GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester- IV

Course Title: Computer Networking
(Course Code: 4343202)

Diploma Programme in which this course is offered	Semester in which offered
Information & Communication Technology	4

1.   RATIONALE

Computer Networks & Data Communication is crucial for students as it forms the backbone of modern communication systems. Understanding this subject is essential for comprehending how data is transferred and shared across devices and networks. It enables students to grasp the fundamentals of internet protocols, network security, and the seamless flow of information in the digital age. Proficiency in this subject is essential for various careers, ensuring students are well-equipped for the ever-evolving technology landscape. Thus, this course is an important course for students who want to work in network administration, cybersecurity, software development, and systems engineering.

2.   COMPETENCY

The course content should be taught and implemented with the aim to develop various types of related skills leading to the achievement of the following competency
Utilize hardware and software technologies For the purpose of setting up, commissioning and maintaining secure computer networks.

3.   COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

   i. Analyze the key concepts of Computer network, the various physical network topologies.
  ii. Select proper devices and transmission media based on network application
 iii. Manage contemporary network infrastructures and configure fundamental network devices based on criteria.
  iv. Use Internet protocols and standards, layered models.
   v. Analyze network security protocols of hardware and software layer.

TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for assessing the attainment 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, **CA** - Continuous Assessment; **ESE** -End Semester Examination.

4.   SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the subcomponents of the COs. . These PrOs need to be attained to achieve the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Introduction to Network Simulator Tool Packet Tracer Simulator.	1	02
2	Using Wireshark to View Network Traffic	1	02
3	Building Ethernet Straight and Crossover	2	02
4	Build a Simple Two Computers Network and Verify the Connectivity in Packet Tracer Simulator.	2	02
5	Configure and Verify the Basic Switch Settings by using Switch.	2	02
6	Set Various Passwords on Router and Verify those Passwords.	2	02
7	Configure and Verify the Basic Router Settings by using Router.	2	02
8	Virtual LAN Configuration and Trunking in Packet Tracer by using Switch.	2	02
9	Virtual LAN Configuration Security in Packet Tracer by using Switch.	2	02
10	Implement Spanning Tree Protocol using Three Switches.	3	02
11	Implement Ether-Channel using LACP and PAGP Protocols.	3	02
12	Router as a Server and as a Client Configuration using DHCPv4 Protocol.	3	02
13	Observing DNS Resolution	3	02
14	Acessing Metwork Devices With SSH	4	02
17	Study and Impliment VPN		
18	Configuring and Verifying Standard ACLs		
19	Configuring and Verifying VTY Restrictions		
20	Configuring Dynamic and Static NAT		
	Total		**30**

Note

i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list**.**

ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Lab Records	05
2	Question answer or Writing steps exercise	20
3	Executing of exercise	40
4	Printout/ Result	20
5	Viva voice	15
	Total	**100**

5.   MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

I.   Computer

II.   Topology Trainer Kit

LIST OF SOFTWARE
I.   Cisco Packet Tracer
II.   https://www.netacad.com/courses/packet-tracer

6.   AFFECTIVE DOMAIN OUTCOMES
The following *sample* Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.
a)   Work as a leader/a team member.
b)   Follow ethical practices.
The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:
i.   'Valuing Level' in 1st year
ii.   'Organization Level' in 2nd year.
iii.   'Characterization Level' in 3rd year.

7.   UNDERPINNING THEORY
Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Introduction to Computer Networks	1.a Explain data communication and its significance in the field of information technology. 1.b Explain and distinguish various physical network topologies, including bus, ring, star, mesh, and hybrid configurations, and comprehend their implications for network design and performance. 1.c Define Protocol and standards 1.d Explain the need for layer modeling. 1.e Describe the functions of each layer of OSI Reference model. 1.f Describe the functions of each layer of TCP/IP Reference model.	1.1 Need, Advantages and Applications of Computer Networks 1.2 Physical topologies of Network : Star, Ring, Bus, Mesh, Tree, Hybrid 1.3 Internet Standards: Protocol, Interface, 1.4 Network Classification i. i. Based on Transmission Technologies: Point-to point, broadcast ii. ii. Based on scale: PAN, LAN, WAN, MAN,VPN, Internet iii. iii. Based on Architecture: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model iv. 1.5 OSI and TCP/IP models and their comparison

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – II **Network** **Devices**	2.a Explain functions of following network devices: Repeater, Hub, Bridge, Switch , Router, B-router, Gateway, Network Adapter, Access point, Wireless Access points and role of them at layer 2 and layer 3. 2.b Differentiate all network devices. 2.c Function firewall in network security. 2.d Describe a network management system with functions of OS, CLI, Administrative Functions, Interfaces. 2.e Explain and distinguish Ethernet, Fast Ethernet, Gigabit Ethernet. 2.f Explain wireless LAN function of each in a data network. 2.g Describe Software define network	2.1 Classification of Transmission Media: Role of different devices 2.2 Repeaters, Hubs, Bridges, Switches (layer 2 and layer 3) 2.3 Routers 2.4 Access Points 2.5 Firewalls : Concept, principles, limitations, trusted system, Kerberos- concept. 2.6 Introduction to Network management system (OS, CLI, Administrative Functions, Interfaces) 2.7 Ethernet, Fast Ethernet, Gigabit Ethernet 2.8 Wireless LAN 2.9 FDDI & CDDI, 2.10 Software defined network
Unit– III **Hardware** **Layer**	3.a Explain characteristics of guided and unguided transmission media. 3.b Sketch constructional details of twisted pair, coaxial cable and fiber optic cable with labels. 3.c Describe ISM band and range of frequencies in it. 3.d Describe DSL technology with its types, advantages and limitations. 3.e Explain cable modem. 3.f Explain error control and flow control at data link layer in detail. 3.g Discuss error control and flow control at the data link layer. 3.h Describe and distinguish Static and Dynamic Routing Algorithms. 3.i Explain IP addressing scheme (all types) with examples. 3.j Explain CIDR. How does it differ from traditional IP address allocation methods? 3.k Describe NAT and the different types of NAT. 3.l Discuss the role of CIDR and NAT in the transition from IPv4 to IPv6. 3.m Explain the role of ICMP. 3.n Describe and distinguish ARP and RARP. 3.o Describe and distinguish DHCP and BOOTP. 3.p Explain how these protocols (ICMP, ARP, RARP, DHCP, BOOTP) contribute to the overall functioning of the Internet and local networks.	3.1 Physical Layer: Transmission media (Twisted pair, Coaxial cable, Fiber optic cable) 3.2 Wireless Medium as Physical layer, 3.3 ISM Band 3.4 DSL technology types-xDSLs 3.5 Cable modem 3.6 Sub Layers of Data Link Layer and functions: Error control, Flow control examples 3.7 Network Layer: Packet Switching, 3.8 Virtual circuits, and datagram, Static and Dynamic Routing Algorithms 3.9 IP Addressing, 3.10 CIDR & NAT 3.11 IP layer protocols (ICMP, ARP, RARP, DHCP, BOOTP) 3.12 IPv4 and IPv6 comparison

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	3.q Distinguish various components of IPv4 and IPv6 protocol.	
Unit– IV **Software Layer**	4.a Explain TCP and UDP protocol in transport layer in relation to connection oriented and connection less network. 4.b Role of DNS- Domain Name System. 4.c Describe the process of DNS resolution. 4.d Difference between IMAP and POP3 in the context of E-mail. Discuss SMTP protocol. 4.e Explain FTP and the difference between active and passive FTP modes. 4.f Describe HTTP and role of cookies in web communication. 4.g Explain WWW.	4.1 Transport Layer: Elements of Transport protocols - TCP & UDP,connection oriented and connection less 4.2 Application Layer: 4.2.1 DNS- Domain Name System 4.2.2 Internet Services: World Wide Web: Web browser, HTML 4.2.3 Electronic Mail: Functions of E-mail system, User agent, Message format , Mail Protocols (SMTP, POP3),FTP, Remote Login 4.3 Voice and Video over IP
Unit –V **Network Security**	5.a Explain web Security, 5.b Explain SSH, IPSec 5.c key aspects related to the Copyright Act in India 5.d Define the terms "encryption" and "decryption" in the context of cryptography. 5.e Difference between symmetric and asymmetric encryption algorithms. 5.f Explain IPSec in detail like architecture,configuration. 5.g Explain IEmail security : Email security standards 5.h Explain ISO and how it contributes to information security? 5.i Briefly describe the Information Technology (Amendment) Act, 2008, and its impact on cyber laws in India. 5.j IT Act 2000 Provisions and latest amendments.	5.1 Introduction to Network Security, Cryptography 5.2 Security topologies - Security zones, DMZ, Internet, Intranet, VLAN, Security implication, Tunnelling. 5.3 IP security : Overview, architecture, IPSec, IPSec configuration, IPSec security. Virtual Private Network. 5.4 Email security : Email security standards : Working principles of SMTP, PEM, PGP, S/MINE, spam. 5.2 Information Security Standards - ISO, IT Act, Copyright Act, Cyber Laws in India. 5.3 IT Act 2000 Provisions and latest amendments 5.4 Social issues, Hacking, precautions

8. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Unit – I Introduction to Computer Networks**	**7**	4	5	3	**12**
2	**Unit – II Network Devices**	**8**	6	4	4	**12**
3	**Unit- III Hardware Layer**	**10**	6	6	6	**16**
4	**Unit –IV Software Layer**	**10**	6	6	4	**16**
5	**Unit –V Network Security**	**7**	4	2	4	**14**
	Total	**42**	**26**	**23**	**21**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

8.   SUGGESTED STUDENT ACTIVITIES

Other than the 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 groups and prepare reports of each activity.

 i. Prepare journals based on practical performance in the laboratory.
 ii. Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning
iii. Prepare chart to represent the Network Topology Diagrams, Protocol Stack Diagrams, Flowcharts for Protocols, Error and Flow Control Graphs, Bandwidth Utilization Charts, Network Performance Metrics, Comparison Charts for Data Link Protocols, Routing Algorithm Comparison Graphs, IP Addressing Schemes, Network Security Charts, Comparison of Wireless Technologies, Network Management Tools Comparison, Data Communication Medium Comparison, Ethical Hacking Incidents etc
 iv. Explore real-world case studies of network implementations, failures, or security breaches, encouraging students to analyze and propose solutions.
 v. To design a network in your department such as one drive can be accessible from any other system.
 vi. Prepare LAN cable and test it.(Practice cable stripping, untwisting, and proper crimping techniques, Learn about different types of LAN cables, such as Cat5e, Cat6, or Cat6a, and their applications, Create a simple diagram or documentation illustrating the cable connections.)
vii. List different types of Network operating system.
viii. Identify the type of Network in your Institute.

9.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:
a) Massive open online courses (*MOOCs*) may be used to teach various topics/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) Some *of the topics/subtopics* are relatively simple and very easy for the students for *self-learning*, but to be assessed using different assessment methods.

d) With respect to *section No.09*, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.

e) Guide students for using the latest Technical Magazine.

f) Arrange visit to relevant industry

g) Show video lectures to explore various network management tools, including both graphical user interfaces (GUI) and command-line interfaces (CLI), emerging technologies, such as 5G, IoT, or SDN, and their impact on network communication with help of the internet.

h) Invite industry experts to deliver guest lectures on current trends, challenges, and best practices in computer networks and data communication

10.   SUGGESTED MICRO-PROJECTS

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 is 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 a dated work diary consisting of individual contributions 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 a micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher.

MICRO PROJECT: Prepare following Designs.

1.   Dynamic Cloud Network Control Under Reconfiguration Delay and Cost.
2.   Measuring Web Latency and Rendering Performance.
3.   Configuration to a DHCP Server
4.   Implement and Verify Static Routes
5.   Connectivity Tests with Traceroute
6.   Configure Dynamic NAT using Packet Tracer
7.   configure Switch and Router VTY,Privilege and enable Password Assignment
8.   Implement and Verify Default Routes
9.   Client-Server based Instant Messenger.
10.   Configure VLAN in Switch
11.   Configure Web browser security settings.
12.   Case study on Demonstration of wireless network between mobile device and PC for file transfer.
13.   Install a small wireless network using access points.
14.   Develop a small Network. (Hands on Training.)

Students can do any other project suggested by faculties or any suggested student activity.

11.   SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Data Communication and Networking	Forouzen	Tata McGraw Hill, Education New Delhi (Latest edition)
2	Computer Networks	Tannebaum Andrew S Wetherall David J.	Pearson, New Delhi, 5th Edition, 2011
3	Data and Computer Communication	Stallings Williams	PHI Learning, New Delhi (Latest edition)
4	Data Communication Networks	Sharma Sanjay	S.K.Kataria and Sons, New Delhi (Latest edition)
5	Cryptography and Network Security	Stallings Williams	PHI Learning, New Delhi (Latest edition)

12. SOFTWARE/LEARNING WEBSITES
a)   **https://www.netacad.com/courses/packet-tracer**
b)   **https://www.javatpoint.com/computer-network-architecture**
c)   **https://www.geeksforgeeks.org/**
d)   **https://www.cisco.com/c/en_in/products/security/what-is-network-security.html**

13. PO-COMPETENCY-CO MAPPING
Program Outcomes (POs):

1.   **Basic & Discipline specific knowledge**: An applied knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
2.   **Problem Analysis:** Identify and analyze well defined engineering problems using codified standard methods.
3.   **Design/ Development of Solution:** Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs.
4.   **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and relevant techniques to conduct standard tests and measurements.
5.   **Engineering practices for Society, Environment and sustainability**: Apply relevant technology in context of Society, sustainability, environment and ethical practices.
6.   **Project Management**: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
7.   **Life-long learning**: Ability to analyze individual needs and engage in updating in the context of technological changes.

Program Specific Outcomes (PSOs):
1.   Develop proficiency in Installation, maintenance and troubleshooting of electronics and communication systems.
2.   Create customized solutions to real-life problems using hardware and software.

Semester VI	Computer Networks & Data Communication								
	POs and PSOs								
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning	PSO 1	PSO 2
Competency									
Analyze the key concepts of Computer network, the various physical network topologies.	3	2	1	1	2	2	2	1	3
vi.Select proper devices and transmission media based on network application	3	2	2	2	1	1	3	2	2
vii.Manage contemporary network infrastructures and configure fundamental network devices based on criteria.	3	2	2	2	1	2	3	1	3
viii.Use Internet protocols and standards, layered models.	3	2	2	1	1	3	3	2	3
ix.Analyze network security protocols of hardware and software layer.	3	3	2	2	2	3	3	2	3

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO

14.   COURSE CURRICULUM DEVELOPMENT COMMITTEE
GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
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