

COURSE PLAN & COURSE DATA SHEET

PROGRAM: B.Tech	DEGREE: UG
COURSE: NETWORK ARCHITECTURE AND DESIGN	SEMESTER: 6 th CREDITS: 3
COURSE CODE: CS-318	COURSE TYPE: CORE
COURSE AREA/DOMAIN: CS	CONTACT HOURS: 3+1 (Tutorial) hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY): CS-368	LAB COURSE NAME (IF ANY): NETWORK ARCHITECTURE AND DESIGN LAB

PROGRAM EDUCATIONAL OBJECTIVES:

SYLLABUS:

UNIT	DETAILS	HOURS
I	LAYERS 1 TO 7: Layer 1 to 7 protocols working principles and attack surface, Networking equipment – switches, routers, bridges – best practices, Network Closets, Wireless, Zigbee and RFID badges, VLANs, Hardening, Private VLANs. Segmentation - Network vs Access Segmentation, Segmentation Principles, Firewall Architecture, DMZ Design, Router ACLs.	09
II	LAYER 3: Router Configuration; Layer 3 Attacks and Mitigation; Layer 2 and 3 Benchmarks and Auditing Tools; Securing SNMP; Securing NTP; Bogon Filtering, Blackholes, and Darknets; IPv6; Securing IPv6; VPN; Layer 3/4 Stateful Firewalls; Proxy, Application proxies.	07
III	NETWORK-CENTRIC SECURITY: NGFW; NIDS/NIPS; Network Security Monitoring - Alert-Driven and Data-Driven Workflows, Network Visibility, Network Metadata, SPAN ports, TAPs, Sensor Placement, Network Traffic Analysis; Sandboxing; Encryption; Secure Remote Access;	08
IV	DATA-CENTRIC SECURITY: Application (Reverse) Proxies; Full Stack Security Design; Web Application Firewalls; Database Firewalls/Database Activity Monitoring; File Classification; Data Loss Prevention (DLP); Data Governance; Mobile Device Management (MDM) and Mobile Application Management (MAM); Private Cloud Security; Public Cloud Security; Container Security.	10
V	ZERO-TRUST ARCHITECTURE Zero-Trust Architecture; Credential Rotation; Compromised Internal Assets; Securing the Network; Tripwire and Red Herring Defenses; Patching; Deputizing Endpoints as Hardened Security Sensors; Scaling Endpoint Log Collection/Storage/Analysis .	08
TOTAL HOURS		42

Teacher Centric Approach			
TC1: Chalk and Talk, Blended learning	TC2: PPT,	TC3: Video Lectures	TC4:
Learner Centric Approach:			
LC1: Assignment.	LC2: Mini project.	LC3: Quiz/Class test.	LC 4: Seminar on recent trends.
LC5: Group Task.	LC6: Others		

DETAILED SESSION PLAN

Lecture session/ Numbe	Topics to be covered	CO addressed	Teacher Centric Approach	Learner Centric Approach	Reference s	Relevance with POs and PSOs
1	UNIT-1 LAYERS 1 TO 7: Layer 1 to 7 protocols working principles and attack surface,	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
2	Networking equipment – switches, routers, bridges – best practices,	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
3	Network Closets	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
4	Wireless, Zigbee and RFID badges	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
5	VLANs, Hardening, Private VLANs	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
6	Segmentation - Network vs Access Segmentation	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
7	Segmentation Principles	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
8	Firewall Architecture	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1

9	DMZ Design, Router ACLs.	1				
10	Doubt call	1	TC1	LC1,LC3	T1	PO1,PO2,PO3,PSO1
11	UNIT-2 LAYER 3: Router Configuration, Layer 3 Attacks and Mitigation;	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
12	Layer 2 and 3 Benchmarks and Auditing Tools;	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
13	Securing SNMP; Securing NTP;	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
14	Bogon Filtering,	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
15	Blackholes, and Darknets;	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
16	IPv6; Securing IPv6; VPN;	2	TC1	LC1,LC3	T1	
17	Layer 3/4 Stateful Firewalls;	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
18	Proxy, Application proxies.	2	TC1	LC1,LC3	T1	PO1,PO2,PO8,PSO1,PSO2
19	Doubt class	2	-	-	-	-
20	UNIT-3 NETWORK- CENTRIC SECURITY: NGFW; NIDS/NIPS; Network Security Monitoring, Alert-Driven & Data-Driven Workflows	3	TC1	LC1,LC3	T1	PO2,PO8,PSO1, PSO2
21	Network Visibility, Network Metadata,	3	TC1	LC1,LC3	T1	PO2,PO8,PSO1, PSO2
22	SPAN ports, TAPs, Sensor Placement,	3	TC1	LC1,LC3	T1	PO2,PO8,PSO1, PSO2
23	Network Traffic Analysis; Sandboxing;	3	TC1	LC1,LC3	T1	PO2,PO8,PSO1, PSO2
24	Encryption; Secure Remote Access;	3	TC1	LC1,LC3	T1	PO2,PO8,PSO1, PSO2
25	Doubt class	3	-	-	-	-

26	UNIT-4 DATA-CENTRIC SECURITY: Application (Reverse) Proxies	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
27	Full Stack Security Design;	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
28	Web Application Firewalls;	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
29	Database Firewalls/Database Activity Monitoring;	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
30	File Classification;	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
31	Data Loss Prevention (DLP); Data Governance;	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
32	Mobile Device Management (MDM) and Mobile Application Management (MAM)	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
33	Private Cloud Security; Public Cloud Security;	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
34	Container Security	4	TC1	LC1,LC3	T1	PO1,PO6,PO9,PO12,PSO1,PSO2
35	Doubt class	4	-	-	-	-
36	UNIT-5 ZERO-TRUST ARCHITECTURE Zero-Trust Architecture;	5	TC1	LC1,LC3	T1	PO1,PO6,PO11, PSO1,PSO2
37	Credential Rotation	5	TC1	LC1,LC3	T1	PO1,PO6,PO11, PSO1,PSO2
38	Compromised Internal Assets; Securing the Network;	5	TC1	LC1,LC3	T1	PO1,PO6,PO11, PSO1,PSO2
39	Tripwire and Red Herring Defenses; Patching;	5	TC1	LC1,LC3	T1	PO1,PO6,PO11, PSO1,PSO2
40	Deputizing Endpoints as Hardened Security Sensors;	5	TC1	LC1,LC3	T1	PO1,PO6,PO11, PSO1,PSO2
41	Scaling Endpoint Log Collection/Storage/Analysis	5	TC1	LC1,LC3	T1	PO1,PO6,PO11, PSO1,PSO2

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1	Network Security Architecture: Best Practices and Techniques, Sean Convery (Latest Edition).
2	Practical Network Security: The Essentials of Effective Network Defense, Chris Sanders (Latest Edition)
3	Data-Centric Security: Protecting Data Against Insider Threats and External Attacks, Bhavani Thuraisingham (Latest Edition).

WEB SOURCE REFERENCES (W):

1	https://www.javatpoint.com/computer-network-architecture
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COURSE PRE-REQUISITES: This course includes foundational knowledge in computer science, basic understanding of networking concepts, and familiarity with operating systems.

C.CODE	COURSE NAME	DESCRIPTION	SEM
CS - 318	Network Architecture & Design	This course explores network design principles, architecture, protocols, and technologies. It covers LAN, WAN, wireless networks, and emerging network technologies with hands-on lab experience.	VI

COURSE OBJECTIVES:

1	Analyze the working principles and attack surface of Layer 1 to 7 protocols and apply best practices for securing networking equipment and network closets.
2	Configure routers, mitigate Layer 3 attacks, and utilize benchmarks and auditing tools for Layer 2 and 3 securities.
3	Understand network-centric security technologies such as NGFW, NIDS/NIPS, and network security monitoring, and apply encryption and secure remote access mechanisms.
4	Implement data-centric security measures including application (reverse) proxies, web application firewalls, DLP, data governance, and mobile device management.
5	Implement a Zero-Trust Architecture, manage credential rotation, secure compromised internal assets, and deploy effective defenses such as Tripwire and red herrings.

COURSE OUTCOMES:

S.NO	DESCRIPTION	PO(1..12) MAPPING	PSO(1..3) MAPPING
Cxxx.1	Implement effective hardening techniques and segmentation strategies to enhance network security, including VLANs and private VLANs.	PO1,PO2,PO3	PSO1
Cxxx.2	Secure SNMP and NTP protocols, implement IPv6 security measures, and utilize VPNs and Layer 3/4 stateful firewalls for network protection.	PO1,PO2,PO8	PSO1, PSO2
Cxxx.3	Implement effective network traffic analysis techniques, and sandboxing methods, and ensure secure remote access to enhance network security.	PO2,PO8	PSO1, PSO2
Cxxx.4	Apply database firewalls, file classification, and ensure secure mobile device management to protect data in various environments such as private cloud, public cloud, and containers.	PO1,PO6,PO9,PO12	PSO1, PSO2
Cxxx.5	Demonstrate the ability to scale endpoint log collection, storage, and analysis, and effectively patch vulnerabilities in a network environment while utilizing endpoints as hardened security sensors.	PO1,PO6,PO11	PSO1, PSO2

COURSE OVERALL PO/PSO MAPPING:

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COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH:3; MEDIUM:2; LOW:1):

S.NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Cxxx.1	2	2	1											1	
Cxxx.2	2	1						3						2	1
Cxxx.3		2						3						1	1
Cxxx.4	1					2			2	3				1	1
Cxxx.5	1					2						1		1	2

POs & PSO REFERENCE:

PO 1	Apply the knowledge of mathematics, science, engineering and Application fundamentals, and an engineering and Application specialization to the solution of complex engineering problems.	PO7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	PSO1	To equip the students with theoretical and implementation knowledgebase in all the latest areas of Computer Science & Engineering for a successful career in software industries, pursuing higher studies, or entrepreneurial establishments.
PO 2	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	PSO2	To nurture the students with the critical thinking abilities for better decision making by offering them a socially acceptable solutions to real life problems through computing paradigm.
PO 3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	PSO3	To nurture the students with the comprehensive analytical and design abilities by offering them techno-commercially feasible solutions of real business problems through computing.
PO	Use research-based	PO1	Communicate effectively on		

4	knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	0	complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.		
PO 5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	PO1 1	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.		
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	PO1 2	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.		

COs VS POs MAPPING JUSTIFICATION:

S.NO	PO/PSO MAPPED	LEVEL OF MAPPING	JUSTIFICATION
Cxxx.1	2/1	1	It ensures students acquire fundamental knowledge in Network Architecture & Design, forming a crucial base for advanced study and practical applications in networking.
Cxxx.2	3/3	2	It justifies that students achieve an intermediate mastery in Network Architecture & Design, bridging foundational concepts with practical application in complex networking environments.
Cxxx.3	3/3	2	It justifies intermediate mastery in Network Architecture & Design, ensuring students can apply knowledge practically and understand complex networking concepts and system designs.
Cxxx.4	2/3	1	It ensures students establish a solid foundation in business intelligence and analytics, providing essential knowledge and skills for further learning and growth.
Cxxx.5	2/1	2	It justifies that students achieve an intermediate understanding and application skills in Network Architecture & Design, essential for designing and managing modern networks.
Cxxx*	2/1	1	It ensures students acquire basic knowledge in network architecture and design, forming a foundation for advanced study and practical applications in networking.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS, POs & PSOs:

SNO	DESCRIPTION	PROPOSED ACTIONS
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1	Insufficient Emphasis on Latest Networking Technologies: The course may not cover emerging networking technologies like 5G, IoT connectivity, or cloud networking in depth.	Update the curriculum to include these cutting-edge technologies and their applications.
2	Limited Practical Hands-On Experience: Students might lack practical, hands-on experience with real-world network design and troubleshooting.	Integrate lab sessions and real-world case studies to provide practical experience.
3	Gap in Cybersecurity Integration: The syllabus might not adequately address the critical aspect of network security and cybersecurity practices.	Include comprehensive modules on network security protocols, practices, and cybersecurity trends.
4	Lack of Soft Skills Development: There may be a gap in developing soft skills, like team collaboration, project management, and communication.	Introduce projects that require teamwork, presentations, and stakeholder communication.
5	Insufficient Focus on Network Management Tools: Students might not be exposed enough to advanced network management and monitoring tools.	Provide training in using state-of-the-art network management software and tools.

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

1	Software-Defined Networking (SDN) and Network Function Virtualization (NFV)
2	5G Networks and Beyond
3	Internet of Things (IoT) Network Design
4	Advanced Cybersecurity in Network Design

5	Cloud Networking and Services
6	Artificial Intelligence and Machine Learning in Networking
7	Quantum Networking and Communications

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

<input type="checkbox"/> CHALK & TALK	<input type="checkbox"/> STUD. ASSIGNMENT	<input type="checkbox"/> WEB RESOURCES	<input type="checkbox"/> NPTEL/OTHERS
<input type="checkbox"/> LCD/SMART BOARDS	<input type="checkbox"/> STUD. SEMINARS	<input type="checkbox"/> ADD-ON COURSES	<input type="checkbox"/> WEBNIARS

ASSESSMENT METHODOLOGIES-DIRECT

<input type="checkbox"/> ASSIGNMENTS	<input type="checkbox"/> STUD. SEMINARS	<input type="checkbox"/> TESTS/MODEL EXAMS	<input type="checkbox"/> UNIV. EXAMINATION
<input type="checkbox"/> STUD. LAB PRACTICES	<input type="checkbox"/> STUD. VIVA	<input type="checkbox"/> MINI/MAJOR PROJECTS	<input type="checkbox"/> CERTIFICATIONS
<input type="checkbox"/> ADD-ON COURSES	<input type="checkbox"/> OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

<input type="checkbox"/> ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	<input type="checkbox"/> STUDENT FEEDBACK ON FACULTY (TWICE)
<input type="checkbox"/> ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	<input type="checkbox"/> OTHERS

INNOVATIONS IN TEACHING/LEARNING/EVALUATION PROCESSES:

1. Incorporating virtual network simulation software to provide students with practical, hands-on experience in designing and managing complex networks without needing physical hardware.
2. Utilizing AR technology to visualize network architectures and designs, enabling students to interact with virtual network models in real-time for a more immersive learning experience.
3. Implementing project-based learning where students work on real-world network design challenges, encouraging practical application of concepts and collaboration skills.
4. Using AI-driven adaptive learning systems to personalize the learning experience, ensuring that students can learn at their own pace and receive content tailored to their understanding level.
5. Encouraging peer assessment where students review and provide feedback on each other's network designs, fostering a collaborative learning environment and developing critical evaluation skills.

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Additionally, the details to be compiled separately by the Departmental Coordinator for the entire Department.