NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR

(AN AUTONOMOUS INSTITUTE)

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Get Future Ready

NIET
Greater Noida
An Autonomous Institute

Affiliated to

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

Evaluation Scheme & Syllabus

For

Bachelor of Technology
Computer Science and Engineering (Internet of Things)

Third Year
(Effective from the Session: 2026-27)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute)

Computer Science and Engineering (Internet of Things)
Evaluation Scheme
SEMESTER –V

Sl. No.	Subject Codes	Subject Name	Type of Subject	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BCSE0502A	Computer Networks	Mandatory	3	1	0	30	20	50		100		150	4
2	BCSIOT0502	Iot Protocol and It's Applications	Mandatory	3	1	0	30	20	50		100		150	4
3		Departmental Elective-II	Departmental Elective	3	0	0	30	20	50		100		150	3
4		Departmental Elective-III	Departmental Elective	3	0	0	30	20	50		100		150	3
5	BCSE0552A	Computer Networks Lab	Mandatory	0	0	4				50		50	100	2
6	BCSIOT0551	Iot Protocol and It's Applications Lab	Mandatory	0	0	2				25		25	50	1
		Departmental Elective-II Lab	Departmental Elective	0	0	2				25		25	50	1
8	BCSIOT0555	Arm Architecture for Iot	Mandatory	0	0	6				50		100	150	3
9	BCSCC0501Y	Design Thinking-II	Mandatory	2	0	0	60	40	100				100	2
10	BCSCC0552	Research Methodology, Ethics and Writing	Mandatory	0	0	2				50			50	1
11	BEC0559X	Internship-II	Mandatory	0	0	2				50			50	1
12	BVAC0551	Professional Practice and Employability-I	Compulsory Audit	0	0	6	60	40	100					NA
13		MOOCs (For B.Tech. Hons. Degree)	*MOOCs											
		TOTAL		**14**	**2**	**24**	**180**	**120**	**300**	**250**	**400**	**200**	**1150**	**25**

*** List of MOOCs (Infosys Springboard) Based Recommended Courses for Third year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	BMC0116	Introduction to Generative AI – Artificial intelligence and Machine Learning	NASSCOM	15h	1
2.	BMC0095	ReactJS	Infosys Wingspan (Infosys Springboard)	61h 2m	4

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-IV and will be assessed during semester-V.**
- **Compulsory Audit (CA) Courses (Non-Credit - BVAC0551)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The Total and obtained marks are not added in the Grand Total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam.
CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit,
MOOCs: Massive Open Online Courses.

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute)
List of Department Elective (V Sem)

S. No.	Subject code	Subject Name	Types of Subjects	Bucket Name	Branch	Sem.
1	BCSAI0512	Advance Java Programming	DE-II	Full stack Development	IOT	V
2	BCSAI0512P	Advance Java Programming Lab	DE-II Lab	Full stack Development	IOT	V
3	BCSE0514	Design Pattern	DE-III	Full stack Development	IOT	V
4	BCSAI0517	Programming For Data Analytics	DE-II	AI Driven Analytics	IOT	V
5	BCSAI0517P	Programming For Data Analytics Lab	DE-II Lab	AI Driven Analytics	IOT	V
6	BCSAI0519N	Business Intelligence and Data Visualization	DE-III	AI Driven Analytics	IOT	V
7	BCSCY0513	Network Security and Cryptography	DE-II	Cyber Security- I	IOT	V
8	BCSCY0513P	Network Security and Cryptography Lab	DE-II Lab	Cyber Security- I	IOT	V
9	BCSCY0515	Ethical Hacking	DE-III	Cyber Security- I	IOT	V

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute)

Computer Science and Engineering (Internet of Things)
Evaluation Scheme
SEMESTER –VI

Sl. No.	Subject Codes	Subject Name	Type of Subject	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BCSIOT0601	Cloud And Edge Computing	Mandatory	3	1	0	30	20	50		100		150	4
2	BCSIOT0602	Wireless Sensor Networks	Mandatory	3	1	0	30	20	50		100		150	4
3		Departmental Elective-IV	Departmental Elective	3	0	0	30	20	50		100		150	3
4		Departmental Elective-V	Departmental Elective	3	0	0	30	20	50		100		150	3
5		Open Elective-I	Elective	2	0	0	30	20	50		50		100	2
6	BCSIOT0651N	Cloud And Edge Computing Lab	Mandatory	0	0	4				50		50	100	2
7	BCSIOT0652	Wireless Sensor Network Lab	Mandatory	0	0	4				50		50	100	2
8		Departmental Elective-Iv Lab	Departmental Elective	0	0	2				25		25	50	1
9	BCSML0653	Machine Learning and It's Applications	Mandatory	0	0	6				50		100	150	3
10	BCSE0659X	Applied Research with Mini Project	Mandatory	0	0	2				50			50	1
11	BVAC0651	Professional Practice & Employability - II	Compulsory Audit	0	0	6	60	40	100					NA
12		MOOCs (For B.Tech. Hons. Degree)												
		TOTAL		**14**	**2**	**24**	**150**	**100**	**250**	**225**	**450**	**225**	**1150**	**25**

*** List of MOOCs (Infosys Springboard) Based Recommended Courses for Third year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	BMC0131	Python for Data Science	NASSCOM	30h	2
2.	BMC0109	Mobile App Development using Flutter	Infosys Wingspan (Infosys Springboard)	44h 37m	3.5
3,	BMC0086	Java Programming Fundamentals	Infosys Wingspan (Infosys Springboard)	36h 10m	3

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-VI and will be assessed during Semester-VII**
- **Compulsory Audit (CA) Courses (Non-Credit - BVAC0651)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The Total and obtained marks are not added in the Grand Total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam.
CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit,
MOOCs: Massive Open Online Courses.

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
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List of Department Elective (VI Sem)

S. No.	Subject code	Subject Name	Types of Subjects	Bucket Name	Branch	Sem.
1	BCSE0614	Web Development Using Mean Stack	DE-IV	Full stack Development	IOT	VI
2	BCSE0614P	Web Development Using Mean Stack Lab	DE-IV Lab	Full stack Development	IOT	VI
3	BCSE0615	Web Development Using Mern Stack with Devops	DE-V	Full stack Development	IOT	VI
4	BCSML0614	Natural Language Processing and Social Media Analytics	DE-IV	AI Driven Analytics	IOT	VI
5	BCSML0614P	Natural Language Processing and social media Analytics Lab	DE-IV	AI Driven Analytics	IOT	VI
6	BCSML0612	Generative AI	DE-V	AI Driven Analytics	IOT	VI
7	BCSCY0613	Malware Analysis and Reverse Engineering	DE-IV	Cyber Security- I	IOT	VI
8	BCSCY0613P	Malware Analysis and Reverse Engineering Lab	DE-IV Lab	Cyber Security- I	IOT	VI
9	BCSCY0612N	Blockchain And Cryptocurrency Security	DE-V	Cyber Security- I	IOT	VI

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AICTE Guidelines in Model Curriculum:

A student will be eligible to get Undergraduate degree with Honours only, if he/she completes the additional MOOCs courses such as Infosys Springboard/NASSCOM/CISCO (as applicable) certifications, or any other online courses recommended by the Institute (Equivalent to 20 credits). During Complete B.Tech. Program Guidelines for credit calculations are as follows.

1. For 6 to 12 Hours =0.5 Credit
2. For 13 to18 =1 Credit
3. For 19 to 24 =1.5 Credit
4. For 25 to 30 =2 Credit
5. For 31 to 35 =2.5 Credit
6. For 36 to 41 =3 Credit
7. For 42 to 47 =3.5 Credit
8. For 48 and above =4 Credit

For registration to MOOCs Courses, the students shall follow Infosys Springboard/NASSCOM/CISCO (as applicable) registration details as per the assigned login and password by the Institute these courses may be cleared during the B. Tech degree program (as per the list provided). After successful completion of these MOOCs courses, the students shall provide their successful completion status/certificates to the Controller of Examination (COE) of the Institute through their coordinators/Mentors only.

The students shall be awarded Honours Degree as per following criterion.

i. If he / she secures 7.50 as above CGPA.
ii. Passed each subject of that degree program in the single attempt without any grace.
iii. Successful completion of MOOCs based 20 credits

SYLLABUS- SEMESTER V

Course Code: BCSE0502A	Course Name: Computer Networks	L	T	P	C
Course Offered in B. Tech: CSE/CS/IT / CSE(IoT)/CSE(AI)/CSE(AIML)/ CSE(DS)/ CSE(CYS)/MCT /ECE		3	1	0	4

Pre-requisite: Knowledge of basic computing

Course Objectives:

The course aims to provide students with a comprehensive understanding of computer network fundamentals, protocol architectures, addressing and routing mechanisms, transport and application layer services, and network security concepts. It also enables students to analyze, design, configure, and evaluate network systems and protocols to support efficient and secure data communication in modern computer networks.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand fundamentals of computer networks, components, performance metrics, multiplexing, topologies, and compare OSI and TCP/IP models with layer-wise responsibilities.	K2
CO2	Analyze data link layer mechanisms, MAC protocols, switching, VLANs, trunking, DTP, VTP, and STP operation for loop prevention and port state transitions.	K4
CO3	Model IPv4 and IPv6 networks, addressing schemes and configure routing protocols, while evaluating routing metrics, administrative distance, and loop prevention mechanisms.	K4
CO4	Analyze TCP and UDP behavior, congestion control, traffic shaping, and their impact on QoS, including connection management, flow control, and port usage.	K4
CO5	Apply application-layer and security solutions using core network services, NAT/PAT, cryptography, firewalls, ACLs, and threat mitigation techniques.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	1	-	3	2	3
CO2	2	2	2	2	3	-	-	-	1	1	1	2	2	2
CO3	3	3	3	1	2	-	-	-	1	1	1	1	2	1
CO4	2	2	1	1	2	-	-	1	1	1	1	2	1	3
CO5	2	2	2	1	2	1	1	2	1	1	1	2	2	3

Course Contents / Syllabus

Unit 1 | **Introduction to Networks and Data Communication** | **08 hours**

Introduction to Computer Networks: Definition, evolution, goals, advantages, disadvantages, Client-server, peer-to-peer networks, modes of communications.
Types of networks: PAN, LAN, WAN, MAN.
Network components: End devices (PCs, servers, printers), Intermediary devices (gateways, routers, switches, APs), NICs.
Network media: Wired and Wireless media, along with performance metrics bandwidth, latency, throughput, and jitter.
Multiplexing Techniques: Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM).
Network representations: Topology diagrams including Bus, Ring, Star, Mesh, Hybrid, Physical vs. Logical Topologies.
Network Communication Model: ISO/OSI and TCP/IP protocol suite with responsibilities of each layer, comparison between models, PDU at each layer.

Unit 2 | **Data Link Layer, Ethernet Switching, VLANs & STP** | **09 hours**

Data Link Layer: Framing, Error Detection and Correction, Flow control (Elementary Data Link Protocols, Sliding Window protocols).
Medium Access Control and Local Area Networks: Channel allocation, Multiple access protocols (ALOHA, Slotted ALOHA, CSMA/CD, CSMA/CA, Binary-backoff algorithm, LAN standards, Protocols and frame formats.
Switching and Techniques: Circuit, Message and Packet switching techniques.
Virtual Local Area Networks (LAN): VLAN concepts, VLAN types, VLAN configuration, 802.1Q trunking: VLAN tagging, native VLAN on trunk, Dynamic Trunking Protocol (DTP), VLAN Trunking Protocol (VTP), Static vs Dynamic VLANs.
STP (IEEE 802.1D): BPDU, root bridge election, port roles (Root, Designated, Non-Designated), port states (Blocking, Listening, Learning, Forwarding, Disabled).

Wireless Networking: WLAN standards, Wireless security standards, CSMA/CA: Hidden/exposed terminal problem, RTS/CTS mechanism, Wireless Security, Bluetooth.

Unit 3	**Network Layer: IP Addressing, Subnetting & Routing**	**09 hours**

Role of the Network Layer: Logical addressing, Path determination, Packet encapsulation.
IP Addressing: Need of IP address, Classification of IP addresses.
IPv4 Address: Notation, IPv4 classes, Public vs. Private address, Classes of IPv4 addresses, Loop back address, IPv4 Header format, ICMPv4.
Subnetting and VLSM: Need of subnetting, Subnet mask, Classless Inter-Domain Routing (CIDR), Variable Length Subnet Masking (VLSM).
IPv6 Addressing: Need of IPv6, difference between IPv4 and IPv6, unicast, multicast, anycast, IPv6 Header format, ICMPv6.
IPv4-to-IPv6 transition: Dual-stack, tunneling techniques (6-to-4, Intra-Site Automatic Tunnel Addressing Protocol (ISATAP), Teredo).
Routing Concepts: Router functions, Routing protocol metrics, Routing table structure, Split Horizon, Route Poisoning, Holddown Timers, Triggered Updates Distance vector vs Link state routing and its examples, Static Routing and its Configuration, Route types, Default route, Administrative Distance, Dynamic Routing Protocols, RIPv1, RIPv2, OSPF, EIGRP, BGP, IS-IS, Packet Forwarding methods.

Unit 4	**Transport Layer**	**10 hours**

Role of the Transport Layer: End-to-end communication, multiplexing/demultiplexing.
Transmission Control Protocol (TCP): Key Characteristics, packet format, flow control (window size), error recovery, Application areas,
Handshaking Techniques: TCP 3-Way Handshaking, four-way Teardown.
User Datagram Protocol (UDP): Key Characteristics, packet format, working, Application areas.
Port numbers: Well-known ports, Registered ports, Dynamic/Private ports.
TCP Socket: Life cycle, Socket programming basics, port scanning & enumeration, banner grabbing, socket-based attacks, man-in- the-middle attacks, packet sniffing, SSL/TLS, socket/session hijacking, firewall & socket filtering, intrusion detection systems, reverse shells & backdoors, Netcat usage, secure socket coding, encryption in socket communication, DoS/DDoS attacks.
Congestion Control Techniques: Open Loop and Closed Loop.
Traffic Shaping: Leaky Bucket Algorithm, Token Bucket Algorithm, Traffic shaping in Quality of Service (QoS).

Unit 5	**Application Layer and Security**	**09 hours**

Application Layer Protocols: DNS, DHCP, HTTP/HTTPS: request/response model, methods (GET, POST, PUT, DELETE), status codes, TLS/SSL, FTP (active/passive modes), SFTP, TFTP.
Email and its protocols: User Agent (UA), Message Transfer Agent (MTA), Message Access Agent (MAA), SMTP, POP3, IMAP.
Network management: SNMP (v1/v2c/v3).
NAT and PAT concepts: Static NAT and its configuration, Dynamic NAT and its configuration, PAT and its configuration
Security: Network threats: DoS/DDoS, reconnaissance, access attacks, MITM, social engineering, phishing, IPSec,
Introduction to Cryptography: Definition and goals of cryptography; Security services: Confidentiality, Integrity, Authentication, Non-repudiation; Types of attacks (passive vs active); Basic terminology: plaintext, ciphertext, key, encryption, decryption; Substitution techniques, Transposition techniques; Symmetric Key Cryptography: Concepts of symmetric encryption, Block ciphers and stream ciphers, Data Encryption Standard (DES); Asymmetric Key Cryptography: Public key cryptography concepts; RSA algorithm; Digital Signature.
Firewall: Types of Firewalls, Packet filtering concepts, Stateful vs stateless inspection, Firewall policies and rules; Access Control List (ACL): Purpose, packet filtering, traffic classification, QoS marking, Standard ACL, Extended ACL, Named ACLs, ACL wildcard masks, IPv6 ACLs: differences from IPv4 ACLs; implicit deny and permit ICMPv6.

	Total Lecture Hours	**45 hours**

Textbook

S NO.	**Book Title**	**Author**
1.	Data Communications and Networking, 4th Edition, McGraw-Hill Education	Behrouz A Forouzan.
2.	Computer Networking: A Top-Down Approach, 7th Edition, Pearson Education.	Hoboken
3.	Introduction to Networks Companion Guide (CCNAv7), 1st Edition, Cisco Press / Pearson Education, 2020.	Cisco Networking Academy
4.	Switching, Routing, and Wireless Essentials (SRWE), (CCNAv7), 1st Edition, Cisco Press/ Pearson Education, 2020.	Cisco Networking Academy, Allan Johnson

Reference Books: 1. **Data and Computer Communications, Eighth Edition**		
Self-Study Content Links:		Duration
MOOCs	1. CCNA: Introduction to Networks 2. CCNA: Switching, Routing, and Wireless Essentials (SRWE) Supplemental Unit 3. CCNA: Enterprise Networking, Security, and Automation (ENSA)	70 Hours each
Video Lectures	Complete CN Computer Networks in one shot | Semester Exam | Hindi https://www.youtube.com/watch?v=l_OPR2yh2co&list=PLh94XVT4dq02frQRRZBHzvj2hwuhzSByN&index=2 Lec-1: Computer Networks and Security Full Syllabus for GATE, UGC NET,DSSSB,NIELIT & University exam	1. 6Hrs 18Min 2. 11Hrs 54Min 3. 24 Hrs 58Min
Web References	https://www.geeksforgeeks.org/computer-networks/computer-network-tutorials/ https://www.geeksforgeeks.org/computer-networks/basics-computer-networking/ https://www.geeksforgeeks.org/computer-networks/ccna-tutorial-for-beginners/	-

Course Code: BCSIOT0551	Course Name: IoT Protocols & its Applications	L	T	P	C
Course Offered in: CSE(IoT)		3	1	0	4

Pre-requisite: Introduction to IoT, Basic Programming (C/Python), Fundamentals of Microcontroller Systems

Course Objectives:

1. To understand the fundamentals of IoT systems and embedded platforms.
2. To study IoT communication architectures and protocols.
3. To analyze networking protocols used in IoT environments.
4. To explore wireless communication technologies for IoT.
5. To understand cloud integration and real-world IoT applications.

Course Outcome: After completion of the course, the student will be able to		Blooms Level
CO1	Explain the architecture and functionality of Raspberry Pi and ARM-based microcontrollers.	K2
CO2	Analyze IoT communication architectures and protocols, including MQTT, CoAP, XMPP, DDS, and AMQP.	K4
CO3	Describe the working of networking protocols, including IPv4, IPv6, TCP/UDP, ICMP, IGMP, and RPL, in IoT systems.	K2
CO4	Analyze wireless communication technologies, including IEEE 802.15.4, ZigBee, LoRa, 6LoWPAN, NFC, and Bluetooth, for IoT applications.	K4
CO5	Apply serial communication and cloud integration concepts to real-world IoT applications and smart systems.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS
CO1	3	2	-	-	2	-	-	-	-	-	-	2	1	-
CO2	3	3	-	2	2	-	-	-	-	-	-	3	1	-
CO3	3	3	-	2	2	-	-	-	-	-	-	3	1	-
CO4	3	3	-	2	2	-	-	-	-	-	-	3	1	-
CO5	3	2	2	2	3	-	-	-	1	1	-	3	2	1

Course Contents / Syllabus

Unit 1	Introduction to Raspberry Pi and ARM-Based Microcontrollers	10 hours

Introduction to Raspberry Pi:
Introduction to Raspberry Pi and its various versions Study the Architecture and Pin diagram of Raspberry Pi, Study the various types of Raspberry Pi, Introduction to Raspberry Pi operating system, Study of GPIO pins, Differences between Raspberry Pi and Arduino
ARM Microcontrollers:
Introduction to different ARM processor families and their specific performance, power, and application needs

Unit 2	IoT Protocols and Communication Architectures	08 hours

IoT Architecture and Communication Models:
Introduction to IoT protocols, IoT 5- layered architecture, Comparison with OSI model layers
IoT Communication Protocols:
MQTT, CoAP, XMPP protocols their characteristics and Architecture, DDS, AMQP protocols their characteristics and Architecture,
Comparison of IoT protocols based on the QoS, reliability, latency and bandwidth usage, and security considerations in IoT communication protocols.

Unit 3	Networking Protocols for IoT	10 hours
Network Layer and Routing Protocols: Introduction to networking protocols used in IoT systems, IPv4 and IPv6 addressing schemes and their differences, IPsec for secure communication, routing protocols including EIGRP, OSPF and RPL, and control protocols such as ICMP and IGMP. Transport Layer Protocols: Transport layer protocols TCP and UDP, their features, comparison, reliability, and applications in IoT environments		
Unit 4	Wireless Communication Standards in IoT	09 hours
Short-Range Communication Technologies: Basic concepts of wireless communication, frequency bands, data rates, range, power consumption, Features and applications of IEEE 802.15.4, RFID, NFC, and Bluetooth, Comparison of short-range communication technologies in IoT Low Power Wide Area and IoT Networking Technologies: Features and applications of LoRa, ZigBee, and 6LoWPAN, Comparison of these technologies based on range, data rate, and power consumption, and their suitability for different IoT applications.		
Unit 5	Serial Communication, Cloud Integration & Smart City Use Cases	08 hours
Serial Communication and UART Protocol: Introduction to serial communication (with UART), Introduction to UART protocol, characteristics and architecture of UART protocol, working of UART protocol, advantages, disadvantages, and applications of UART protocol. Cloud Integration and IoT Applications: Interfacing IoT protocols with cloud, Thing Speak and MQTT cloud, implementation of CoAP protocol, and case studies on smart city applications (Singapore, Dubai).		
Total Lecture Hours		45 hours
Textbook: 1. "Enabling Things to Talk", Springer-Verlag Berlin, 2016. 2. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017. 3. "The Internet of Things: Key Applications and Protocols", John Wiley & Sons, 2011.		
Reference Books: 1.Internet of Things: A Hands-On Approach, Universities Press. 2.Raspberry Pi IoT Projects: Prototyping Experiments for Makers, McGraw-Hill Education		
Self-Study Content Links:		Duration (in Hrs)
MOOCs (NPTEL)	Introduction to Internet of Things https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_cs53	45 Hrs
Video Lectures	https://www.youtube.com/watch?v=6mBO2vqLv38&utm_source	3 Hrs
Web References	https://iotmadlab.es/wp-content/uploads/2023/10/Performance_CN_2021.pdf?utm	1 Hrs

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: BCSE0552A	LAB Course Name: Computer Networks Lab	L	T	P	C
Course Offered in: CSE/CS/ CSE(IoT)/IT /CSE(AI)/CSE(AIML)/ CSE(DS)/ CSE(CYS)/MCT /ECE		0	0	4	2

Pre-requisite: Fundamental of Computers.

Course Objectives:

Understand and configure fundamental networking concepts, develop practical skills in IP addressing, subnetting, VLANs, routing, switching, and wireless networking, configure and manage essential network services, perform network testing and troubleshooting using Cisco IOS tools, and gain hands-on experience aligned with industry networking standards and Cisco CCNA certification.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Model computer network through cabling, assigning IP addresses along with subnetting using CISCO packet tracer.	K4
CO2	Analyse Layer 2 and Layer 3 networking features including switching, VLANs, trunking, inter-VLAN routing, STP, EtherChannel, static routing, and basic dynamic routing.	K4
CO3	Demonstrate core network services and security features such as wireless connectivity, DHCP, NAT/PAT, ACLs, transport/application layer protocols, and connectivity verification using network diagnostic tools.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	2	2	1	–	2	2
CO2	3	3	3	2	3	1	-	-	2	2	1	–	2	3
CO3	3	3	2	3	3	1	-	1	2	2	1	1	2	3

List Of Practical's (Indicative & Not Limited To)	CO
1. Explore the CISCO Packet Tracer.	CO1
2.Explore Network Devices and Cabling: Identify different network devices (router, switch, PC) and understand cable types (straight-through, crossover, fiber).	CO1
3.Basic Switch and End Device Configuration: Configure hostname, passwords, and basic security settings on switches and PCs.	CO1
4.Build a Simple Network Using Packet Tracer: Create a small network and verify connectivity using ping and traceroute.	CO1
5.Configure IPv4 Addressing: Assign IP addresses manually and test communication between devices.	CO1
6.Subnetting and Address Calculation: Apply subnetting techniques to divide networks efficiently.	CO1
7.Configure IPv6 Addressing: Assign IPv6 addresses and test connectivity.	CO1
8.Access Cisco IOS and CLI Navigation: Use CLI commands to configure and manage network devices.	CO1
9.MAC Address and ARP Analysis: Understand how MAC addresses and ARP work in local communication.	CO1
10. Basic Switch Configuration Configure switch settings, ports, and management IP.	CO2
11.VLAN Configuration: Create VLANs and assign ports to segment network traffic.	CO2
12.Inter-VLAN Routing: Enable communication between VLANs using router or Layer 3 switch.	CO2

13.Trunking Configuration (802.1Q): Configure trunk links to allow multiple VLAN traffic.	**CO2**
14.Spanning Tree Protocol (STP): Understand STP operation and prevent switching loops.	**CO2**
15.Static Routing Configuration: Configure static routes and verify packet forwarding.	**CO2**
16.Default and Dynamic Routing (RIP): Implement basic dynamic routing and default routes.	**CO2**
17.Wireless Network Configuration: Configure a wireless router and connect wireless clients.	**CO3**
18.NAT (Network Address Translation): Configure NAT/PAT for internet access.	**CO3**
19.Network Troubleshooting: Identify and resolve connectivity issues using commands like ping, traceroute, and show.	**CO3**
Total Hours: 60 hrs.	

B Course Code:	LAB Course Name: IoT Protocols and its Applications Lab	L	T	P	C
Course Offered in: CSE(IoT)		0	0	2	1

Pre-requisite: Basic knowledge of IoT concepts, Fundamentals of Raspberry Pi / Arduino, sensors and actuators, Basic programming (Python/C)

Course Objectives:

1. To provide hands-on experience with Raspberry Pi and interfacing of sensors and actuators.
2. To implement IoT communication protocols such as MQTT, CoAP, and AMQP for real-time data exchange.
3. To develop skills in configuring networking and wireless communication in IoT systems.
4. To enable cloud integration and data visualization using IoT platforms like ThingSpeak and Blynk.
5. To design and develop real-time IoT applications for practical use cases.

Course Outcome: After completion of the course, the student will be able to		Blooms Level
CO1	Implement interfacing of sensors and actuators using Raspberry Pi for IoT applications.	K3
CO2	Apply IoT communication protocols (MQTT, CoAP, AMQP) for data transmission and device control.	K3
CO3	Analyze IoT-based systems using networking, wireless communication, and cloud integration.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	1	-	-	3	1	-
CO2	3	3	2	2	3	-	-	-	1	-	-	3	1	-
CO3	3	3	3	2	3	-	-	-	2	1	1	3	2	1

List Of Practical's (Indicative & Not Limited To)	CO
1. Raspberry Pi & Interfacing a. Install Raspberry Pi OS and verify system boot. b. Design a system where an LED turns ON when a push button is pressed and OFF otherwise. c. Read analog input from a potentiometer (0–3.3V) and map it to LED brightness (0–255 PWM levels). d. Display sensor data on LCD such that values update every 2 seconds. e. Measure distance using an ultrasonic sensor in the range 2 cm to 400 cm and display readings. f. Detect at least 3 different colors using a color sensor and classify them. g. Detect sound intensity using an audio sensor and trigger LED if value exceeds a threshold (e.g., > 60 dB equivalent). h. Control a DC motor such that its speed varies from 0% to 100% using PWM.	CO1

i. Measure temperature in the range 20°C to 50°C using DHT11 sensor. Control LED brightness using PWM with duty cycle variation from 0–100%.	
2. IoT Protocols a. Design a system where LED turns ON if received temperature data > 30°C, otherwise OFF, using MQTT protocol. b. Using MQTT protocol transmit DHT11 data in every 5 seconds and trigger an alert message if: Temperature > 35°C OR Humidity < 30% c. Design a system using MQTT protocol and LDR where: LED turns ON if light intensity < 250 lux and motion sensor detects movement. d. Implement a system using MQTT protocol and DHT11 sensor where: QoS 0 → normal data, QoS 1 → important data (temperature > 30°C), QoS 2 → critical data (temperature > 40°C) e. Control a relay using MQTT protocol such that: Turns ON for 10 seconds when command received and Turns OFF automatically afterward. f. Using AMQP protocol transmit gas sensor data and trigger alarm if gas level > 400 ppm. g. Implement a set up using Raspberry Pi to control a servo motor by subscribing to AMQP messages through Rabbit MQ for robust message delivery. h. Design a system using Raspberry Pi to read data from a rain sensor and reliably publish it to an AMQP queue using Rabbit MQ for robust message delivery. i. To interface a soil moisture sensor with Raspberry Pi and develop a CoAP server that allow remote access to real time soil moisture data for smart irrigation applications. j. Perform secure MQTT Communication with Login Condition that allow data transmission only if: Username = “admin”, Password = “iot123” Otherwise deny access.	CO2
3. Networking a. Configure IPv4 addressing on Raspberry Pi and establish communication with another device in the network. b. Assign static IPv4 addresses to two devices and establish communication between them. Measure network latency by: Sending 10 continuous ping requests, Recording average delay. c. Configure IPv6 addressing on Raspberry Pi and establish communication with another IPv6-enabled device. Design and implement a client-server communication system using both TCP and UDP protocols to transmit data packets of different sizes and compare their performance based on transmission time, reliability, and packet loss.	CO3
4. Wireless Communication a. Design and implement an RFID-based authentication system using Raspberry Pi that identifies authorized users within 2 seconds. b. Establish wireless communication between two ZigBee nodes to transmit sensor data over a distance of 10–50 meters.	CO3

c. Implement Bluetooth-based communication between Raspberry Pi and an Android device within a range of up to 10 meters. d. Design and implement a ZigBee mesh network using at least 3 nodes and evaluate data transmission across multiple hops.	
. Serial Communication & Cloud a. To design and implement a unidirectional serial communication system between an Arduino microcontroller and a Raspberry Pi using the UART protocol, in order to reliably transmit real-time data (such as sensor readings or text messages) from Arduino to Raspberry Pi. b. To establish a full-duplex (two-way) serial communication system between Arduino and Raspberry Pi using UART, enabling both devices to simultaneously send and receive data. c. To develop a system that enables communication between a Raspberry Pi and an Android application using serial communication (via Bluetooth or USB interface), allowing users to remotely send commands and receive data. d. To design and implement an Internet of Things (IoT)-based LED control system using Raspberry Pi and the Blynk cloud platform, enabling remote switching of an LED through a mobile application. e. To interface a sensor (such as DHT11 for temperature and humidity) with Raspberry Pi and transmit the collected data to the Thing Speak cloud platform using HTTP or MQTT protocols. f. To develop a smart lighting system that automatically controls an LED based on ambient light intensity detected using an LDR sensor, with data processed locally and/or via the Thing Speak cloud. g. To develop a mini project based on an IoT system integrating sensors, actuators, serial communication, and cloud platforms for real-time monitoring and control.	CO3
Total Hours: 30 hrs.	

Course Code:BCSIOT0555	Course Name: ARM Architecture for IoT	L	T	P	C
Course Offered in: CSE(IoT)		0	0	6	3

Pre-requisite: Basics of electronic Circuits and Digital electronics, Basics of C language.

Course Objectives: The course objective is to introduce the basic concepts of ARM microcontrollers This course introduces the architecture, assembly language and C language programming of ARM Cortex M0+ and ARM 7 microcontrollers. It gives hands-on training of interfacing external sensors and actuators with microcontroller. to develop assembly and C language programming skills for real time applications ARM 7 LPC 2148Microcontroller.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Study the basics of ARM Processor Families and Cortex M0+ microcontroller. Also Understand mbed RTOS and implement Embedded c programs using mbed.	K2
CO2	Understand the ARM 7 architecture, memory organization and pin configuration; the use of GPIO, On board memory ADC, DAC timer ports; and serial communication.	K2
CO3	Implement assembly and embedded C programs for ARM 7 LPC 2148 microcontroller.	K6
CO4	Understand the working of KEIL 4 IDE and Proteus circuit simulator	K2
CO5	Implement embedded c programs to interface various sensors and actuators to ARM 7 LPC 2148 and simulate and verify the outputs using KEIL 4 IDE and Proteus Circuit Simulator.	K6

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	-	-	-	-	3	3	2	1
CO2	3	3	2	2	3	-	-	-	-	-	2	3	2	1
CO3	3	3	3	3	3	-	-	-	-	-	3	3	2	2
CO4	2	2	2	2	3	-	-	-	-	-	2	2	1	1
CO5	3	3	3	3	3	-	-	-	-	-	3	3	3	2

Course Contents / Syllabus

Unit 1	Introduction to ARM Architecture and RTOS	15 hours

Introduction, ARM Processor Families. Cortex-M0+ Block Diagram, Registers, Processor Memory Map, Instruction Sets: ARM and Thumb Instruction Set, Cortex-M0+ Instruction Set, Program-Generation Flow, Cortex-M0+ Program Image, Program Data, how is Data Stored in RAM, Data Types. Assembly Language vs Embedded C Digital Input and Output, GPIO Controller. Introduction to RTOS: Overview of Mbed OS, Mbed Working and flow diagram in IoT.

Unit 2	Introduction to ARM 7 LPC 2148.	15 hours

Introduction to ARM 7 LPC 2148. General features of LPC2148 microcontroller. Architecture Block Diagram of LPC 2148 Microcontroller: GPIO pins, On Chip Static RAM (SRAM), Flash memory, Vectored Interrupt Controller, ADC, DAC. Serial Communication: UART, I2C, SPI Timers and Counters

Unit 3	Assembly and Embedded C Programming using ARM 7	15 hours

Introduction to Arm 7 Assembly Instructions: Classification of Instructions, Addressing Modes, Assembly language Programs. Learn the basics of Embedded C programming for device control.

Unit 4	Overview of ARM Development Tools/IDEs	15 hours

Overview of KEIL 4 IDE, its interface, Embedded c Programming on Keil. Introduction to Proteus, Its interface and Programming on Proteus.

Unit 5	**Interfacing of sensors and actuators with LPC 2148**	**20 hours**
Interfacing of Switch, LED and Seven Segment Display to ARM7. Interfacing of IR, Ultrasonic, Soil Moisture and Temperature sensors and DC motor with LPC2148.		
Total Lecture Hours		**80 hours**

Textbook:

S.No	**Book Title**	**Author**
1	The Definitive Guide to the ARM Cortex-M0, Newnes publication	Joseph Yiu,
2	ARM system developers guide, Kaufman publishers, 2008.	Andrew N Sloss, Dominic Symes and Chris Wright, Elsevier,Morgan

Reference Books:

S.No	**Book Title**	**Author**
1	ARM Cortex-M0 Technical Reference Manual	
2	ARM System-on-Chip Architecture, Addison-Wesley Educational Publishers Inc; 2nd edition (17 August 2000)	

NPTEL/ Youtube/ Faculty Video Link:

1.	https://www.youtube.com/watch?v=frbV2fiZl7Y&list=PLZv8x7uxq5XYUfOWyPjeN96bJSLDQ4WrV	8 Hours
2.	https://www.youtube.com/watch?v=F321087yYy4&list=PLXyB2ILBXW5FLc7j2hLcX6sAGbmH0JxX8	4 Hours

Required Software and Tools:

1	Mbed online compiler
2	Assembly Language online compiler
3	KEIL µvison 4 IDE
4	Proteus 8
5	ARM 7 with LPC 2148 Microcontroller board with various sensors and actuators

List Of Practical's (Indicative & Not Limited To)

1.

1. To study about introduction to ARM microcontroller and its architecture.
2. Write and Implement Embedded C Code of LED interfacing on an ARM base Mbed Microcontroller board using the Mbed.
3. Write and Implement Embedded C Code using Switch and timer on an ARM base Mbed Microcontroller board using Mbed. Perform following: -

a) LED1 will blink every second

b) LED3 will toggle after 2.5 seconds

c) LED2 can be toggled through BUTTON1

4. Write and Implement Embedded C Code of graphics LCD (C12832) interfacing with ARM based Mbed Microcontroller board using Mbed.

	5. Write and Implement Embedded C Code for interfacing temperature and humidity sensor (SHT31) with ARM based Mbed Microcontroller board using Mbed. 6. Write and Implement Embedded C Code for interfacing Speaker using ARM based Mbed Microcontroller board using the Mbed Studio tool. Play different frequency tones on speaker.
2.	1. To study general features and architecture of ARM 7 Microcontroller. 2. To Study GPIO, ADC/ADC in ARM 7 LPC 2148. 3. To Study on-Chip Static RAM (SRAM) and Flash memory available on ARM 7 LPC 2148. 4. To study Vectored Interrupt Controller available on ARM 7 LPC 2148. 5. To study Serial communication on ARM 7 LPC 2148. 6. To study Timers and counter available in ARM 7 LPC 2148.
3.	1. To study Arm 7 Assembly Instructions in assembly language in ARM 7. 2. To study Classification of Instructions in ARM 7. 3. Understand All Addressing Modes in ARM 7 with Assembly language Programs. 4. Write and Execute assembly language program to add and subtract two 8, and 32-bit numbers. 5. Write and Execute assembly language program to add and subtract two 8, and 32-bit numbers using logical shifting only. 6. Write and Execute assembly language program to perform logical operations (AND, OR, XOR) . 7. Write and Execute assembly language program for addition of five numbers located at memory started from 0x2000, using all types of register indirect addressing modes. 8. Write and Execute assembly language program to multiply two numbers.
4.	1. To study about KEIL 4 IDE and learn to create projects and their implementations. 2. To study about Proteus circuit simulator tool and learn to create projects and their implementations. 3. Write a program to connect the LED to port 0.4 and blink the LED continuously in KEIL 4 IDE and verify the program in Proteus. 4. Write a program to interface 4 LED to ARM7 and blink the LED 1 after some time LED 2 then LED 3 and after that LED 4 in KEIL 4 IDE and verify the program in Proteus. 5. Write a program to interface 4 LED and first LED should be ON, after some time second, then third and at last fourth in KEIL 4 IDE and verify the program in Proteus.
5.	1. Write a program to interface LCD to ARM7 LPC 2148 and display NIET on first line. 2. Write a program to interface LCD to ARM7 LPC 2148 and display WELCOME TO IOT. 3. Write a program to interface LCD to ARM7 LPC 2148 and display WELCOME TO IOT on the first line and WELCOME TO NIET on second line.

4. Write a program to interface LCD to ARM7 LPC 2148 and display "WELCOME TO INTERNET OF THINGS" on LCD.
5. Write a Program to transfer the character "A' through UART 0.
6. Write a aprogram to transfer the string "WELCOME TO ALEXA".
7. Write a program to receive the character and display the received character on LCD.
8. Write a program to receive the character, If the character is K, display "WELCOME TO NIET", for any other character display" WELCOME To IoT.
9. Write a program to receive the character if user entered the character is "1", LED 1 is ON, Display the same info in the serial window. If user enter 2, LED 1 is OFF, If user entered 3, LED 2 should be ON, If user entered 4 , LED should be OFF.
10. Write a program to interface two switches and LED to ARM 7, When two switches are HIGH, LED should be ON. If any switch is LOW, LED should be OFF.
11. Write a program to interface IR sensor to 0.4.If any object is bound, LED should be "ON" and display the status in serial window.
12. Write a program to interface Gas sensor to ARM7 and if any harmful gases are released display the status in the serial window.If gas leakage is there display "1".
13. Write a program to interface Moisture Sensor Sensor to ARM7. and display the status of soil in serial window and if soil is wet LED should be off and if soil is dry LED should be on.
14. Write a program to interface 7 Segment display ot ARM 7 LPC 2148
15. Write a program to interface SPI with ARM7.
16. Write a program to interface Bluetooth with ARM7.
17. Write a program to interface RFID with ARM7.
18. Interfacing DC Motor with ARM 7 LPC 2148.
19. Develpment of a Mini project.

Course Code: BCSCC0501Y	Course Name: Design Thinking –II	L	T	P	C
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(CYS)/CSE(IOT)/MCT		2	0	0	2

Pre-requisite: Student must complete Design Thinking-I course.

Course Objectives: The objective of this course is to upgrade Design Thinking skills by learning & applying advanced and contextual Design Thinking Tools. It aims to solve a Real-Life Problem by applying Design Thinking to create an impact for all the stakeholders

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Learn sophisticated design tools to sharpen their problem-solving skills	K2
CO2	Construct innovate ideas using design thinking tools and converge to feasible idea for breakthrough solution	K6
CO3	Implement storytelling for persuasive articulation	K3
CO4	Understanding the nature of leadership empowerment	K2
CO5	Understand the role of a human being in ensuring harmony in society and nature	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	3	3	2	2	2	3	2	3	3	-	-
CO2	3	2	3	2	3	2	2	3	2	2	2	3	3	-
CO3	3	2	3	2	3	2	2	3	2	2	2	3	3	-
C04	3	2	3	2	3	2	2	3	2	2	2	3	3	-
CO5	3	2	3	3	3	2	2	3	3	2	3	3	3	-

Course Contents/ Syllabus

Unit- 1	Introduction	8 hours

Design thinking & Innovation, Design Thinking Mindset and Principles, recap of 5-Step Process of Design Thinking, Design Approaches, additional in-depth examples of each design approaches. Simon Sinek's – Start with Why, The Golden Circle, Asking the "Why" behind each example (an in-class activity of asking 5-WHYS), The Higher Purpose, in-class activity for LDO & sharing insights

Visualization and its importance in design thinking, reflections on wheel of life (in-class activity for visualization & Wheel of Life), Linking it with Balancing Priorities (in class activity), DBS Singapore and Bank of Americas' Keep the Change Campaign. Litter of Light & Arvind Eye Care Examples, understanding practical application of design thinking tools and concepts, case study on McDonald's Milkshake / Amazon India's Rural Ecommerce & Gillette Working on 1-hour Design problem, Applying RCA and Brainstorm on innovative solutions. Main project allocation and expectations from the project.

Unit- 2	Refinement and Prototyping	10 hours

Refine and narrow down to the best idea, 10-100-1000gm, QBL, Design Tools for Convergence – SWOT Analysis for 1000gm discussion. In-class activity for 10-100-1000gm & QBL

Prototyping (Convergence): Prototyping mindset, tools for prototyping – Sketching, paper models, pseudo-codes, physical mockups, Interaction flows, storyboards, acting/role-playing etc, importance of garnering user feedback for revisiting Brainstormed ideas.

Napkin Pitch, Usability, Minimum Viable Prototype, Connecting Prototype with 3 Laws, A/B Testing, Learning Launch. Decision Making Tools and Approaches – Vroom Yetton Matrix, Shift-Left, Up, Right, Value Proposition, Case study: Careerbuddy, You-Me-Health Story & IBM Learning Launch.

In-class activities on prototyping- paper-pen / physical prototype/ digital prototype of project's 1000gm idea.

Unit - 3	Storytelling, Testing and Assessment	8 hours

Storytelling: Elements of storytelling, Mapping personas with storytelling, Art of influencing, Elevator Pitch, Successful Campaigns of well-known examples, in-class activity on storytelling. Testing of design with people conducting usability test, testing as hypothesis, testing as empathy, observation and shadowing methods, Guerrilla Interviews, validation workshops, user feedback, record results, enhance, retest, and refine design, Software validation tools, design parameters, alpha &beta testing, Taguchi, defect

classification, random sampling. Final Project Presentation and assessing the impact of using design thinking		
Unit - 4	**Innovation, quality and Leadership**	**8 hours**
Innovation: Need & Importance, Principles of innovations, Asking the Right Questions for innovation, Rationale for innovation, Quality: Principles & Philosophies, Customer perception on quality, Kaizen, 6 Sigma. FinTech case study of Design Thinking application – CANVAS Leadership, types, qualities and traits of leaders and leadership styles, Leaders vs Manager, Personas of Leaders & Managers, Connecting Leaders-Managers with 13 Musical Notes, Trait theory, LSM (Leadership Situational Model), Team Building Models: Tuckman's and Belbin's. Importance of Spatial elements for innovation.		
Unit - 5	**Understanding Human Desirability**	**8 hours**
Comprehensive human goal: the five dimensions of human endeavour (Manaviya - Vyavstha) are: Education- Right living (Sikhsa-Sanskar), Health – Self-regulation (Swasthya - Sanyam), Justice – Preservation (Nyaya- Suraksha), Production – Work (Utpadan – Karya), Exchange – Storage (Vinimya – Kosh), Darshan- Gyan-Charitra (Shifting the Thinking) Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature, Thinking expansion for harmony: Self-exploration (Johari's window), group behaviour, interpersonal behaviour and skills, Myers-Briggs personality types (MBTI), FIRO-B test to repair relationships.		
	Total Lecture Hours	**42 hours**

Textbook:

S. No	Book Title	Author
1.	UnMukt : Science & Art of Design Thinking, 2020, Polaris	Arun Jain
2.	Basics Design 08: Design Thinking, 2010, AVA Publishing SA	Gavin Ambrose and Paul Harris
3.	A Foundation Course in Human Values and Professional Ethics, First Edition, 2009, Excel Books: New Delhi	R R Gaur, R Sangal, G P Bagaria

Reference Books:

S.No	Book Title	Author
1.	Solving Problems with Design Thinking – Ten Stories of What Works, 2013, Columbia Business School Publishing.	Jeanne Liedta, Andrew King and Kevin
2.	Universal Human Values and Professional Ethics, 2022, Katson Books.	Dr Ritu Soryan
3.	101 Design Methods: A Structured Approach for Driving Innovation in Your Organization, 2013, John Wiley and Sons Inc, New Jersey.	Vijay Kumar
4.	Design of Business: Why Design Thinking is the Next Competitive Advantage, 2009, Harvard Business Press, Boston MA.	Roger L. Martin
5.	Change by Design, 2009, Harper Collins.	Tim Brown

Self-Study Content Links:

MOOCs	1. https://www.coursera.org/specializations/design-thinking?utm_medium=sem&utm_source=gg&utm_campaign=b2c_india_x_multi_ftco f_career-academy_cx_dr_bau_gg_pmax_gc_in_all_m_hyb_24-03_desktop&campaignid=21104989118&adgroupid=&device=c&keyword=&matchtype=&network=x&devicemodel=&creativeid=&assetgroupid=6544944776&targetid=&extensionid=&placement=&gad_source=1&gad_campaignid=21104990591&gbraid=0AAAADdKX6YJHt3GyzupmRYbPOgHkEeFp&gclid=Cj0KCQjw3K7RBhDJARIsAKRtP5RBjckHBvGEYiEnTRFA8EtXpl89ha-X8id2TOYd0e4Sf9WTvVnonK4aAmqrEALw_wcB 2. https://www.coursera.org/learn/uva-darden-designbiz	4 weeks 6 hrs
Video Lectures	1. https://www.youtube.com/watch?v=6_mHCOAAEI8 https://nptel.ac.in/courses/110106124 https://designthinking.ideo.com/ 2. https://www.youtube.com/watch?v=7enWesSofhg 3. https://youtu.be/rthuFS5LSOo https://www.youtube.com/watch?v=kho6oANGu_A 4. https://www.youtube.com/watch?v=9vMpHk44XXo&list=PL1xHD4vteKYVpaIiy295 pg6_SY5qznc77&in 5. Reinforcement Learning Tutorial | Reinforcement Learning Example Using Python| Edureka - YouTube 6. Association Rule Mining – Solved Numerical Question on Apriori 7. Algorithm(Hindi) - YouTube Q Learning Explained | Reinforcement Learning Using Python | Q Learning in AI | Edureka - YouTube	7 hrs
Web References	https://blog.experiencepoint.com/how-mcdonalds-evolved-with-design-thinking	

Course Code: BCSCC0552	Course Name: Research Methodology Ethics and Writing	L	T	P	C
Course Offered in: All branches		0	0	2	1

Pre-requisite: Basic communication skills, engineering fundamentals

Course Objectives:
This course equips students with fundamental research skills, including problem identification, literature review, data analysis, technical documentation, and ethical publication practices, while enhancing technical writing and scientific communication for academic and professional applications.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Analyze research methodologies, experimental design principles, and literature review techniques for identifying research gaps.	K3
CO2	Apply quantitative and qualitative data acquisition, analytical methods, technical documentation, and scientific citation practices in research activities.	K4
CO3	Develop technical reports, research manuscripts, and professional presentations using standard scientific writing and ethical communication practices.	K2

CO-PO Mapping (Scale: 1: Low, 2: Medium, 3: High)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	2	1	–	–	2	–	1	–	1	–	2
CO2	2	3	1	3	2	–	–	2	1	2	–	2	1	2
CO3	2	3	2	3	2	–	–	3	2	3	1	1	–	1

Course Contents / Syllabus

Unit- 1	Fundamentals of Research Methodology and Literature Review	7 hours

Definition of research, objectives of research, motivation and significance of research, types of research including fundamental, applied, qualitative, quantitative, and experimental research, stages of research process, research problem identification, formulation of research questions, identification of technical gaps, literature review methodologies, use of scientific databases such as Google Scholar, Scopus, Web of Science, IEEE Xplore, and ScienceDirect, keyword selection strategies, source reliability and credibility evaluation, annotated bibliography preparation, critical analysis of published research papers, and review writing techniques.

Unit- 2	Data Collection, Analysis, and Technical Documentation	7 hours

Primary and secondary data sources, data gathering methods, survey techniques, questionnaire design, experimental observations, data organization, structured sampling methods including random sampling, stratified sampling, and systematic sampling, basic statistical concepts including mean, median, standard deviation, graphical data representation, data analysis techniques, spreadsheet-based analysis, technical report preparation, scientific report structure including abstract, introduction, methodology, results, discussion, and conclusion, mini-project execution, research documentation, and technical documentation practices.

Unit- 3	Citation Management, Publication Ethics, and Research Integrity	7 hours

Ethical research practices, scholarly publishing standards, academic reference management, citation systems including IEEE, APA, and MLA, reference management software such as Mendeley and Zotero, plagiarism awareness, similarity detection tools, responsible citation practices, authorship ethics, predatory journals, peer review systems, journal indexing, impact factors, research integrity principles, publication misconduct, ethical compliance, professional publishing standards, citation formatting exercises, plagiarism analysis, journal quality evaluation, and ethical case studies.

Unit- 4	Technical Writing and Research Documentation	9 hours

Scientific and technical writing skills, engineering research documentation, professional documentation practices, technical report writing, project report preparation, review paper writing, conference paper drafting, research manuscript development, scientific writing styles, report organization, abstract preparation, introduction framing, methodology documentation, results presentation, discussion development, conclusion writing, proofreading, technical editing, document formatting, visual representation of technical data using tables, charts, and figures, documentation standards, formal technical presentations, dissemination of research findings, manuscript section drafting, technical document editing, and professional written communication.

	Total Lecture Hours	30 hours

Textbook:

SNO	Book Title	Author
1.	Research Methodology: Methods and Techniques	C.R. Kothari & Gaurav Garg

2.	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar
3.	The Craft of Scientific Writing	Michael Alley
4.	How to Write and Publish a Scientific Paper	Day & Gastel
5.	Research Methodology and Scientific Writing	George Thomas

Reference Materials	
SNO	
1.	IEEE Author Guidelines
2.	Elsevier Researcher Academy Resources
3.	Springer Author Academy
4.	WIPO Resources for Research Documentation
5.	University digital library resources

Self Study Content Links:

MOOCs Courses	1. https://www.coursera.org/learn/research-methods 2. https://researcheracademy.elsevier.com/	6 hrs 20 hrs
Video Lectures	1. https://www.youtube.com/watch?v=rz30rRfManE&list=PLdj5pVg1kHiOypKNUmO0NKOfvoIThAv4N 2. https://www.youtube.com/watch?v=HYj4Ght1_qs 3. https://www.youtube.com/watch?v=N9tJCs-czOU&list=PLnIj1GYixjfrOhcWQq_ANzLFDniGYZ_-Q 4. https://www.youtube.com/watch?v=NM53k7x_jjk	17 hrs
Web References	https://researcheracademy.elsevier.com https://authorservices.wiley.com	

Course Code: BCSAI0512	**Course Name: Advanced Java Programming**	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(CYS)/CSE(IOT)/MCT/CSE/CSE-R/IT/M.Tech. (INT).		**3**	**0**	**0**	**3**

Pre-requisite: Basic knowledge of Core Java (OOP, exception handling, collections), multithreading, and fundamentals of SQL/database operations.

Course Objectives:

To equip students with in-depth knowledge of server-side programming using Java technologies such as Servlets, JSP, JDBC, and frameworks like Spring and Hibernate. The aim of this course is to enable students to build dynamic web applications and enterprise-level solutions with real world project exposure.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Apply JDBC to integrate Java applications with relational databases for dynamic data handling and managing server-side programming using Servlets for handling web requests and responses.	K3
CO2	Analyze the use of JSP scripting elements, expression language, and directives to determine their effectiveness in dynamic web page rendering and maintainability.	K4
CO3	Implement modular, maintainable Java applications using advanced dependency injection techniques within the Spring Ecosystem.	K3
CO4	Design modular loosely coupled web applications by implementing the MVC architecture using Spring MVC and Spring Boot.	K6
CO5	Deploy JPA to map, store, retrieve, and update data from java objects to relational databases and vice versa with RESTful APIs to enable scalable and maintainable services.	K6

CO-PO Mapping (Scale: 1: Low, 2: Medium, 3: High)

CO-PO Mapping	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	2	1	1	1	1	2	3	2	1
CO2	3	2	3	2	2	2	1	1	1	1	2	3	2	1
CO3	3	3	3	2	3	2	1	1	1	1	2	3	2	1
CO4	3	3	2	3	3	1	2	2	2	1	2	2	1	1
CO5	3	3	3	3	3	1	2	2	2	2	3	3	2	1

Course Contents / Syllabus

Unit 1	**JDBC & Servlets**	**9 hours**

JDBC: Introduction, JDBC Driver, DB Connectivity, Connection, Statement, Result Set, Prepared Statement, Transaction Management, Stored Procedures.
Servlet: Servlet Overview, Servlet Life Cycle, Servlet API, Generic Servlet, HTTP Servlet, Redirect requests to other resources using RequestDispatcher, sendRedirect, Session Tracking: Using cookies, URL rewriting, and HttpSession.

Unit 2	**JSP**	**9 hours**

JSP: Introduction, Life Cycle of JSP, JSP to Servlet Conversion, JSP Scripting Elements , JSP Implicit Objects, JSP Directives, Expression Language, Servlet-JSP-JDBC Integration, Login and registration system using JSP and Servlet.

Unit 3	**Spring Framework**	**9 hours**

Spring: Overview of Spring Ecosystem, Spring Unit- s, IOC container, Types of Dependency Injection (DI): Constructor Injection, XML based Configuration, Setter Injection, Field Injection, Configuration Approaches: Java-based Configuration, Component Scanning, Annotation-based Configuration, Spring JDBC, Spring Project Setup using Maven.

Unit 4	**Spring MVC & Spring Boot**	**9 hours**

Spring MVC: Overview of Spring MVC architecture, Controllers in Spring MVC, Passing Data Between Controller and View, JSP in Spring MVC, Integration with Spring JDBC.
Spring Boot: Introduction, Creating a Spring Boot project using Spring Initializer, Spring Boot Annotations & Auto Configuration, Spring Data JPA, Serving HTML pages and static content, Handling HTTP methods, H2 databased Integration, Project Lombok.

Unit 5	**JPA**	**9 hours**

JPA: Introduction to ORM & JPA, JPA Annotations, JPA Relationships, RESTful API, CRUD with Spring Data JPA, Repository Interfaces: JpaRepository, CrudRepository, JSON/XML handling, Postman testing and deployment.

	Total Lecture Hours	**45 hours**

Textbook:		
S.No	**Book Title**	
1	B. Basham, K. Sierra, and B. Bates, Head First Servlets and JSP, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2008.	
2	H. Bergsten, Java Server Pages, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2003.	
3	C. Walls, Spring in Action, 6th ed. Shelter Island, NY, USA: Manning Publications, 2022.	
4	C. Walls, Spring Boot in Action, 1st ed. Shelter Island, NY, USA: Manning Publications, 2016.	
5	M. Pollack and O. Gierke, Spring Data: Modern Data Access for Enterprise Java, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2012.	
Reference Books:		
S.No	**Book Title**	
1	M. Hall and L. Brown, Core Servlets and JavaServer Pages, Volume 1: Core Technologies, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2003.	
2	M. Hall and L. Brown, Core Servlets and JavaServer Pages, Volume 2: Advanced Technologies, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2004.	
3	C. Ho, R. Harrop, and C. Schaefer, Pro Spring 6, 1st ed. New York, NY, USA: Apress, 2023.	
4	M. Keith and M. Schincariol, Pro JPA 2 in Java EE 8, 3rd ed. New York, NY, USA: Apress, 2018.	
Self Study Content Link:		
MOOCs	1. https://nptel.ac.in/courses/106105191 2. https://www.coursera.org/specializations/spring-framework	12 Weeks 50 hrs
Video Lectures	1. https://www.youtube.com/playlist?list=PLlhM4lkb2sEjVsbbZ_kiixY5CcR84IQUg 2. https://www.youtube.com/playlist?list=PL-XjHn7CHrmQhMkVC6KCfmsPHdklvUlQr 3. https://www.youtube.com/playlist?list=PL9ooVrP1hQOEfi91PCFQMawtBJrPpir7y 4. https://www.youtube.com/playlist?list=PL-XjHn7CHrmQhMkVC6KCfmsPHdklvUlQr 5. https://www.youtube.com/playlist?list=PLGRDMO4rOGcNSBOJOlrgQqGpIgo6_VZgR	13 hrs 1 hrs 18 hrs 50 Min 25 hrs
Web References	1. https://spring.io/guides 2. https://docs.oracle.com/javase/tutorial/	

LAB Course Code: BCSAI0512P	LAB Course Name: Advanced Java Programming Lab	L	T	P	C
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CSE(CS)/CYS/IOT/MCT		0	0	2	1

Pre-requisite: PROGRAMMING LANGUAGE PREFEREBALLY JAVA

Course Objectives:

Provide hands-on experience to develop scalable, database-driven applications using Spring Boot, JPA, and RESTful APIs with proper integration and deployment practices.

Course Outcome: After completion of the course, the student will be able to

1. Students will be able to develop dynamic web applications using JDBC, Servlets, and JSP with proper database connectivity and session management.
2. Students will apply Spring Framework concepts, including IOC and Dependency Injection, to build structured and scalable applications.
3. Students will design and implement RESTful web services using Spring Boot and JPA, and deploy complete full-stack applications effectively.

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	-	3	1	1	2	3	2	1
CO2	3	3	3	2	2	1	-	3	1	1	2	3	2	1
CO3	3	3	3	2	2	1	-	3	1	1	2	3	2	1

List Of Practical's (Indicative & Not Limited To)

1. Write Java program to create a demo table emp having fields is, name, city and insert two rows by using JDBC.
2. Write a Java program using Statement to create a table Students with fields id, name, age, and grade.
3. Write a Java program to demonstrate a money transfer transaction between two bank accounts. Ensure that both debit and credit operations are either committed together or rolled back in case of an error.
4. Write a Java program using PreparedStatement to delete student records where grade is below a given threshold.
5. Write a Java program to call a stored procedure that calculates the total salary of employees in a given department.
6. Write a servlet program to select the details of an employee (emp id, empname, empadd,empphone) and display on browser in appropriate format.
7. Write a GenericServlet to handle employee registration. The servlet should: Accept employee details (name, email, designation, salary) via a form (POST request).Store the details in a database (use JDBC). Display a success message after successful insertion

8. Implement a servlet program that redirect a request to Google.com.

9. Develop a Java Servlet program to demonstrate session tracking using the following techniques:

(i) Cookies
(ii) URL Rewriting
(iii) HttpSession
The program should maintain user information (such as visit count or username) and display it across multiple requests using all three session tracking methods.

10. Implement all JSP scripting element (scriptlet, expression and declaration).

11. Implement all JSP directive element (page, include and taglib).

12. Implement a JSP program for arithmetic exception error handling by using html page, jsp page, and errorPage, isErrorPage directives.

13. A company's recruitment portal requires candidates to register before applying for jobs. Design a JSP page for registration and a Servlet to store user details in a MySQL database using JDBC. How would you implement session management in a JSP-based web application to keep users logged in across multiple pages?

14. Implement a JSP which insert the details of the 3 or 4 users who register with the web site by using registration form. Authenticate the user when he submits the login form using the user's name and password from the database. Design and implement a simple shopping cart example with session tracking API.

15. Demonstrate the use of ApplicationContext as IOC container to load beans. Concept: Spring IOC container usage.

16. Define multiple Spring Beans and manage them using XML-based configuration. Concept: Spring Modules and IOC in action.

17. Implement Setter-based DI to inject a service bean into another. Concept: Using setters for bean wiring.

18. Demonstrate Field Injection using @Autowired annotation. Concept: Simplified DI using annotations.

19. Program: Configure beans using Java-based configuration with @Configuration and @Bean. Concept: Pure Java Spring configuration.

20. Program: Use Component Scanning and @Component, @Service, @Repository. Concept: Auto-detection of components.

21. Program: Set up a Maven project structure for a spring app and manage dependencies using pom.xml. Concept: Maven-based project setup

22. You are designing a web application for an online bookstore. Set up a basic Spring MVC structure with Dispatcher Servlet, controller, and view." Program Goal: Create a minimal Spring MVC app showing folder structure and web.xml setup.

23. Create a basic Spring Boot application using Spring Initializer and write a program to display "Hello World" on the browser using appropriate Spring Boot annotations.

24. Develop a Spring Boot application that uses annotations like @SpringBootApplication and @RestController to create a simple REST API that returns a welcome message.

25. Build a feedback page for a college portal. Create a Spring MVC controller that returns a welcome message on accessing /feedback." Program Goal: Implement a basic controller class using @Controller and map a simple GET request.
26. Develop a Spring Boot web application for a library website that displays a homepage containing contact information and a static banner. The application should serve HTML pages from the /templates directory and load static resources such as images and CSS from the /static directory to demonstrate proper handling of dynamic views and static content.
27. Develop a Java program for a Book management system where you need to reduce boilerplate code (such as getters, setters, and constructors) in the Book class. Use Project Lombok annotations like @Data, @NoArgsConstructor, and @AllArgsConstructor to simplify the class definition. The program should create Book objects and display their details to demonstrate the use of these annotations.
28. You are designing a simple library system. Begin by creating an entity Book and use JPA to persist data to a relational database.
29. In a school database system, annotate an @Entity class Student with appropriate JPA annotations like @Id, @GeneratedValue, @Column.
30. In a hospital management system, create a one-to-one relationship between Patient and Medical Record using JPA
31. Implement CRUD operations on MYSQL database using spring data rest with POSTMAN client.
32. Develop a system for online courses where one Instructor can have many Courses. Model this using JPA annotations.
33. Develop a simple Java application using JPA to create an entity class (e.g., Student) and map it to a database table using basic JPA annotations like @Entity, @Id, and @Column.
34. Write a program using JPA to perform basic CRUD operations (insert and display) on an entity using annotations and an ORM approach.
35. Create a JPA-based application that demonstrates the use of annotations such as @Table, @GeneratedValue, and @Column for mapping an entity to a relational database.
36. Build a college management system where Students can enroll in multiple Courses. Implement many-to-many using JPA.
37. Develop an employee management system that performs Create, Read, Update, and Delete operations using JpaRepository.
38. In a book store app, compare the use of CrudRepository vs. JpaRepository for managing Book entities
39. Develop a RESTful web service that produces and consumes data in both JSON and XML formats, and test the API using Postman.
40. Create a Simple application with a REST API for CRUD operations, demonstrate JSON/XML data handling, test it using Postman, and deploy the application on a local server.

Course Code: BCSE0514	**Course Name: Design Patterns**	**L**	**T**	**P**	**C**
Course Offered in: CSE/IT/ CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(CYS)/CSE(IOT)/MCT		**3**	**0**	**0**	**3**

Pre-requisite: Object Oriented Analysis and Design. Data structures and algorithms. Programming Language (C++ or Java)

Course Objectives: The course objective is to familiarize the student with techniques for designing reusable combinations of Java classes and organizing their cooperation to produce modular and maintainable Java programs.

Course Outcome: After completion of the course, the student will be able to

CO	Course Outcome	Bloom's Level
CO1	Analyze, classify, and apply appropriate design patterns to solve real-world software problems, understanding their structure and selection principles.	K3
CO2	Identify, compare, and apply creational design patterns (Factory, Abstract Factory, Builder, Prototype, Singleton) to develop flexible and reusable software components.	K4
CO3	Analyze, design, and implement structural design patterns to improve flexibility, reusability, and maintainability of software systems.	K4
CO4	Analyze, design, and apply behavioral design patterns (Mediator, Memento, Observer) to manage object interactions and system behavior effectively.	K3
CO5	Analyze and implement advanced behavioral design patterns to solve common software design problems.	K4

CO-PO Mapping (Scale: 1: Low, 2: Medium, 3: High)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	1	1	-	2	2	–	3
CO2	3	2	3	1	3	-	-	1	1	-	2	2	1	3
CO3	3	3	3	2	3	-	-	1	1	-	2	2	1	3
CO4	3	3	3	2	2	-	-	1	1	-	2	2	–	3
CO5	3	2	3	2	2	-	-	1	2	-	3	2	–	3

Course Contents / Syllabus

Unit 1	**Introduction to Design Patterns**	**9 hours**

Describing Design Patterns, Design Patterns in Smalltalk MVC, The Catalog of Design Patterns, Organizing the Catalogue, Design Patterns for Solving the Real-life Problems, Selection and Use of Design patterns.

Unit 2	**Creational Design Pattern**	**9 hours**

Creational Patterns: Abstract Factory, Builder, Factory Pattern, Prototype Pattern, Singleton pattern.

Unit 3	**Structural Design Pattern**	**9 hours**

Structural Pattern Part-I, Adapter, Bridge, Composite.

Structural Pattern Part-11, Decorator Pattern, Facade Pattern, Flyweight Pattern, Proxy Pattern.

Unit 4	**Behavioural Patterns - I**	**9 hours**

Behavioural Patterns Part: I, Chain of Responsibility Pattern, Command Pattern, Interpreter Pattern, Iterator Pattern. Behavioural Patte rns Part: II, Mediator, Memento, Observer Pattern.

Unit 5	**Behavioural Patterns - II**	**9 hours**

Behavioral Patterns Part: III, State Patterns, Strategy, Template Patterns, Visitor, Expectation from Design Patterns Relationship between different Design Patterns.

	Total Lecture Hours	**45 hours**

Textbook:

S.NO.	**TITLE**	**Authors**
1	First Design Patterns, 2004, O'Reilly	Eric Freeman, Elisabeth Freeman, Kathy Sierra, Bert Bates Head
2	Design Patterns: Elements of Reusable Object oriented Software Addison-Wesley, 1995.	Erich Gamma, Richard Helm,

		Ralph Johnson, John Vlissides
Reference Books:		
S.NO.	**TITLE**	**Authors**
1	Design Patterns Pearson Education	Erich Gamma
2	Patterns in JAVA Volume -I	Mark Grand, Wiley Dream
Self Study Content Link:		
MOOCs	1. https://www.coursera.org/learn/design-patterns 2. https://www.udemy.com/course/soft-design-patterns/?utm_campaign=Search_DSA_Beta_Prof_la.EN_cc.India&utm_source=google&utm_medium=paid-search&portfolio=India&utm_audience=mx&utm_tactic=nb&utm_term=_._ag_160270535505_._ad_696202838334_._kw_&utm_content=g&funnel=&test=&gad_source=1&gad_campaignid=21178559974&gbraid=0AAAADROdO3wWjcAcJrZ3ow_Fcj2OFn24&gclid=Cj0KCQjw3K7RBhDJARIsAKRtP5TgfS7r7XJhzwC-gZgMsTFRkUx44pchkPY7WDXEXQyxDGeidGMqrbAaAn56EALw_wcB&couponCode=PMNVD2025	25 hrs 5 hrs
Video Lectures	1. https://www.youtube.com/watch?v=ysoC8S96pZU&list=PLBBog2r6uMCResrR48HziFtNx4-BDOmU0 2. https://www.youtube.com/playlist?list=PLmCsXDGbJHdhULIoYzIIIeFFJSo1NlMbN 3. https://www.youtube.com/watch?v=dCWuXDBRFtk&list=PL2NZAYdLkYvhFnqbvLbwf4ZM4rH99Jap6 4. https://www.youtube.com/watch?v=a4u_caEWTR8&list=PL2NZAYdLkYvg__5SpIDMlRopz-dD_KsIX	36 Min 1 hr 6 Min 8 Min 50 Sec
Web References	1. https://refactoring.guru/design-patterns 2. https://www.geeksforgeeks.org/system-design	

Course Code: BCSAI0517	Course Name: Programming for Data Analytics	L	T	P	C
Course Offered in: **CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT**		3	0	0	3
Pre-requisite: Basic Knowledge of Python and R					

Course Objectives:

Demonstrate knowledge of statistical data analysis techniques, apply Data Science principles, utilize data mining software, and employ modern Big Data tools and technologies to solve real-world business problems and support effective decision-making.

	Course Outcome: After completion of the course, the student will be able to	Bloom's Knowledge Level (KL)
CO1	Implement Python & R Programming Language and explain the use of R Studio IDE to perform basic tasks on Vectors, Matrices, and Data Frames.	K2
CO2	Apply the concepts of R packages to develop and manage data analysis applications.	K3
CO3	Apply the basic concepts of MongoDB to perform database operations in data-driven applications.	K3
CO4	Analyze the concepts of Recurrent Neural Networks (RNN) and TensorFlow for solving AI and deep learning problems.	K4
CO5	Analyze the role of Keras in developing and evaluating deep learning models.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	3	-	-	-	-	-	2	3	2	-
CO2	2	3	-	2	3	-	-	-	-	-	2	2	3	-
CO3	3	3	2	2	3	-	-	-	-	-	2	3	3	2
CO4	3	3	3	3	3	-	-	-	-	-	2	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	2	3	3	3

Course Contents / Syllabus

Unit- 1: BASIC DATA ANALYSIS USING PYTHON/R	**09 hours**
Pandas data structures — Series and Data Frame, Data wrangling using pandas, Statistics with Pandas, Mathematical Computing Using NumPy, Data visualization with Python, Descriptive and Inferential Statistics, Introduction to Model Building, Probability and Hypothesis Testing, Sensitivity Analysis, Regular expression: RE packages.	
Unit- 2: R GRAPHICAL USER INTERFACES	**10 hours**
Built-in functions, Data Objects-Data Types & Data Structure, Structure of Data Items, Manipulating and Processing Data in R using Dplyr package &Stringr package, Building R Packages, Running and Manipulating Packages, data import and export, attribute and data types, descriptive statistics, exploratory data analysis, Flexdashboard and R-shiny.	
Unit- 3: DATA ENGINEERING FOUNDATION	**08 hours**
Connecting to a database (sqlite) using Python, Sending DML and DDL queries and processing the result from a Python Program, Handling error, NOSQL query using MongoDB, MongoDB Compass.	
Unit- 4: INTRODUCTION TO TENSORFLOW AND AI	**09 hours**

Introduction, Using TensorFlow for AI Systems, Up and Running with TensorFlow, Understanding TensorFlow Basics, Convolutional Neural Networks, Working with Text and Sequences, and TensorBoard Visualization, Word Vectors, Advanced RNN, and Embedding Visualization, TensorFlow Abstractions and Simplifications, Queues, Threads, and Reading Data, Distributed TensorFlow, Exporting and Serving Models with TensorFlow.	
Unit- 5: DEEP LEARNING WITH KERAS	**09 hours**
Introducing Advanced Deep Learning with Keras, Deep Neural Networks, Autoencoders, Generative Adversarial Networks (GANs), Improved GANs, Disentangled Representation GANs, Cross-Domain GANs, VariationalAutoencoders (VAEs), Deep Reinforcement Learning, Policy Gradient Methods.	
Total Lecture Hours	**45 hours**

Textbook:

Book Details	**Authors Name**
1.	Glenn J. Myatt, Making Sense of Data: A Practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007.
2.	Tom Hope, Yehezkel S. Resheff, Itay Lieder, Learning TensorFlow, O'Reilly Media, Inc.
3.	Advanced Deep Learning with TensorFlow 2 and Keras: Apply DL, GANs, VAEs, Deep RL, Unsupervised Learning, Object Detection and Segmentation, and More, 2nd Edition.

Reference Books:

Book Details	**Authors Name**
1.	Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", 1st Edition, Wrox, 2013.
2.	Chris Eaton, Dirk Deroos et al., "Understanding Big Data", Indian Edition, McGraw Hill, 2015.
3.	Tom White, "HADOOP: The Definitive Guide", 3rd Edition, O'Reilly, 2012.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs / Video Lectures / Web References		
Unit 1	https://www.ibm.com/cloud/blog/python-vs-r	
Unit 2	https://www.youtube.com/watch?v=CSR5SdYzOBI	
Unit 3	https://hevodata.com/learn/data-engineering-and-data-engineers/	
Unit 4	https://www.youtube.com/watch?v=lEZmH7byZO	
Unit 5	https://www.youtube.com/watch?v=pWp3PhYI-OU	01:11 Min

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, or other student activities, etc.

Course Code: BCSAI0517P	Course Name: Programming for Data Analytics Lab	L	T	P	C
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		0	0	2	1
Pre-requisite: Basic Knowledge of Python and R					

Course Objectives:

Develop practical skills in data analysis, wrangling, visualization, statistical analysis, and regression using Python and R, build interactive dashboards and web applications, perform database operations using SQLite and MongoDB, and apply basic AI techniques using TensorFlow to solve real-world data-driven problems.

Course Outcome:	After completion of the course, the student will be able to	Bloom's Knowledge Level (KL)
CO-1	Apply Python libraries (Pandas, NumPy, Matplotlib, Scikit-learn) to perform data wrangling, statistical computation, visualization, and basic regression modeling.	K3
CO-2	Implement statistical hypothesis testing and R programming constructs, including packages, EDA, dashboards, R-Shiny apps, and SQLite database operations.	K3
CO-3	Implement NoSQL database operations using MongoDB and build basic AI systems using TensorFlow.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	3	-	-	-	-	-	1	3	2	-
CO2	2	3	1	2	3	-	-	-	-	-	1	2	3	-
CO3	3	3	2	2	3	-	-	-	-	-	1	3	3	2

List of Programs

S.No	List of Program	CO
1	Create a Pandas Series and DataFrame, perform indexing, slicing, filtering, and handle missing values.	CO1
2	Perform data wrangling using Pandas – merge, reshape, group, and aggregate data from a dataset.	CO1
3	Perform mathematical computing using NumPy – array operations, matrix multiplication, and statistical functions.	CO1
4	Visualize data using Matplotlib – draw line plot, bar chart, histogram, scatter plot, and pie chart.	CO1
5	Perform descriptive statistics (mean, median, mode, std, variance) and inferential statistics on a dataset.	CO1
6	Fit a simple linear regression model using Scikit-learn and visualize the regression line.	CO1
7	Perform hypothesis testing (t-test) and calculate confidence intervals for a sample dataset.	CO2
8	Perform a chi-squared test for independence on categorical data and interpret the p-value.	CO2
9	Perform sensitivity analysis on a function by varying input parameters and observing output changes.	CO2
10	Extract phone numbers and email addresses from a text string using Regular Expression (RE) packages.	CO2
11	Demonstrate R built-in functions: mean(), sum(), median(), length(), sd() on a sample dataset.	CO2
12	Create and manipulate R data structures – vectors, lists, matrices, arrays, and data frames.	CO2
13	Explore structure of data items in R using str(), typeof(), class(), and mode() functions.	CO2

14	Use the dplyr package to filter, arrange, select, mutate, and summarize data from a dataset.	CO2
15	Use the stringr package for pattern matching, string replacement, substring extraction, and case transformation.	CO2
16	Install, load, update, and uninstall R packages (ggplot2, dplyr, tidyr) and demonstrate their usage.	CO2
17	Read data from a CSV file into R, manipulate using dplyr, and export the processed data back to CSV.	CO2
18	Perform Exploratory Data Analysis (EDA) using summary statistics, visualizations, and correlation checks in R.	CO2
19	Create an interactive dashboard using the flexdashboard package to visualize key statistics of a dataset.	CO2
20	Develop a basic interactive web application using R Shiny with user inputs and dynamic plot/table outputs.	CO2
21	Write a Python program to connect to an SQLite database and create a table using DDL queries.	CO2
22	Write a Python program to send SELECT queries to an SQLite database and display the processed results.	CO2
23	Write a Python program to insert, update, and delete records in an SQLite table using DML queries.	CO2
24	Write a Python program to handle SQLite database connection and query errors using try-except blocks.	CO3
25	Write a Python program to connect to MongoDB using pymongo and retrieve a list of all collections.	CO3
26	Write a Python program to insert single and multiple documents into a MongoDB collection.	CO3
27	Write a Python program to query MongoDB data using find(), find_one(), and various filter conditions.	CO3
28	Write a Python program to update and delete MongoDB documents using update_one(), update_many(), delete_one(), and delete_many().	CO3
29	Write a Python program using MongoDB aggregation framework to perform grouping, counting, and summing operations.	CO3
30	Explore a MongoDB database using MongoDB Compass – view, filter, update, and delete data through the GUI.	CO3
31	Create a TensorFlow program to perform basic mathematical operations – tensor creation, matrix multiplication, and addition.	CO3
32	Build a basic AI system using TensorFlow that predicts simple outputs from input data (linear regression model).	CO3
Total Hours: 30 hrs.		

Course Code: BCSAI0519N	Course Name: Business Intelligence and Data Visualization	L	T	P	C
Course Offered in: CS/CSE(IOT)		3	0	0	3

Prerequisite: Basic Knowledge of Excel, Statistics and Computer Skills.

Course Objectives:

Present the concepts, architecture, and lifecycle of Business Intelligence systems, develop skills in data preparation and modeling using BI tools, create interactive visualizations and dashboards, apply analytical techniques for data-driven decision-making, and build end-to-end Business Intelligence solutions using real-world case studies and projects.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts, architecture, and components of Business Intelligence, Query, Reporting, and Development systems.	K2
CO2	Apply data modeling, ETL/ELT processes, and data preparation techniques using BI tools like Tableau and Power BI.	K3
CO3	Analyze datasets using visualization techniques, OLAP operations, and interactive reporting features such as drill-down and drill-up.	K4
CO4	Evaluate business problems using advanced analytics, dashboards, KPI metrics, and decision-support systems for meaningful insights.	K5
CO5	Design end-to-end BI solutions including dashboards, reports, and mini-projects using real-world datasets and modern BI platforms.	K6

CO-PO Mapping (Scale: 1: Low, 2: Medium, 3: High)

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1	-	1	1	1	1	2	1	1
CO2	2	2	2	2	3	1	-	1	1	1	1	2	3	1
CO3	1	3	2	3	3	1	-	1	1	2	1	3	3	1
CO4	1	3	2	3	3	2	-	2	1	2	2	3	3	2
CO5	2	2	3	3	3	2	-	2	3	3	3	3	3	3

Course Contents / Syllabus

Unit- 1	Business Intelligence, Query, Reporting and Development	10 hours

Introduction to Business Intelligence (BI) and Business Analytics; Evolution, scope, architecture, and components of BI systems; Data sources, data warehousing, and ETL/ELT processes; Cloud data warehousing, lakehouse architecture, OLAP, and multidimensional modeling; Advanced analytics, predictive analytics, AI/ML integration, real-time and self-service BI; Data visualization, dashboards, reports, scorecards, and interactive BI development including drill-down and drill-up techniques; Functional applications of BI tools and platforms such as Tableau, Power BI, Qlik, and Looker; KPI monitoring, decision support systems, and performance measurement; Big data analytics, Hadoop ecosystem, IoT, and generative AI applications in BI; Data governance, metadata management, security, and privacy; BI project lifecycle including design, development, deployment, reporting, automation, mobile BI, SDK usage, risk management, and success evaluation; BI adoption challenges, industry trends, and real-world Industry 4.0 applications.

Unit- 2	Introduction to TABLEAU	8 hours

Overview of Tableau ecosystem with focus on Tableau Public; Installation, interface, and workspace navigation; Connecting to data sources (Excel, CSV, Google Sheets, web data); Data preparation basics (cleaning, filtering, joins, unions); Understanding data types and dimensions/measures; Basic charts (bar, line, pie, scatter plots); Sorting, filtering, grouping, and aggregation; Introduction to calculated fields and simple expressions; Building basic dashboards in Tableau Public; Publishing and sharing visualizations online;

Case study: Sales performance dashboard using public dataset; Lab work: Creating basic charts and publishing to Tableau Public profile.		
Unit- 3	**Advanced Visualization, Dashboards and Projects in Tableau**	**9 hours**
Advanced chart types (maps, heat maps, tree maps, dual-axis charts); Interactive dashboards and dashboard actions (filter, highlight, URL actions); Parameters and advanced calculated fields; Data blending and multiple data sources; Storytelling with Tableau (story points and narratives); Introduction to Level of Detail (LOD) expressions; Performance optimization and best practices; Real-world BI dashboards for business domains (finance, marketing, healthcare, supply chain); Case studies: KPI dashboard for executive reporting and COVID/stock market visualization using public datasets; Lab work: End-to-end dashboard development and publishing on Tableau Public; Mini project: Design and deploy a complete interactive BI solution using real-world dataset with documentation and presentation.		
Unit- 4	**Introduction to POWER BI and Data Preparation**	**8 hours**
Introduction to Business Intelligence and Power BI ecosystem; Overview of Power BI Desktop, Service, and Mobile; Installation and interface navigation; Connecting to data sources (Excel, CSV, databases, web data); Data loading and transformation using Power Query Editor; Data cleaning, shaping, merging, and appending datasets; Data modeling concepts (relationships, star schema basics); Introduction to DAX (Data Analysis Expressions); Basic measures and calculated columns; Creating simple visuals (bar, line, pie, table, map); Filters, slicers, and report interactions; Publishing reports to Power BI Service; Case study: Sales data analysis dashboard; Lab work: Data cleaning and basic report creation using real dataset.		
Unit- 5	**Advanced Power BI, Dashboards and Project Development**	**10 hours**
Advanced DAX functions (CALCULATE, FILTER, time intelligence); Advanced visualizations (KPI cards, drill-through, decomposition tree, funnel charts); Interactive dashboards and report design best practices; Data modeling optimization and relationships management; Power BI Service features (workspaces, sharing, collaboration, refresh scheduling); Row-level security and data governance basics; Performance optimization techniques; Real-world business dashboards (finance, HR, marketing, operations); Case studies: Executive KPI dashboard and retail performance analysis; Lab work: End-to-end dashboard development and deployment; Mini project: Design a complete Power BI solution using real-world dataset with dashboard publishing, documentation, and presentation.		
	Total Lecture Hours	**45 hours**

Textbook:

1. "Business Intelligence Guidebook: From Data Integration to Analytics" – Rick Sherman
2. "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" – Ralph Kimball & Margy Ross.
3. "Business Intelligence in Plain Language: A Practical Guide to Data Mining and Business Analytics" – Jeremy Kolb

Reference Books:

1. Learning Tableau 2025 (6th Edition) – Joshua N. Milligan.
2. The Definitive Guide to DAX – Marco Russo & Alberto Ferrari

NPTEL/ YouTube/ Faculty Video Link

Self-Study Content Links:		Duration (in Hrs)
MOOCs	1. https://www.tableau.com/learn/training 2. https://www.coursera.org/specializations/data-visualization	60 Hrs.
Video Lectures	1. https://www.youtube.com/watch?v=aHaOIvR00So 2. https://www.youtube.com/watch?v=4RW7JgbQ4ao	12 Hrs.
Web References	1. https://learn.microsoft.com/en-us/power-bi/ 2. https://trailhead.salesforce.com/trailblazer 3. community/neighborhoods/tableau	15 Hrs.

Course Code: BCSCY0513	**Course Name: Network Security and Cryptography**	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		**3**	**0**	**0**	**3**

Prerequisite: Familiarity Understanding of basic Networking Terms (e.g., IP, LAN, Router), Awareness of Digital Tools (Email, Cloud, Antivirus), Fundamental Logical Thinking, Cybersecurity fundamentals

Course Objectives: This course aims to introduce the fundamental principles and concepts of network security and cryptography, provide insights into common network-based attacks and vulnerabilities and develop the ability to design secure network architectures using modern cryptographic tools and techniques.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of cryptography and its applications in network security.	K1
CO2	Analyze different encryption algorithms and cryptographic protocols.	K2
CO3	Implement secure communication protocols to protect data transmission over networks.	K3
CO4	Identify common network attacks and employ countermeasures to mitigate them.	K3
CO5	Implement secure network architectures using cryptographic techniques.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	-	-	1	-	-	-	-	-	-	2	3	1
CO2	3	3	1	1	2	-	-	-	-	-	-	2	3	2
CO3	2	2	3	2	3	1	-	1	1	1	1	3	2	2
CO4	2	3	2	2	2	2	1	1	-	-	-	2	2	3
CO5	3	2	3	2	3	2	1	1	1	1	2	3	3	3

Course Contents / Syllabus

Unit 1	**Cryptographic Techniques**	**10 hours**

Introduction to Cryptography, Classical Cryptographic Techniques (Caesar Cipher, Monoalphabetic Cipher), Modern Symmetric Encryption Algorithms (AES, DES), Public Key Cryptography and RSA Algorithm (Key Generation, Encryption/Decryption), Digital Signatures and Hash Functions (SHA, Message Authentication Codes)

Unit 2	**Introduction to Network Security**	**9 hours**

Overview of Network Security Principles, Goals and Objectives of Network Security, Threats, Attacks, and Vulnerabilities (e.g., Malware, DoS), Security Policies and Mechanisms (e.g., Access Control, Firewalls), Risk Management and Assessment (e.g., Risk Analysis, Mitigation Strategies).

Unit 3	**Secure Communication Protocols**	**9 hours**

Secure Socket Layer (SSL) / Transport Layer Security (TLS – handshake process, certificate-based authentication), Internet Protocol Security (IPsec – AH/ESP protocols, tunnel and transport mode), Secure Shell (SSH – key-based authentication, port forwarding), Wireless Security Protocols (WPA, WPA2 – PSK, EAP authentication), Virtual Private Networks (VPNs – site-to-site VPN, remote access VPN).

Unit 4	**Network Attacks and Defense Mechanisms**	**8 hours**

Types of Network Attacks (e.g., Denial of Service, Man-in-the-Middle), Intrusion Detection and Prevention Systems (IDS/IPS, Signature-based and Anomaly-based Detection), Secure DNS and DHCP (DNSSEC, DHCP Snooping), Introduction to OSSEC, OSSEC Architecture (Agent-based and Agentless Modes), Event Collection (Syslog, File Monitoring), Rule-Based Detection (Decoders and Rules), Real-Time Alerting (Active Responses, Notifications).

Unit 5	**Secure Network Design and Implementation**	**9 hours**

Network Architecture Design Principles (segmentation, least privilege), Defense-in-Depth Strategy (multiple security layers, redundancy), Secure Routing Protocols (BGP security, OSPF authentication), Security Best Practices for LANs, WANs, and Wireless Networks (encryption, access control), Security Assessment and Auditing (vulnerability scanning, log analysis)

	Total Lecture Hours	**45 hours**

Textbook:

1. Network Security with OpenSSL: Cryptography by John Viega, Matt Messier, Pravir Chandra, published by O'Reilly Media **2.** Cryptography and Network Security: Principles and Practice by William Stallings, 7th Edition publishe Pearson Education		
Reference Books:		
1. Cryptography: Theory and Practice by Douglas Stinson, 4th Edition, CRC Press, taylor and Francis		
Self-Study Content Links:		Duration (in Hrs)
MOOCs	1. Python Case Study - Cryptography - TOC | Infosys Springboard	5 Hrs 47 Min
Video Lectures	1. https://www.youtube.com/watch?v=Q-HugPvA7GQ&list=PL71FE85723FD414D7 https://onlinecourses.nptel.ac.in/noc22_cs90/preview	59 Min 2 Sec 21 Hrs
Web References	1. NIST Cryptographic Standards 2. NIST Computer Security Resource Center (CSRC) 3. RFC Editor Repository 4. OpenSSL Documentation 5. Wireshark Documentation 6. Cisco Networking Academy	2 Hrs 3 Hrs 15 min 1 Hrs 4 Hrs 5 Hrs 3 Hrs

LAB Course Code: BCSCY0513P	Course Name: Network Security and Cryptography Lab	L	T	P	C
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		0	0	2	1

Pre-requisite: Understanding basic Networking Terms (e.g., IP, LAN, Router), Awareness of Digital Tools (Email, Cloud, Antivirus), Fundamental Logical Thinking, Cybersecurity fundamentals.

Course Objectives:

This course aims to introduce the fundamental principles and concepts of network security and cryptography, provide insights into common network-based attacks and vulnerabilities and develop the ability to design secure network architectures using modern cryptographic tools and techniques. Provide hands-on experience with classical and modern cryptographic algorithms.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Demonstrate the implementation and analysis of classical and modern cryptographic techniques including shift cipher, monoalphabetic cipher, one-time pad, MACs, hash functions, AES, DES, RSA, and ECC for secure data communication.	K3
CO2	Configure and evaluate secure communication protocols and network security mechanisms such as SSL/TLS, TLS handshake analysis, IPsec VPNs, and firewall configurations using appropriate security tools and techniques.	K4
CO3	Analyze and perform network security assessment activities including Man-in-the-Middle (MITM) attack simulation, DoS attack simulation, and penetration testing to identify vulnerabilities and strengthen system security.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	1	-	-	-	2	3	1
CO2	3	3	2	2	3	1	-	1	1	1	1	3	2	2
CO3	3	3	1	2	2	-	-	1	-	-	-	1	3	3

List Of Practical's (Indicative & Not Limited To)	CO Level
1. Implementing Shift Cipher (Caesar Cipher).	CO1
2. Implementing Monoalphabetic Substitution Cipher.	CO1
3. Implementing Vigenère Cipher.	CO1
4. Implementing One-Time Pad and Perfect Secrecy.	CO1
5. Implementing Message Authentication Codes (MAC).	CO1
6. Implementing Cryptographic Hash Functions (SHA-256).	CO1
7. Implementation of AES Encryption Algorithm.	CO1
8. Implementation of DES Encryption Algorithm using Python.	CO1
9. Implementation of RSA Algorithm (Key Generation, Encryption/Decryption).	CO1
10. Digital Signature Generation and Verification using RSA/ECC.	CO1
11. Packet Capturing and Analysis using Wireshark.	CO2
12. Basic Firewall Configuration using IPTables/pfSense.	CO2
13. Vulnerability Scanning using Nmap/OpenVAS.	CO2
14. Risk Assessment and Security Policy Documentation for a Small Network.	CO2
15. Configuration of SSL/TLS for Secure Web Communication.	CO2
16. TLS Handshake Analysis using Wireshark.	CO2
17. Secure Remote Login using SSH and Key-Based Authentication.	CO2
18. SSH Port Forwarding and Secure Tunneling.	CO2
19. Setting up IPsec VPN for Secure Network Communication.	CO2

20. Wireless Security Configuration using WPA2/WPA3.	CO2
21. DoS Attack Simulation in a Safe Lab Environment.	CO3
22. Man-in-the-Middle (MITM) Attack Simulation.	CO3
23. Intrusion Detection using Snort IDS.	CO3
24. OSSEC Installation, Log Monitoring, and Alert Configuration.	CO3
25. Secure Network Design using VLAN Segmentation and Access Control.	CO3
26. Network Security Assessment and Penetration Testing.	CO3
Total Hours: 30 hrs.	

Course Code: BCSCY0515	**Course Name: Ethical Hacking**	**L**	**T**	**P**	**C**
Course Offered in: CSE/IT/CSE-r/ M.Tech./ M.Tech.(INT.)/ CSE(AI)/ CSE(AIML)/ CSE(DS)/ CS/ CSE(IOT) / MCT		**3**	**0**	**0**	**3**

Prerequisite: Basic understanding of computer networks, operating systems, cybersecurity fundamentals, and programming concepts.

Course Objectives:

Equip participants with hands-on skills in ethical hacking methodologies from reconnaissance to reporting enabling them to identify, exploit, and remediate vulnerabilities in real-world environments.

Course Outcome: After completion of this course students will be able to		Bloom's Knowledge Level (KL)
CO1	Explain ethical hacking concepts and apply basic ethical hacking techniques in practical scenarios.	K2
CO2	Describe and use tools for footprinting, reconnaissance, and port scanning activities.	K2, K3
CO3	Identify and examine security vulnerabilities in web applications using ethical hacking tools and techniques.	K2, K3
CO4	Explain scanning and enumeration concepts for identifying network resources and vulnerabilities using OpenVAS.	K3
CO5	Describe system hacking techniques such as unauthorized access, privilege escalation, and persistent control along with defense methods.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	1	-	1	-	1	-	2	-	2	1
CO2	3	3	2	2	2	-	2	-	2	-	2	2	3	2
CO3	3	3	3	2	3	-	3	2	2	1	3	3	3	3
CO4	2	2	2	1	2	1	3	2	2	-	3	-	3	3
CO5	2	2	2	2	1	1	3	2	2	1	3	-	2	3

Course Contents / Syllabus

Unit- 1	**Introduction to Ethical Hacking.**	**9 hours**

Introduces the origins and progression of hacking, ethical guidelines and code-of-conduct, applicable legal frameworks (IT Act, GDPR), core terminologies (white-hat, black-hat, APT), and provides hands-on orientation to essential toolkits like Kali Linux and Metasploit.

Unit- 2	**Foot printing & Reconnaissance**	**8 hours**

OSINT techniques; Passive/active reconnaissance; DNS interrogation (NS lookup, dig command); WHOIS lookup; Social engineering; Vulnerability scanning.

Unit- 3	**Web Application Security**	**10 hours**

Introduction to Web Application Security, Common Web Vulnerabilities, Owasp: Broken Access Control, Securities Misconfiguration, Software Supply Chain failures, Cryptographic failures, Injection, Insecure Design, Authentication failures, Software data integrity failures, Securities logging and alerting failures, Mishandling of exceptional conditions, Web Application Reconnaissance and Foot printing, Web Application Scanning and Enumeration, Secure Coding Practices and Web Application Hardening.

Unit- 4	**Network Attacks and Défense Mechanisms**	**8 hours**

Port Scanning Techniques (TCP, UDP), Nmap Tool, Service Enumeration and Version Detection, OS Fingerprinting, Vulnerability Assessment and Analysis Using Scanning Tools like, Nessus, and OpenVAS..		
Unit- 5	**Defensive strategies**	**10 hours**
Introduction to Password Cracking Tools & Techniques, Wi-Fi Password Cracking Techniques, Escalating Privileges and Gaining Unauthorized Access, Exploiting System Vulnerabilities, Introduction to Malware Analysis & Reverse Engineering, Countermeasures and Defensive Strategies against System Hacking.		
	Total Lecture Hours	**45 hours**

Textbook:

1. The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy By Patrick Engebretson. 2nd Edition Elsevier / Syngress
2. CEH Certified Ethical Hacker All-in-One Exam Guide By Matt Walker. 2th Edition, McGraw Hill.
3. Web Application Hacker's Handbook: Finding and Exploiting Security Flaws By Dafydd Stuttard and Marcus Pinto. 2nd Edition, Wiley Publishing

Reference Books:

1. Penetration Testing: A Hands-On Introduction to Hacking, Georgia Weidman. 1st Edition, No Starch Press

NPTEL/ YouTube/ Faculty Video Link:

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

SYLLABUS- SEMESTER VI

Course Code: BCSIOT0601	**Course Name: CLOUD AND EDGE COMPUTING**	**L**	**T**	**P**	**C**
Course Offered in: CSE(IoT)		**3**	**1**	**0**	**4**

Pre-requisite: Basics of Computer Network

Course Objectives: To understand basic concepts of cloud computing, different cloud computing services, storage, and the concept of edge computing.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Knowledge Level (KL)**
CO1	**Understand Cloud Computing and different deployment models.**	**K1**
CO2	**Describe the importance of virtualization along with its technologies.**	**K2**
CO3	**Apply different cloud computing services.**	**K3**
CO4	**Implement an Edge application.**	**K3**
CO5	**Analyze and apply OTA mechanisms, IoT agents, and streaming complex event processing to design real-time data-handling solutions for edge computing environments.**	**K4**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO**
CO1	**3**	**2**	**–**	**–**	**2**	**–**	**–**	**–**	**–**	**–**	**1**	**2**	**–**	**–**
CO2	**3**	**2**	**–**	**–**	**2**	**–**	**–**	**–**	**–**	**–**	**1**	**2**	**–**	**–**
CO3	**2**	**2**	**2**	**1**	**3**	**–**	**–**	**–**	**–**	**1**	**1**	**3**	**1**	**–**
CO4	**2**	**3**	**3**	**2**	**3**	**–**	**–**	**–**	**1**	**1**	**1**	**3**	**2**	**–**
CO5	**2**	**3**	**3**	**3**	**3**	**–**	**–**	**1**	**1**	**1**	**2**	**3**	**2**	**1**

Course Contents / Syllabus

Unit 1	**Introduction**	**07 hours**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and
Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning, EC2 Instances and its types. Overview of different cloud service providers

Unit 2	Cloud Enabling Technologies:	08 hours

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish Subscribe Model – Basics of Virtualization – Types of Virtualizations – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices –Virtualization Support and Disaster Recovery.

Unit 3	Cloud Architecture, Services and Storage:	10 hours

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3, RDS, EBS.

Unit 4	Edge Computing	12 hours

Introduction of edge computing, Difference between client-server model and edge computing, components of edge computing, Edge Testbed: edge environment, launching an edge testbed and edge application, Building an edge application; Agent-based systems, Secret agent communications.

Unit 5	OTA & IoT Agent	08 hours

OTA introduction, Terminology, Design Considerations, OTA example, Porting the OTA Library. IoT agent: overview, Agent Console, Comparison between Edge and Fog computing.
Streaming complex event processing: Streaming data, complex event processing, and complex event processing in edge computing.

Total Lecture Hours	**45 hours**

Textbook:

1. **Rajkumar Buyya, Satish Narayana Srirama "Fog and Edge Computing: Principles and Paradigms" Wiley Publication E1 January 2019**

2. **Kamal, R. (2022). *Internet of Things: Architecture and Design Principles* (2nd ed.). McGraw Hill Education.**

Reference Books:

1. **Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009**

2. **Anwesha Mukherjee (Editor), Debashis De (Editor), Soumya K. Ghosh (Editor), Rajkumar Buyya Mobile Edge Computing Springer; 1st ed. 2021 edition (November 19, 2021)**

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	**Swayam (Cloud Computing) https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_cs20** **AWS Cloud Practitioner Essentials https://skillbuilder.aws/learn/94T2BEN85A/aws-cloud-practitioner-essentials/8D79F3AVR7**	**30-36 hours** **12 Hours**
Video Lectures	**AWS Tutorial For Beginners https://www.youtube.com/watch?v=uQdzcIf_KII&list=PLEiEAq2VkUUI86MoKLo4JowpYsBjyaHmS**	**11 hours**
Web References	**AWS Whitepaper Overview of Amazon Web Services https://d1.awsstatic.com/whitepapers/aws-overview.pdf**	**10 hours**

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BCSIOT0602	**Course Name: Wireless Sensors Network**	**L**	**T**	**P**	**C**
Course Offered in: CSE(IoT)		**3**	**1**	**0**	**4**

Pre-requisite: Computer Networks, IoT Protocols

Course Objectives:

6. **To understand the fundamentals of wireless communication and wireless sensor networks.**
7. **To study the architecture and design of wireless sensor nodes.**
8. **To learn MAC protocols and routing techniques used in WSNs.**
9. **To understand infrastructure establishment, synchronization, localization, and security issues in WSNs.**
10. **To explore various real-world applications and standards of wireless sensor networks.**

Course Outcome: After completion of the course, the student will be able to		**Blooms Level**
CO1	**Understand concept of wireless communication and challenges in wireless sensor networks**	**K2**
CO2	**Interpret sensor node architecture, design issues and optimization goals**	**K3**
CO3	**Applying MAC and different routing protocol based on Wireless sensor network**	**K3**
CO4	**Discuss Infrastructure and security issues in wireless node sensor networks**	**K2**
CO5	**Design Wireless sensor network for different applications**	**K6**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO PPS PSO
CO1	3	2	-	-	1	-	-	-	-	-	-	3	1	2
CO2	2	3	2	-	2	-	-	-	-	-	-	2	3	2
CO3	2	3	3	2	2	-	-	-	-	-	-	3	2	3
CO4	2	2	1	2	2	-	-	-	-	-	-	2	2	2
CO5	2	2	3	2	3	-	1	-	1	-	-	3	3	3

Course Contents / Syllabus

Unit 1	**Wireless Communication and WSN**	**10 hours**

Wireless Communication: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, Wireless Internet
Introduction to wireless sensor networks: Key definitions of sensor networks, Characteristics, advantages and challenges of wireless sensor network

Unit 2	**Wireless Sensor Node Design**	**08 hours**

Wireless Sensor node architecture: Wireless Single-Node Architecture Hardware Components, commercially available sensor nodes - IRIS, Mica Mote, EYES nodes, BT nodes, Energy Consumption of Sensor Nodes, Operating Systems, Network Architecture, Sensor Network Scenarios, Optimization Goals

Unit 3	**MAC and Routing Protocols**	**10 hours**

MAC Protocols: IEEE 802.15.4 MAC protocol, MAC protocols for sensor network, location discovery, SMAC, BMAC, Traffic-adaptive medium access protocol (TRAMA), Issues in designing MAC protocols for wireless networks.
Routing Protocols: classification of routing protocols, table-driven, on-demand, hybrid and flooding routing protocols, Issues in designing a routing protocol.

Unit 4	**Infrastructure and Security**	**09 hours**

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and

Positioning, Sensor Tasking and Control Platform Tool and Security: Programming Challenges, Node-level software platforms, Node-level Simulators. Security issues in Sensor Networks. Future Research Direction.		
Unit 5	**Applications of WSN**	**08 hours**
Applications of WSN: Home Control, Industrial Automation, Medical Applications, Reconfigurable Sensor Networks, Civil and Environmental Engineering Applications. Case Study: IEEE 802.15.4 LR-WPANs Standard, IEEE 802.11ax, Target detection and tracking, Field sampling.		
Total Lecture Hours		**45 hours**

Textbook:

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications ", John Wiley & Sons, 2007.

2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks," John Wiley & Sons, Ltd, 2005.

3. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo, Fundamentals of Massive MIMO, Cambridge University Press

Reference Books:

1. **C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008.**
2. **William Stallings, "Wireless Communications and Networks ", Pearson Education - 2004.**

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs (NPTEL)	**Wireless Ad Hoc and Sensor Networks, IIT Kharagpur, Prof. Sudip Misra https://nptel.ac.in/courses/106105160**	**40 Hrs**
Video Lectures	**Introduction to Wireless Sensor Networks https://www.youtube.com/watch?v=BdMHIHFmlWY**	**2 Hrs**
Web References	**Research Papers on Wireless Sensor Networks https://arxiv.org/search/?query=wireless+sensor+network&searchtype=all&utm**	**50 Hrs**

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: BCSIOT0651N	LAB Course Name: CLOUD AND EDGE COMPUTING LAB	L	T	P	C
Course Offered in: CSE(IoT)		0	0	4	2

Pre-requisite: Basics of IoT and Computer Network

Course Objectives: To understand basics concept of cloud computing, different cloud computing services, storage and concept of edge computing.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Implement cloud services like EC2 VPC S3 using AWS	K4
CO2	Implement edge computing deployments, connect, manage, and secure RTOS.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO
CO1	2	2	3	2	3	–	–	–	1	1	1	3	1	–
CO2	2	3	3	2	3	1	–	1	2	1	1	3	2	1

List Of Practical's (Indicative & Not Limited To)

1.	How to create a free AWS account?
2.	AWS Pricing Calculator and TCO Calculator.
3.	Launch an EC2 and configure Security Groups to access control.
4.	Build your VPC and deploy an EC2 instance with a Web Server.
5.	Getting Started with S3 in Cloud.
6.	Hosting a static website on S3 in Cloud.
7.	Deploy and connect RTOS using AWS IoT for edge.
8.	Manage and secure RTOS using AWS IoT for edge.
9.	Design and implement an Over-The-Air (OTA) firmware update mechanism on an edge device (such as Raspberry Pi/ESP32) to remotely deploy and update application code, and analyze its impact on system performance, reliability, and downtime in an edge computing environment.
10.	Develop an edge computing application that performs real-time data processing (e.g., sensor or image data) locally on an edge device and implements OTA-based updates to dynamically upgrade processing logic or machine learning models without physical access to the device.
11.	Development of a mini project.

Total Hours: 60 hrs.

LAB Course Code: BCSIOT0652	LAB Course Name: Wireless Sensors Network Lab	L	T	P	C
Course Offered in: CSE(IoT)		0	0	4	2

Pre-requisite: Computer Networks, IoT Protocols

Course Objectives:

6. **To develop and simulate wireless network topologies and communication protocols using MATLAB simulation tools.**
7. **To design and implement Wireless Sensor Network applications using Raspberry-Pi, sensors, and messaging protocols such as MQTT and AMQP.**

Course Outcome: After completion of the course, the student will be able to

CO1	Create different topologies of Wireless Networks and implement protocols using MATLAB Simulation Tool.	K6
CO2	Design Wireless Sensor Network using Raspberry-Pi, sensors, and messaging protocols.	K6

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	-	-	1	-	-	3	2	3
CO2	2	3	3	2	3	-	-	-	2	1	-	2	3	3

List Of Practical's (Indicative & Not Limited To)	CO
1. Create a sample wireless topology using MATLAB Simulation Tool.	CO1
2. Implement a Transmission Control Protocol and its variants using MATLAB Simulation Tool.	CO1
3. Implement a User Datagram Protocol using MATLAB Simulation Tool.	CO1
4. Implement a Power Efficient Gathering in Sensor Information System using MATLAB Simulation Tool.	CO1
5. Interface DHT Sensors with Node MCU and publish the sensing information on could using MQTT.	CO2
6. Communicate between two raspberry-pi nodes using MQTT protocol. Publish from one node and subscribe the data on second node.	CO2
7. Create WSN network with three raspberry-pi nodes and interface the sensors information among those. Use AMQP protocol for data exchange.	CO2
8. Five source nodes sensing temperature values are deployed in the ground floor of a building and these nodes send the values to a sink node deployed in the same floor of the building. A hierarchical network having 2 cluster nodes and three source nodes under each cluster is implemented in the first floor of a building for sensing light intensities. The sink nodes of both networks average the received values and send it to a gateway node located in the second floor. write a program for implementing this scenario.	CO2
9. To simulate and analyze the performance of the IEEE 802.15.4 MAC protocol in a Wireless Sensor Network using MATLAB.	CO1
10. To implement and simulate localization techniques for determining sensor node positions in a Wireless Sensor Network using MATLAB.	CO2

Total Hours: 60 hrs.

Course Code: BCSML0653	**Course Name: MACHINE LEARNING AND IT'S APPLICATIONS**	**L**	**T**	**P**	**C**
Course Offered in: CSE(IoT)		**0**	**0**	**6**	**3**

Pre-requisite: Python libraries (Numpy, Pandas, Matplotlib, Seaborn)

Course Objectives: The course objective is to apply foundational machine learning concepts, including data preprocessing, supervised and unsupervised learning algorithms (regression, classification, clustering), and ensemble methods, to address real-world problems, evaluate model performance critically, and implement practical solutions, particularly in areas like IoT applications.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental concepts, types, and applications of Machine Learning, particularly within the context of IoT, and apply various data preprocessing and dimensionality reduction techniques to prepare datasets for Machine Learning models.	K3
CO2	**Analyze** and **evaluate** linear regression models, optimizing them with Gradient Descent and improving their robustness using regularization techniques.	K4
CO3	Explore and utilize various classification algorithms, including Logistic Regression, Decision Trees, Support Vector Machines, and K-Nearest Neighbors, to solve binary and multiclass classification problems.	K4
CO4	Apply probabilistic methods (Naive Bayes) and advanced ensemble techniques (Random Forest, AdaBoost, Gradient Boosting, XGBoost) to build robust classification models.	K4
CO5	Implement and evaluate diverse unsupervised learning techniques, including K-Means, hierarchical, and DBSCAN clustering along with anomaly detection systems.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**P**
CO1	3	2	1	2	3	–	–	–	–	–	–	3	2	
CO2	3	3	2	3	2	–	–	–	–	–	–	2	2	
CO3	3	3	2	3	3	–	–	–	1	–	–	3	2	
CO4	3	3	2	3	3	–	–	–	1	–	–	3	2	
CO5	3	3	2	3	3	2	1	–	1	–	–	3	2	

Course Contents / Syllabus

Module 1	**Introduction to Machine Learning and Feature Engineering**	**12 hours**

Introduction to Machine Learning: Motivation, Definition, Applications of Machine Learning focusing on IoT
Types of Machine Learning: Supervised, Unsupervised and Reinforcement Learning
Datasets and Features: Features and their types, handing missing data, Dealing with categorical features, Feature Scaling, Feature selection, outlier detection and removal
Dimensionality reduction: Curse of Dimensionality, Principal Component Analysis (PCA) Algorithm

Module 2	**Regression and Regularizat on**	**16 hours**

Introduction to Regression: Regression Problem**,** Linear regression model (Simple, Multiple and Polynomial)
Errors : Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE)
Cost function: formula, intuition and visualization
Gradient Descent: Algorithm, intuition, learning rate and Gradient Descent for linear regression.
Evaluating the Accuracy of Linear Regression Model: R^2 and Adjusted R^2
Regularization: Bias and Variance, Overfitting and Underfitting, L1 and L2 Regularization, Regularize cost function, Regularized Linear Regression

Module 3	**Classification Algorithms**	**16 hours**

Classification: Classification problem, Binary and Multiclass Classification, Decision Boundary

Logistic regression model for binary classification, Cost function of logistic regression model, Regularized logistic regression, One Vs. All strategy for multiclass classification using logistic regression.

Measuring Performance of Classification Model: Accuracy, Precision, Recall, F1-Score, ROC-AUC curve, Confusion matrix

Decision Trees: Decision Tree Classification Algorithm, Attribute Selection Measures, Variants of Decision Trees (ID3, C4.5, CART)

Large Margin Classifier: Support Vector Machines

Instance Based Learning: K Nearest Neighbor Algorithm

Module 4	**Probabilistic Models and Ensembles**	**16 hours**

Probabilistic Methods for Classification: Bayesian Learning, Naive Bayes Classifier, Bayesian belief networks

Tree Ensembles: Using multiple decision trees, Bagging Vs. Boosting, Sampling with replacement, Random Forest Algorithm, Adda boost, Gradient Boosting, Xgboost Algorithm.

Module 5	**Clustering Algorithms and Anomaly Detection**	**20 hours**

Unsupervised Learning &Clustering: The problem of clustering, Distance measures

Partition Based Methods:

K-Means Clustering (Intuition, Algorithm, Optimization objective, Initializing K-Means, Choosing number of clusters)
K-Medoids and K-Mode clustering algorithms.

Hierarchical Clustering (Single Linkage, Complete Linkage, AGNES (Agglomerative Nesting), DIANA (Divisive Analysis).

Density-based Clustering: DBSCAN Algorithm

Anomaly Detection: Finding unusual events, Gaussian Distribution and Gaussian Mixture Model, Anomaly Detection Algorithm**,** Developing and evaluating anomaly detection system.

	Total Lecture Hours	**80 hours**

Textbook:

S.No	**Book Title**	**Author**
1	Marco Gori , Machine Learning: A Constraint-Based Approach, Morgan Kaufmann. 2017	
2	Ethem Alpaydin, Machine Learning: The New AI, MIT Press-2016	

Reference Books:

S.No	**Book Title**	**Author**
NPTEL/ Youtube/ Faculty Video Link:		
1	Ryszard, S., Michalski, J. G. Carbonell and Tom M. Mitchell, Machine Learning: An Artificial Intelligence Approach, Volume 1, Elsevier. 2014	
2	Stephen Marsland, Taylor & Francis 2009. Machine Learning: An Algorithmic Perspective.	

Video link

1. https://www.youtube.com/playlist?list=PLZoTAELRMXVPS-dOaVbAux22vzqdgoGhG
2. https://www.youtube.com/watch?v=vStJoetOxJg&list=PLkDaE6sCZn6FNC6YRfRQc_FbeQrF8BwGI

Required software and Tools

1	Anaconda
2	Jupyter Notebook
3	Google Colab
4	Kaggle

Mode of Evaluation

List Of Practical's (Indicative & Not Limited To)

1.	1. Introduction to Anaconda and Jupyter Notebooks, Sklearn library, Datasets available in Sklearn library, Kaggle Datasets to develop basic understanding of features and applications of Machine Learning. 2. Perform the following on an IoT based dataset: a) Basic data exploration, Check for missing values, Remove rows with missing values, Fill missing numerical values with mean or median, Fill in categorical values with mode or a specific value, Handling duplicate rows, Removing outliers. b) Dealing with categorical Variables: one-hot encoding, label encoding, ordinal encoding, and target encoding c) Feature Scaling: MinMaxScaler, StandardScaler, MaxAbsScaler, RobustScaler, Normalizer d) Correlation Analysis

	3. Implement Principal Component Analysis (PCA) algorithm for dimensionality reduction.
2.	1. Implementing a class having functions for Mean Absolute Error, Root Mean Square Error, Log loss, R-square and Adjusted R Square 1. Fit a linear regression model to predict housing prices based on the size of the house. 2. Implement linear regression model to predict PM2.5 concentrations based on various air quality features using Air Quality Index (AQI) dataset. 3. Forecasting Stock Closing Prices with Polynomial Regression and Bias-Variance Trade-off Analysis. 4. Implement Gradient Descent algorithm and analyse the effect of learning rate and derivatives. 5. Demonstrate effect of underfitting and overfitting and hyper parameters in already implemented regression algorithms along with Hyper-parameter tuning. 6. Implementation of regularized linear regression: Lasso and Ridge regression
3.	1. Implement logistic regression for binary classification on IoT-23: A l dataset with malicious and benign IoT network traffic 2. Implement logistic regression model for Handwritten digit classification. 3. Sentiment Analysis of Product Reviews Using One-Hot Encoding and Logistic Regression 4. Implement K-Nearest Neighbor regression from scratch for classification. 5. Credit Card Fraud Detection Using KNN and ROC-AUC Evaluation 6. Use the ID3 algorithm to build a decision tree to predict whether a customer will purchase a product based on their browsing behaviour on an e-commerce website. 7. Use a support vector machine (SVM) to classify images into different categories using the CIFAR-10 dataset.
4.	1. Implement Email Spam Classifier using Naïve Bayes Algorithm. 2. Implementation of Naïve Bayes Classifier for Titanic Dataset. 3. Implement Random Forest algorithm and Xgboost algorithm for Telco Customer Churn Prediction and compare the performance of both the algorithms. 4. Implement Random Forest algorithm and Xgboost algorithm for Credit Card Fraud Detection and compare the performance of both the algorithms.
5.	1. Customer Segmentation for a Retail Store Using K-Means Clustering. 2. Grouping News Articles by Topics Using K-Medoids Clustering. 3. Document Clustering Using Hierarchical Clustering and Dendrograms. 4. Fraud Pattern Detection in Transactions Using DBSCAN Clustering. 5. Clustering City Temperature Patterns Using Gaussian Mixture Models. 6. Implementation of anomaly detection system.

LAB Course Code: BCSE0659X	**LAB Course Name: Applied Research with Mini Project**	**L**	**T**	**P**	**C**
Course Offered in: CSE/CSE(R)/IT/M.Tech Int. (CSE)		**0**	**0**	**2**	**1**

Pre-requisite: Basic knowledge of programming, data structures, databases, and fundamental concepts of software development. Familiarity with tools and technologies for system development is desirable.

Course Objectives:

This course aims to develop the ability to design and implement solutions for real-world problems using appropriate tools and technologies. It emphasizes system integration, performance evaluation, and effective documentation, along with promoting research skills through the preparation of a structured research paper.

Course Outcome: After completion of the course, the student will be able to		Bloom's level
CO1	Identify and define a domain-specific real-world problem through literature review, objective formulation, and structured project planning suitable for research-based implementation.	K4
CO2	Design, develop, and validate a functional prototype/model/system using appropriate tools, technologies, or methodologies while considering performance, ethics, safety, and reliability.	K6
CO3	Document, analyze, and present project outcomes through a technical report and a structured research paper in IEEE/Scopus/UGC-approved format, demonstrating research communication and publication readiness.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	-	-	1	2	2	1	3	1	2	3
CO2	3	3	3	3	3	1	1	2	3	2	2	3	3	3	3
CO3	2	2	2	2	2	-	-	2	3	3	2	2	–	2	3

Module	**Common Applied Research-Based Mini Project Activities (All Branches)**	**Expected Outcomes**
Module 1: Research Foundation & Project Planning	1. Identify domain-specific problem statement relevant to the branch. 2. Define objectives, hypothesis, and expected outcomes 3. Conduct literature review 4. Select suitable tools, technologies, software, datasets, laboratory methods, or platforms. 5. Design project methodology, workflow, or system/process architecture	Clear research problem formulation, defined objectives, foundational knowledge, and structured project roadmap. **(CO1)**
Module 2: Development, Design & Implementation	6. Develop core project components, models, experiments, prototypes, or processes. 7. Integrate relevant modules such as software, hardware, simulation, experimentation, analysis, or field implementation. 8. Apply discipline-specific techniques such as coding, fabrication, experimentation, surveys, analytics, optimization, or modelling. 9. Incorporate safety, ethics, reliability, sustainability, and security considerations where applicable	Functional prototype/model/system/process with interdisciplinary implementation and practical technical skills. **(CO2)**
Module 3: Testing, Validation & Optimization	10. Perform testing, experimentation, or validation of developed work. 11. Analyze performance, efficiency, feasibility, or effectiveness. 12. Apply analytical, computational, statistical, or	Validated and optimized project demonstrating performance improvement, technical analysis, and practical feasibility. **(CO2)**

	intelligent techniques where relevant. 13. Optimize design, methodology, process, or implementation for improved outcomes	
Module 4: Documentation, Research Publication & Presentation	14. Document project design, methodology, implementation, and results. 15. Prepare technical report/project dissertation. 16. Draft a research paper in standard format (Abstract, Introduction, Methodology, Results, Conclusion, References) 17. Format manuscript according to IEEE/Scopus/UGC-approved guidelines. 18. Include proper figures, tables, graphs, citations, and references 19. Present project findings through seminar/poster/presentation. 20. Demonstrate developed system/model/prototype/process. 21. Submit final project report and research paper for evaluation/publication consideration	Complete technical documentation, publishable-quality research paper, professional presentation skills, and final project submission. **(CO3)**

Course Code: BCSE0614	Course Name: WEB DEVELOPMENT USING MEAN STACK	L	T	P	C
Course Offered in: CSE/CSE(R)/IT/M.Tech Int. (CSE)/ CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		3	0	0	3

Pre-requisite: Basic knowledge of HTML, CSS and ES6 required.

Course Objectives:
This course focuses on how to design and build static as well as dynamic webpages and interactive web applications. Students examine advanced topics like Angular, nodejs, Mongodb and Express framework for interactive web applications that use rich user interfaces.

Course Outcome: After completion of the course, the student will be able to

CO	Course Outcome	Bloom's Level
CO1	Explain, analyze and apply the role of server-side scripting language like Nodejs in the workings of the web and web applications.	K3
CO2	Demonstrate web application framework i.e., Express is to design and implement typical dynamic web pages and interactive web based applications.	K4
CO3	Apply the knowledge of Typescript that are vital in understanding angular is, and analyze the concepts, principles and methods in current client-side technology to implement angular application over the web.	K3
CO4	Analyze build and develop single page application using client-side programming i.e. angular js and also develop a static web application.	K4
CO5	Understand the impact of web designing by database connectivity with Mongodb in the current market place where everyone use to prefer electronic medium for shoping, commerce, and even social life also.	K3

CO-PO Mapping (Scale: 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	1	3	-	-	1	3	-	3	2	2	3
CO2	2	2	3	1	3	-	-	1	-	-	2	2	2	3
CO3	2	2	2	2	2	-	-	-	2	-	2	2	2	2
CO4	2	1	2	1	2	-	-	-	1	1	2	2	1	2
CO5	2	1	3	2	3	-	-	-	3	2	3	2	1	3

Course Contents / Syllabus

Unit 1	Introduction to Nodejs	9 hours

Installing Nodejs, Node in-built packages (buffer, fs, http, os, path, util, url) Node.js Units, File System Unit, Json data, Http Server and Client, Error handling with appropriate HTTP, Callback function, asynchronous programing REST API's(GET, POST PUT, DELETE UPDATE), GraphQL, Promises, Promise Chaining, Introduction to template engine (EJS).

Unit 2	Express Framework	9 hours

Configuring Express, Postman configuration, , Environment Variables, Routing, Defining pug templates, HTTP method of Express, URL binding, middleware function, Serving static files, Express sessions, REST full API's, FORM data in Express, document modeling with Mongoose.

Unit 3	Basics of Angular js	8 hours

Typescript, Setup and installation, Power of Types, Functions, Function as types Optional and default parameters, Arrow functions, Function overloading, Access modifiers, Getters and setters, Read-only & static, Abstract classes, Interfaces, Extending and Implementing Interface, Import and Export Units.

Unit 4	Building Single Page App with Angular js	10 hours

MVC Architecture, One-way and Two-way data binding, AngularJS Expressions, AngularJS Controllers, AngularJS Units, adding controller to a Unit, Component, Dependency Injection, Filters, Tables, AngularJS Forms and Forms validation, Select

using ng-option, AngularJS AJAX.		
Unit 5	**Connecting Angular js with MongoDB**	**9 hours**
Environment Setup of Mongodb, data modeling, The current SQL/NoSQL landscape, Create collection in Mongodb, CRUD Operations in MongoDB. Mongo's feature set, Introduction to Mongoose, Understanding mongoose schemas and datatypes, Connecting Angular with mongoDB using API.		
	Total Lecture Hours	**45 hours**

Text Books

S.NO	Book Title	Author
1.	"Web Application Development with MEAN", 3rd Illustrated Edition 2017, Packt Publications.	Amos Q. Haviv , Adrian Mejia , Robert Onodi
2.	"Getting MEAN with Mongo, Express, Angular, and Node", 2nd Edition 2016, Addison Wesley Publication.	Simon Holmes , Clive Herber
3.	"Comprehensive guide to learn Node.js", 1st Edition, 2018 BPB Publications.	Dhruti Shah
4.	"Learning Angular",3rd Edition,2017 Packt publications	Christoffer Noring, Pablo Deeleman

Reference Books:

S. NO	Book Title	Author
1.	"Fullstack Angular: The Complete Guide to AngularJS and Friends", 4th edition, 2020 International Publishing.	Anthony Accomazzo, Ari Lerner, and Nate Murray
2.	"Full-Stack Angular, Type Script, and Node: Build cloud-ready web applications using Angular 10 with Hooks and GraphQL", 2nd edition, 2017 Packt Publishing Limited.	David Cho
3.	"Complete node.js: The fast guide: Learn complete backend development with node.js"5th edition, 2017 SMV publication.	Richard Haltman & Shubham Vernekar
4.	"Mastering Node.js: Build robust and scalable real-time server-side web applications efficiently" 2nd edition,2016 Packt Publishing Limited.	Glenn Geenen, Sandro Pasquali , Kevin Faaborg
5.	Express & MongoDB Development ,kindle edition,2019 international publishing.	Greg Lim
6.	"AngularJS Master Angular.js with simple steps, guide and instructions" 3rd edition, 2015 SMV publication.	Daniel Perkins
7.	"MongoDB Basics", 2nd edition ,2018 International Publication.	Peter Membrey, David Hows, Eelco Plugge

Self Study Content Links:

MOOCs	1. https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer?utm_medium=sem&utm_source=gg&utm_campaign=b2c_india_ibm-full-stack-cloud-developer_ibm_ftcof_professional-certificates_cx_dr_bau_gg_sem_pr_in_all_m_hyb_24-06_x&campaignid=21316592778&adgroupid=165695367991&device=c&keyword=courses%20for%20full%20stack%20developer&matchtype=p&network=g&devicemodel=&creativeid=700589190893&assetgroupid=&targetid=kwd-571198547272&extensionid=&placement=&gad_source=1&gad_campaignid=21316592778&gbraid=0AAAADdKX6Y4gVe2nrA-BD75Xjo7XWZvc&gclid=Cj0KCQjw3K7RBhDJARIsAKRtP5T6KxJN_3NMwp5KCs0I8bBY35dSkaUg10Y0FBCfhLqnqqyQCAG9yzgaAonEEALw_wcB 2. https://www.udemy.com/career/full-stack-web-developer/?utm_campaign=Search_Keyword_CareerAccelerator_Prof_la.EN_cc.India&utm_source=google&utm_medium=paid-search&portfolio=CALP-India&utm_audience=mx&utm_tactic=nb&utm_term=_._ag_177463970814_._ad_749449716155_._kw_how%20to%20become%20a%20web%20developer&utm_content=g&funnel=&test=&gad_source=1&gad_campaignid=22487789892&gbraid=0AAAAADROdO0RdwZEytECk3hJ8p0YLN6Wu&gclid=Cj0KCQjw3K	40 hrs 30 hrs

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Video Lectures	1. https://youtu.be/BLl32FvcdVM 2. https://youtu.be/fCACk9ziarQ 3. https://youtu.be/YSyFSnisip0 4. https://youtu.be/mGVFltBxLKU 5. https://youtu.be/bWaucYA1YRI 6. https://youtu.be/7H_QH9nipNs 7. https://youtu.be/AX1AP83CuK4 8. https://youtu.be/SccSCuHhOw0 9. https://youtu.be/lY6icfhap2o 10. https://youtu.be/z7ikpQCWbtQ 11. https://youtu.be/0LhBvp8qpro 12. https://youtu.be/k5E2AVpwsko 13. https://youtu.be/SQJkj0WYWOE.list=PLvQjNLQMdagP3OzoBMfBT48uJ-SPfSsWj 14. https://youtu.be/0eWrpsCLMJQ.list=PLC3y8-rFHvwhBRAgFinJR8KHIrCdTkZcZ 15. https://youtu.be/ZSB4JcLLrIo 16. https://youtu.be/0LhBvp8qpro 17. https://youtu.be/k5E2AVpwsko 18. https://youtu.be/SQJkj0WYWOE.list=PLvQjNLQMdagP3OzoBMfBT48uJ-SPfSsWj 19. https://youtu.be/0eWrpsCLMJQ.list=PLC3y8-rFHvwhBRAgFinJR8KHIrCdTkZcZ 20. https://youtu.be/ZSB4JcLLrIo 21. https://youtu.be/Kvb0cHWFkdc 22. https://youtu.be/pQcV5CMara8 23. https://youtu.be/c3Hz1qUUIyQ 24. https://youtu.be/Mfp94RjugWQ 25. https://youtu.be/SyEQLbbSTWg	17 hrs
Web References	1. https://angular.io 2. https://www.mongodb.com/docs	

LAB Course Code: BCSE0614P	**LAB Course Name: Web Development Using Mean Stack Lab**	**L**	**T**	**P**	**C**
Course Offered in: CSE/CSE(R)/IT/M.Tech Int. (CSE) /CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		**0**	**0**	**2**	**1**

Pre-requisite: Basic knowledge of HTML, CSS and ES6 required.

Course Objectives: This course focuses on how to design and build static as well as dynamic webpages and interactive web applications. Students examine advanced topics like Angular, nodejs, Mongodb and Express framework for interactive web applications that use rich user interfaces.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Develop server-side web applications using Node.js and Express framework by implementing Units, asynchronous programming, REST APIs, middleware, template engines, and document modeling with Mongoose.	**K6**
CO2	Design and build dynamic Single Page Applications (SPAs) using AngularJS and TypeScript by applying components, Units, data binding, controllers, dependency injection, forms, and AJAX concepts.	**K6**
CO3	Create and manage MongoDB databases by performing data modeling, CRUD operations, schema design using Mongoose, and integrating Angular applications with MongoDB through APIs.	**K6**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	-	-	1	1	-	3	3	2
CO2	3	2	3	2	3	-	-	-	2	2	-	3	3	3
CO3	3	3	3	2	3	-	-	-	1	1	-	3	2	3

List Of Practical's (Indicative & Not Limited To)

1. Construct a program to demonstrate usage of Node.js fs Unit to read a file.	CO1
2. Construct a program to display system information using the os Unit.	CO1
3. Construct a program to create and export a simple Node.js Unit.	CO1
4. Construct a program to parse a URL using the Node.js url Unit.	CO1
5. Construct a program to create a basic HTTP server using Node.js	CO1
6. Construct a program to demonstrate callback-based asynchronous execution.	CO1
7. Construct a program to illustrate promise creation and resolution.	CO1
8. Construct a program to demonstrate promise chaining with multiple operations.	CO1
9. Construct a program to show JSON data parsing and stringifying.	CO1
10. Construct a program to demonstrate routing in an Express application.	CO1
11. Construct a program to demonstrate AngularJS data binding.	CO1
12. Construct a program to build a Node.js server that handles GET requests.	CO1
13. Construct a program to implement POST request handling using Express.	CO1
14. Construct a program to perform CRUD operations using Express and MongoDB.	CO1
15. Construct a program to create middleware for logging request details.	CO1
16. Construct a program to serve static files using Express.	CO1
17. Construct a program to create a MongoDB collection and insert documents.	CO1
18. Construct a program to build an AngularJS form with validation.	CO1
19. Construct a program to implement an API call using AngularJS AJAX.	CO1
20. Construct a program to compare synchronous and asynchronous file operations.	CO1
21. Construct a program to demonstrate differences between callbacks and promises.	CO1
22. Construct a program to illustrate REST API endpoints with multiple HTTP methods.	CO1
23. Construct a program to demonstrate middleware execution order in Express.	CO1
24. Construct a program to show one-way and two-way data binding in AngularJS.	CO2
25. Construct a program to analyze MongoDB document structure using Mongoose schema.	CO2

26. Construct a program to measure execution time of synchronous vs asynchronous code.	CO2
27. Construct a program to test REST API endpoints using different HTTP methods.	CO2
28. Construct a program to validate user authentication using Express sessions.	CO2
29. Construct a program to handle error responses with proper HTTP status codes.	CO2
30. Construct a program to demonstrate secure API access using middleware.	CO3
31. Construct a program to develop a RESTful API using Node.js, Express, and MongoDB.	CO3
32. Construct a program to build a single-page application using AngularJS.	CO3
33. Construct a program to integrate AngularJS frontend with Node.js backend.	CO3
34. Construct a program to implement user registration and login system.	CO3
35. Construct a program to build a full-stack application with CRUD operations and API integration.	CO3
Total Hours: 30 hrs	

Note: After completing all the laboratory experiments, students are required to obtain a Free Angular Online Course with Certificate - Beginner through ScholarHat

Course Code: BCSE0615	Course Name: Web Development using MERN STACK with Devops	L	T	P	C
Course Offered in: CSE/CSE(R)/IT/M.Tech Int. (CSE)/ CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		3	0	0	3

Pre-requisite: Basic knowledge of HTML, CSS, JavaScript, and fundamental programming concepts in any language.

Course Objectives: This course aims to equip students with practical skills in building dynamic full-stack applications using React, Node.js, Express, and MongoDB. It also introduces DevOps principles, Agile methodologies, and CI/CD automation using tools like GitHub, Jenkins, Docker, and Kubernetes.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Apply the knowledge of ES6 that are vital to implement react application over the web.	K3
CO2	Implement and Understand the impact of web designing by database connectivity with Mongodb.	K3
CO3	Explain, analyze and apply the role of server side scripting language like Nodejs and Express js framework.	K4
CO4	Apply the benefits of DevOps over other software development processes to Gain insights into the DevOps environment.	K4
CO5	Demonstrate popular open-source tools with features and associated terminology used to perform Continuous Integration and Continuous Delivery.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	1	1	-	1	-	2	2	2	3
CO2	3	2	3	1	3	1	1	-	1	-	2	2	2	3
CO3	3	2	3	1	3	1	1	2	1	2	2	2	2	2
CO4	3	1	1	1	3	2	-	-	2	1	2	2	1	2
CO5	3	1	1	1	3	1	-	-	2	1	2	2	1	3

Course Contents / Syllabus

Unit 1	Modern Frontend Development with React JS	9 hours

Introduction: to React, Setting up React projects, React Folder Structure, JSX, Functional Components, and React Hooks (useState, useEffect, use Context), Props vs State, Stateless vs Stateful Components, Component Lifecycle, Routing with react-router-dom Introduction to Next.js for Server-Side Rendering and SEO, Integrating APIs with axios or fetch,.

Unit 2	UI Libraries & MongoDB Integration	10 hours

UI Libraries : Introduction to Google Material UI, Tailwind CSS, Theming and responsive design with MUI, Creating reusable UI components (Navbar, Toolbar, Dialogs), Introduction to MongoDB, CRUD Operations using Mongoose Indexes: Creating, Getting, Dropping, Aggregation Pipelines and Query Optimization, Data Modeling & Relationships, Auto-Sharding and Replication Concepts, Modern MongoDB tools: MongoDB Atlas, Compass.

Unit 3	Backend with Node.js & Express	10 hours

Node.js: Introduction to Node.js Setting up Express applications, Routing & Middleware, Restful API Design , JWT-based Authentication & Authorization ,Working with dotenv, CORS, body-parser. Express MVC Architecture in Express, File Upload Handling with Multer, Connecting Frontend with Backend via APIs, Introduction to GraphQL.

Unit 4	DevOps Culture and Lifecycle	8 hours

Introduction to DevOps: Culture & Principles, DevOps Lifecycle and Agile vs DevOps, SDLC Models: Agile, Lean, Scrum, Kanban, Scrum: Process flow, Planning, Testing, Release Management, Introduction to Site Reliability Engineering (SRE), Overview of Terraform/Ansible, Configuration Management basics

Unit 5	CI/CD, Docker & Kubernetes	8 hours

Git & GitHub: Introduction to Git, GitHub, Branching strategies, CI/CD Pipelines: Jenkins, GitHub Actions, Creating Jenkins Jobs and Pipelines, Integrating Git, Maven, and SonarQube, Introduction to Docker: Images, Containers, Lifecycle ,Building custom Docker Images, Docker Compose for multi-container apps, Container orchestration with Kubernetes Creating Deployments, Services, and scaling with K8s, Basic monitoring tools: Prometheus and Grafana		
	Total Lecture Hours	**45 hours**

Textbook:

S.No	Book Title	Author
1.	Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node Paperback, 2nd Edition (2017)	Vasan Subramanian
2.	Hands-On MERN Stack Web Development: Build production-grade web apps and APIs with MERN stack ,3rd Edition (2019)	Shama Hoque
3.	Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js App 2nd Edition (2021)	Greg Lim

Reference Books:

S.No	Book Title	Author
1.	The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations 2nd Edition (2003).	Gene Kim, Jez Humble, Patrick Debois, John Willis
2.	Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, 2nd Edition (2004).	Jez Humble, David Farley
3.	Test and Deploy Production-Grade Web Applications 1st Edition (2023).	Nabendu Biswas

Self Study Content Link:

MOOCs	1. https://www.coursera.org/learn/fullstack-web-development 2. https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer	4 Weeks 6 Months
Video Lectures	1. https://youtu.be/CvCiNeLnZ00 2. https://youtu.be/4nKWREmCvsE 3. https://youtu.be/f2EqECiTBL8 4. https://youtu.be/6GQRb4fGvtk 5. https://youtu.be/kTp5xUtcalw	8 hrs 25 Min 7 hrs 8 Min 6 hrs
Web References	1. https://react.dev 2. https://docs.docker.com	

Course Code: BCSML0614	**Course Name: Natural Language Processing and Social Media Analytics**	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		**3**	**0**	**0**	**3**

Pre-requisite: Machine learning, formal languages, Data Structures, Algorithms Probability and Statistics

Course Objectives:

Develop an understanding of the fundamental concepts of Natural Language Processing, apply text vectorization and document similarity techniques, perform text analytics and information extraction, utilize sequential and transformer-based models, and evaluate real-world NLP applications and systems.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand and explain the fundamentals of Natural Language Processing	K2
CO2	Apply text vectorization and similarity techniques.	K3
CO3	Analyze text analytics methods	K4
CO4	Demonstrate knowledge of sequential models and transformer architectures	K3
CO5	Examine real-world NLP applications	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1	2	-	-	-	1	1	-	2	1	1
CO2	3	3	2	2	3	-	-	-	1	1	-	3	2	1
CO3	3	3	2	3	3	1	-	-	1	2	1	3	3	2
CO4	3	2	3	2	3	1	-	-	1	2	1	3	3	2
CO5	3	3	3	2	3	2	1	1	1	2	1	3	3	3

Course Contents / Syllabus

Unit 1	**Introduction to Natural Language Processing**	**07 hours**

Definition, Applications and emerging trends in NLP, Challenges. Ambiguity. NLP tasks using NLTK: Tokenization, stemming, lemmatization, stop-word removal, POS tagging, Parsing, Named Entity Recognition, coreference resolution.

Unit 2	**Text Vectorization and Similarity**	**10 hours**

Text Vectorization: Bag-of-Words model, N-Gram Models and vector space models, Term Presence, TF-IDF
Textual Similarity: Cosine similarity, Word Mover's distance, Word embeddings: Word2Vec (Skip Gram & CBOW), GloVe.

Unit 3	**Text Analytics**	**10 hours**

Text classification, Sentiment Analysis, Topic modelling, LSA, LDA, Opinion Mining, Information Extraction, Information Retrieval.

Unit 4	**Sequential Modelling and Transformers**	**10 hours**

Sequential data, Introduction to sequence models - RNN and LSTM, Attention Mechanism, Transformer, Transformer-based
models: BERT, FastText, Elmo, GPT, T5, Introduction to Hugging Face Transformers.

Unit 5	**Applications and Case Studies**	**08 hours**

NLP applications: Machine translation: Rule-based and statistical approaches, Text summarization Dialog systems, conversational agents and chatbots.
Question Answering and Retrieval-Augmented Generation (RAG): Extractive vs Generative Question Answering, BERT- based QA systems, SQuAD benchmark, Introduction to Retrieval-Augmented Generation (RAG), RAG pipeline: Retriever
and Generator components, Evaluation of QA systems, Real-world case studies.

Total Lecture Hours	**45 hours**

Textbook:

S.No	Book Title	Authors:
1.	Speech and Language Processing, 3rd Edition, Pearson Education, 2008	Daniel Jurafsky, James H.Martin
2.	Deep Learning for Natural Language Processing, 1st Edition, Apress, 2018	Palash Goyal, Sumit Pandey, Karan Jain

Reference Books:

S.no	Book Title	Authors:
1.	Natural Language Understanding, 2nd Edition, Pearson, 1995	James Allen
2.	Neural Network Methods for Natural Language Processing, 1st Edition, Morgan & Claypool Publishers, 2017	Yaov Goldeberg

Self-Study Content Links:		Duration (in Hrs)
MOOCs	Deep Learning for Natural Language Processing by Prof. Pawan Goyal https://nptel.ac.in/courses/108105572	45Hrs
Video Lectures	https://web.stanford.edu/class/cs224n/?utm	45Hrs
Web References	https://www.nltk.org/?utm https://huggingface.co/docs/transformers/index?utm https://web.stanford.edu/class/cs224n/?utm	30Hrs

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: BCSML0614P	LAB Course Name: Natural Language Processing Social Media Analytics Lab	L	T	P	C
Course Offered in: CS/CSE(IOT)		0	0	2	1

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Apply and demonstrate NLP preprocessing techniques using NLTK and spaCy.	K3
CO2	Analyze and justify ML/DL models for text analytics and classification tasks.	K4
CO3	Examine transformer-based NLP applications and chatbots.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	-	-	-	1	1	-	3	1	1
CO2	3	3	2	2	3	1	-	-	1	2	1	3	3	2
CO3	3	3	3	3	3	1	1	1	2	2	1	3	3	3

List Of Practical's (Indicative & Not Limited To)

S.No	List of Programs	CO
1	Tokenization of Sentences and Words using NLTK and spaCy	CO1
2	Stemming and Lemmatization on sample text	CO1
3	Stop-word Removal from a document	CO1
4	Part-of-Speech (POS) Tagging of a given sentence	CO1
5	Parsing and Chunking using regex and spaCy	CO1
6	Named Entity Recognition (NER) using spaCy	CO1
7	Coreference Resolution using neuralcoref (or similar)	CO2
8	Bag-of-Words (BoW) vectorization and representation	CO2
9	TF-IDF Implementation and comparison with BoW	CO2
10	N-Gram Model (uni-, bi-, tri-gram) generation from corpus	CO2
11	Cosine Similarity computation between text documents	CO2
12	Word2Vec word embeddings using gensim on a custom corpus	CO2
13	GloVe Embeddings loading and vector representation	CO2
14	Text Similarity using Word Mover's Distance (WMD)	CO2
15	Text Classification using Naïve Bayes/SVM with TF-IDF	CO2
16	Sentiment Analysis using TextBlob and VADER	CO2
17	Topic Modeling using Latent Dirichlet Allocation (LDA)	CO2
18	Topic Modeling using Latent Semantic Analysis (LSA)	CO2
19	Opinion Mining on product/service reviews dataset	CO2
20	Information Extraction (IE) from structured/unstructured documents	CO2
21	Information Retrieval system with ranking using TF-IDF	CO2
22	Sequence Classification using RNN/LSTM (Keras/TensorFlow)	CO2
23	Implementing Attention Mechanism (Basic custom model)	CO2
24	Fine-Tuning BERT for text classification using Hugging Face	CO3
25	Sentence Embeddings using BERT and GPT-2	CO3
26	Text Generation using GPT-2 on a custom dataset	CO3
27	Named Entity Recognition using Transformers (BERT)	CO3
28	Machine Translation using MarianMT or T5 (Hugging Face)	CO3
29	Text Summarization using BART or T5	CO3
30	Chatbot Development using pre-trained transformer (DialoGPT/ChatGPT-style)	CO3
31	Automatic Document Classification and Separation using ML	CO3
32	Hybrid Probabilistic + FSM-Based Sequence Modeling for document boundary detection	CO3

Total Hours: - 30 Hours

Course Code: BCSML0612	Course Name: Generative AI	L	T	P	C
Course Offered in: CSE(IoT)/CS		3	0	0	3

Pre-requisite: Statistics, Machine Learning, Deep Learning

Course Objectives:

Develop an understanding of deep learning fundamentals and artificial neural networks, design CNN-based computer vision and object detection models, implement sequence learning techniques, apply autoencoders for feature extraction, and build deep learning solutions for real-world AI applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Knowledge Level (KL)**
CO1	Apply the concepts of discriminative vs. generative models.	K3
CO2	Describe GMMs and HMMs via Expectation-Maximization.	K2
CO3	Analyze VAEs with a focus on the reparameterization trick.	K4
CO4	Apply GANs for realistic image generation and training challenges.	K3
CO5	Examine Autoencoders for dimensionality reduction and image reconstruction.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	1	1	-	2	3	3
CO2	3	3	2	2	3	-	-	-	1	1	-	3	3	3
CO3	3	3	3	2	3	-	-	-	2	1	-	3	3	3
CO4	2	3	2	2	2	-	-	-	1	1	-	3	3	3
CO5	2	2	3	2	3	1	-	-	1	1	1	3	3	3

Course Contents / Syllabus

Unit-1 Foundations of Generative Model — **9 hours**

Introduction to Generative vs. Discriminative Models, Probabilistic Foundations: Joint, Marginal, and Conditional Distributions, Maximum Likelihood Estimation (MLE) and KL Divergence, Latent Variable Models: GMM, HMM, Use Cases of Generative AI:Image synthesis, Text generation, Healthcare

Unit-2 Classical Models & Autoencoders — **9 hours**

Gaussian Mixture Models (GMM), Expectation-Maximization, Hidden Markov Models (HMMs)
Autoencoders (AE): Undercomplete, Denoising, Sparse Autoencoders, Variational Autoencoders (VAE): ELBO, Reparameterization Trick, Applications: Image reconstruction, Denoising, Latent Space Interpolation

Unit-3 Generative Adversarial Networks (GANs) — **9 hours**

GAN Architecture: Generator and Discriminator, Training Challenges: Mode Collapse, Vanishing Gradients, GAN Variants: DCGAN, cGAN, CycleGAN, StyleGAN2, BigGAN, Evaluation Metrics: FID, IS, PR Curves, Applications: Image synthesis, Super- resolution, Image translation, etc.

Unit-4 Attention Mechanism, Transformers & Large Language Models — **9 hours**

Self-Attention, RNN vs. Attention, Multi-Head Attention, Transformer Architecture: Encoder-Decoder, Positional Encoding, Generative Transformers: GPT (Generative Pretrained Transformer), BERT (Masked Language Model), Fine-Tuning Pretrained Models: GPT-3, T5, BERT, and specialized applications like Text Summarization, Question Answering, LLMs in Action: GPT-3, GPT-4, LLaMA, Prompt Engineering: Understanding and crafting prompts to guide LLM outputs, Applications: Text Generation, Code generation, Conversational AI

Unit-5 Advanced Generative Models & Fine-Tuning — **9 hours**

Diffusion Models: Forward and Reverse Process, Denoising Diffusion Probabilistic Models (DDPM) Flow-Based Models: NICE, RealNVP, Glow, Fine-Tuning Pretrained Models: GPT-2, Stable Diffusion, Multimodal Models: CLIP, DALL·E, Flamingo, GPT-4 + Multimodal Inputs, Ethical Issues: Deepfakes, AI Bias, Copyright, Content Authenticity, and Responsible AI

Total Lecture Hours	**45 hours**
Textbook:	
Book Details	**Authors Name**
Probabilistic Machine Learning: From Algorithms to Applications	Kevin P. Murphy
Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play	David Foster
Hands-On Generative AI with Transformers and Diffusion Models	Omar Sanseviero
Reference Books:	
Book Details:	**Authors Name**
Machine Learning: From the Classics to Deep Networks, Transformers, and Diffusion Models.	Sergios Theodoridis
Essentials of Generative AI	Takeshi Okadome (Springer)
Self-Study Content Links:	**Duration (in Hrs)**
MOOCs https://onlinecourses.nptel.ac.in/e-learning	24h
Video Lectures https://youtu.be/vwncYfhxbR0?si=3jjFY5r3nroGNHKK	3h 52m
Web References https://huggingface.co/learn	15h

Course Code: BCSCY0613	**Course Name: Malware Analysis and Reverse Engineering**	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		**3**	**0**	**0**	**3**

Prerequisite: Computer Networks, Operating Systems, C/C++ or Python Programming

Course Objectives: This course introduces techniques for analyzing and understanding malware behavior and reverse engineering malicious software. It equips students with skills to dissect malware through static and dynamic analysis and understand countermeasures and detection techniques.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Demonstrate an understanding of malware, its types, lifecycle, and behavioral characteristics.	K2
CO2	Apply static analysis techniques to examine file structures, metadata, and signatures of malware.	K3
CO3	Perform dynamic analysis to observe runtime behavior and system interaction of malware in isolated environments.	K4
CO4	Detect evasion and obfuscation techniques employed by malware to bypass security mechanisms.	K4
CO5	Develop comprehensive malware analysis reports including IOCs, attack vectors, and mitigation recommendations.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	2	3		3	1		1	3		2	1
CO2	2	3	3	3	3		3	1		1	3	2	3	2
CO3	2	2	3	3	3	1	3	1	1	1	3	3	3	3
CO4	3	2	3	3	3	1	2	2	1	2	2	2	3	3
CO5	3	3	3	2	3	1	3	2	1	2	3	2	2	3

Course Contents / Syllabus

Unit 1	**Introduction to Malware**	**10 hours**

Definition and classification of malware: viruses, worms, Trojans, ransomware, spyware, bots and fileless malware. Malware attack vectors and lifecycle: infection, persistence, execution, command and control (C2), and data exfiltration. Motivation behind malware: cybercrime, hacktivism, cyber espionage, and cyber warfare. Overview of living-off-the-land attacks and script-based malware (PowerShell/macros). Legal and ethical considerations in malware research and responsible handling of malicious software.

Unit 2	**Static Analysis Techniques**	**10 hours**

Analyzing executable file formats (Windows) and ELF (Linux) structure. Analyzeing executable headers and attributes using tools such as PEStudio, Detect It Easy (DIE), and Exeinfo PE. Extracting and analyzing strings using Strings and FLOSS, File fingerprinting using SHA-256 hashing and reputation analysis with VirusTotal. Detecting and unpacking packed binaries. Introduction to YARA rules for malware identification and classification.

Unit 3	**Dynamic Analysis Techniques**	**10 hours**

Setting up isolated malware analysis environments using VirtualBox/VMware. Monitoring process behaviour using Process Explorer and Process Monitor, Observing network activity –using Wireshark, and FakeNet-NG. Identifying system changes: file system, registry, services, and persistence mechanisms. Introduction to automated malware analysis platforms such as Cuckoo Sandbox, Hybrid Analysis or Any. Run. Behavioural indicators and basic malware evasion techniques.

Unit 4	Reverse Engineering Essentials	**8 hours**

Overview of x86 architecture and assembly fundamentals. Understanding program control flow (: loops, branches, function calls) and stack operations. Disassembling binaries using IDA Pro and Ghidra Recognizing common library functions and reconstructing , program logic. Debugging malware using x64dbg breakpoints, stepping, memory inspection, . Introduction to code obfuscation and anti-disassembly techniques.

Unit 5	Advanced Topics & Reporting	**7 hours**

Code injection and hooking techniques : DLL injection, and API hooking, . Memory forensics using Volatility framework for malware investigation. Anti-analysis techniques: anti-debugging, anti-VM, detection and code obfuscation. Extracting Indicators of Compromise (IOC): IPs, domains, registry keys, file paths, and hashes, Mapping malware behaviour to the MITRE ATT&CK framework. Preparation of professional malware analysis reports including attack summary, indicators and mitigation strategies. Case studies of real-world malware such as WannaCry, Emotet, and Zeus).

	Total Lecture Hours	**45 hours**

Textbook:

1. Practical Malware Analysis, Michael Sikorski, Andrew Honig, 1st Edition (2012), No Starch Press.
2. The IDA Pro Book, Chris Eagle, 2nd Edition, No Starch Press.
3. The Art of Memory Forensics, Michael Hale Ligh, Andrew Case, Jamie Levy, Aron Walters, 1st Edition (2014), John Wiley & Sons / Wiley.

Reference Books:

1. Practical Reverse Engineering, Bruce Dang, Alexandre Gazet, Elias Bachaalany, Sebastien Josse, 1st Edition, Wiley.
2. Reversing: Secrets of Reverse Engineering, Eldad Eilam, 1st Edition, Wiley Publishing.
3. Malware Analyst's Cookbook and DVD, Michael Hale Ligh, Steven Adair, Blake Hartstein, Matthew Richard, 1st Edition, Wiley.
4. Learning Malware Analysis, Monnappa K. A., 1st Edition, Packt Publishing.
5. Mastering Malware Analysis, Alexey Kleymenov, Amr Thabet, 1st Edition, Packt Publishing.
6. The Ghidra Book, Chris Eagle, Kara Nance, 1st Edition, No Starch Press.
7. Windows Internals, Part 1 & 2, Pavel Yosifovich, Mark Russinovich, David Solomon, Alex Ionescu, 7th Edition, Microsoft Press.
8. Rootkits and Bootkits, Alex Matrosov, Eugene Rodionov, Sergey Bratus, 1st Edition, No Starch Press.
9. The Shellcoder's Handbook, Chris Anley, John Heasman, Felix Lindner, Gerardo Richarte, 2nd Edition, Wiley.
10. Malware Data Science, Joshua Saxe, Hillary Sanders, 1st Edition, No Starch Press.
11. Windows Kernel Programming, Pavel Yosifovich, 2nd Edition, Leanpub.
12. Rootkits: Subverting the Windows Kernel, Greg Hoglund, James Butler, 1st Edition, Addison-Wesley

Self-Study Content Links:		Duration (in Hrs)
MOOCs	Advanced Malware Analysis - TOC | Infosys Springboard	5 Hrs 3 Min
Video Lectures	1. OpenSecurityTraining.info – Reverse Engineering 2. Malware Unicorn – https://www.malwareunicorn.org/ https://bazaar.abuse.ch/	15 hours 10 hours 10 hours
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: BCSCY0613P	**LAB Course Name: Malware Analysis and Reverse Engineering Lab**	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		**0**	**0**	**2**	**1**

Pre-requisite: Computer Networks, Operating Systems, C/C++ or Python Programming

Course Objectives:

This course introduces techniques for analyzing and understanding malware behavior and reverse engineering malicious software. It equips students with skills to dissect malware through static and dynamic analysis and understand countermeasures and detection techniques.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Knowledge Level (KL)**
CO1	Understand malware fundamentals, malware categories, attack vectors, executable formats, malware lifecycle, legal and ethical considerations, and basic static malware analysis techniques.	**K2**
CO2	Apply static and dynamic malware analysis techniques using malware analysis tools, sandboxing environments, network monitoring, and behavioral analysis utilities.	**K3**
CO3	Perform reverse engineering, debugging, memory forensics, IOC extraction, anti-analysis detection, and professional malware investigation and reporting.	**K3**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO – PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	3	2	-	2	-	1	-	2	1	2
CO2	2	3	2	3	3	1	-	1	1	1	-	2	1	2
CO3	3	3	3	3	3	2	-	2	2	2	-	2	2	1

List Of Practical's (Indicve & Not Limited To)	**CO**
1. Study malware categories, lifecycle, and attack vectors using real-world malware examples	CO1
2. Analyze legal and ethical issues in malware analysis through case studies	CO1
3. Analyze PE and ELF executable structures using PEStudio and Detect It Easy	CO1
4. Perform string extraction, hashing, and VirusTotal reputation analysis	CO1
5. Detect packed malware and create basic YARA rules for malware identification	CO2
6. Configure an isolated malware analysis environment using VirtualBox/VMware	CO2
7. Monitor malware behaviour using Process Explorer and Process Monitor	CO2
8. Capture and analyze malware network traffic using Wireshark and TCPView	CO2
9. Perform automated malware analysis using Cuckoo Sandbox and observe evasion behaviour	CO2
10. Study x86 assembly instructions and analyze program control flow	CO3
11. Perform binary disassembly and debugging using IDA Pro/Ghidra and x64dbg	CO3
12. Identify obfuscation and anti-disassembly techniques in malware binaries	CO3
13. Perform memory forensics using Volatility and extract Indicators of Compromise (IOCs)	CO3
14. Prepare a professional malware analysis report with mitigation strategies and case study analysis	CO3
Total Hours: - 30 Hours	

Course Code: BCSCY0612N	Course Name: Blockchain and Cryptocurrency Security	L	T	P	C
Course Offered in: CSE/CSE(R)/IT/M.Tech Int. (CSE)/ CSE(AI)/CSE(AIML)/CSE(DS)/CS/CSE(IOT)/MCT		3	0	0	3

Pre-requisite: Computer Networks, Network Security, Operating Systems, Programming skills

Course Objectives: To explore the foundational concepts of blockchain technology and its architecture to develop secure blockchain-based applications and assess their resilience to cyber threats.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the evolution, core architecture, types of blockchain, and distinguish between centralized, decentralized and distributed ledger systems and their real-world use cases across IoT, AI/ML, Data Science and other engineering domains.	K2
CO2	Explain the fundamental cryptographic concepts hashing, Merkle trees, digital signatures, wallets and PKI that underpin blockchain security, without requiring advanced mathematical background.	K2
CO3	Apply knowledge of consensus mechanisms, smart contract vulnerabilities and blockchain attack vectors to analyze the security and operational behavior of decentralized networks.	K3
CO4	Develop and deploy smart contracts using Solidity on Remix IDE and understand enterprise blockchain architecture using Hyperledger Fabric, demonstrating ability to write, test and interact with blockchain applications hands-on.	K4
CO5	Evaluate and map real-world blockchain applications across financial systems, supply chain, government, healthcare, IoT and AI/ML domains, and assess emerging trends such as Zero-Knowledge Proofs, Layer 2 solutions and cross-chain interoperability.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	2	1	-	-	2	2	-
CO2	3	2	1	2	2	1	1	2	1	1	-	2	1	1
CO3	3	3	2	3	2	2	1	3	2	1	-	3	3	2
CO4	3	3	3	2	3	2	1	3	2	2	-	3	2	2
CO5	2	2	2	2	2	3	2	2	2	2	1	2	2	2

Course Contents / Syllabus

Unit 1	Introduction to Blockchain Technology	08 hours

Evolution and history of blockchain; Structure and components of a blockchain (nodes, blocks, chain, mining); Types of blockchains: Public, Private, Consortium; Centralized traditional databases vs. Decentralized databases vs. Distributed Ledger Technology (DLT), Use cases: cryptocurrency (Bitcoin), supply chain, identity management, healthcare; Digital Money to Distributed Ledgers; Blockchain Design Primitives: Protocols, Permissions (Permissioned vs. Permissionless Blockchains), Privacy

For Demo: https://andersbrownworth.com/blockchain , https://blockchaindemo.io

Unit 2	Cryptographic Foundations	09 hours

Hash functions and Merkle trees (conceptual); Digital signatures and public-key cryptography (how it works, not proofs); Wallets: types and key management; Blockchain addresses and transactions; PKI Infrastructure — conceptual overview; Two-Factor Authentication with Blockchain.
Browser based tool : CyberChef (GCHQ)https://gchq.github.io/CyberChef , https://www.myetherwallet.com

Unit 3	**Consensus, Contracts, and Attacks**	**10 hours**

Need for consensus in decentralized systems; Proof-of-Work (PoW) (conceptual); Proof-of-Stake (PoS), Delegated PoS; Proof-of-Authority (PoA); Practical Byzantine Fault Tolerance (PBFT);Mining and its role in blockchain security , Introduction to Bitcoin, Ethereum and altcoins; Transaction lifecycle; UTXO model vs. account-based model; Smart contracts and their working; Common vulnerabilities: reentrancy, overflow/underflow (awareness level); Attacks:51% attack, Sybil Attack, Eclipse Attack, Routing Attack, Distributed Denial of Service (DDoS)
Online Tool: https://www.blockchain.com/explorer, https://txstreet.com/

Unit 4	**Enterprise Blockchain and Smart Contract Development**	**09 hours**

Hyperledger Fabric — Components and Architecture; Chaincode: What it is and how it works; Introduction to Remix IDE — Interface and Setup; Writing Your First Smart Contract on Remix IDE; Smart contract development using Solidity; Deploying and Testing Smart Contracts on Remix IDE;Events, Functions and Modifiers in Solidity; ERC-20 Token Standard — Overview , Tools for auditing smart contracts (Mythril, Slither, Oyente) , (Remix IDE)
https://remix.ethereum.org , https://github.com/hyperledger/fabric-samples

Unit 5	**Blockchain Applications and Emerging Technologies**	**09 hours**

Introduction of version control engine, use case of automated assignment grading, peer review workflow, public repositories, building portfolios, collaborating on codebases, track changes, and resolve conflicts, Version-controlled technical manuals ensure up-to-date knowledge sharing using GitHub. Regulatory and legal frameworks for cryptocurrencies (global and national perspectives)
https://etherscan.io/

	Total Lecture Hours	**45 hours**

Textbook:

1. Mastering Bitcoin: Programming the Open Blockchain, Andreas M. Antonopoulos and David A. Harding, 3rd Edition, O'Reilly Media, 2023
2. Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, 1st Edition, Apress, 2017
3. Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos and Gavin Wood, 1st Edition, O'Reilly Media, 2018

Reference Books:

1. Blockchain Technology and Applications, Pethuru Raj, Kavita Saini and Chellammal Surianarayanan, 1st Edition, CRC Press / Routledge, 2020
2. The Basics of Bitcoins and Blockchains, Antony Lewis, Updated Edition, Mango Media, 2021
3. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, 1st Edition, Princeton University Press, 2016

Self-Study Content Links:		Duration (in Hrs)
MOOCs	1. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012929490529533952761_shared/overview ~ 9 hrs OR 2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013038627363602432360_shared/overview ~ 11 hrs	10 hrs
Video Lectures	1. https://www.youtube.com/watch?v=EH6vE97qIP4 ~2.5 hrs 2. https://www.youtube.com/watch?v=PPFsG92-HiI ~2.5 hrs 3. https://www.youtube.com/watch?v=0UvVOMZqpEA ~1.5 hrs 4. https://www.youtube.com/watch?v=7Cu8KQmUhu0 ~1.5 hrs 5. https://www.youtube.com/watch?v=w7HDA8gUbpQ ~2 hrs 6. https://www.youtube.com/watch?v=JPkgJwJHYSc ~1.5 hrs 7. https://www.youtube.com/watch?v=9mZpc6sKryk ~1.5 hrs 8. https://www.youtube.com/watch?v=RGOj5yH7evk ~1 hr https://www.youtube.com/watch?v=prG1DJMoqoI ~1 hr	15 hours

Web References	1. https://en.wikipedia.org/wiki/Blockchain ~1 hr 2. https://openknowledge.worldbank.org/bitstreams/5166f335-35db-57d7-9c7e-110f7d018f79/download ~1 hr 3. https://arxiv.org/html/2508.01280v1 ~1.5 hrs https://hyperledger-fabric.readthedocs.io/en/latest/whatis.html ~1 hr	5 hours
Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.		