Multicasting, Broadcasting		
35		Introduction to Transport Layer	skills in implementing transport protocols, ensuring reliable data transfer, managing network congestion, and optimizing overall network performance	competencies in transport layer protocols, connection management, reliable data transmission, congestion control
36		Connectionless Versus Connection-Oriented Service: Connectionless Service, Connection Oriented Service, Reliable Versus Unreliable		
37		TRANSPORT-LAYER PROTOCOLS: Simple Protocol, Stop-and-Wait Protocol		
38		Go-Back-*N* Protocol (GBN), Selective-Repeat Protocol		
39		DATA TRAFFIC: Average Data Rate, Peak Data Rate, Maximum Burst Size, Effective Bandwidth, Traffic Profiles: Constant Bit Rate, Variable Bit Rate		
40		CONGESTION, Network Performance: Delay Versus Load, Throughput Versus Load CONGESTION CONTROL MECHANISH		

BIBLIOGRAPHY

Text Book

1. Forouzan, Data Communications and Networking, McGraw Hill, 4th ed.

Reference Books

1. Tannenbaum, Computer Networks, Pearsoned Education.

PROBLEM-BASED LEARNING

Exercises in Problem-based Learning (Value Added Experiments)

S. No	Problem	KL
1	Apply different technique for Analog to Digital conversion.	KL5
2	Design and simulate the star topology on packet tracer	KL5
3	Design and simulate the BUS topology on packet tracer	KL5
4	Design and simulate the MESH topology on packet tracer	KL5
5	Design and simulate the RING topology on packet tracer	KL5
6	Create a network topology using router on packet tracer	KL6
7	Apply the CRC technique and Calculate the Cyclic Redundancy Code(CRC) for data word: 110010101 with Generator = 10101 then n=5	KL6
8	Apply the hamming code generation technique for the 7 bit Hamming code on 1101	KL6
9	Apply the concept and find if a Company require 60 hosts then What is the best possible subnet mask?	KL6
10	Apply the concept of classful addressing and Identify the following IP addresses and their address class: (i) 200.58.20.165 ii)128.127.23.20 iii)16.196.128.50 iv)150.156.10.10	KL6
11	Design the network using VLSM technique. For the given address space is 192.168.1.0/24.	KL6
12	sketch the corresponding waveforms for NRZ-L, , Manchester, and Differential Manchester For the bit stream 01010101.	KL5
13	The message 11001001 is to be transmitted using the CRC polynomial x^3 + 1 to protect it from errors. Apply the concept and find the message that should be transmitted.	KL6
14	Apply the concept and Change the following IP addresses from dotted-decimal notation to binary notation. a. 114.34.2.8 b. 129.14.6.8 c. 208.34.54.12 d. 238.34.2.1	KL6
15	Apply the concept and Find the netid and the hostid of the following IP addresses. • a. 114.34.2.8 b. 132.56.8.6 c. 208.34.54.12	KL6
16	Apply the concept of classful addressing and Identify the following IP addresses and their address class: (i) 200.58.20.165 ii)128.127.23.20 iii)16.196.128.50 iv)150.156.10.10	KL6
17	An organization is granted the block 130.56.0.0/16. The administrator wants to create 1024 subnets. a. Find the subnet mask. b. Find the number of addresses in each subnet. c. Find the first and last addresses in subnet 1. d. Find the first and last addresses in subnet 1024.	KL5
18	An ISP has a block of 1024 addresses. It needs to divide the addresses among 1024 customers. Does it need subnetting? Explain your answer.	KL6

19	In a block of addresses, we know the IP address of one host is 182.44.82.16/26. What are the first address (network address) and the last address in this block?	KL5
20	An organization is granted the block 16.0.0.0/8. The administrator wants to create 500 fixed-length subnets. a. Find the subnet mask. b. Find the number of addresses in each subnet. c. Find the first and last addresses in subnet 1. d. Find the first and last addresses in subnet 500.	KL5

A) SELF-LEARNING THROUGH MOOCs (Cognitive Skills):

1. https://www.geeksforgeeks.org/what-is-an-ip-address/
2. https://www.my-mooc.com/en/mooc/computer-networking--ud436