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

(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 (Artificial Intelligence and Machine Learning)

Third Year

(Effective from the Session: 2026-27)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)
Bachelor of Technology
Computer Science and Engineering (Artificial Intelligence and Machine Learning)

Evaluation Scheme
SEMESTER-V

Sl. No.	Subject Codes	Subject Name	Types of Subjects	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	BCSAI0501	Natural Language Processing	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 Network Lab	Mandatory	0	0	4				50		50	100	2
6	BCSAI0551	Natural Language Processing Lab	Mandatory	0	0	2				25		25	50	1
7		Departmental Elective-II Lab	Departmental Elective	0	0	2				25		25	50	1
8	BCSML0555A	Deep Learning	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
12	BEC0559X	Internship-II	Mandatory	0	0	2				50			50	1
13	BVAC0551	Professional Practice and Employability-I	Compulsory Audit	0	0	6								NA
14		MOOCs (For B.Tech. Hons. Degree)	*MOOCs											
		TOTAL		**14**	**2**	**24**	**180**	**120**	**300**	**275**	**400**	**225**	**1150**	**25**

List of MOOCs Based Recommended Courses for Third year B. Tech Students

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	BMC0111	Deep Learning for Devlopers	Infosys Wingspan (Infosys Springboard)	34h 51m	2.5
2.	BMC0112	A TechA Network Hacking Prevention Foundation Certification	IIHT	8h	0.5
3	BMC0113	Certificate Program in Deep Learning/NLP/Artificial Intelligence	NASSCOM	30h	2

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 Departmental Electives

Sl. No.	Subject Codes	Subject Name	Types of Subjects	Bucket Name	Applicable Branch	Semester
1	BCSAI0512	Advance Java Programming	Departmental Elective - II	Full Stack Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS/CYS	V
2	BCSAI0512P	Advance Java Programming Lab	Departmental Elective - II Lab	Full Stack Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS/CYS	V
3	BCSIOT0513	Introduction to IoT	Departmental Elective - II	IoT Smart Systems Bucket	AI / AIML / DS M&C / CS / CYS	V
4	BCSIOT0513P	Introduction to IoT Lab	Departmental Elective - II Lab	IoT Smart Systems Bucket	AI / AIML / DS M&C / CS / CYS	V
5	BCSCY0513	Network Security and Cryptography	Departmental Elective - II	Cyber Security Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS	V
6	BCSCY0513P	Network Security and Cryptography Lab	Departmental Elective - II Lab	Cyber Security Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS	V
7	BCSAI0520	Cloud Virtualization	Departmental Elective - II	Cloud Computing Bucket	AI/ AIML/ DS/ M&C/ CYS	V
8	BCSAI0520P	Cloud Virtualization Lab	Departmental Elective - II Lab	Cloud Computing Bucket	AI/ AIML/ DS/ M&C/ CYS	V
9	BCSAI0523	Big Data	Departmental Elective - III	Cloud Computing Bucket	AI/ AIML/ DS/ M&C/ CYS	V
10	BCSIOT0514	Privacy and Security in IoT	Departmental Elective - III	IoT Smart Systems Bucket	AI / AIML / DS M&C / CS / CYS	V
11	BCSCY0515	Ethical Hacking	Departmental Elective - III	Cyber Security Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS	V
12	BCSE0514	Design Pattern	Departmental Elective - III	Full Stack Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS/CYS	V

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Bachelor of Technology

Computer Science and Engineering (Artificial Intelligence and Machine Learning)

Evaluation Scheme
SEMESTER-VI

Sl. No.	Subject Codes	Subject Name	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BCSE0604	Computer Vision	Mandatory	3	1	0	30	20	50		100		150	4
2	BCSE0603	Software Engineering and Design	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	Open Elective-I	2	0	0	30	20	50		50		100	2
6	BCSE0654	Computer Vision Lab	Mandatory	0	0	4				50		50	100	2
7	BCSE0653Y	Software Engineering and Design Lab	Mandatory	0	0	4				50		50	100	2
8		Departmental Elective-IV Lab	Departmental Elective	0	0	2				25		25	50	1
9	BCSAI0652	Generative AI	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 and Employability-II	Compulsory Audit	0	0	6								NA
12		MOOCs (For B.Tech. Hons. Degree)												
		TOTAL		**14**	**2**	**24**	**150**	**100**	**250**	**225**	**450**	**225**	**1150**	**25**

List of MOOCs Based Recommended Courses for Third year B. Tech Students

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	BMC0087	JavaScript Essential	Infosys Wingspan (Infosys Springboard)	19h 42m	1.5
2.	BMC0126	TechA Computer Vision Certificate	IIHT	17h 24m	1
3.	BMC0127	Certificate Program in Testing Tools	NASSCOM	30h	2

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.

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List of Departmental Electives

S. No.	Subject Codes	Subject Name	Types of Subjects	Bucket Name	Applicable Branch	Semester
1	BCSAI0611	Cloud Storage Management	Departmental Elective - IV	Cloud Computing Bucket	AI/ AIML/ DS/ M&C/ CYS	VI
2	BCSAI0611P	Cloud Storage Management Lab	Departmental Elective - IV Lab	Cloud Computing Bucket	AI/ AIML/ DS/ M&C/ CYS	VI
3	BCSIOT0613	IoT protocols and It's Applications	Departmental Elective - IV	IoT Smart Systems Bucket	AI / AIML / DS / M&C / CS / CYS	VI
4	BCSIOT0613P	IoT protocols and It's Applications Lab	Departmental Elective - IV Lab	IoT Smart Systems Bucket	AI / AIML / DS / M&C / CS / CYS	VI
5	BCSCY0613	Malware Analysis and Reverse Engineering	Departmental Elective - IV	Cyber Security Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS	VI
6	BCSCY0613P	Malware Analysis and Reverse Engineering Lab	Departmental Elective - IV Lab	Cyber Security Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS	VI
7	BCSE0614	Web Development using MEAN stack	Departmental Elective - IV	Full Stack Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS/CYS	VI
8	BCSE0614P	Web Development using MEAN stack Lab	Departmental Elective - IV Lab	Full Stack Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS/CYS	VI
9	BCSCY0612N	Blockchain and Cryptocurrency Security	Departmental Elective - V	Cyber Security Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS	VI
10	BCSAI0613	Cloud Security	Departmental Elective - V	Cloud Computing Bucket	AI/ AIML/ DS/ M&C/ CYS	VI
11	BCSIOT0614	IoT for Smart Cities	Departmental Elective - V	IoT Smart Systems Bucket	AI / AIML / DS / M&C / CS / CYS	VI
12	BCSE0615	Web Development using MERN STACK with DevOps	Departmental Elective - V	Full Stack Bucket	AI/ AIML/ IoT/ DS/ M&C/ CS/CYS	VI

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AICTE Guidelines in Model Curriculum:

A student will be eligible to get Under Graduate 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

Course Code: BCSE0502A	**Course Name:** COMPUTER NETWORKS	**L**	**T**	**P**	**C**
Course Offered in B. Tech: CSE/CS/IT /CSE(AI)/CSE(AIML)/ CSE(DS)/ CSE(CYS)/MCT /ECE/CSE(IOT)		**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	-	-	-	-
CO2	2	2	2	2	3	-	-	-	1	1	1	2	1	-
CO3	3	3	3	1	2	-	-	-	1	1	1	1	1	-
CO4	2	2	1	1	2	-	-	1	1	1	1	1	2	1
CO5	2	2	2	1	2	1	1	2	1	1	1	1	2	2

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 Module 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: BCSAI0501	**Course Name:** NATURAL LANGUAGE PROCESSING	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)		**3**	**1**	**0**	**4**

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

Course Objectives:

The objective of this course is to introduce students to the fundamental concepts and linguistic foundations of Natural Language Processing (NLP), enabling them to understand how computers process and analyze human language. The course covers essential text representation and vectorization techniques, along with methods for measuring document similarity and semantic relationships..

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

Course Code: BCSAI0512	**Course Name:** ADVANCED JAVA PROGRAMMING	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)/CSE(DS)/CS/CYS/IOT/MCT		**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	Explain the use of JDBC for integrating Java applications with relational databases and demonstrate server-side programming concepts using Servlets to handle web requests and responses.	**K2**
CO2	Analyze JSP scripting elements, expression language, and directives to evaluate their role in dynamic web page generation and application maintainability.	**K4**
CO3	Apply dependency injection concepts and core features of the Spring Framework to develop modular and maintainable Java applications.	**K3**
CO4	Analyze the MVC architecture and explain the implementation of web applications using Spring MVC and Spring Boot.	**K4**
CO5	Apply JPA concepts and RESTful APIs to perform data mapping and CRUD operations between Java objects and relational databases.	**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	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 Modules, 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:

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:

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.

NPTEL/ YouTube/ Faculty Video Link:

Unit 1	https://www.youtube.com/playlist?list=PLlhM4lkb2sEjVsbbZ_kiixY5CcR84IQUg
Unit 2	https://www.youtube.com/playlist?list=PL-XjHn7CHrmQhMkVC6KCfmsPHdklvUlQr
Unit 3	https://www.youtube.com/playlist?list=PL9ooVrP1hQOEfi91PCFQMawtBJrPpir7y
Unit 4	https://www.youtube.com/playlist?list=PL-XjHn7CHrmQhMkVC6KCfmsPHdklvUlQr
Unit 5	https://www.youtube.com/playlist?list=PLGRDMO4rOGcNSBOJOlrgQqGpIgo6_VZgR

Course Code: BCSIOT0513	**Course Name:** INTRODUCTION TO IOT	**L**	**T**	**P**	**C**
Course Offered in:		**3**	**0**	**0**	**3**

Pre-requisite: Basic Electronics and C programming

Course Objectives: To study about introduction of IoT technology, Components, architecture, network communications and applications protocols of IoT. Course also aims at understanding various hardware for IoT, programming concepts using Arduino and Raspberry Pi and study about applications of IoT.

Course Outcome: After completion of the course, the student will be able to	Bloom's Knowledge Level (KL)

CO	**Course Outcome**	**Bloom's Level**
CO1	Explain the concepts, architecture, design principles, communication models, and enabling technologies of the Internet of Things (IoT).	**K2**
CO2	Identify and compare various IoT hardware platforms, sensors, actuators, RFID technology, and embedded computing devices for IoT applications.	**K2**
CO3	Develop basic IoT applications using Arduino/Raspberry Pi and implement suitable communication technologies and protocols.	**K3**
CO4	Analyze IoT networking architectures, communication protocols, wireless sensor networks, and data aggregation techniques for efficient IoT systems.	**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	-	-	1	-	-	-	-	-	-			
CO2	3	2	1	-	2	-	-	-	-	-	-			
CO3	2	2	3	1	3	-	-	-	1	1	-			
CO4	2	3	2	2	2	-	-	-	1	-	-			
CO5	2	3	3	2	3	2	1	1	2	2	1			

Course Contents / Syllabus

Unit 1	**Introduction of IoT and Design Principles**	**9hours**

Vision, Definition, Characteristics of IoT, Components of the IoT, Conceptual Framework, Architectural Framework, Technology behind IoT,M2M Communication, IoT/M2M systems layers and design standardization, Difference between IoT and M2M, IoT Examples, Data enrichment and consolidation. Introduction to Integrated Developed Environments, Tools and Programming.

Unit 2	**Hardware Components**	**9 hours**

Sensors, different types of Sensors, Transducer, Actuators, Radio Frequency Identification (RFID) Technology. Overview of IOT supported Hardware Computational platforms such as Arduino, NetArduino, Raspberry pi, Node MCU and ARM cortex and its Architecture.

Unit 3	**Programming Arduino and Raspberry Pi**	**9 hours**

Application Protocols: Layered Architecture of IoT Protocols, Communication Technologies, Low range protocols: BLE, ZigBee. Long range protocols: LoRa and its programing. Wireless sensor networks, Wireless medium access issues, Sensor deployment & Node discovery, Data aggregation & Dissemination

Unit 4	Network & Communication Aspects in IoT	**8 hours**

Application Protocols: Layered Architecture of IoT Protocols, Communication Technologies, Low range protocols: BLE, ZigBee. Long range protocols: LoRa, Sensor deployment & Node discovery, Smart metering, e-health, Smart city automation, Automotive applications, home automation, Designing of smart streetlights in smart city, Ideation of Mini Project.

Unit 5	**IoT Applications**	**10 hours**

Smart metering, e-health, Smart city automation, Automotive applications, home automation, communicating data with H/W units, mobiles, tablets, Designing of smart streetlights in smart city. Ideation of Mini Project.

Total Lecture Hours	**45 hours**

Textbook:

S.No	Book Title	Author
1	"The Internet of Things" Pearson. 1st Edition March 2015	Michael Miller,
2	"INTERNET OF THINGS", McGraw-Hill, 2nd Edition, May 2022	Raj Kamal
3	"Internet of Things", Khanna Publications. 1st Edition Jan 2018	Jeeva Jose

Reference Books:

S.No	Book Title	Author
1	"Programming arduino next steps", 2nd Edition, Mc Graw-Hill Education 2018	Simon Monk
2	"Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2015.	Vijay Madisetti and Arshdeep Bahga
3	"Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013.	Francis daCosta
4	"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle,
5	"The Internet of Things key applications and protocols". 1st Edition Dec 2011.	Olivier Hersent, David Boswarthick, Omar Elloumi

Self-Study Content Links:		Duration (in Hrs)
MOOCs	Introduction To Internet Of Things, IIT Kharagpur https://www.nptel.ac.in/courses/106105166	30 hours approx
Video Lectures	Design of Internet of Things https://www.youtube.com/watch?v=urUBLmXFKl0&list=PLgMDNELGJ1CaBrefq-0eYatfOnoncW0y-	11 hours
Web References	https://www.cisco.com/site/us/en/learn/topics/industrial-iot/what-is-iot.html Arduino Official Documentation https://docs.arduino.cc/	8 hours

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	59 Min 2 Sec
	2. https://onlinecourses.nptel.ac.in/noc22_cs90/preview	21 Hrs
Web References	1. NIST Cryptographic Standards	2 Hrs
	2. NIST Computer Security Resource Center (CSRC)	3 Hrs 15 min
	3. RFC Editor Repository	1 Hrs
	4. OpenSSL Documentation	4 Hrs
	5. Wireshark Documentation	5 Hrs
	6. Cisco Networking Academy	3 Hrs
Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.		

Course Code: BCSAI0520	Course Name: Cloud Virtualization	L	T	P	C
Course Offered in: B. Tech. 3rd Year Departmental Elective		3	0	0	3

Pre-requisite: Introduction to Cloud Computing

Course Objectives:

1. Provide virtualization concepts to design, deploy, and manage open-source virtualized environments and cloud infrastructure.
2. Learn different types of virtualization techniques, including server virtualization, storage virtualization, network virtualization, and desktop virtualization.
3. Develop the ability to install, configure, and manage virtual machines using virtualization tools and platforms.
4. Analyze the performance, resource allocation, security, and scalability aspects of virtualized environments.
5. Gain practical knowledge of deploying and managing virtualization solutions for efficient utilization of hardware and cloud infrastructure resources.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO-1	Understand the fundamentals of virtualization technologies, hypervisors, and their role in cloud computing environments	K2
CO-2	Analyze server and desktop virtualization platforms, virtual machines, and resource allocation mechanisms.	K4
CO-3	Apply network virtualization concepts and Software-Defined Networking (SDN) techniques in virtualized environments.	K3
CO-4	Apply storage virtualization models and cloud-based storage solutions for efficient data management.	K3
CO-5	Examine various security tools and techniques for selecting suitable security solutions in cloud 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	PSO3
CO1	3	1	–	–	1	–	–	–	–	–	–	-	-	-
CO2	2	3	2	1	3	–	–	–	–	–	1	-	1	-
CO3	2	2	3	2	3	–	–	–	1	–	–	1	1	-
CO4	2	2	3	2	3	–	–	–	–	–	1	1	-	1
CO5	2	3	2	1	2	–	–	1	–	–	2	-	-	1

Course Contents / Syllabus

Module-1	Introduction to Virtualization Technologies and Hypervisors	08 hours

Virtualization and cloud computing: Evolution of virtualization technologies, Limitations and challenges, Need of virtualization, benefits, limitations, Level of Virtualization, Types of Virtualizations, Session-based virtualization, Guest OS and host OS
Hardware virtualization: Full virtualization, Partial virtualization, Paravirtualization, Hardware assisted Virtualization
Software virtualization: Hypervisor, role of hypervisors, Hypervisor Architecture, Types of Hypervisors (Type-1, Type-2), Virtualization Architecture, Virtual Box, VMware.

Module-2	Server and Desktop Virtualization	09 hours

Virtual Machine: Introduction, Types of virtual machines, Server Virtualization, types of server virtualization, Physical vs virtual servers, Resource allocation (CPU, memory, storage and I/O). Business Cases for Server Virtualization, Uses of Virtual Server Consolidation, Selecting Server Virtualization, Platform-Desktop Virtualization, Remote access protocols (RDP, ICA), Centralized vs distributed desktop environments,
Types of Desktop Virtualization: VDI, EC2.
VMware ESXi, Microsoft Hyper-V, KVM, QEMU, XenServer Installation and configuration.

Module-3	Network Virtualization	10 hours

Network Virtualization: Concept and Evolution of network virtualization Types, Overlay and underlay networks, VLAN Vs. VXLAN, VMware NSX, Virtual Network Interface Cards (vNICs),
Software-Defined Networking (SDN): SDN architecture and control plane/data plane, Virtual switches, Virtual Routing, OpenFlow protocol, SDN controllers (e.g., ONOS, OpenDaylight), Virtual Private Cloud (Public, Private).

Module-4	Storage Virtualization	10 hours

Storage Virtualization: Introduction, Benefits, Types of Storage: Direct Attached Storage, Storage Area Network, Network Attached Storage, RAID), Virtualization-Block, File-Address space Remapping, Risks of Storage,
Types of Storage Virtualization: Block-level virtualization, File-level virtualization, Object storage virtualization. Storage Provisioning Techniques: Thick provisioning vs thin provisioning, Storage tiering (hot, warm, cold data).
Data Management Techniques: Data deduplication, Data compression, Data replication (synchronous and asynchronous), Data migration, Backup and Recovery.
Storing data in the cloud: S3 and Glacier, EBS and EFS, Using Relational Database Service: RDS, NoSQL Database Service: DynamoDB.

Module-5	**Security & Trends**	**08 hours**

Threats and Vulnerabilities: Hypervisor attacks and vulnerabilities, VM escape and VM hopping, Denial of Service (DoS), Insider Secure boot, VM Security, VM isolation and sandboxing, Network Security, Data Security, Virtualization in edge and hybrid c virtualization, Virtual firewalls and security policies.
Coud Security: firewall, IAM, Multi-Factor Authentication, Data Encryption (at rest and in-transit)
Emerging trends: Serverless computing, Function-as-a-Service (FaaS), Confidential computing.

	Total Lecture Hours	**45 hours**

Textbook:

Book Details	**Authors Name**
Virtualization Essentials, Wiley India Pvt. Ltd., 2nd Edition, 2016	Matthew Portnoy
Virtual Machines: Versatile Platforms for Systems and Processes, Morgan Kaufmann Publishers, 1st Edition, 2005	James E. Smith and Ravi Nair
Professional Xen Virtualization, Wiley Publishing Inc., 1st Edition, 2008	William von Hagen

Reference Books:

Book Details	**Authors Name**
Virtualization: From the Desktop to the Enterprise, Apress Publications, 1st Edition, 2005	Chris Wolf, Erick M. Halter
Cloud Native Security, O'Reilly Media, 1st Edition, 2021	Mike Ryan
Cloud Computing Security: Concepts and Practice, Emereo Publishing, 1st Edition, 2013,	Ivanka Menken

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	Mastering VMware vSphere 6.5	16Hrs 08Min
Video Lectures	https://www.youtube.com/watch?v=7m3f-P-WWbg (Edureka) https://www.youtube.com/watch?v=wOBA6Wri0Fg https://www.youtube.com/watch?v=b_krXFeOEDU youtube.com/watch?v=2LaAJq1lB1Q&t=147s&pp=0gcJCQYLAYcqIYzv	00Hrs 25Min 01Hrs 51Min 03Hrs 48Min 10Hrs 17Min
Web References	https://awsacademy.instructure.com/courses/ https://www.getyoureducation.net/course/virtualization-sharing-cloud-resources?utm_source=chatgpt.com	

Course Code: BCSAI0523	Course Name: Big Data	L	T	P	C
Course Offered in: B. Tech. 3rd Year Departmental Elective		3	0	0	3

Pre-requisite: Introduction to Cloud Computing

Course Objectives:

Provide virtualization concepts to design, deploy, and manage open-source virtualized environments and cloud infrastructure. Learn different types of virtualization techniques, including server virtualization, storage virtualization, network virtualization, and desktop virtualization. Develop the ability to install, configure, and manage virtual machines using virtualization tools and platforms. Analyze the performance, resource allocation, security, and scalability aspects of virtualized environments. Gain practical knowledge of deploying and managing virtualization solutions for efficient utilization of hardware and cloud infrastructure resources.

Course Outcomes – After completion of this course students will be able to:

CO 1	Identify Big Data and relevance of Big Data Analytics.	K2
CO 2	Analyze Map Reduce and demonstrate its use in features extraction.	K4
CO 3	Explain the YARN and HDFC in Data management	K2
CO 4	Articulate the concept of Cloud Computing and evolution of cloud computing with characteristics.	K3
CO 5	Analyze the components of open stack & Google Cloud platform	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	1	-	2	1	-	-	-	1	-	3	2	1
CO2	3	3	3	2	3	1	-	-	1	1	-	3	3	2
CO3	3	3	3	3	3	1	1	-	1	1	-	3	3	3
CO4	3	3	2	2	3	2	1	-	1	1	1	3	3	2
CO5	3	3	3	3	3	2	2	1	2	2	2	3	3	3

Course Contents / Syllabus

Unit-1 | **INTRODUCTION TO BIG DATA** | **08 hours**

Types of digital data, history of Big Data innovation, introduction to Big Data platform, drivers for Big Data, Big Data architecture and characteristics, 5 Vs of Big Data, Big Data technology components, Big Data importance and applications, Big Data features, Big Data Analytics, modern data analytic tools.

Introduction to Cloud Computing: Definition of Cloud, Evolution of Cloud Computing, Underlying Principles of Parallel and Distributed Computing, Cloud Characteristics.

Unit-2 | **HADOOP** | **08 hours**

Hadoop: History of Hadoop, Apache Hadoop, the Hadoop Distributed File System, components of Hadoop, data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, Hadoop Echo System.

Map Reduce: Map-Reduce framework and basics, how Map Reduce works, anatomy of a Map-Reduce job run, failures, job scheduling, shuffle and sort, task execution, Map Reduce types, input formats, output formats, Map Reduce features, Real-world Map Reduce.

Hadoop Eco System and YARN: Hadoop ecosystem components, Hadoop 2.0 New Features, MRv2, YARN

Unit-3 | **HDFS (Hadoop Distributed File System)** | **08 hours**

Design of HDFS, HDFS concepts, benefits and challenges, file sizes, block sizes and block abstraction in HDFS, how does HDFS store, read, and write files, Flume and Scoop, Hadoop archives, Hadoop I/O: compression, serialization, Avro and file-based data structures. Hadoop Eco- System Frameworks: PIG
, HIVE , HBASE , ZOOKEEPER. Importing and Handling Relational Data in Hadoop using Sqoop , Scala , spark.

Unit-4 | **CLOUD TECHNOLOGIES AND ADVANCEMENTS HADOOP** | **08 hours**

MapReduce, Cloud overview & characteristics, cloud service model (iaas, paas, saas) , cloud deployment model (public, private, hybrid), Google cloud platform (gcp) infrastructure overview create gcp account & console overview, Virtual Box , Google App Engine, Programming Environment for Google App Engine Open Stack Federation in the Cloud, our Levels of Federation, federated

Services and Applications, Future of Federation.		
Unit-5	**VIRTUAL NETWORKS**	**08 hours**
virtual private cloud (vpc) & types, subnets , ip addresses (public/private), nic ,routes & route table , firewalls , network topology options . Google cloud storage overview & Structure: cloud datastore, cloud bigtable : nosql big data service bigquery basics, how to use machine learning with Bigquery.		
	Total Lecture Hours	**40 hours**

Text Books:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013. 2. Big-Data Black Book, DT Editorial Services, Wily India
2. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012. 5. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012. 7. Lars George, "HBase:The Definitive Guide", O'Reilley, 2011.

Reference Books:

1. Alan Gates, "Programming Pig", O'Reilley, 2011.
2. Big-Data Black Book, DT Editorial Services, Wily India
3. Viktor Mayer-Schonberger, ennethCukier, Big Data: A Revolution that will transform how we live,work and think.

Links: NPTEL/You Tube/Web Link

Introduction to Business Intelligence - YouTube

Business Intelligence Tutorial - YouTube

What Is Power BI? | Introduction To Microsoft Power BI | Power BI Training | Edureka - YouTube

https://www.tableau.com/academic/students

Top 10 Data Visualization Tools in 2020 | Best Tools for Data Visualization | Edureka - YouTube Learn Data Visualization Using Tableau | Tableau Tutorial | Tableau | Edureka Live - YouTube

Course Code: BCSIOT0514	**Course Name: Privacy and Security in IoT**	**L**	**T**	**P**	**C**
Course Offered in:		**3**	**0**	**0**	**3**

Pre-requisite: Python, IoT fundamentals

Course Objectives:

Course Objectives: The objective of the course is to understand the importance of security and privacy in IoT systems and apply fundamental security techniques to protect IoT devices and data.

Course Outcome: After completion of the course, the student will be able to		
CO1:	Understand fundamental concepts of IoT security, including CIA triad, security architecture, and common threats in IoT environments.	K1
CO2:	Apply techniques to identify device-level vulnerabilities, firmware risks, and lightweight cryptography in IoT systems.	K3
CO3:	Apply secure communication techniques and protocols to mitigate network attacks	K3
CO4:	Implement authentication, authorization, and trust mechanisms in IoT Devices.	K5
CO5:	Analyze secure IoT solutions using real-world case studies and vulnerability assessment.	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**	3	1	2
CO2	**3**	**3**	**2**	**1**	**2**	–	–	–	–	–	**2**	2	1	1
CO3	**3**	**2**	**2**	**1**	**3**	–	–	–	–	–	**2**	2	2	2
CO4	**3**	**2**	**3**	**2**	**2**	–	–	**1**	**1**	–	**2**	2	1	1
CO5	**2**	**3**	**3**	**2**	**2**	**1**	–	**1**	**1**	**1**	**2**	3	1	1

Course Contents / Syllabus

Unit 1	**Introduction to IoT Security**	**08 hours**

Introduction to IoT Security, Importance of security in IoT, Basic security concepts (Confidentiality, Integrity, Availability) , Common threats in IoT devices, IoT Security Architecture, Examples of IoT security issues

Unit 2	**IoT Devices and Security**	**10 hours**

Introduction to firmware and updates, Risks in connected devices, Attack types (Device-based attacks, Sensor attacks, , Firmware attacks), Device-level security basics, Lightweight Cryptography (AES, ECC, SHA)

Unit 3	**Network and Communication Security**	**09 hours**

Basics of IoT communication (WiFi, Bluetooth), Secure data transmission (encryption basics), Common network attacks (e.g., sniffing, spoofing), Introduction to secure communication protocols, BLE Security

Unit 4	**Authentication, Authorization & Trust Management**	**10 hours**

Authentication Techniques (Password-based, Token-based, Certificate-based, Biometric-based, Authorization), Role-Based Access Control (RBAC) , Attribute-Based Access Control (ABAC), Device Identity Management, Secure Device Provisioning Trust Management in IoT

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

Vulnerability Scanning of IoT Device, Privacy-preserving Sensor Data Transmission, Mirai Botnet Attack (2016), Itron Smart Infrastructure Cyberattack (2026), Hikvision Camera Vulnerability Exploitation (2025)

	Total Lecture Hours	**45 hours**

Textbook:

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things A Hands on Approach, Universities Press, 2015Rap Payne, *Beginning App Development with Flutter*, Apress, 2019
2. Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Morgan Kaufmann, 2016
3. Security and Privacy in Internet of Things Iots: Models, Algorithms, and Implementations,2016

Reference Books:

1. Peter Waher, Learning Internet of Things, Packt Publishing, 2015
2. Eran Boudjnah, *Clean Architecture for Android*, BPB Publications, 2022
3. Deepak Gupta, Fundamentals of IoT and Wearable Technology Design, CRC Press, 2021
4. Fei Hu, Security and Privacy in Internet of Things IoTs Models Algorithms and Implementations, CRC Press, 2016

Self-Study Content Links:	**Number of hours**
MOOCs https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013301335203848192100 95_shared/overview	20
Video Lectures: 1. https://nptel.ac.in/courses/106105166 2. https://www.youtube.com/watch?v=dlQoXrAq8IM	15
Web References 1. https://www.ibm.com/think/topics 2. https://www.hivemq.com/blog/mqtt-essentials-part-1-introducing-mqtt/	10

Course Code: BCSCY0515	Course Name: Ethical Hacking	L	T	P	C
Course Offered in: CSE (Cyber Security)		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)
CO 1	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
CO 3	Identify and examine security vulnerabilities in web applications using ethical hacking	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	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	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.			

Course Code: BCSE0514	**Course Name:** DESIGN PATTERNS	**L**	**T**	**P**	**C**
Course Offered in: CSE/CS/CSR-R/M.TECH(INT) /IT//CSE(AI)/CSE(AIML)/CSE(DS)/CSE(CS)		**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		**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)

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

1. Eric Freeman, Elisabeth Freeman, Kathy Sierra, Bert Bates Head First Design Patterns, 2004, O'Reilly
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides Design Patterns: Elements of Reusable Object oriented Software Addison-Wesley, 1995.

Reference Books:

1. Design Patterns Pearson Education by Erich Gamma
2. Patterns in JAVA Volume -I by Mark Grand, Wiley Dream

NPTEL/ YouTube/ Faculty Video Link:

Unit-1	https://www.youtube.com/watch?v=ysoC8S96pZU&list=PLBBog2r6uMCResrR48HziFtNx4-BDOmU0
Unit-2	https://www.youtube.com/playlist?list=PLmCsXDGbJHdhULIoYzIIIeFFJSo1NlMbN
Unit-3	https://www.youtube.com/watch?v=dCWuXDBRFtk&list=PL2NZAYdLkYvhFnqbvLbwf4ZM4rH99Jap6
Unit-4	https://www.youtube.com/watch?v=a4u_caEWTR8&list=PL2NZAYdLkYvg 5SpIDMlRopz-dD_KsIX
Unit-5	https://www.youtube.com/watch?v=a4u_caEWTR8&list=PL2NZAYdLkYvg 5SpIDMlRopz-dD_KsIX

LAB Course Code: BCSE0552A	**Course Name:** COMPUTER NETWORKS LAB	**L**	**T**	**P**	**C**
Course Offered in: CSE/CS/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 basic networking concepts using CISCO Packet Tracer and device. Develop practical skills in IP addressing, Subnetting, V LAN, Routing, Switching and wireless networking. Learn to configure and manage network services such as DHCP, NAT, ACLs, and inter VLAN Routing.Perform network testing, Troubleshooting and connectivity verification using CISCO IOS CLI commands and diagnostic tools. Prepare students for industry-oriented networking rules and certification such CISCO CCNA by providing hands-on networking experience.

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, Ether Channel, 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	3	2	1
CO2	3	3	3	2	3	1	-	-	2	2	1	3	2	2
CO3	3	3	2	3	3	1	-	1	2	2	1	3	3	2

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

S.N.	List of Program	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.	CO1
11	VLAN Configuration: Create VLANs and assign ports to segment network traffic.	CO2
12	Inter-VLAN Routing: Enable communication between VLANs using a 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.		

LAB Course Code: BCSAI0551	**Course Name:** NATURAL LANGUAGE PROCESSING LAB	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)		**0**	**0**	**2**	**1**

Pre-requisite: Machine Learning/ Deep Learning

Course Objectives: The objective of this course is to provide students with a strong foundation in Natural Language Processing (NLP) by introducing fundamental and advanced techniques for processing, analyzing, and understanding human language. The course enables students to apply text preprocessing methods, linguistic analysis, feature extraction, text representation, and machine learning algorithms for solving real-world language processing problems.

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

Course Code: BCSAI0512P	**Course:** ADVANCE JAVA PROGRAMMING LAB	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)		**0**	**0**	**2**	**1**

Pre-requisite: Java

Course Objectives:

Apply programming and database concepts to develop software applications. Design and develop web-based applications using modern technologies. Analyze, implement, and manage enterprise-level software solutions and web services.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain the concepts of JDBC architecture, database connectivity, SQL statements, PreparedStatement, and transaction management in Java applications.	**K2**
CO2	Apply JDBC APIs and SQL queries to create, retrieve, update, and manage data in relational databases using Java programs.	**K3**
CO3	Develop Servlet-based web applications to process client requests, interact with databases, and generate dynamic web pages.	**K3**

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	3	2	2	3	-	-	-	-	-	1	3	2	2
CO2	3	2	3	2	3	-	-	-	2	2	1	3	3	2
CO3	2	2	3	1	3	-	-	-	2	2	1	2	3	3

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

S.No.	List Of Programs	CO
1.	Install a database (MySQL or Oracle). Program to illustrate JDBC connectivity. Program for maintaining database by sending queries.	CO1
2.	Write program to create a demo table emp having fields is, name, city and insert two rows by using JDBC.	CO1
3.	Write a Java program using Statement to create a table Students with fields id, name, age, and grade.	CO1
4.	Write a Java program using Statement to insert multiple records into the Students table	CO1
5.	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.	CO1
6.	Write a Java program using PreparedStatement to delete student records where grade is below a given threshold.	CO1
7.	Write a Java program using PreparedStatement to insert multiple records efficiently using batch execution.	CO1
8.	Write a Java program to call a stored procedure that calculates the total salary of employees in a given department.	CO1
9.	Implement a java program using TCL statements commit (), rollback(), setAutoCommit(), setSavepoint(), and releaseSavepoint() method on Employee table.	CO1
10.	Write a servlet program to select the details of an employee (emp id, empname, empadd,empphone) and display on browser in appropriate format.	CO1
11.	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.	CO1
12.	Implement a servlet program that receive two inputs Name and Password from HTML page and display on the browser.	CO1

13.	Implement a servlet program that redirect a request to Google.com.	CO1
14.	Implement session handling concept by using HTTPSession object.	CO1
15.	Implement session handling concept by using URL rewriting method.	CO1
16.	Create a servlet Program which displays cookie id with the help of session handling concepts.	CO1
17.	Implement a program that takes three input as: User Name, User Password and User Mobile from html form and access these data by using servlet also display these details on browser.	CO1
18.	Implement a servlet program to select the details of an employee (emp id, empname, empadd, empphone) and display on browser in appropriate format.	CO1
19.	Implement a program to add any data on cookies and also access these data from cookies.	CO1
20.	Implement servlet a program to implement the redirection of any request to other resources such as an html file.	CO1
21.	Create a table which should contain at least the following fields: name, password, email-id, phone number Implement a java program/servlet/JSP to connect to that database and extract data from the tables and display them. Insert the details of the users who register with the web site, whenever a new user clicks the submit button in the registration page.	CO1
22.	Design and implement a simple servlet book query such as book_id, book_name, book_author and published date with the help of JDBC & SQL. Create on ODBC/latest driver link, Compile & Execute JAVA JDBC Socket.	CO1
23.	Design a simple application program using Servlet and Database 1. Simple login form 2. Customer Feedback Form 3. Admission Form 4. Student Mark Sheet	CO1
24.	Assume four users user1, user2, user3 and user4 having the passwords pwd1, pwd2, pwd3 and pwd4 respectively. Implement a servlet for doing the following. Create a Cookie and add these four-user id's and passwords to this Cookie.2. Read the user id and passwords entered in the Login form and authenticate with the values available in the cookies.	CO1
25.	Implement all JSP scripting element (scriptlet, expression and declaration).	CO1
26.	Implement all JSP directive element (page, include and taglib).	CO1
27.	Implement JSP program that calculates factorial values for an integer number, while the input is taken from an HTML form	CO1
28.	Implement a JSP program for displaying basic arithmetic functions that calculates Powers of 2 for integers in the range 0-10.	CO1
29.	Implement a JSP (EmpBeanTest.jsp) page that illustrates how to access a JavaBean class by using all required action tags from a JSP page.	CO1
30.	Implement a JSP program to display strings that shows a sample order form in restaurant.	CO1
31.	Implement a JSP program to upload file into server.	CO1
32.	Implement a JSP program to count no. of visitors once user clicks on submit button on webpage.	CO1
33.	Implement a JSP program to illustrate session tracking for printing the string array (color) through index.jsp page and print the length of the selected color through another page print.jsp.	CO1
34.	Implement a JSP program for arithmetic exception error handling by using html page, jsp page, and errorPage, isErrorPage directives.	CO1
35.	Implement a JSP program to display current date & time of your system.	CO1
36.	Implement a JSP page to retrieve data from HTML into JSP and display information on browser.	CO1
37.	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?	CO2
38.	Implement a JSP program to validate username and password in sample order form.	CO2
39.	Implement a JSP program to select record from database Employee.	CO2
40.	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.	CO2
41.	Create a simple Spring project using Maven that prints a welcome message using a Spring Bean.	CO2
42.	Demonstrate the use of ApplicationContext as IOC container to load beans.	CO2

43.	Define multiple Spring Beans and manage them using XML-based configuration.	CO2
44.	Demonstrate Constructor-based DI in Spring using Injecting dependencies using constructor.	CO2
45.	Implement Setter-based DI to inject a service bean into another.	CO2
46.	Demonstrate Field Injection using @Autowired annotation.	CO2
47.	Configure beans using Java-based configuration with @Configuration and @Bean.	CO2
48.	Use Component Scanning and @Component, @Service, @Repository.	CO2
49.	Demonstrate Annotation-based configuration with full @Configuration and @ComponentScan.	CO2
50.	Create a simple JDBC DAO using Spring JDBC Template to fetch data from H2 database.	CO2
51.	Implement Insert and Update operations using Spring JDBC.	CO2
52.	Handle exceptions and use Row Mapper with Spring JDBC for object mapping.	CO2
53.	Set up a Maven project structure for a Spring app and manage dependencies using pom.xml.	CO2
54.	Integrate external dependency (like MySQL connector) and test project compilation.	CO2
55.	Create a modular app with User Service, injected via constructor, and use annotations (@Component, @Autowired).	CO2
56.	Develop a full Spring app managing user profiles with Component Scanning, Java-based Config, JDBC for persistence, tested via H2 DB.	CO2
57.	Develop a Spring application utilizing Dependency Injection, component scanning, and annotation-based configuration within a Maven-based setup.	CO2
58.	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.	CO2
59.	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.	CO2
60.	In a product catalog system, pass a product's name and price from the controller to the view for display." Program Goal: Use Model or ModelMap in the controller to send data to JSP.	CO2
61.	"Create a login form where the user inputs their username. Display a welcome message using data passed from the form." Program Goal: Use @RequestParam to capture form input and display it in JSP.	CO2
62.	Build a registration form for students and bind form data to a Student object." Program Goal: Use @ModelAttribute to map form fields to a model bean.	CO2
63.	In a tourism site, display a list of popular destinations in a JSP page returned from a controller." Program Goal: Configure JSP view resolution in spring-servlet.xml and use JSTL to display dynamic content.	CO2
64.	Create a feedback form where name and message fields are mandatory. Validate the form input and show error messages." Program Goal: Use Spring Form tag library and BindingResult to perform simple validation.	CO2
65.	Design a student records system that fetches student data from a MySQL database and displays it using Spring MVC." Program Goal: Connect Spring MVC to a database using Spring JDBC and show data in a JSP.	CO2
66.	Case Study: "Your team is building a microservice for user registration. Initialize a basic Spring Boot application structure." Program Goal: Use @SpringBootApplication, run the app, and understand the auto-configured structure.	CO2
67.	Case Study: "You want to quickly start a RESTful service for a contact book using Spring Initializer." Program Goal: Generate a Spring Boot project with Spring Web and Spring Boot DevTools.	CO2
68.	Case Study: "In a university portal, configure a controller without any XML and rely on auto-configuration." Program Goal: Use @RestController, @RequestMapping, and rely on application.properties.	CO2
69.	Case Study: "Build a student management module that stores data in an in-memory H2 database." Program Goal: Integrate Spring Data JPA with H2, create an entity, repository, and test data storage.	CO2
70.	Case Study: "Your library website needs to show a homepage with contact info and a static banner." Program Goal: Serve HTML from /templates and static images/CSS from /static.	CO2
71	Case Study: "Create a contact form submission endpoint. Use GET to load the form and POST to save data." Program Goal: Implement separate methods for @GetMapping and @PostMapping.	CO2

72	Case Study: "You want to reduce boilerplate in your Book class (getters, setters, constructors)." Program Goal: Use @Data, @NoArgsConstructor, @AllArgsConstructor from Lombok.	CO2
73	Case Study: "Develop a course catalog system that allows adding, listing, updating, and deleting courses." Program Goal: Build full CRUD using Spring Boot, Spring Data JPA, H2, and REST endpoints.	CO2
74	You are designing a simple library system. Begin by creating an entity Book and use JPA to persist data to a relational database.	CO3
75	In a school database system, annotate an @Entity class Student with appropriate JPA annotations like @Id, @GeneratedValue, @Column.	CO3
76	In a hospital management system, create a one-to-one relationship between Patient and Medical Record using JPA	CO3
77	Implement CRUD operations on MYSQL database using spring data rest with POSTMAN client.	CO3
78	Implement CRUD operations on POSTGRESQL database using spring data rest with POSTMAN client.	CO3
79	Develop a system for online courses where one Instructor can have many Courses. Model this using JPA annotations.	CO3
80	Build a college management system where Students can enroll in multiple Courses. Implement many-to-many using JPA.	CO3
81	In a retail system, expose CRUD operations for Product entity using Spring Boot REST API.	CO3
82	Develop an employee management system that performs Create, Read, Update, and Delete operations using JpaRepository and exception handling. Document the RESTful APIs using Swagger Open API.	CO3
83	In a book store app, compare the use of CrudRepository vs. JpaRepository for managing Book entities. Document the RESTful APIs using Swagger Open API.	CO3
84	In a weather app, build an API that serves both JSON and XML responses using appropriate Spring annotations. Document the RESTful APIs using Swagger Open API.	CO3
85	After building a student API, demonstrate how to test CRUD endpoints using Postman including headers and body format.Also check how they handle exceptions. Document the RESTful APIs using Swagger Open API.	CO3
86	Once your API is ready, deploy the project on localhost using Spring Boot and test endpoints in a browser or Postman. Document the RESTful APIs using Swagger Open API.	CO3
87	Simulate a simplified Netflix system: design entities like User, Content, and Watch History using JPA relationships, and expose REST APIs for user registration and content tracking. Also show the api versioning techniques. Document the RESTful APIs using Swagger Open API.	CO3
88	You are designing a simple REST API for a library system. Begin by creating an OpenAPI specification to document a Book resource with endpoints to add, view, update, and delete books. Use the OpenAPI Specification to define request and response schemas.	CO3

Course Code: BCSIOT0513P	**Course Name:** INTRODUCTION TO IOT LAB	**L**	**T**	**P**	**C**
Course Offered in: CSE(IoT)		**0**	**0**	**2**	**1**

Pre-requisite: Basic Electronics and C programming

Course Objectives: To familiarize the students to the basics of Internet of things, sensors, development board, actuators, hardware and protocols.

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Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Describe the functionality of computing, sensing and actuating components of Internet of things.	K1
CO2	Develop IoT applications using Arduino IDE.	K6

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

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

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

Lab No.	Unit	Title of Program	CO Mapping
1	1	Installation of Arduino IDE and introduction to tools, assembly and libraries.	CO 1
2	1	Getting Programming board Info and configure boot loader settings using Arduino IDE.	CO 1
3	1	Study and design IoT reference architecture for IoT based applications like Smart home	CO 1
4	2	Study Hardware Architecture and Pin Out of Arduino UNO Board. Compare Arduino Uno Arduino Nano and Arduino Mega. Identification of their use case according to given scenario.	CO 1
5	2	Study Hardware Architecture and Pin Out of Node MCU and ESP8266. Identification of their use case according to given snapshot.	CO 1
6	2	a. Study Pin out Architecture of Sensors and actuators b. DHT 11 Sensor c. MQ 135 Sensor d. MQ 7 Sensor e. MQ 3 Sensor f. Ultrasonic Sensor HC-04 g. Rain Sensor h. Soil moisture Sensor i. PIR Sensor j. LDR Sensor k. Line Sensor l. Colour Sensor m. Servo Motor	CO 1

		n. Relay	
7	3	a. Working with structures using Arduino IDE b. Working with Variables using Arduino IDE c. Working with Flow control using Arduino IDE d. Working with Digital i/o using Arduino IDE e. Working with Analog i/o using Arduino IDE f. Working with Time function using Arduino IDE g. Working with Math function using Arduino IDE h. Working with Random function using Arduino IDE i. Working with Serial communication using Arduino IDE j. Working with loops and control statements using Arduino IDE k. Working with PinMode function using Arduino IDE l. Working with analog Read, analog Write, digital Read, digital Write using Arduino IDE m. Blinking LED Program using Arduino Uno	CO 2
8	3	"Write a program using Arduino uno to generate a random number in between 0 to 25. Use 4 LEDs (Red, Green, Blue, Yellow) and design LED patterns as (i) if random number is less than 5 then only Red LED should glow. (ii) if random number is in between 5-10 then only Blue LED should glow. (iii)if random number is in between 11-20 then only Yellow LED should glow. (iv) if random number is greater than 20 then only Green LED should glow." "Write a program using Arduino uno for addition of digits of a user defined number. Example: number is 257 then output should be 14." Write a program to take LED color as input from user and glow that LED using Arduino Uno.	CO 2
9	3	Interfacing of DHT 11 Sensor with Arduino Uno. Implement LED mechanism for notifying rise in temprature. Interfacing of MQ 135/MQ7 Sensor with Arduino Uno. Implement alarm mechanism for notifying rise in amount of hazardious gases in air. Interfacing of MQ 3 Sensor with Arduino Uno. Implement alarm mechanism for checking amount of alcohol in the air.	CO 2
10	3	a. Interfacing of Ultrasonic Sensor HC-04 with Arduino Uno. b. Interfacing of Rain Sensor with Arduino Uno. Implement buzzer mechanism as the sensor identify rain. c. Interfacing of Soil moisture Sensor with Arduino Uno. d. Interfacing of PIR Sensor with Arduino Uno. e. Interfacing of LDR Sensor with Arduino Uno. f. Interfacing of LCD with Arduino Uno g. Interfacing of I2C LCD with Arduino Uno	CO 2
11	4	a. Interfacing Bluetooth Module with Arduino Uno b. Connecting Node MCU with Wi-fi Hotspots using Arduino IDE c. Interfacing of DHT 11 Sensor with Node MCU d. Interfacing of MQ 135 Sensor with Node MCU e. Interfacing of MQ 7 Sensor with Node MCU f. Interfacing of MQ 3 Sensor with Node MCU	CO 2
12	4	a. Interfacing of Ultrasonic Sensor HC-04 with Node MCU b. Interfacing of Rain Sensor with Node MCU	CO 2

		c. Interfacing of Soil moisture Sensor with NodeMCU d. Interfacing of PIR Sensor with Node MCU e. Interfacing of LDR Sensor with Node MCU	
13	5	a. Sending Data to Thingspeak Cloud Server using Node MCU b. Detection of LPG Gas using MQ6 and Node MCU. Notify Thing speak server that "LPG gas Leakage has been detected".	CO 2
14	5	Controlling LED with Node MCU using Blynk cloud App.	CO 2
			Total Hours: 30 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.	

LAB Course Code:	LAB Course Name: Cloud Virtualization Lab	L	T	P	C
Course Offered in: B. Tech. 3rd Year Departmental Elective Lab		0	0	2	1

Pre-requisite: Introduction to Cloud Computing

Course Objectives:

Learn to provide students with practical experience in using cloud services and tools. This involves setting up virtual machines, storage solutions, databases, and networking configurations. Understand and implement different virtualization techniques including server, storage, and network virtualization. Gain hands-on experience in creating and managing virtualized cloud environments and resource allocation. Analyse the performance, scalability, and security aspects of virtualization in cloud computing environments. Apply virtualization technologies to optimize hardware utilization, system management, and cloud infrastructure deployment.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO-1	Configuration of virtualization platforms such as VirtualBox, VMware ESXi, and Hyper-V	K3
CO-2	Analyze virtual networking and storage using tools like VPC and cloud services (S3, EBS, RDS).	K4
CO-3	Apply security features like Firewalls and IAM along-with auto-scaling and its policies.	K3

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	2	1	2	1	3	–	–	–	1	–	–	-	1	-
CO2	2	3	2	2	3	–	–	–	1	–	1	1	1	-
CO3	2	2	3	2	3	–	–	1	–	–	1	-	-	1

List Of Practical's		CO
1	Creation of Virtual Machines using Virtual Box	CO1
2	Configuration of VMware ESXi / Hyper-V Type-1 hypervisor and explore its interface and VM deployment capabilities.	CO1
3	Create and configure Linux/Windows EC2 instances with key pairs and security groups.	CO1
4	Start, stop, reboot, terminate, and connect to EC2 instances via SSH or RDP.	CO1
5	Monitor CPU, disk, and network metrics of a virtual instance.	CO1
6	Configure subnets, route tables, internet gateway, and NAT for a Virtual private cloud setup.	CO2
7	Create S3 buckets, upload/download files, set access policies, and enable versioning.	CO2
8	Create, attach, detach, and snapshot EBS volumes.	CO2
9	Set up a MySQL/PostgreSQL database using Amazon RDS and connect it to an application.	CO2
10	Configure Security Groups for a Virtual private cloud setup.	CO3
11	Create IAM users/groups, assign policies, and demonstrate fine-grained access control.	CO3
12	Configure launch templates, auto scaling groups, and scaling policies for an EC2 virtual environment.	CO3

Total Hours: 30 hrs.

Course Code: BCSML0555A	**Course Name:** DEEP LEARNING	**L**	**T**	**P**	**C**
Course Offered in: AI/AIML		**0**	**0**	**6**	**3**

Pre-requisite: Python, Machine Learning

Course Objectives:

The objective of this course is to provide students with a strong foundation in Artificial Neural Networks (ANN) and Deep Learning concepts, enabling them to understand the principles and architectures of modern neural network models. The course focuses on developing Convolutional Neural Network (CNN) models for image classification tasks and implementing advanced Deep Learning techniques such as object detection and Recurrent Neural Network (RNN) models for sequential data processing. Students will also explore Autoencoders and feature extraction methods to learn efficient data representation techniques.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Knowledge Level (KL)**
CO-1	Analyze ANN models and evaluate their performance metrics.	K4
CO-2	Examine CNN models for multi-class image classification.	K4
CO-3	Apply deep learning techniques for object detection and recognition.	K3
CO-4	Implement RNN models for time series forecasting and sequence analysis.	K4
CO-5	Apply dimensionality reduction techniques for feature extraction and data representation.	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	2	1	1	1	-	2	1	2	3	3
CO2	3	3	2	2	3	-	-	-	1	1	1	3	3	3
CO3	3	3	3	2	3	-	-	-	2	1	1	3	3	3
CO4	2	3	2	2	2	-	-	1	2	1	1	3	3	3
CO5	2	2	3	2	3	-	-	-	1	1	1	3	3	3

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UNIT-1 INTRODUCTION — **16 hours**

Artificial Neural Network: Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: Single layer and Multilayer feed forward networks, Various learning techniques; Perception and Convergence rule, Hebb Learning. Perceptron's, Multilayer perceptron, Gradient descent and the Delta rule, Multilayer networks, Derivation of Backpropagation Algorithm, Introduction to Deep Learning. Regularization for Deep Learning -Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stopping, Dropout, Batch Normalization.

UNIT-2 CONVOLUTION NEURAL NETWORK — **16 hours**

Introduction to Computer Vision and CNN, Train a simple convolutional neural net, Explore the design space for convolutional nets, Pooling layer motivation in CNN, Padding and Edge Detection, Strided Convolution, Design a convolutional layered application, Understanding and visualizing a CNN, Transfer learning and fine-tuning CNN, Image classification, Text classification, Image classification and hyper-parameter tuning.

UNIT-3 DETECTION & RECOGNITION — **16 hours**

Object Detection Fundamentals: Bounding Box and Localization, IoU; Evaluation metrics: Precision, Recall, mAP; Real-Time Detection: YOLO, SSD; Advanced Object Detection Models: YOLOv8, RetinaNet; Object Tracking: Tracking by Detection, Algorithm: SORT, Deep SORT

UNIT-4 RECURRENT NEURAL NETWORKS — **16 hours**

Sequential Data, Sequence models, Recurrent Neural Network Model, Notation, Back-propagation through time (BTT), Different types of RNNs, Language model and sequence generation, Sampling novel sequences, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM), Bidirectional RNN, Deep RNNs

UNIT-5 AUTO ENCODERS IN DEEP LEARNING — **08 hours**

Definition and Motivation, Architecture of Autoencoder, Loss Functions in Autoencoders, Type of Autoencoder, Variational Autoencoder, Stacked auto-encoders, Sequence Autoencoder Application of Autoencoder.

Total Lecture Hours — **72 hours**

Textbook:

Book Details	**Authors Name**
Deep Learning: An MIT Press Book	Ian Goodfellow and Yoshua Bengio Aaron Courville.
Neural Networks and Deep Learning, Determination Press,2015.	Michael Nielson
Neural networks: A classroom Approach, Tata McGraw-Hill Education, 2004.	Satish Kumar

Reference Books:		
Book Details:		**Authors Name**
Deep Learning with Python, Manning publications, 2018		Francois Chollet
Advanced Deep Learning with Keras, PACKT Publications, 2018		Rowel Atienza
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_ auth_0127481425493114885 9_shared/overview	34h 51m
Video Lectures	YOLOv8 Full Tutorial Playlist | Object Detection, Segmentation & Classification Explained - YouTube:	10h 30m
Web References	https://www.datacamp.com/blog/yolo-object-detection- explained	2h

Course Code: BCSCC0501Y	**Course Name:** Design Thinking-II	**L**	**T**	**P**	**C**
Course Offered in:		2	0	0	**2**

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

Course Objectives: Understand the concepts, principles, mindset, and process of Design Thinking, innovation, and human-centered problem solving. Apply design thinking tools and techniques to identify problems, generate innovative ideas, and develop feasible solutions through brainstorming and root cause analysis. Design, prototype, test, and refine innovative solutions using user feedback, usability testing, and validation techniques. Analyze innovation, quality management principles, leadership styles, and team-building models for effective project implementation.
Demonstrate understanding of human values, interpersonal behavior, personality assessment, and sustainable design approaches to create socially responsible innovations.

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	Apply innovate ideas using design thinking tools and converge to feasible idea for breakthrough solution	K4
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)

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

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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

NPTEL/ You tube/ Faculty Video Link:

Unit-1	https://www.youtube.com/watch?v=6_mHCOAAEI8 https://nptel.ac.in/courses/110106124 https://designthinking.ideo.com/ https://blog.experiencepoint.com/how-mcdonalds-evolved-with-design-thinking
Unit-2	https://www.coursera.org/lecture/uva-darden-design-thinking-innovation/the-ibm-story-iq0kE https://www.coursera.org/lecture/uva-darden-design-thinking-innovation/the-meyouhealth-story-part-i-what-is-W6tTs https://onlinecourses.nptel.ac.in/noc19_mg60/preview
Unit-3	https://www.youtube.com/watch?v=HTSCbxSxsg&list=PL1xHD4vteKYVpaIiy295pg6_SY5 qznc77&index=5 https://www.youtube.com/watch?v=NnlS2BzXvyM https://www.youtube.com/watch?v=7enWesSofhg
Unit-4	https://youtu.be/rthuFS5LSOo https://www.youtube.com/watch?v=kho6oANGu_A
Unit-5	https://www.youtube.com/watch?v=9vMpHk44XXo&list=PL1xHD4vteKYVpaIiy295pg6_ SY5qznc77&index=6 Reinforcement Learning Tutorial | Reinforcement Learning Example Using Python | Edureka - YouTube Association Rule Mining – Solved Numerical Question on Apriori Algorithm(Hindi) - YouTube Q Learning Explained | Reinforcement Learning Using Python | Q Learning in AI | Edureka - YouTube

Course Code: BCSCC0552	**Course Name:** Research Methodology, Ethics and Writing	**L**	**T**	**P**	**C**
Course Offered in: All Engineering Programs		**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 Taxonomy Level**
CO1	Explain the fundamentals of research methodology, research process, literature review techniques, and identify research problems and technical gaps using scientific databases.	**K2**
CO2	Apply appropriate data collection methods, sampling techniques, statistical analysis, and prepare technical reports based on research findings.	**K3**
CO3	Analyze publication ethics, citation management systems, plagiarism issues, journal quality, and research integrity for responsible scholarly communication.	**K3**
CO4	Develop professional research documents including technical reports, review papers, conference papers, and research manuscripts following scientific writing standards.	**K3**

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

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

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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:

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

Reference Materials

- IEEE Author Guidelines
- Elsevier Researcher Academy Resources
- Springer Author Academy
- WIPO Resources for Research Documentation
- University digital library resources

NPTEL/ YouTube/ Faculty Video Link:

Unit 1	https://www.youtube.com/watch?v=rz30rRfManE&list=PLdj5pVg1kHiOypKNUmO0NKOfvoIThAv4N
Unit 2	https://www.youtube.com/watch?v=HYj4Ght1_qs
Unit 3	https://www.youtube.com/watch?v=N9tJCs-czOU&list=PLnIj1GYixjfrOhcWQq_ANzLFDniGYZ_-Q
Unit 4	https://www.youtube.com/watch?v=NM53k7x_jjk

Semester-VI
Syllabus

Course Code: BCSE0604	Course: Computer Vision	L	T	P	C
Course Offered in: CSE(AIML)		3	0	0	3

Pre-requisite: Students should have a basic understanding of **programming (preferably Python)**, **data structures**, and **object-oriented programming concepts**. Familiarity with **linear algebra.**

Course objective:

To understand the fundamental concepts, techniques, and applications of Computer Vision and image processing. To develop the ability to apply computer vision algorithms using modern tools and libraries for solving real-world problems. To analyze visual data and design intelligent vision-based systems for object detection, recognition, and image understanding.

Course outcome: After completion of this course students will be able to

CO	CO Statements	KL
CO1	Analyze knowledge of deep architectures used for solving various Vision and Pattern Association tasks.	K4
CO 2	Apply appropriate learning rules for each of the architectures of perceptron and learn about different factors of back propagation.	K3
CO 3	Apply training algorithm for pattern association with the help of memory network.	K3
CO 4	Examine the models of deep learning with the help of use cases.	K3
CO 5	Analyze different theories of deep learning using neural networks.	K4

High=3, Moderate=2, Low=1

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	2	–	–	–	–	–	–	1	3	1
CO 2	3	3	2	2	2	–	–	–	–	–	–	1	3	1
CO 3	2	3	3	3	2	–	–	–	1	–	–	1	3	2
CO 4	2	3	3	3	3	1	–	1	2	1	–	2	3	3
CO 5	3	3	1	2	1	–	–	–	–	–	–	2	2	2

Pre-requisites: Python, along with fundamental knowledge of mathematics, including linear algebra.

Course Contents / Syllabus

UNIT-I	Introduction to Computer Vision	10 Hours

Computer Vision, Research and Applications, (Self-Driving Cars, Facial Recognition, Augmented & Mixed Reality, Healthcare). Most popular examples Categorization of Images, Object Detection, Observation of Moving Objects, Retrieval of Images Based on Their Contents, Computer Vision Tasks classification, object detection, Instance segmentation.
Convolutional Neural Networks, Evolution of CNN Architectures for Image, Recent CNN

UNIT-II	Architectures	9 Hours

Representation of a Three-Dimensional Moving Scene. Convolutional layers, pooling layers, and padding.
Transfer learning and pre-trained models Architectures.
Architectures Design: LeNet-5, AlexNet, VGGNet, GoogLeNet, ResNet, Efficient Net, Mobile Net, RNN Introduction.

UNIT-III	Segmentation	10 Hours

Popular Image Segmentation Architectures, FCN Architecture, Upsampling Methods, Pixel Transformations, Geometric Operations, Spatial Operations in Image Processing, Instance Segmentation, Localisation, Object detection and image segmentation using CNNs, LSTM and GRU's. Vision Models, Vision Languages, Quality Analysis, Visual Dialogue, Active
Contours & Application, Split & Merge, Mean Shift & Mode Finding, Normalized Cuts.

UNIT-IV	Object Detection	7 Hours
Object Detection and Sliding Windows, R-CNN, Fast R-CNN, Object Recognition, 3-D vision and Geometry, Digital Watermarking. Object Detection, face recognition instance Recognition, Category Recognition Objects, Scenes, Activities, Object classification.		
UNIT-V	**Visualization and Generative Models**	**9 Hours**
Benefits of Interpretability, Fashion MNIST, Class Activation, Map code walkthrough, GradCAM,ZFNet. Introduction about Deep Generative Models, Generative Adversarial Networks Combination VAE and GAN's, other VAE and GAN's deep generative models. GAN Improvements, Deep Generative Models across multiple domains,Deep Generative Models image and video applications.		
		TOTAL: 45 Hours

Text books:

S. No.	Book Title	Author(s)
1	*Introductory Techniques for 3D Computer Vision*, 2009 Edition	Emanuele Trucco, Alessandro Verri
2	*Computer Vision: Algorithms and Applications*, The University of Washington Edition, 2022	Richard Szeliski
3	*Computer Vision: A Modern Approach*, Prentice Hall, 2015 Edition	David A. Forsyth, Jean Ponce
4	*Introductory Techniques for 3D Computer Vision*, Prentice Hall	Emanuele Trucco, Alessandro Verri
5	*Computer & Machine Vision: Theory, Algorithms, Practicalities*, Academic Press, 4th Edition, 2012	E. R. Davies
6	*Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012 Edition	Simon J. D. Prince

Reference Books:

S. No.	Book Title	Author(s)
1	*Computer Vision: A Modern Approach*, Prentice Hall, 2nd Edition, 2015	David A. Forsyth, Jean Ponce
2	*Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 1st Edition, 2012	Simon J. D. Prince
3	*Computer Vision*, Prentice-Hall, 2008	Dana H. Ballard, Christopher M. Brown
4	*Understanding Augmented Reality: Concepts and Applications*, Morgan Kaufmann, 2013 Edition	Alan B. Craig
5	*Computer Vision: Algorithms and Applications (CVAA)*, Springer, 2022 Edition	Richard Szeliski

Self-Study Contents

Resources	Name and Link	Duratio n
MOOCs	**(edX – Computer Vision and Image Analysis) https://www.edx.org/learn/computer-vision?utm_source=chatgpt.com**	**33h**
Video Links	1. https://www.youtube.com/playlist?list=PLoROMvodv4rOmsNzYBM e0g JY2XS8AQg16&utm_source=chatgpt.com https://www.youtube.com/playlist?list=PL05umP7R6ij35L2MHGzis	**10h**

	8AEHz7mg381_&utm_source=chatgpt.com	
Web References	**https://trainbrain.app/youtube/x7n85SJMjUA/?utm_source=chatgpt. Com**	**2h**

Course Code: BCSE0603	**Course Title:** Software Engineering & Design	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)		**3**	**1**	**0**	**4**

Pre-requisite: Basic knowledge of computer fundamentals and software development processes

Course Objectives:

To help students understand all phases of the Software Development Life Cycle (SDLC) both theoretically and practically, enabling them to systematically apply principles of analysis, design, development, testing, and maintenance to build cost-effective software solutions and become competent software engineering professionals

Course outcome: After completion of this course students will be able to		**Bloom's Knowledge Level (KL)**
CO1	Understand various software characteristics and explain different Software Development Life Cycle (SDLC) models.	**K2**
CO2	Explain the Software Requirement Specification (SRS) process and apply basic Software Quality Assurance (SQA) practices.	**K3**
CO3	Understand software design principles and apply appropriate software design methods for different applications.	**K4**
CO4	Apply various software testing techniques to identify software defects.	**K4**
CO5	Explain software project management concepts and use basic project management tools during software development.	**K4**

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

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

Course Contents / Syllabus

UNIT-I	**INTRODUCTION AND DEVELOPMENT MODELS**	**10 Hours**

Evolving role of software, Software Characteristics, Software crisis, silver bullet, Software myths, Software Engineering Phases, Team Software Process (TSP), Emergence of software engineering, Software process, project and product, Software Process Models: Waterfall Model, Prototype Model, Spiral Model, Iterative Model, Incremental Model, Agile Methodology: Scrum Sprint, Scrum Team, Scrum Master, Product Owner, Kanban framework.

UNIT-II	**SOFTWARE REQUIREMENT QUALITY ASSURANCE**	**8 Hours**

Software Requirement Specifications (SRS): Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modelling, Use Case Diagram, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS. Software Quality Assurance (SQA): Quality concepts, SQA activities, Formal approaches to SQA; Statistical software quality assurance;
CMM, The ISO standard.

UNIT-III	**SOFTWARE DESIGN**	**10**

		Hours
Design principles, the design process; Design concepts: refinement, modularity: Cohesion, Coupling, Effective modular design: Functional independence, Design Heuristics for effective modularity, Software architecture: Function Oriented Design, Object Oriented Design: OOPs concepts-Abstraction, object, classification, inheritance, encapsulation, UML Diagrams-Class Diagram, Interaction diagram, Activity Diagram, Control hierarchy: Top-Down and Bottom-Up Design, structural partitioning, software procedure		
UNIT-IV	**SOFTWARE TESTING**	**9 Hours**
Software Testing: Testing Objectives, 7 Principals of Testing, Levels of Testing: Unit Testing, System Testing, Integration Testing, User Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top Down and Bottom-Up Testing Strategies: Test Drivers and Test Stubs, Structural (White Box Testing Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha, and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards, Test Management, Test Planning and Estimation, Test Monitoring and Control, Configuration Management, Risks and Testing, Defect Management, Tool Support for Testing, Effective Use of Tools.		
UNIT-V	**PROJECT MAINTENANCE MANAGEMENT CONCEPTS**	**8 Hours**
Software Maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Need for Maintenance. Project management concepts, Planning the software project, Estimation: Software Measurement and Metrics, Various Size Oriented Measures-LOC based, FP based, Halestead's Software Science, Cyclomatic Complexity Measures: Control Flow Graphs, Use-case based empirical estimation COCOMO- A Heuristic estimation technique, staffing level estimation, team structures, risk analysis and management. Configuration Management, Software reengineering, reverse engineering, restructuring forward engineering, Clean Room software engineering. Case Tools		
	Total Lecture Hours	**45 Hours**

Text books:

S.N.	Book Title	Author
1	KK Aggarwal and Yogesh Singh, Software Engineering, New Age International Publishers 3RDEdition	
2	RS Pressman, Software Engineering: A Practitioners Approach, McGraw Hill. 7thEdition	
3	Rajib Mall, Fundamentals of Software Engineering, PHI Publication.4th Edition	

Links: NPTEL/You Tube/Web Link

UNIT-1	https://www.youtube.com/watch?v=bLrbX4ZCQeY
UNIT-2	https://www.youtube.com/watch?v=ZloPeQA1G4E
UNIT-3	https://www.youtube.com/watch?v=rpk7fSkTIu8
UNIT- 4	https://www.youtube.com/watch?v=T0TynxN77oY
UNIT-5	https://www.youtube.com/watch?v=nulFv99VBGs

Course Code: BCSAI0611	Course Name: Cloud Storage Management	L	T	P	C
Course Offered in: B. Tech. 3rd Year Departmental Elective- IV		3	0	0	3

Pre-requisite: Basics of Cloud Computing

Course Objectives:

1. To understand cloud storage fundamentals and architectural models.
2. To examine modern cloud storage services and technologies.
3. To familiarize learners with migration strategies in cloud environments.
4. To develop understanding of security and governance mechanisms in cloud storage.
5. To explore advanced storage systems and their real-world applications.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO-1	Describe cloud storage fundamentals and architectures.	K2
CO-2	Examine various cloud storage services and technologies.	K4
CO-3	Infer migration strategies in cloud environments.	K2
CO-4	Analyze security and governance techniques in cloud storage.	K4
CO-5	Illustrate advanced storage systems and real-world applications.	K2

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

CO–PO Mapping	PO 1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	–	2	–	–	–	–	–	–	2	2	1
CO2	2	3	–	1	3	–	–	–	–	–	–	2	3	2
CO3	2	2	2	–	2	–	–	–	–	–	–	2	2	2
CO4	3	3	2	2	3	2	–	2	–	–	–	3	3	3
CO5	2	2	2	–	2	–	–	–	2	2	2	2	2	3

Course Contents / Syllabus

Unit-1	Fundamentals of Cloud Storage	08 hours

Introduction to Cloud Computing, Evolution of Storage Systems (Traditional vs Cloud), Importance of Cloud Storage, Types of Cloud Storage: Object, Block, and File Storage, Storage Virtualization, Storage Architectures (Centralized & Distributed), Cloud Deployment Models (Public, Private, Hybrid), Challenges in Cloud Storage (Latency, Availability, Durability)

Unit-2	Cloud Storage Solutions	09 hours

Tiered Storage - Storage Reliability - Availability - Serviceability (RAS) - Storage Services and Functionalities - Storage System Architectures - Storage Virtualization and Virtual Storage, Cloud storage, Types of storage in cloud, AWS: S3, EBS, EFS, FSx, RDS, DynamoDB. Google Cloud Storage: Persistent Disk, Filestore, Cloud Storage, Archival storage. Hybrid cloud storage: AWS storage gateway.

Unit-3	Cloud Infrastructure and Migration Solutions	10 hours

Data Movement and Migration, IaaS migration, PaaS Migration, SaaS migration, VM migration, Migration solutions, AWS: Snow family, DataSync, Transfer family. Google cloud migration, Database Migration Services (DMS).

Unit-4	Security in Cloud Storage	10 hours

Data Security Concepts – Threats, data breaches, insider attacks, malware, Shared responsibility model in cloud security.
Encryption (At Rest & In Transit): Concept of encryption and its importance, Encryption at rest (stored data protection), Encryption in transit (data during transfer), Use of SSL/TLS protocols.
Access Control Mechanisms: Role-Based Access Control, Attribute-Based Access Control, Access Control Lists, Multi-Factor Authentication, IAM.

Unit-5	Advanced Cloud Storage and Applications	08 hours

Big Data Storage- Data ingestion methods (batch & real-time), Metadata management and Data Lakes architecture and components, Storage Solutions, Storage Cost Optimization Techniques, Storage Automation and Orchestration, Case Studies of Enterprise Cloud S driven Storage).

	Total Lecture Hours	45 hours

Textbook:

Book Details	Authors Name
"Cloud Storage Forensics" (Elsevier); 1st edition, 2014,	Darren Quick, Ben Martini, Kim-Kwang

	Raymond Choo, Syngress
Virtual Machines: Versatile Platforms for Systems and Processes, Morgan Kaufmann Publishers, 1st Edition, 2005	James E. Smith and Ravi Nair
"Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'Reilly Media; 1st edition, 2009	Tim Mather, Subra Kumaraswamy, Shahed Latif, ,
Reference Books:	
Book Details	**Authors Name**
Virtualization: From the Desktop to the Enterprise, Apress Publications, 1st Edition, 2005	Chris Wolf, Erick M. Halter
Cloud Native Security, O'Reilly Media, 1st Edition, 2021	Mike Ryan
Cloud Computing Security: Concepts and Practice, Emereo Publishing, 1st Edition, 2013,	Ivanka Menken

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	Google Associate Cloud Engineer: Data & Storage Management AWS SysOps Associate 2021: Storage Management AWS Solutions Architect Associate (SAA-C03): Cost-Optimized Storage Design	02Hrs 02Min 01Hrs 41Min 01Hrs 02Min
Video Lectures	https://www.youtube.com/watch?v=7m3f-P-WWbg (Edureka) https://www.youtube.com/watch?v=wOBA6Wri0Fg https://www.youtube.com/watch?v=b_krXFeOEDU youtube.com/watch?v=2LaAJq1lB1Q&t=147s&pp=0gcJCQYLAYcqIYzv	00Hrs 25Min 01Hrs 51Min 03Hrs 48Min 10Hrs 17Min
Web References	https://awsacademy.instructure.com/courses/ https://www.getyoureducation.net/course/virtualization-sharing-cloud-resources?utm_source=chatgpt.com	

Course Code: BCSIOT0613	**Course Name:** IoT Protocols & its applications	**L**	**T**	**P**	**C**
Course Offered in:		**3**	**0**	**0**	**3**

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

Course Objectives:

To understand the fundamentals of IoT systems and embedded platforms. To study IoT communication architectures and protocols. To analyze networking protocols used in IoT environments. To explore wireless communication technologies for IoT. 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**	**PSO3**
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

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

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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.

Course Code: BCSE0614	**Course Name: WEB DEVELOPMENT USING MEAN STACK**	**L**	**T**	**P**	**C**
Course Offered in: CSE/CS/CSR-R/M.TECH(INT) /IT//CSE(AI)/CSE(AIML)/CSE(DS)/CSE(CS)		**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

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

Module 1	**Introduction to Nodejs**	**9 hours**

Installing Nodejs, Node in-built packages (buffer, fs, http, os, path, util, url) Node.js modules, File System Module, 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).

Module 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.

Module 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 modules.

Module 4	**Building Single Page App with Angular js**	**10 hours**

MVC Architecture, One-way and Two-way data binding, AngularJS Expressions, AngularJS Controllers, AngularJS Modules, adding controller to a module, Component, Dependency Injection, Filters, Tables, AngularJS Forms and Forms validation, Select using ng-option, AngularJS AJAX.

Module 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**

Textbook:

1. Amos Q. Haviv (Author), Adrian Mejia (Author), Robert Onodi (Author), "Web Application Development with MEAN", 3rd Illustrated Edition 2017, Packt Publications.
2. Simon Holmes (Author), Clive Herber (Author), "Getting MEAN with Mongo, Express, Angular, and Node", 2nd Edition 2016, Addison Wesley Publication.
3. Dhruti Shah, "Comprehensive guide to learn Node.js", 1st Edition, 2018 BPB Publications.
4. Christoffer Noring, Pablo Deeleman, "Learning Angular",3rd Edition,2017 Packt publications.

Reference Books:

1. Anthony Accomazzo, Ari Lerner, and Nate Murray, "Fullstack Angular: The Complete Guide to AngularJS and Friends", 4th edition, 2020 International Publishing.
2. David Cho, "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.
3. Richard Haltman & Shubham Vernekar, "Complete node.js: The fast guide: Learn complete backend development with node.js"5th edition, 2017 SMV publication.
4. Glenn Geenen, Sandro Pasquali , Kevin Faaborg, "Mastering Node.js: Build robust and scalable real-time server-side web applications efficiently" 2nd edition,2016 Packt Publishing Limited.
5. Greg Lim, "Beginning Node.js, Express & MongoDB Development ,kindle edition,2019 international publishing.
6. Daniel Perkins, "AngularJS Master Angular.js with simple steps, guide and instructions" 3rd edition, 2015 SMV publication.
7. Peter Membrey, David Hows, Eelco Plugge, "MongoDB Basics", 2nd edition ,2018 International Publication.

NPTEL/ YouTube/ Faculty Video Link:

Unit 1	https://youtu.be/BLl32FvcdVM https://youtu.be/fCACk9ziarQ https://youtu.be/YSyFSnisip0 https://youtu.be/mGVFltBxLKU https://youtu.be/bWaucYA1YRI
Unit 2	https://youtu.be/7H_QH9nipNs https://youtu.be/AX1AP83CuK4 https://youtu.be/SccSCuHhOw0 https://youtu.be/lY6icfhap2o https://youtu.be/z7ikpQCWbtQ
Unit 3	https://youtu.be/0LhBvp8qpro https://youtu.be/k5E2AVpwsko https://youtu.be/SQJkj0WYWOE.list=PLvQjNLQMdagP3OzoBMfBT48uJ-SPfSsWj https://youtu.be/0eWrpsCLMJQ.list=PLC3y8-rFHvwhBRAgFinJR8KHIrCdTkZcZ https://youtu.be/ZSB4JcLLrIo
Unit 4	https://youtu.be/0LhBvp8qpro https://youtu.be/k5E2AVpwsko https://youtu.be/SQJkj0WYWOE.list=PLvQjNLQMdagP3OzoBMfBT48uJ-SPfSsWj https://youtu.be/0eWrpsCLMJQ.list=PLC3y8-rFHvwhBRAgFinJR8KHIrCdTkZcZ https://youtu.be/ZSB4JcLLrIo
Unit 5	https://youtu.be/Kvb0cHWFkdc https://youtu.be/pQcV5CMara8 https://youtu.be/c3Hz1qUUIyQ https://youtu.be/Mfp94RjugWQ https://youtu.be/SyEQLbbSTWg

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.

Course Code : BCSAI0613	**Course Name :** CLOUD SECURITY	**L**	**T**	**P**	**C**
Course Offered in: CSE/CS/CSR-R/M.TECH(INT) /IT//CSE(AI)/CSE(AIML)/CSE(DS)/CSE(CS)		**3**	**0**	**0**	**3**

Pre-requisite: Basic knowlege of : OS, Computer Network, Cyber Security, Networking Device

Course objective: To provide in-depth knowledge of securing cloud environments, with practical alignment to AWS security services, best practices, and certification domains.

Course Outcome: After completion of the course, the student will be able to :		**Bloom's Level**
CO1	Explain cloud security principles, threat landscape, and governance frameworks.	K2
CO2	Infer identity and access management techniques for secure cloud environments.	K2
CO3	Assess data protection mechanisms including encryption and secure storage practices	K4
CO4	Analyze cloud infrastructure security components and network protection mechanisms	K4
CO5	Analyze monitoring, incident response, and compliance strategies in cloud systems.	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	2	-	-	-	-	-	-	-	-	1	3	2	1
CO2	2	3	2	-	3	-	-	-	-	-	2	3	3	2
CO3	2	3	3	-	2	-	-	-	2	-	-	3	3	2
CO4	2	2	3	3	3	-	-	-	2	-	1	3	3	3
CO5	2	3	-	-	-	2	2	3	-	-	-	2	3	3

Course Contents / Syllabus

UNIT-I	**CLOUD SECURITY FOUNDATIONS & GOVERNANCE**	**9 Hours**

Introduction to cloud security concepts, Security benefits and challenges in cloud computing, Cloud Threat Landscape, CSA Top Threats, Insider Threats, Data Breaches, Security design principles (defense in depth, least privilege, zero trust), Edge Locations, AWS Shared Responsibility Model(customer vs provider responsibilities), AWS Well-Architected Framework (Security Pillar), Policies, Standards, Cloud Governance Framework.

UNIT-II	**IDENTITY, ACCESS MANAGEMENT & SECURITY ADMINISTRATION**	**9 Hours**

IAM: Introduction, JSON elements, Users, Roles, Groups, Policies, Policy evaluation logic, role chaining, Managed vs inline policies, permission boundaries, Principle of least privilege and policy optimization, Authentication & Authorization, Multi-Factor Authentication, Federation & Single Sign-On, SAML, Open Authorization basics. **Access Control Models:** RBAC vs ABAC, Trust Boundaries, Temporary credentials using AWS Security Token Service.

UNIT-III	**DATA SECURITY & PROTECTION**	**9 Hours**

Data Security Concepts: CIA Triad (Confidentiality, Integrity, Availability), **Data States:** Data at Rest, In Transit, In Use. **Encryption Techniques:** Symmetric vs Asymmetric Encryption, Encryption at rest and in transit (TLS/SSL), AWS Key Management, KMS, Envelope Encryption, Key Rotation. **Secure Storage:** S3 Security (Bucket Policies, Versioning, Access Control), Database security (RDS encryption, backups, IAM authentication).		
UNIT-IV	**CLOUD INFRASTRUCTURE SECURITY**	**9 Hours**
Infrastructure Security: Host-Level, Network-Level, Application-Level Security**,** Secure Cloud Architecture**,** VM Security, Auto Scaling, Load Balancing**.** **Amazon VPC Design:** Subnets (Public/Private), Routing Tables, Internet Gateway, NAT Gateway, Bastion Hosts, DNS security with Amazon Route 53. **Security Controls:** Security Groups vs Network ACLs (stateful vs stateless), DDoS Protection & Mitigation, Hybrid Cloud Security, VPN, Direct Connect.		
UNIT-V	**CLOUD MONITORING, INCIDENT RESPONSE & COMPLIANCE**	**9 Hours**
Monitoring & Logging: CloudTrail, CloudWatch, Log Analysis, Threat Detection (Behavioral Analysis, Anomaly Detection, Incident Response Lifecycle, Preparation) Containment, Recovery. **AWS Security Services:** GuardDuty, CloudWatch, Security Hub, Application Security. Privacy & Compliance, Data Privacy Concepts, GDPR, HIPAA, Digital Personal Data Protection Act-2023, ISO 27001 basics, Legal & Regulatory Framework.		
	Total Lecture Hours	**45 Hours**
Text books:		
Tim Mather, Subra Kumara swamy,Shahed Latif,"Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'ReillyMedia; 1edition [ISBN:0596802765], 2009		
Cloud Security Handbook, Eyal Estrin, "Cloud Security Handbook: Find out how to effectively secure cloud environments using AWS, Azure, and GCP", Packt Publishing; 1st edition, 2023		
Cloud Computing Security: Strategies and Best Practices, Krishnendu Gupta, Nabanita Roy, "Cloud Computing Security: Strategies and Best Practices", CRC Press; 1st edition, 2021		
Cloud Security: Concepts, Applications and Practices Kumar Saurabh, "Cloud Security: Concepts, Applications and Practices", Springer; 1st edition, 2017,		
Unit-1	https://youtu.be/XsRBDJ5hcdg https://youtu.be/w2caA8ty36s	
Unit-2	https://youtu.be/fpNmvxYhsN0	
Unit-3	https://youtu.be/amCrXVFX1C4	
Unit-4	https://youtube.com/playlist?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J&si=wLJBL0TKrcs8Jkmc	
Unit-5	https://youtu.be/1ZKuwyATV3c https://youtu.be/ZHCtVZ6cjdg?si=G0w6pE1v4dDNt2KV	

Course Code: BCSIOT0614	**Course Name:** IoT for Smart Cities	**L**	**T**	**P**	**C**
Course Offered in B. Tech: CSE/CS/IT /CSE(AI)/CSE(AIML)/ CSE(DS)/ CSE(CYS)/MCT /ECE/CSE(IOT)		**3**	**0**	**0**	**3**

Pre-requisite: Computer Networks, IoT Protocols

Course Objectives:

Students should understand Fundamentals of Smart cities and its urban planning structure and should be able to architect process of smart cities using IoT application. Student should be able to analyze changes in sustainable growth of smart cities.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the structure, issues and challenges in designing smart cities	K2
CO2	Communicate and visualize IoT data with communication techniques and Hologram	K2
CO3	Implement the concept of automated doors and security systems for different IoT applications	K3
CO4	Analyze the concept of sustainable green energy and architect smart waste and water management like systems	K4
CO5	Implement smart city use cases with respect to Indian smart city plans	K3

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

COs \ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO3
CO1	3	2	1	-	2	2	2	-	-	1	-	3	2	1
CO2	3	3	2	2	3	1	1	-	1	1	-	3	3	2
CO3	3	3	3	2	3	2	1	2	1	1	-	3	3	3
CO4	2	3	2	2	3	3	3	1	1	1	1	2	3	2
CO5	2	3	3	3	2	3	2	2	2	2	2	3	3	3

Course Contents / Syllabus

UNIT-1	**INTRODUCTION TO SMART CITIES**	**08 hours**

Structures of city systems, Urban and Regional Planning, Informatics and Smart Cities, Smart Environment, Smart Streetlight, Smart Hospital Management System, Smart Automations, Smart Vehicles, Programming environment for IDE sensor and actuators used in the Development of smart city, Issues and Challenges in design of smart cities

UNIT-2	**TECHNOLOGY AND INFRASTRUCTURE USED FOR SMART CITIES**	**08 hours**

Wireless sensor networks, Wi-Fi, ZigBee, 6lowpan Networks, Bluetooth, Ethernet Terahertz Communications, Intelligent personal edge computing, Hologram Technology, Inter-User Inter-Operator Knowledge Sharing, User-Centric Network Architecture, Full-Duplex Communication Stack

UNIT-3	**SECURITY IN SMART CITES**	**08 hours**

Flexible and Intelligent Materials, Smart Meter Deployment, Automated door locks, Finger print Door Systems, Surveillance Cameras, RFID security systems, Library books anti-theft systems, Fog computing paradigms, Data Encryption Standard (DES) Techniques and its types, Blockchain for Decentralized Security,

UNIT-4	**UNDERSTANDING SUSTAINABILITY AND URBAN MOBILITY**	**10 hours**

Green 6G network, Green IoT, Visible light communication, WPT and Energy Harvesting, B2C (MAKER SCENE), Smart Agriculture, Reduction of CO2, Smart Chemical Technology, Energy Consumption Monitoring, Smart Waste Management, Waste generation geo-specific data analysis, Smart bin sensors, Container Tracking, smart water management, Smart irrigation, Rain and storm water management.

UNIT-5	**SMART CITIES CASE STUDIES**	**06 hours**

International Case Studies of Dubai, Singapore with reference technologies (Communication technologies, Sensing technologies, Database technologies, architecture etc.) applications implementation and challenges India's Ecosystem for smart cities, Case Study on Smart City Projects in India: An analysis of Nagpur, Allahabad and Dehradun, Ideation of smart city implementation project..

Total Lecture Hours	**40 hours**

Textbook

S.NO.	Book Title	Author
1.	Introduction To Smart Cities 1St Ediion 2019 Edition by	ANIL KUMAR, PEARSON
2.	Smart Cities by Claude ROCHET,	Wiley-ISTE 2018

Reference Books:

1. Smart City on Future Life - Scientific Planning and Construction by Xianyi Li 2012
2. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony Townsend 2013
3. A smart city case study of Singapore—Is Singapore truly smart? – ScienceDirect
4. (PDF) Case study of Dubai as a Smart City (researchgate.net)
5. **Open-Source Web Repositories**
   Smart city government of India. http://smartcities.gov.in Reconceptualising Smart Cities: A Reference Framework https://www.niti.gov.in/writereaddata/files/document_publication/CSTEP%20Report%20Smart%2 %20Framework.pdf for India 0Cities Draft Concept Note on Smart City Scheme". Government of India - Ministry of Urban Development martcitiesoftomorrow.com/wp-content/uploads/2014/09/CONCEPT_NOTE_3.12.2014_REVISED_AND_LATEST_.pdf

Video Links

Unit-1	Nokia Technology Vision 2030 - YouTube
Unit-2	What is Zigbee and How it Works | Zigbee Network Explained - YouTube
Unit-3	How to Make Remote Control Door Lock at Home - YouTube
Unit-4	IoT - Smart Green Building - YouTube
Unit-5	Smart waste management using IOT - real benefits of Sensoneo - YouTube

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	

LAB Course Code: BCSE0654	LAB Course Name **Computer Vision Lab**	L	T	P	C
Course Offered in: CSE(AI)/CSE(AIML)		**0**	**0**	**2**	**1**

Pre-requisite: Python Programming, Machine Learning

Course Objectives:

- Explore **image compression models** and their applications in efficient image representation.
- Gain knowledge of **autoencoders** and their use in feature learning, dimensionality reduction, and image reconstruction.
- Study advanced deep learning concepts and techniques that improve the performance and reliability of vision-based systems in real-world applications.

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

CO	CO Statements	KL
CO1	Implement a various convolutional neural network and understand its architecture.	K3
CO2	Apply image Modeling acquisition, Segmentation and develop a programming model to implement an Image morphological	K3
CO3	Apply Visualization of various models and Deep GAN Networks .	K3

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	3	3	2	3	1	1	1	1	2	2	3	3	3
CO2	3	3	2	3	3	1	1	1	1	2	2	3	3	2
CO3	2	3	3	3	3	1	1	1	1	2	3	3	3	3

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

S.No.	Experiment (Case Study Based Question)	CO Mapping
1	Fine-tuning a pre-trained CNN for a specific image recognition task.	CO1
2	Building a simple convolutional neural network for transfer learning using Finetuning	CO1
3	Building a simple convolutional neural network for transfer learning using feature extraction.	CO1
4	Building a CNN model for object detection using a pre-trained architecture like YOLO.	CO1
5	Exploring different activation functions and comparing their effects on network performance.	CO1
6	Fine-tuning a pre-trained CNN for a specific image recognition task.	CO1

7	Building a simple convolutional neural network for transfer learning using Finetuning	CO1
8	Building a simple convolutional neural network for transfer learning using feature extraction.	CO1
9	Building a CNN model for object detection using a pre-trained architecture like YOLO.	CO1
10	Exploring different activation functions and comparing their effects on network performance.	CO1
11	Write a program to Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.	CO1
12	Implement a program for basic image operations.	CO2
13	Implement a program for image enhancement	CO2
14	Implement a program for image compression	CO2
15	Implement a program for color image processing	CO2
16	Implement a program for image segmentation	CO2
17	Design a program for image morphology	CO2
18	Implementing De-noising auto encoder.	CO2
19	Implementing Deep auto encoder.	CO2
20	Implementing convolutional auto encoder.	CO2
21	Implementing feature extraction for classification using auto encoder.	CO3
22	Implementing feature extraction for regression using auto encoder.	CO3
23	Perform scaling, rotation and shifting operations on an image using OpenCV ()	CO3
24	Perform image reflection on an image using OpenCV ().	CO3
25	Implementing a basic Variational Autoencoder (VAE) for image generation	CO3
26	Training a Generative Adversarial Network (GAN) to generate synthetic images.	CO3
27	Implement and apply using Image Restoration	CO3
28	Implement and apply using Edge detection	CO3
29	Perform Image shearing on an image using OpenCV ().	CO3
30	Write a function for all the geometric transformations and apply it to any image	CO3
31	Implement a program for color image processing	CO2
32	Implement a program for image segmentation	CO2
		Total Hours: 30 hrs.

LAB Course Code: BCSE0653Y	LAB Course Name: SOFTWARE ENGINEERING AND DESIGN LAB	L	T	P	C
Course Offered in: CSE(AI)		0	0	4	2

Pre-requisite: Programming(C/C++/Java/Python), SDLC, OOAD, UML, DBMS, Software Testing, DS

Course Objectives:

Understand software engineering concepts, software development life cycle (SDLC), software requirement analysis, and UML modeling techniques for software development. Apply software design methodologies, CASE tools, and software testing techniques for developing reliable and quality software systems.

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

CO	Course Outcome	Bloom's Level
CO1	Software requirement analysis and develop UML models, DFDs, ER diagrams, and SRS documents using standard software engineering practices.	K2
CO2	Software design and software testing techniques to develop, execute, and validate software applications using appropriate test cases.	K3
CO3	Use CASE tools, testing tools, bug tracking tools, and project management tools to support software development and maintenance activities.	K3

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

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

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

List of Practical

Sr. No.	Program Title	CO Mapping
1	Team formation and allotment of Mini project: Problem statement, Literature survey, Requirement. analysis.	CO1
2	Draw the use case diagram	CO1
3	Draw the Data Flow Diagram (DFD): All levels.	CO1
4	Design an ER diagram for with multiplicity	CO1
5	Prepare SRS document in line with the IEEE recommended standards.	CO1
6	Draw State chart diagram.	CO1
7	Draw Object and Class diagram.	CO2
8	Create Interaction diagram: sequence diagram for SDD	CO2
9	Create Interaction diagram: collaboration diagram for SDD.	CO2
10	Create Activity diagram	CO2
11	Create Component diagram	CO2

12	Create Deployment diagram	CO2
13	Estimation of Test Coverage Metrics and Structural Complexity.	CO2
14	Design and develop a program in a language of your choice to solve the triangle problem defined as follows: Accept three integers which are supposed to be the three sides of a triangle and determine if the three values represent an equilateral triangle, isosceles triangle, scalene triangle, or they do not form a triangle at all. Assume that the upper limit for the size of any side is 10. Derive test cases for your program based on boundary-value analysis, execute the test cases, and discuss the results	CO2
15	Design, develop, code, and run the program in any suitable language to solve the commission problem. Analyze it from the perspective of boundary value testing, derive different test cases, execute these test cases, and discuss the test results.	CO2
16	Design and develop a program in a language of your choice to solve the triangle problem defined as follows: Accept three integers which are supposed to be the three sides of a triangle and determine if the three values represent an equilateral triangle, isosceles triangle, scalene triangle, or they do not form a triangle at all. Assume that the upper limit for the size of any side is 10. Derive test cases for your program based on equivalence class partitioning, execute the test cases, and discuss the results.	CO2
17	Design and develop a program in a language of your choice to solve the triangle problem defined as follows: Accept three integers which are supposed to be the three sides of a triangle and determine if the three values represent an equilateral triangle, isosceles triangle, scalene triangle, or they do not form a triangle at all. Derive test cases for your program based on decision-table approach, execute the test cases, and discuss the results.	CO2
18	Create test cases for a program which determine whether an integer is prime or not by using path testing.	CO2
19	Create test cases for a program which determine whether an integer is prime or not by using Cyclomatic complexity.	CO2
20	Consider a program to input two numbers and print them in ascending order. Find all du paths and identify those du-paths that are not feasible. Also find all dc paths and generate the test cases for all paths (dc paths and non dc paths).	CO2
21	Consider the code to arrange the nos. in ascending order. Generate the test cases for loop coverage and path testing. Check the adequacy of the test cases through mutation testing and compute the mutation score for each.	CO2
22	Write Test cases for any Known Application (e.g., Banking Application)	CO2
23	Create a test plan document for any application (e.g., Library Management System)	CO2
24	Study of any testing tool (e.g., Win Runner)	CO3
25	Study of any bug tracking tool (e.g., Bugzilla, Bug bit)	CO3
26	Study of any test management tool (e.g., Test Director)	CO3
27	Study of any open source-Testing tool (e.g., Test link, Test Rail)	CO3
28	Study of any web testing tool (e.g., Selenium)	CO3
29	Mini Project with CASE tools.	CO3
30	Case Study Provided by Industry.	CO3

Course Code: BCSAI0611P	**Course Name:** CLOUD STORAGE MANAGEMENT LAB	**L**	**T**	**P**	**C**
Course Offered in: B. Tech. 3rd Year Departmental Elective-IV Lab		**0**	**0**	**2**	**1**

Pre-requisite: Basics of Cloud Computing

Course Objectives:

1. To develop practical skills in cloud storage provisioning and virtualization using AWS services.
2. To enable learners to configure and manage cloud-based storage resources efficiently.
3. To provide hands-on experience in cloud storage backup, migration, and monitoring techniques.
4. To familiarize learners with data lake implementation and efficient cloud data management practices.
5. To apply security, encryption, access control, and cost optimization techniques in cloud storage environments.

Course Outcome: After completion of the course, the student will be able to	Bloom's Knowledge Level (KL)
CO-1 Demonstrate cloud storage provisioning, virtualization, and storage management using AWS services and virtualized environments.	K3
CO-2 mplement cloud storage operations including backup, migration, monitoring, and data lake solutions for efficient data management.	K3
CO-3 Apply security, access control, encryption, and cost optimization techniques in cloud storage environments.	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	PO1	PSO2	PSO3
CO1	2	–	3	–	3	–	–	–	–	–	–			
CO2	2	2	3	2	3	–	–	–	1	–	2			
CO3	2	3	2	2	3	–	–	1	–	–	2			

List Of Practical's		**CO**
1	Storage Virtualization and Virtual Machine Storage Management using VirtualBox	**CO1**
2	Create S3 buckets, upload/download files, set access policies, and enable versioning.	**CO1**
3	Create, attach, detach, and snapshot EBS volumes.	**CO1**
4	Set up a MySQL/PostgreSQL database using Amazon RDS and connect it to an application.	**CO1**
5	Implementing Data Backup using EBS Snapshots	**CO2**
6	Storage Cost Optimization using S3 Intelligent-Tiering	**CO2**
7	Migrate Virtual Machine in a cloud environment using Virtual Box	**CO2**
8	Monitoring Storage Performance and Usage of storage services using CloudWatch	**CO2**
9	Performing Cloud Data Migration using AWS DataSync	**CO3**
10	Encrypting Cloud Storage Data at Rest and In Transit using AWS KMS	**CO3**
11	Create IAM users/groups, assign policies, and demonstrate fine-grained access control.	**CO3**
12	Building a Simple Data Lake Architecture using AWS Glue	**CO3**

Total Hours: 30 hrs.

Course Code: BCSIOT0613P	**Course Name:** IOT PROTOCOLS AND ITS APPLICATIONS LAB	**L**	**T**	**P**	**C**
Course Offered in:		**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:

To provide hands-on experience with Raspberry Pi and interfacing of sensors and actuators. To implement IoT communication protocols such as MQTT, CoAP, and AMQP for real-time data exchange. To develop skills in configuring networking and wireless communication in IoT systems. To enable cloud integration and data visualization using IoT platforms like ThingSpeak and Blynk. 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. 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%.	**CO1**
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. 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.	**CO3**
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: BCSCY0613P	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	

LAB Course Code: BCSE0614P	LAB Course Name: WEB DEVELOPMENT USING MEAN STACK	L	T	P	C
Course Offered in: CSE/CS/CSR-R/M.TECH(INT) /IT//CSE(AI)/CSE(AIML)/CSE(DS)/CSE(CS)		0	0	4	2

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

Course Outcome		Bloom's Level
CO1	Explain the concepts of server-side scripting using Node.js and analyze its role in developing modern web applications.	K4
CO2	Apply the Express.js framework to develop dynamic web pages and interactive web-based applications.	K3
CO3	Apply the concepts of TypeScript and Angular to develop client-side web applications and analyze their functionality.	K3–K4

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

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	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**

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

1. Construct a program to demonstrate usage of Node.js fs module to read a file.
2. Construct a program to display system information using the os module.
3. Construct a program to create and export a simple Node.js module.
4. Construct a program to parse a URL using the Node.js url module.
5. Construct a program to create a basic HTTP server using Node.js
6. Construct a program to demonstrate callback-based asynchronous execution.
7. Construct a program to illustrate promise creation and resolution.
8. Construct a program to demonstrate promise chaining with multiple operations.
9. Construct a program to show JSON data parsing and stringifying.
10. Construct a program to demonstrate routing in an Express application.
11. Construct a program to demonstrate AngularJS data binding.
12. Construct a program to build a Node.js server that handles GET requests.
13. Construct a program to implement POST request handling using Express.
14. Construct a program to perform CRUD operations using Express and MongoDB.
15. Construct a program to create middleware for logging request details.
16. Construct a program to serve static files using Express.
17. Construct a program to create a MongoDB collection and insert documents.
18. Construct a program to build an AngularJS form with validation.

19. Construct a program to implement an API call using AngularJS AJAX.	
20. Construct a program to compare synchronous and asynchronous file operations.	
21. Construct a program to demonstrate differences between callbacks and promises.	
22. Construct a program to illustrate REST API endpoints with multiple HTTP methods.	
23. Construct a program to demonstrate middleware execution order in Express.	
24. Construct a program to show one-way and two-way data binding in AngularJS.	
25. Construct a program to analyze MongoDB document structure using Mongoose schema.	
26. Construct a program to measure execution time of synchronous vs asynchronous code.	
27. Construct a program to test REST API endpoints using different HTTP methods.	
28. Construct a program to validate user authentication using Express sessions.	
29. Construct a program to handle error responses with proper HTTP status codes.	
30. Construct a program to demonstrate secure API access using middleware.	
31. Construct a program to develop a RESTful API using Node.js, Express, and MongoDB.	
32. Construct a program to build a single-page application using AngularJS.	
33. Construct a program to integrate AngularJS frontend with Node.js backend.	
34. Construct a program to implement user registration and login system.	
35. Construct a program to build a full-stack application with CRUD operations and API integration.	
Web Reference	https://www.scholarhat.com/free-course/angular-course?utm_source=chatgpt.com **Free Angular Online Course with Certificate - Beginner Level (8 hours)**

Course Code: BCSAI0652	**Course Name:** Generative AI	**L**	**T**	**P**	**C**
Course Offered in: CSE(AI)/CSE(AIML)		**0**	**0**	**6**	**3**

Pre-requisite: Statistics, Machine Learning, Deep Learning

Course Objectives:

This course is designed to provide students with a comprehensive understanding of Deep Learning and its applications in Artificial Intelligence. It begins with the fundamental concepts of Artificial Neural Networks (ANN) and Deep Learning architectures, enabling students to understand how intelligent systems learn from data. The course further focuses on the development and implementation of Convolutional Neural Networks (CNNs) and various Computer Vision models for image classification, recognition, and analysis tasks.

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	PO1	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**	**14 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**	**14 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)**	**14 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**	**15 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**	**15 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	**72 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: BCSE0659X	**Course Name:** APPLIED RESEARCH WITH MINI PROJECT	**L**	**T**	**P**	**C**
Course Offered in: CSE/CSE(R)/IT/M.Tech Int. (CSE)/AI		**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 Taxonomy**
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)

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

UNIT	**Common Applied Research-Based Mini Project Activities (All Branches)**	**Expected Outcomes**
Unit-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)**
Unit-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)**
Unit-3: Testing, Validation & Optimization	10. Perform testing, experimentation, or validation of developed work. 11. Analyze performance, efficiency, feasibility, or effectiveness.	Validated and optimized project demonstrating performance improvement, technical analysis, and practical feasibility. **(CO2)**

	12. Apply analytical, computational, statistical, or intelligent techniques where relevant. 13. Optimize design, methodology, process, or implementation for improved outcomes	
Unit- 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)**