GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Advanced Computer Network
(Course Code: 4350706)

Diploma programme in which this course is offered	Semester in which offered
Computer Science & Engineering	5th semester

1.   RATIONALE

In today's interconnected world, computer networks form the backbone of communication and information exchange between individuals, businesses, and organizations. As the demand for faster and more efficient network communication continues to increase, there is a need for professionals who can design, implement, and manage computer networks. This course on Advanced Computer Networks will focus on various concepts and protocols of computer networks. Students will learn about IPv4, IPv6 and its features, routing protocols like RIP, OSPF and BGP, and Transport Layer Protocols like TCP, UDP and SCTP. They will also gain knowledge about Application Layer Protocols such as HTTP, SMTP, POP3, IMAP4, and DNS. The course will provide hands-on experience in configuring and managing network infrastructures, troubleshooting network issues, and analyzing network traffic. Upon completion, students will be equipped with the skills and knowledge to design, implement, and manage advanced computer networks with a strong understanding of network, transport and application layers concepts and protocols.

2.   COMPETENCY

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

- **Configure network using different network, transport, and application layer protocols of TCP/IP protocol stack.**

3.   COURSE OUTCOMES (COs)

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

a) Configure a computer network using IPv4 protocol.
b) Configure a computer network using IPv6 protocol.
c) Choose unicast routing protocols to implement routing in the given computer network.
d) Compare features, formats, and applications of various transport layer protocols.
e) Use various application layer protocols in the network configuration.

4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+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 the 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.*

5.   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	a) Rewrite the following IP addresses in binary notation 192.168.12.79 156.152.187.189 172.16.12.11 10.159.187.198 b) Rewrite the following IP addresses in dotted decimal notation 11000000.10101000.00111000.00001100 10101001.00001100.00001011.01001111 00001010.10111011.00001100.01111011 01111101.10111011.11100000.11111111 c) Consider the following IP addresses 214.229.206.83/28 153.120.147.39/26 115.173.104.1/18 70.173.166.71/1 Find the following for each above IP address 1. Network Address 2. First Host Address 3. Last Host Address 4. Broadcast Address 5. Next Subnet Address d) An organization is granted block 212.18.190.0/24. The administrator wants to create 32 subnets. 1. Find the subnet mask. 2. Find the number of addresses in each subnet. 3. Find the first and last address in subnet 1 4.Find the first and last address in subnet 32.	1	2

2	a) Investigate IP protocols by capturing and studying IP datagrams using Wireshark		2
	b) An IP datagram has arrived with the following partial information in the header (in hexadecimal): 45000054 00030000 2006... What is the header size? Are there any options in the packet? What is the size of data? Is the packet fragmented? How many more routers can the packet travel to? What it the protocol number of the payload being carried by the packet?	1	
3	Capture and study ICMPv4 packets generated by Other utility programs such as ping and traceroute using relevant software	1	2
4	Create a small IPv4 static routing network using relevant software.	1	2
5	Create a small IPv6 network using any relevant software.	2	2
6	Configure RIP routing protocol using relevant software.	3	2
7	Configure OSPF routing protocol using relevant software.	3	2
8	Configure BGP routing protocol using relevant software.	3	2
9	a) The following is a dump (contents) of a UDP header in hexadecimal format. 0045DF0000580000 a. What is the source port number? b. What is the destination port number? c. What is the total length of the user datagram? d. What is the length of the data? e. Is the packet directed from a client to a server or vice versa? f. What is the application-layer protocol? g. Has the sender calculated a checksum for this packet? The following is part of a TCP header dump (contents) in hexadecimal format. E293 0017 00000001 00000000 5002 07FF.. a. What is the source port number? b. What is the destination port number? c. What is the sequence number? d. What is the acknowledgment number? e. What is the length of the header? f. What is the type of the segment? g. What is the window size? The following is a dump of an SCTP general header in hexadecimal format. 04320017 00000001 00000000 a. What is the source port number? b. What is the destination port number? c. What is the value of the verification tag? d.What is the value of the checksum?	4	2

10	Capture and Study TCP and UDP Packets using relevant software.	4	2
11	Configure Dynamic Host Configuration Protocol using relevant software.	5	2
12	a) Configure Domain Name Server (DNS) using relevant software. b) Configure Web Server using relevant software.	5	2
13	Configure File Transfer Protocol (FTP) using relevant software.	5	2
14	Configure Mail Server Using relevant software.	5	2
	Total		**28**

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 embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Completion of given task	25
2	Correctness of the given task	30
3	Question & Answers	25
4	Regularity of report submission	20
	Total	**100**

6.   MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure the proper conduct of practicals in all institutions across the state in a proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO S.No.
1	Computer System with basic configuration and connected with LAN and Internet.	2 to 8, 10 to 14
2	Wireshark or any other similar software to capture and investigate packets.	2, 3 and 10
3	Cisco Packet Tracer or any other similar software.	4,5,6,7,8 and 11 to 14

7.   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) Practice good housekeeping
b) Follow ethical practices.
c) Work as a leader/a team member.
d) Follow standard configuration.
e) Follow safety 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.

8.   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 the attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-1 Network Layer Protocols	1.a Explain classful and classless IP addressing. 1.b Solve various problems related to subnetting and supernetting. 1.c Explain Network Address Translation. 1.d Explain forwarding of IP packets based on destination address. 1.e Explain significance of the fields of IPv4 Datagram format. 1.f Explain ICMPv4 protocol.	1.1 **Introduction** - Network layer protocols 1.2 **IPV4 Addresses** - Address space, Classful addressing, Classless addressing, Network Address Resolution (Translation). 1.3 **Forwarding of IP Packets**- Forwarding based on destination address. 1.4 **Internet Protocol**-Datagram Format, Fragmentation, Options, Security of IPv4 Datagrams. **ICMPv4**-Messages, Debugging tools, ICMP checksum.
Unit-2 Next Generation IP	2.a Compare IPv4 and IPv6 2.b Classify Binary and Hexadecimal representation of IPv6 address. 2.c Explain address space allocation of IPv6 address. 2.d Describe the benefits of autoconfiguration and renumbering. 2.e Convert the given IPv4 address to IPv6 address. 2.f Explain significance of the fields of	2.1 **IPv6 Addressing**-Representation, Address space, Address space allocation, Autoconfiguration, Renumbering 2.2 **The IPv6 Protocol**-Packet Format, Extension Header 2.3 **The ICMPv6 Protocol**- Error reporting, Informational Messages, Neighbor-Discovery Messages, Group Membership Messages **Transition from IPv4 to IPv6**- Strategies,

		IPv6 Packet Format. 2.g Compare ICMPv6 and ICMPv4. 2.h Outline the given strategy of Transition from IPv4 to IPv6.	Use of IP addresses
Unit-3 Unicast Routing		3.a Differentiate intra and interdomain routing. 3.b Explain various routing algorithms. 3.c Demonstrate various unicast routing protocols	3.1 **Introduction -** Routing 3.2 **Intra- and Interdomain Routing** 3.3 **Routing Algorithms**-Distance vector routing, Link-state routing, Path-vector routing 3.4 **Unicast Routing Protocols**-Internet structure, Routing Information Protocol, Open Shortest Path first, Border Gateway Protocol version 4
Unit-4 Transport Layer Protocols		4.a Explain significance of the fields of UDP 4.b Explain various UDP services. 4.c Outline the different features of UDP. 4.d Explain various TCP services. 4.e List out different features of TCP. 4.f Explain significance of the fields of TCP Segment. 4.g Explain TCP connections. 4.h Describe State Transition Diagram of TCP. 4.i Explain various SCTP services. 4.j Explain significance of the fields of SCTP packet format.	4.1 **Introduction**-Services, Port Numbers 4.2 **User Datagram Protocol**-User Datagram, UDP Services, UDP Applications **4.3Transmission Control Protocol**-TCP Services, TCP Features, Segment, A TCP Connection, State Transition Diagram 4.4 **SCTP**-SCTP Services, SCTP Features, Packet Format, An SCTP Association
Unit-5 Application Layer Protocols		5.a Explain WWW and URL. 5.b Demonstrate the working of HTTP Protocol. 5.c Demonstrate the working of FTP Protocol. 5.d Explain the architecture of Electronic mail. 5.e Compare POP3 and IMAP4. 5.f Describe MIME protocol. 5.g Describe Web-based Mail. 5.h Explain working of DNS. 5.i Explain the significance of the fields of resource records. 5.j Explain DNS message format. Outline DDNS and security of DNS.	5.1 **Introduction –** Application Layer Protocols 5.2 **World Wide Web and HTTP** 5.3 **FTP**-Two connections, Control Connections, Data Connection, Security for FTP 5.4 **Electronic Mail**-Architecture (SMTP, POP, IMAP, Introduction of MIME) Web-Based Mail, E-mail Security **5.5Domain Name System**-Name Space, DNS in the internet, Resolution, Caching, Resource Records, DNS Messages, Registrars, DDNS, Security of DNS

Note: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

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
1	Network Layer Protocols	10	4	6	6	16
2	Next Generation IP	6	4	5	3	12
3	Unicast Routing	7	4	9	0	13
4	Transport Layer Protocols	9	4	7	3	14
5	Application Layer Protocols	10	4	11	0	15
Total		42	**20**	**38**	**12**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)
__Note__: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from the 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) Undertake micro-projects in teams.
   b) Give a seminar on any relevant topics.
   c) Visit any ISP in your area.
   d) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning.
   e) Encourage students to form a Network club at institute level and can help to solve basic network related faults in your institute as well as help slow learners.

11.   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) Managing Learning Environment.
   d) Diagnosing Essential Missed Learning concepts that will help students.
   e) Guide students to do personalized learning so that students can understand the course material at his or her pace.
   f) Encourage students to do group learning by sharing so that teaching can easily be enhanced.
   g) *'L' in section No. 4* means different types of teaching methods that are to be employed

by teachers to develop the outcomes.

h) About *20% of the topics/sub-topics* which are relatively simpler or descriptive in nature is to be given to the students for *self-learning*, but to be assessed using different assessment methods.

i) With respect to *section No.10*, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.

j) Demonstrate students thoroughly before they start doing the practice.

k) Encourage students to refer different websites to have deeper understanding of the topic.

l) Observe continuously and monitor the performance of students in the laboratory.

m) Guide students on how to address issues on environment and sustainability using the knowledge of this course.

12. 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 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 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:

a) Create a webserver. Host any two websites in this webserver. Create a domain server for the domain of these websites and enter the domain of the websites in it. Access these websites from another computer's browser with its domain name.

b) Configure an email server in intranet and access it by using any email client.

c) Configure an ftp server in intranet and access it by using any ftp client.

d) Configure Telnet & SSH Server in intranet and access it by using particular client.

e) Configure Proxy server in intranet.

f) Prepare one static and one dynamic network with DHCP server. Use routing protocol to route packets between these networks using any network simulator.

g) Configure VLAN using any network simulator.

h) Configure Site to Site VPN using any network simulator.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Data Communication and Networking 5E	Forouzan Behrouz	McGraw Hill Educattion (India), New Delhi, 2005, ISBN-13:978-1-25-906475-3 ISBN-13:978-0-07-337622-6

2	Computer Networks: A Top-Down Approach Special Indian Edition	Behrouz A. Forouzan, Firouz Mosharraf	McGraw Hill Education(India) ISBN-13:978-1-25-900156-7 ISBN-10:1-25-900156-3
3	Computer Networks Fifth Edition	Andrew S. Tanenbaum DaviD J. Wetherall	Pearson Education India; 5th edition ISBN-10 : 9332518742 ISBN-13 : 978-9332518742
4	Computer Networking, A Top-down approach, Seventh Edition	James F. Kurose Keith W. Ross	Pearson; 7th edition, 2016 ISBN-10 : 9780133594140 ISBN-13 : 978-0133594140
5	Packet Tracer Network Simulator	Jesin A	Packt Publishing Limited ISBN-10 : 1782170421 ISBN-13 : 978-1782170426
6	Wireshark Network Analysis (Second Edition)	Laura Chappell	Chappell University; 2nd edition ISBN 978-1-893939-94-3

14.   SOFTWARE/LEARNING WEBSITES
   a) https://subnetipv4.com/
   b) https://learningcontent.cisco.com/games/binary/index.html
   c) http://cisco.num.edu.mn/CCNA_R&S1/index.html
   d) https://study-ccna.com/
   e) https://www.nwkings.com/types-of-ipv6-addresses
   f) https://campus.barracuda.com/product/cloudgenfirewall/doc/79462780/dynamic-routing-protocols-ospf-rip-bgp/
   g) https://www.geeksforgeeks.org/multipurpose-internet-mail-extension-mime-protocol/
   h) https://www.cloudns.net/blog/what-is-dynamic-dns/
   i) https://study-ccna.com/ios-basic-commands/
   j) https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/fundamentals/configuration/15mt/fundamentals-15-mt-book/cf-cli-basics.html
   k) https://www.cisco.com/c/en/us/td/docs/ios/fundamentals/command/reference/cf_book.pdf
   l) https://www.packettracernetwork.com/
   m) https://www.computernetworkingnotes.com/networking-tutorials/
   n) https://www.youtube.com/watch?v=lb1Dw0elw0Q
   o) https://www.javatpoint.com/wireshark
   p) https://nptel.ac.in/courses/106105183
   q) https://nptel.ac.in/courses/106106091
   r) https://www.udemy.com/course/computer-networks-course-networking-basics/
   s) https://www.studytonight.com/computer-networks/
   t) https://www.wireshark.org/download.html
   u) https://www.netacad.com/courses/packet-tracer
   v) https://www.server-world.info/en/

15.   PO-COMPETENCY-CO MAPPING

Semester II	Advanced Computer Network (Course Code: 4350706)						
	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
Competency: Configure network using different network, transport, and application layer protocols of TCP/IP protocol stack.							
CO a) Configure a computer network using IPv4 protocol.	2	3	3	3	1	1	1
CO b) Configure a computer network using IPv6 protocol.	2	2	2	2	-	1	1
CO c) Choose unicast routing protocols to implement routing in the given computer network.	2	2	2	2	-	1	1
CO d) Compare features, formats, and applications of various transport layer protocols.	2	1	1	2	-	1	1
CO e) Use various application layer protocols in the network configuration.	2	2	2	2	1	1	1

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

16.   COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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1	Smt. Manisha P. Mehta HOD, Computer	GP, Himmatnagar	manishamehtain@gmail.com
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