CURRICULUM 2023 (Autonomous)

Version 1.0

B.TECH

Computer Science and Engineering (AI)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

Mar Ivanios Vidyanagar, Nalanchira,

Thiruvananthapuram – 695 015

CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence)

SEMESTER V & VI

2023 SCHEME
(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)

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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:
To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:
To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Vision and Mission of the Department

Vision:
To be a Centre of Excellence in Computer Science and Engineering providing quality education and research for the betterment of the society.

Mission:
To impart sound knowledge in theoretical and applied foundations of Computer Science and Engineering, and to train the students to solve real life issues to effectively define and shape life.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates will be successful professionals in Industries of core or interdisciplinary natureor entrepreneurs, demonstrating effective leadership and excellent team work.

PEO2: Graduates will expand the horizon of knowledge through higher education or research, leading to self-directed professional development

PEO3: Graduates will demonstrate competency in AI & ML, professional attitude and ethics whileproviding solutions in societal and environmental contexts

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex

engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public healthand safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independentand life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To apply Algorithmic Principles, Programming Skills and Software Engineering Principles to design, develop and evaluate Software Systems of varying complexities.

PSO2: To apply knowledge of System Integration to design and implement computer-basedsystems

PSO3: To solve real world and socially relevant problems using AI

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING (Artificial Intelligence)

Third YEAR SYLLABI

2023 SCHEME

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	29/04/2025	28/05/2025

Head of the Department
Chairman, Board of Studies

Principal
Chairman, Academic Council

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

For the students admitted from 2023

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of B. Tech Programme is placed in one of the nine categories as listed in the following table. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Sl. No.	Category	Category Code	2020(REVISED)	2023(REVISED)
1	Humanities and Social Sciences including Management Courses	HSC	5	6
2	Basic Science Courses	BSC	26	26
3	Engineering Science Courses	ESC	22	22
4	Programme Core Courses, Comprehensive Course Work and Viva Voce	PCC	79	69
5	Programme Elective Courses	PEC	15	18
6	Institute Elective Courses	OEC/IEC	3	6
7	Project Work and Seminar	PWS	10	13
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	---	--
9	Mandatory Student Activities (P/F)	MSA	2	3
Total Mandatory Credits			**162**	**163**
	Value Added Courses (Optional) – Honours/Minor	VAC	15	15

ii) Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	***Total Credits***
Credits for Courses	17	21	22	23	22	22	18	15	**160**
	38		45		44		33		**160**
Credits for Activities	3								**3**
Total Credits									**163**
Value Added Courses (Optional) – Honours / Minor									**15**
Total Credits									**178**

SEMESTER V										
Slot	Category	Course Code	Courses	Credit Structure				SS	Hours	Credit
				L	T	P	J			
A	PCC	23CSL30A	Computer Networks	3	1	0	0	5	4	4
B	PCC	23CTL30A	Introduction to Artificial Intelligence	3	1	0	0	5	4	4
C	PCC	23CTL30B	Data Science	2	1	0	0	3.5	3	3
F	PCC	23CTB30C	Introduction to Machine Learning	3	0	2	0	5.5	5	4
D	PEC	23CTL31X	Programme Elective I-Course1	2	1	0	0	3.5	3	3
E	HSC	23HSL30A	Business Economics and Accountancy	3	0	0	0	4.5	3	3
S	PCC	23CTP30A	Artificial Intelligence Lab	0	0	3	0	1.5	3	2
T	PCC	23CSP30B	Networking Lab	0	0	3	0	1.5	3	2
M/H	VAC		Minor/Honours	3	0	0	0	4.5	3	3
TOTAL								**29.5/34**	**28/31**	**25/28**

SEMESTER VI										
Slot	Category	Course Code	Courses	Credit Structure				SS	Hours	Credit
				L	T	P	J			
A	PCC	23CSL30D	Algorithm Analysis and Design	3	1	0	0	5	4	4
C	PCC	23CTB30D	Deep Learning	3	0	2	0	5	5	4
B	PCC	23CTL30D	Robotics and Intelligent systems	3	1	0	0	5	4	4
E	IEC	23IEL31X	Institute Elective 1	3	0	0	0	4.5	3	3
F	PEC	23CTL32X	Programme Elective II-Course2	2	1	0	0	3.5	3	3
S	PCC	23CTP30B	Robotics Lab	0	0	2	0	1	2	1
T	PWS	23CTS38A	Seminar	0	0	4	0	2	4	2
U	PWS	23CTJ38B	Miniproject	0	0	4	0	4	4	2
M/H	VAC		Minor/Honours	3	0	0	0	4.5	3	3
TOTAL								**30/34.5**	**29/32**	**23/26**

PROGRAMME ELECTIVE I

Slot	Category Code	Course Number	Courses	L-T-P-J	Hours	Credit
E	PEC	23CSL31A	Parallel Computer Architecture	2-1-0-0	3	3
		23CSL31C	Computer Graphics and Multimedia	2-1-0-0	3	3
		23CTL31A	Web Technology	2-1-0-0	3	3

PROGRAMME ELECTIVE II

Slot	Category Code	Course Number	Courses	L-T-P-J	Hours	Credit
D	PEC	23CSL32A	Cloud Computing	2-1-0-0	3	3
		23CSL32B	Applied Data Science Using Python	2-1-0-0	3	3
		23CSL32D	Virtual and Augmented Reality Systems	2-1-0-0	3	3
		23CTL32A	Natural Language Processing	2-1-0-0	3	3
		23CTL32B	Foundations of Security in Computing	2-1-0-0	3	3
		23CTL32C	Data Analytics	2-1-0-0	3	3

INSTITUTE ELECTIVE I

Slot	Category Code	Course Number	Courses	L-T-P-J	Hours	Credit
E	**IEC**	23IEL31E	Data Science for Engineers	3-0-0-0	3	3
		23IEL31F	Introduction to Mobile Application	3-0-0-0	3	3
		23IEL31G	Introduction to Cyber Security and Ethical Hacking	3-0-0-0	3	3
		23IEL31H	Digital Marketing and E-commerce	3-0-0-0	3	3

BASKET I Specialization: SOFTWARE ENGINEERING				BASKET II Specialization: MACHINE LEARNING				BASKET III Specialization: NETWORKING			
Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit
23CSL2MB	Programming Methodologies	3-0-0-0	3	23CSL2MD	Concepts in Machine Learning	3-0-0-0	3	23CSL2MF	Introduction to Computer Networks	3-0-0-0	3
23CSL3MA	Concepts in Software Engineering	3-0-0-0	3	23CSL3MC	Concepts in Deep Learning	3-0-0-0	3	23CSL3ME	Client Server Systems	3-0-0-0	3

MINOR

Semester	Basket IV Specialization: Data Science				Basket V Specialization: Network Security			
	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit
S 5	23CSL3MG	Natural Language Processing	3-0-0-0	3	23CSL3MI	Introduction to Block-chain technologies	3-0-0-0	3
S 6	23CSL3MH	Deep Learning	3-0-0-0	3	23CTL3MJ	Privacy and security in IoT	3-0-0-0	3

HONOURS

Semester	Basket I Specialization: SECURITY IN COMPUTING				Basket II Specialization: COMPUTATIONAL BIOLOGY				Basket III Specialization: COMPUTER VISION			
	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit
S5	23CSL3HA	Cryptographic Algorithms	3-0-0-0	3	23CTL3HA	Computational Biology	3-0-0-0	3	23CTL3HC	Advanced Concepts In Computer Vision	3-0-0-0	3
S6	23CSL3HB	Network Security	3-0-0-0	3	23CTL3HB	Machine Learning in Computational Biology	3-0-0-0	3	23CTL3HD	Image And Video Processing	3-0-0-0	3

SEMESTER V

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL30A	COMPUTER NETWORKS	PCC	3	1	0	0	4	2023

i. COURSE OVERVIEW

This course provides an in-depth understanding of how computer networks are built from local area networks to the global internet and how network communication happens. This course covers the physical aspects of computer networks, layers of reference models and internetworking. This course helps the learners to compare and analyze the existing network technologies and choose a suitable network design for a given system.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the fundamental components of computer networks and fundamental characteristics of application layer in internetworking.	Understand
CO 2	Explain the functions and protocols of transport layer and the effectiveness of TCP congestion control mechanisms in various network conditions.	Understand
CO 3	Analyze and compare different routing algorithms and describe the components and operation of routers and the process of IP forwarding and addressing.	Analyze
CO 4	Describe various congestion control algorithms and explain Quality of Service (QoS) requirements and techniques used to improve QoS in communication networks.	Apply
CO 5	Explain the architecture and operation of IEEE 802.11 (Wi-Fi) wireless LANs and the concept and functioning of Mobile IP and its role in supporting mobility in IP networks.	Understand

iii. SYLLABUS

Introduction-Reference models- Application Layer - Transport Layer-User Datagram Protocol (UDP)-Transmission Control Protocol (TCP) - Network layer -Routing algorithms - Congestion Control Algorithms-Quality of Service (QoS)- The Link Layer- Wireless and Mobile Networks – Wi-Fi: 802.11 Wireless LANs. Mobile IP.

iv (a) TEXT BOOKS	
1.	J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring Internet, 6/e, Pearson Education, 2012.
2.	Andrew S. Tanenbaum, *Computer Networks*, 4/e, PHI, 2018.
3.	Behrouz A. Forouzan, *Data Communications and Networking*, 4/e, Tata McGraw Hill, 2017.
4.	William Stallings, *Computer Networking with Internet Protocols*, Prentice Hall, 2004
(b) REFERENCES	
1.	Larry L Peterson and Bruce S Dave, Computer Networks- A systems Approach, 5/e, Morgan Kaufmann, 2011.
2.	Fred Halsall, Computer Networking and the Internet,5/e,Addison Wesley,2005 .
3.	Keshav, An Engineering Approach to Computer Networking: ATM networks, the Internet and the Telephone Network, Addison Wesley,1/e , 2002.

v. COURSE PLAN

Module	Contents	Hours
I	Computer Networks and the Internet – What is the Internet – What is a Protocol. Protocol layers and their service models. Reference Models-OSI, Reference Models-TCP/IP, Comparison of OSI and TCP/IP Models. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product. Application Layer – The web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, DNS, Internet for Registry, ICANN	**12**
II	Transport Layer – Introduction and Transport-Layer Services, Connectionless Transport: UDP, Connection- Oriented Transport: TCP, Principles of Congestion Control, TCP Congestion Control.	**12**
III	The Network Layer – Introduction, Virtual Circuit and Datagram Networks, What's Inside a Router? The Internet Protocol (IP): Forwarding and Addressing in the Internet. IPv4, IPv6. Routing Algorithms. Routing in the Internet, Broadcast and Multicast Routing. Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.	**12**

IV	The Link Layer: Links, Access Networks and LANs – Introduction to the Link Layer, Error- Detection and Correction Techniques – Cyclic Redundancy Check (CRC). Multiple Access Links and Protocols, ARP, Ethernet, Hubs, Bridges, Switches, Switched Local Area Networks.	**11**
V	Wireless and Mobile Networks – Wi-Fi: 802.11 Wireless LANs – The 802.11 Architecture- The 802.11 Mac Protocol- The 802.11 Frame- Mobility in the same IP subnet- Advanced Features in 802.11- Personal Area Networks: Bluetooth and Zigbee. Mobile IP. Physical layer-Transmission media	**13**
	Total Hours	**60**

vi. ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTL30A	Introduction to Artificial Intelligence	PCC	3	1	0	0	4	2023

i.COURSE OVERVIEW

The course aims to introduce the fundamental principles of intelligent systems to students. This involves ideas about the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms. The course helps the learner to understand the design of self learning systems along with some of their typical applications in the emerging scenario where the business world is being transformed by the progress made in machine learning.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts of intelligent systems and their architecture.	Understand
CO 2	Apply uninformed and informed search techniques for problem solving in intelligent systems.	Apply
CO 3	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems.	Apply
CO 4	Solve Constraint Satisfaction Problems using search techniques.	Apply
CO 5	Implement different types of learning techniques used in intelligent systems.	Apply

iii. SYLLABUS

Introduction – What is Artificial Intelligence(AI) ? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, nature of Environments, Structure of Agents.

Problem Solving-Solving Problems by searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions.

Knowledge Representation and Reasoning-Logical Agents – Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic – Syntax and Semantics of First Order Logic, Using First Order Logic,

Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution.

Search in Complex environments-Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.

Machine Learning-Learning from Examples – Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and choosing the best hypothesis, Regression and classification with Linear models.

iv (a) TEXT BOOKS

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition. Prentice Hall.

(b) REFERENCES

1. Nilsson N.J., Artificial Intelligence - A New Synthesis, Harcourt Asia Pvt. Ltd.

v. COURSE PLAN

Module	Contents	Hours
I	**Introduction** – What is Artificial Intelligence(AI) ? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, nature of Environments, Structure of Agents.	**8**
II	**Problem Solving**-Problem solving Agents, Illustration of the problem solving process by agents, Searching for solutions, Uninformed search strategies: BFS, Uniform-cost search, DFS, Depth-limited search, Iterative deepening depth-first search, Informed search strategies: A* Search, Heuristic functions.	**12**
III	**Knowledge Representation and Reasoning**-Logical Agents – Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic – Syntax and Semantics of First Order Logic, Using First Order Logic, Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution.	**14**
IV	**Search in Complex environments**-Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint	**13**

	Satisfaction Problems – Defining CSP, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.	
V	**Machine Learning**-Learning from Examples – Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and choosing the best hypothesis, Regression and classification with Linear models.	**13**
	Total Hours	**60**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

C Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
AssAssessment through Tests	:	20 marks
TotTotal Continuous Assessment	:	**40 marks**
En End Semester Examination	:	**60 marks**
TO TOTAL	:	**100 marks**

vii.CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL30B	**Data Science**	PCC	2	1	0	0	3	2023

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The course is designed to provide fundamental knowledge on data science and to help learners understand the role of statistics and optimization in performing mathematical operations relevant to the field. It aims to equip students with the skills necessary to handle heterogeneous data and effectively visualize it for better interpretation and decision-making. Additionally, the course introduces various open-source data science tools, offering foundational knowledge of their functionalities and practical applications in solving real-world industrial problems.

iii) COURSE OUTCOMES

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

CO1	Demonstrate the ability to obtain fundamental knowledge on data science .	Understand
CO2	Demonstrate proficiency in statistical analysis of data.	Understand
CO3	Apply basic tools and techniques of Exploratory Data Analysis (EDA)	Apply
CO4	Make use of the concepts of Outlier Detection Approaches and Feature encoding Approaches	Apply
CO5	Apply the various types of data and visualize them using through programming for knowledge representation.	Apply

iv) SYLLABUS

Syllabus covers the fundamentals of **Data Science and Exploratory Data Analysis (EDA)**, starting with an introduction to Data Science, Big Data, datafication, and the current landscape. It explores **data types and statistical descriptions**, including attributes, measures of central tendency, dispersion, and normal distribution concepts such as CDF, PDF, z-scores, and the Central Limit Theorem, along with probability distributions like Bernoulli, Binomial, Log-normal, and Poisson. The course then focuses on **EDA**, data acquisition, preprocessing, handling missing values, imputation methods, and outlier detection. It further discusses **feature engineering** through encoding and transformation methods, including scaling, normalization, and standardization. Finally, it introduces **data visualization**, covering dimensions and measures, chart types, visualization workflows, and abstraction methods to effectively represent categorical, hierarchical, relational, temporal, and spatial data.

v) a) TEXTBOOKS

1. R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 8th Ed., 2. Pearson Education India, 2019.
2. Avrim Blum, John Hopcroft, Ravindran Kannan, “Foundations of Data Science”, Cambridge University Press, 2020.
3. Hossein Pishro-Nik, “Introduction to Probability, Statistics, and Random Processes”, Kappa Research, LLC, 2014.

b) REFERENCES

1. Ani Adhikari and John DeNero, „Computational and Inferential Thinking: The Foundations of 2 Data Science“ , GitBook, 2019.
2. Cathy O“Neil and Rachel Schutt, „Doing Data Science: Straight Talk from the Frontline“, O“Reilly Media, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Definition of Data Science- Big Data and Data Science hype – and getting past the hype - Datafication - Current landscape of perspectives Data Types & Statistical Description Types of Data: Attributes and Measurement, What is an Attribute? The Type of an Attribute, The Different Types of Attributes, Describing Attributes by the Number of Values, Asymmetric Attributes, Binary Attribute, Nominal Attributes, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes. Basic Statistical Descriptions of Data: Measuring the Central Tendency: Mean, Median, and Mode	9
II	Measuring the Dispersion of Data: Range, Quartiles, Variance, Standard Deviation, and Interquartile Range, Graphic Displays of Basic Statistical Descriptions of Data Normal Distribution, CDF of Normal Distribution,Probability Density Function (PDF) of Normal Distribution Standard Normal Variate (z Score) and Standardization Central Limit Theorem Kernel Density Estimation Bernooulli Distribution, Binomial Distribution,Log Normal Distribution,Poisson Distribution using Example	**6**
III	Exploratory Data Analysis (EDA) - Definition, Motivation, Steps in data exploration, The basic datatypes, Data type Portability, Basic Tools of EDA,	**10**

	Data Analytics Life cycle, Discovery, Data Acquisition, Data Pre-processing and Preparation, Data Quality and Transformation, Handling Text Data; Data Imputation Methods –Representing missing values, Identifying Missing Values, Visualize Missing Values with missingno, Approaches to Filling in Missing Data, Interpolation, MICE Predictions	
IV	Outlier Detection Approaches Feature encoding Approaches Label Encoding, Need for Feature Encoding ,Label and Ordinal, One hot Encoding, Frequency encoding ,Target Encoding ,Blending Method, Leave one out Encoding , Weights of Evidence and Information Value Feature Transformation Need of scaling Standardisation and normalisation	**10**
V	Introduction to data visualization, Introduction to Dimensions and Measures, Bar Chart, Line Chart, Table, Heat Map, Treemap, Packed Bubble, Tooltip Visualization workflow: describing data visualization workflow, Visualization Periodic Table; Data Abstraction -Analysis: Four Levels for Validation- Task Abstraction - Analysis: Four Levels for Validation Data Representation: chart types: categorical, hierarchical, relational, temporal & spatial	**10**
	Total	**45 hours**

vii) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

ix) END SEMESTER EXAMINATION

For Theory Courses

- Maximum Marks: 60
- Exam Duration: 3 hours
-

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTB30C	Introduction to Machine Learning	**PCC**	**3**	**0**	**2**	**0**	**4**	**2023**

i. COURSE PREREQUISITE

23ESB10H Programming using Python

ii. COURSE OVERVIEW

This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course focuses on the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the Naive Bayes algorithm, basic clustering algorithms and classifier performance measures. This course helps the students to provide machine learning based solutions to real world problems.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate Machine Learning concepts and basic parameter estimation methods.	Understand
CO 2	Apply the supervised learning concepts (regression, linear classification).	Apply
CO 3	Apply the concepts of Multilayer neural network and Support Vector Machine.	Apply
CO 4	Make use of the unsupervised learning concepts and dimensionality reduction techniques.	Apply
CO 5	Solve real life problems using appropriate machine learning models and evaluate the performance measures.	Apply

iv. SYLLABUS

This syllabus presents the fundamentals of machine learning, including supervised and unsupervised learning. It explores key algorithms like Neural Networks, Support Vector Machines (SVM), and clustering methods. The course emphasizes classification tasks, evaluation metrics such as accuracy, precision, and recall, and practical applications in real-world problems. A case study on developing a face detection classifier demonstrates the end-to-end process of data preprocessing, model selection, training, evaluation, and deployment. Students will gain a

comprehensive understanding of machine learning concepts and their applications in diverse fields.

v (a) TEXT BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

(b) REFERENCES

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali.Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

vi. COURSE PLAN

Module	Contents	Hours
I	**Machine learning paradigms** - supervised, semi-supervised, unsupervised, reinforcement learning. **Basics of parameter estimation** - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.	9
	● Develop python programs using Pandas, Numpy and Visualization tools.	8

II	**Regression -** Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, Overfitting and under fitting, Cost function. **Regularization** –L1 and L2 in regression. **Linear Methods for Classification**- Logistic regression, Naive Bayes, Decision tree algorithm ID3.	**9**
	● Implement and demonstrate Single, Multi variable and Polynomial Regression for a given set of training data stored in a .CSV file and evaluate the accuracy. ● Implement a Python program to perform logistic regression on a dataset. ● Implement K-Nearest Neighbor algorithm to classify any dataset. ● Implement a python program that demonstrates the use of Naive Bayes classifier and calculate the accuracy, precision, and recall for your data set. ● Implement a Python program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	**8**
III	**Perceptron, Neural Network** - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. **SVM** - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF). Class Imbalance – SMOTE – One Class SVM – Optimization of hyper parameters.	**9**
	● Assuming a set of data that need to be classified, use a Support Vector Machine classifier to perform this task and evaluate the accuracy.	**4**
IV	**Clustering** - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. **Dimensionality reduction** – Principal Component Analysis. Ensemble methods, Voting, Bagging, Boosting.	**9**
	● Implement K-Means Clustering using any given dataset. ● Implement Agglomerative Hierarchical Clustering. ● Implement dimensionality reduction using PCA.	**6**
V	Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC. Bootstrapping, Cross Validation. Model Evaluation-Bias-Variance-tradeoff	**9**

	Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination **Case Study**: Develop a classifier for face detection.	
	• Build an Artificial Neural Network using Backpropagation algorithm and test the same with appropriate dataset.	**4**
	Total Hours	**75**

vii. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60: 40

Continuous Assessment		
Attendance	:	5 marks
Assessment through Tests	:	20 marks
Project Work	:	15 marks
Assessment of Lab Work	:	10 marks
Lab Exam	:	10 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

Final Lab Assessment–2 hours exam for 40 marks

viii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

ix. CONTINUOUS ASSESSMENT TEST

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit
23HSL30A	Business Economics and Accountancy	HSC	3	0	0	0	3

i) COURSE OVERVIEW: To familiarize the prospective engineers with elementary Principles of Business Economics and Accountancy to analyse various business structures by using Economics principles and Accounting tools at an elementary level.

ii) COURSE OUTCOMES

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

CO 1	Explain the problem of scarcity of resources and consumer behaviour	Understand
CO 2	Examine the production efficiency and profitability with the help of quantitative and qualitative methods	Analyse
CO3	Interpret the macro-economic policies, trends and issues of the economy	Understand
CO4	Analyse business viability with the help of business models and financial planning.	Analyse
CO5	Develop an accurate and compliant balance sheet by classifying and recording financial transactions systematically	Apply

iii) SYLLABUS

Introductory Micro-Economics

Scarcity and choice - Basic economic problems- PPC – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Microeconomic Foundations: Production, Cost, Market Structures & Pricing Strategies

Production function – law of variable proportion – economies of scale – internal and external economies – Cobb-Douglas production function - Cost concepts - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point. Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopolyNon-price competition – Product pricing strategies

Introductory Macro-Economics

Circular flow of income-two sector and multi-sector models- National Income Concepts-Measurement Methods-Problems-Inflation, deflation - Fiscal Policy (Government spending & taxation) - Monetary Policy (Interest rates & money supply) - Wage Rigidity & Unemployment - Demand-Pull vs. Cost-Push Inflation.

Business Models and Financial Planning

Innovation and creativity in entrepreneurship - Business idea generation and feasibility analysis - Business planning (Lean Canvas, SWOT, PESTEL analysis) - Types of business structures (sole proprietorship, partnership, corporation) - Legal aspects and regulatory requirements - Sources of funding: Bootstrapping and personal savings, Venture capital and angel investors, Bank loans and government grants (Startup India, MSME financing), Crowdfunding and alternative finance - Financial planning and forecasting - Challenges in entrepreneurial finance (liquidity, risk management) - Exit strategies (IPO, mergers, acquisitions)

Introduction to Accounting

Book-Keeping and Accountancy- Elements of Double Entry- Book – Keeping-rules for journalizing-Ledger accounts-Cash book- Banking transactions- Trial Balance- Method of Balancing accounts-the journal proper.

Final accounts: Preparation of trading and profit and loss Account- Balance sheet preparation and interpretation - Introduction to accounting packages.

iv) Text Books

1. Gregory N Mankiw, Principles of Micro Economics, Cengage Publications 2023
2. Gregory N Mankiw, Principles of Macro Economics, Cengage Publications 2023
3. Steven Rogers, Entrepreneurial Finance, McGraw-Hill, Fourth Edition, 2020
4. Agrawal R and Sriniwasan R, Accounting Made Easy, Tata McGraw-Hill 2010

REFERENCES

1. Dominick Salvatore, Theory and Problems of Micro Economic Theory. Tata Mac Graw- Hill, New Delhi.2017
2. Dwivedi D.N., Macroeconomics: Theory And Policy, Tata McGraw Hill, New Delhi 2018
3. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 12th edition, 2018.
4. Janet Kiholm Smith and Richard L Smith, Entrepreneurial Finance: Venture Capital, Deal Structure & Valuation, Stanford Business Books US, 2019
5. M.Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting. Prentice Hall of India. New Delhi. 2008

v) COURSE PLAN

Module	Contents	No. of hours
I	Scarcity and choice - Basic economic problems - PPC – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	9
II	Production function – law of variable proportion – economies of scale – internal and external economies – Cobb-Douglas production function - Cost concepts - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point. Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly - Non-price competition – Product pricing strategies	8
III	Circular flow of income - two sector and multi-sector models - National Income Concepts - Measurement Methods – Problems - Inflation, deflation - Fiscal Policy (Government spending & taxation) - Monetary Policy (Interest rates & money supply) - Wage Rigidity & Unemployment - Demand-Pull vs. Cost-Push Inflation	9
IV	Innovation and creativity in entrepreneurship - Business idea generation and feasibility analysis - Business planning (Lean Canvas, SWOT, PESTEL analysis) - Types of business structures (sole proprietorship, partnership, corporation) - Legal aspects and regulatory requirements - Sources of funding: Bootstrapping and personal savings, Venture capital and angel investors, Bank loans and government grants (Startup India, MSME financing), Crowdfunding and alternative finance - Financial planning and forecasting - Challenges in entrepreneurial finance (liquidity, risk management) - Exit strategies (IPO, mergers, acquisitions)	9
V	Book-Keeping and Accountancy - Elements of Double Entry - Book – Keeping - rules for journalizing - Ledger accounts - Cash book- Banking transactions - Trial Balance - Method of Balancing accounts - the journal proper. Final accounts: Preparation of trading and profit and loss Account - Balance sheet preparation and interpretation - Introduction to accounting packages.	10
	Total	**45**

vi) Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks

Total : 40 Marks

vii) End Semester Examination

There will be an end semester examination for 60 marks with a duration of 3 hours.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTP30A	**Artificial Intelligence Lab**	**PCC**	**0**	**0**	**3**	**0**	**2**	**2023**

i. COURSE OVERVIEW

This laboratory course enables the students to get the fundamental concepts in the area of Artificial Intelligence. This course covers the AI based Algorithms, logical reasoning agents and implementation of these reasoning systems using either backward or forward inference mechanisms. This course helps the learners to apply AI techniques to solve real world problems.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Apply basic and informed search algorithms to solve real-world AI problems using state space representation.	**Apply**
CO 2	Implement constraint satisfaction problems (CSP) using backtracking and local search algorithms.	**Apply**
CO 3	Develop AI solutions using adversarial search algorithms for game playing.	**Apply**
CO 4	Design and implement AI systems using knowledge representation techniques and propositional logic inferences.	**Apply**
CO 5	Formulate and solve optimization problems using heuristic and metaheuristic approaches.	**Apply**

iii. SYLLABUS

1. Implement basic search strategies for selected AI applications.
2. Implement state space search algorithms.
3. Implement informed search algorithms.
4. Implementation of Game playing (adversarial search).
5. Implement backtracking algorithms for CSP.

6. Implement local search algorithms for CSP.
7. Implement propositional logic inferences for AI tasks.
8. Implementation of Knowledge representation schemes.
9. Implement travelling salesman problem.
10. Mini Project that implement a real-world application using AI techniques (Group project with a maximum of four students).

LIST OF EXPERIMENTS

1. Implement Depth-First Search (DFS).
2. Implement Breadth First Search (BFS).
3. Implement a Python program to solve the 8-puzzle problem using DFS.
4. Implement a Python program to solve the water jug problem using BFS.
5. Implement a Python program to solve the 8-puzzle problem using heuristic search(A*)
6. Implement Tic Tac Toe game in Python using MINMAX algorithm (adversarial search)
7. Implement a Python program to solve the 4-Queen's Problem using CSP.
8. Implement a Python program to solve the travelling salesman problem using hill climbing algorithm.
9. Develop a Python program to implement a simple chat-bot.

iv.REFERENCES

1. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third edition, Pearson Edition, 2006
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013 (http://nptel.ac.in/)
5. Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases -by Dennis Rothman, 2018
6. Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford University Press.
7. Brachman, R. and Levesque, H. 2004. Knowledge Representation and Reasoning, Morgan Kaufmann.

v.ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 60 : 40

Continuous Assessment

Attendance	:	5 marks
Continuous Evaluation	:	30 marks
Viva	:	10 marks

Internal Test	:	15 marks
Total Continuous Assessment	:	**60 marks**
Final Lab Assessment	:	**40 marks**
Total	:	**100 Marks**

vi. FINAL LAB ASSESSMENT

- Maximum Marks: 40
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSP30B	Networking Lab	PCC	0	0	3	0	2	2023

i. COURSE OVERVIEW

The course enables the learners to get hands-on experience in network programming using Linux System calls, networking using IPv4 and IPv6 addresses and network monitoring tools. It covers implementation of network protocols and algorithms, configuration of network services, static and dynamic routing, setting up layer 2 switching, and VLANs and familiarization of network simulators. This helps the learners to develop, implement protocols and evaluate its performance for real world networks. This course also offers hands-on experience in building, configuring, and managing networks using Software Defined Networking (SDN) concepts.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Make use of network related commands and configuration files in Linux Operating System.	Apply
CO 2	Exploit the client server paradigm to develop real time networking applications using transport layer protocols.	Apply
CO 3	Employ IPv4 and IPv6 addressing, subnetting to efficiently design networks.	Apply
CO 4	Make use of network monitoring tools to analyze network traffic.	Apply
CO 5	Apply basic SDN concepts to configure and simulate network topologies.	Apply

iii (a) TEXT BOOKS

1. W. Richard Stevens, Andrew M Rudoff, Bill Fenner UNIX Network Programming-Volume-1: The Sockets Networking API,2/e, Pearson Education, 3/e, 2004
2. Todd Lammle, CCNA Cisco certified network associate study guide Exam 640-802 6, Wiley, 6/e,2007
3. Brian "beej Jorgensen" Hall, Beej's Guide to Network Programming: using Internet Sockets, Amazon Digital Services,2019

4. Paul Goransson, Chuck Black, Timothy Culver**,** Software Defined Networks: A Comprehensive Approach**, 2/e,Morgan Kaufmann, 2/e, 2016**

5. http://mininet.org

6. https://osrg.github.io/ryu

(b) REFERENCES

1. Behrouz A Forouzan, Computer Networks: A Top- Down Approach, McGraw Hill, SIE, 2017
2. J. F. Kurose and K. W.Ross, Computer Networking: A Top-Down Approach Featuring Internet, Pearson Education, 8/e, 2022

v. COURSE PLAN

Module	Contents	Hours
	Warm Up	
1	Getting started with the basics of network configuration files and networking commands in Linux.	**3**
	Socket Programming Based	
2	Implement a concurrent Time Server using UDP.	**6**
3	Implement a multi-user chat server using TCP as the transport layer protocol.	**6**
	Hardware Based	
4	Familiarize router commands.	**3**
5	Configure static routing for a particular topology. After configuring the routes, display the routing tables and verify network connectivity using the ping command.	**3**
6	Configure RIPv2 for a particular topology. After configuring the routes, display the routing tables and verify network connectivity using the ping command.	**3**
7	Configure OSPF for a particular topology. After configuring the routes, display the routing tables and verify network connectivity using the ping command.	**3**
8	Set up an IPv6- based network and interconnect the various subnets using the RIPng routing protocol.	**3**
9	A company has three departments: Sales, Support, and Admin. Assign each to a different VLAN. Ensure users within the same department can communicate, but not with users from other departments.	**3**
10	An Engineering College has three departments: **CSE (VLAN 10)**, **ECE (VLAN 20)**, and **EEE (VLAN 30)**. Each department is on a separate VLAN configured on a single Layer 2 switch. Perform the following Tasks: i) Configure VLANs on the switch. ii) Assign ports to each VLAN. iii) Use a router-on-a-stick configuration to enable inter-VLAN communication. iv) Verify that a PC in HR can ping a PC in Finance and IT. v) Ensure VLAN interfaces are configured with correct IPs and subnets.	**3**
	Network Analysis Based	
11	Install Wireshark and perform packet captures to analyze and answer the following scenario-based questions. i) A user opens a website in a browser. Analyze the HTTP GET request and the response.	**3**

	ii) Ping a known IP address (e.g., 8.8.8.8) and observe the ICMP request and reply. iii) A student accesses a remote SSH server. Capture and analyze the TCP handshake.	
SDN Based		
12	Design and implement a SDN application that functions as a basic Layer-2 switch. The application should learn MAC addresses dynamically and forward packets accordingly using flow rules installed in the OpenFlow switch. Simulate the network using Mininet and verify correct packet forwarding between hosts.	**3**
13	Design and implement a basic load balancing mechanism using SDN controller, distributing client requests across multiple backend servers to ensure efficient network utilization.	**3**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	5 marks
Assessment of Lab Work	:	55 marks
Continuous Assessment in Lab (Lab work + Record + Viva - voce) -40 marks and Internal Lab test -15 marks		
Final Lab Assessment	:	40 marks
TOTAL	**:**	**100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL31D	**PARALLEL COMPUTER ARCHITECTURE**	**PEC**	**2**	**1**	**0**	**0**	**3**	**2023**

i.PRE-REQUISTE: 23CSL20B Computer Organization and Architecture

ii. COURSE OVERVIEW

The purpose of the course is to provide students with a basic understanding of parallel architecture and its operations. Modern Processor architectures and design issues are introduces along with some of the key features of high performance computers were added.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO1	Apply parallel computer models and performance metrics such as Amdahl's Law to evaluate and compare the efficiency of different parallel architectures.	Apply
CO2	Explain advanced processor technologies, instruction set architectures, and memory hierarchy concepts in modern computing systems.	Understand
CO3	Apply interconnection network techniques and cache coherence protocols to analyze and improve the performance of multiprocessor systems.	Apply
CO4	Apply message passing and routing strategies, and implement pipelining techniques including superscalar and arithmetic pipeline designs for performance improvement.	Apply
CO5	Explain parallel programming models, languages, and basic compiler techniques for optimization and scheduling	Understand

iv. SYLLABUS

Basic concepts of parallel computer models, SIMD computers, Multiprocessors and multi-computers, Cache Coherence Protocols, Multicomputers, Pipelining computers, Parallel models, Languages and compilers.

v(a)TEXTBOOKS

1. K. Hwang and Naresh Jotwani, Advanced Computer Architecture, Parallelism, Scalability, Programmability, TMH, 2010.
2. J. L. Hennessy and D. Patterson, Computer Architecture: A Quantitative Approach, 6th ed., Morgan Kaufmann, 2017.

(b) REFERENCES

1. M J Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House, 2012.
2. M Sasikumar, D Shikkare and P Raviprakash, Introduction to Parallel Processing, PHI, 2014.
3. Patterson D. A. and Hennessy J. L., Morgan Kaufmann , Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann Pub, 6/e, 2017.

vi. COURSE PLAN

Module	Contents	Hours
I	Parallel computer models – Evolution of Computer Architecture, System Attributes to performance, Performance metrics and benchmarks -Moore's Law, Amdahl's law for a fixed workload. Multiprocessors and Multicomputers, Multivector and SIMD computers, Architectural development tracks, Conditions of parallelism.	**8**
II	Processors and memory hierarchy – Advanced processor technology- Design Space of processors, Instruction Set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar and vector processors, Memory hierarchy technology.	**9**

III	Multiprocessors system interconnects - Hierarchical bus systems, Cross bar switch and multiport memory, Multistage and combining networks. Cache Coherence and Synchronization Mechanisms, Cache Coherence Problem, Snoopy Bus Protocol, Directory Based Protocol, Hardware Synchronization Problem	**10**
IV	Message Passing Mechanisms-Message Routing schemes, Flow control Strategies, Multicast Routing Algorithms. Pipelining and Superscalar techniques – Instruction pipeline design, Arithmetic pipeline deign - Super Scalar Pipeline Design	**10**
V	Parallel programming Models, Parallel Language and compilers, Code optimization and scheduling, Loop Parallelization and Pipelining. Parallel Programming models and languages.	**8**
	Total Hours	**45**

vii. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

ix. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL31C	COMPUTER GRAPHICS AND MULTIMEDIA	PEC	2	1	0	0	3	2023

i. COURSE OVERVIEW

This course offers an integrated study of computer graphics and multimedia systems, covering both foundational theory and practical implementation. Students will learn key techniques used in the generation and manipulation of graphical content, including line and circle drawing algorithms, polygon filling techniques, 2D and 3D transformations, clipping algorithms, and projection methods. The course also covers 3D viewing pipelines and visible surface detection algorithms to develop a solid understanding of how 3D scenes are rendered and visualized. The second half of the course focuses on multimedia technologies. Students will explore multimedia fundamentals, system architectures, data representation standards, compression techniques, and storage solutions. Topics such as digital audio, video, animation, multimedia databases, and authoring tools are examined. Additionally, the course addresses hypermedia messaging, mobile messaging systems, and the integration of multimedia documents in distributed environments.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO1	Describe the working principles of graphics devices.	Understand
CO2	Apply line drawing, circle drawing and polygon filling algorithms to render precise geometric shapes.	Apply
CO3	Demonstrate geometric representations, transformations on 2D & 3D objects, clipping algorithms and projection algorithms.	Apply
CO4	Summarize visible surface detection methods.	Understand
CO5	Apply foundational concepts of multimedia systems including architecture, data standards, compression techniques, and I/O	Apply

	technologies to analyze and develop multimedia content across various platforms.	
CO6	Design and implement interactive multimedia applications using authoring tools and standards for hypermedia messaging, integrated document management, and distributed multimedia systems.	Apply

iii. SYLLABUS

Basics of Computer Graphics and its applications. Video Display devices
Line drawing algorithms-Circle drawing algorithms.
Fill area primitives, Two dimensional and 3 dimensional transformations
Window to view port transformations-Line clipping-Polygon clipping-Projections- visible surface detection algorithms
Multimedia basics, Multimedia applications, Multimedia system architecture technologies for multimedia.

Multimedia authoring and user interface - Hypermedia messaging -Mobile messaging – Hypermedia message component.

iv(a)TEXTBOOKS

1. Donald Hearn and M. Pauline Baker, Computer Graphics, 2nd Edition, PHI, 1996

2. Andleigh, P. K and KiranThakrar, Multimedia Systems and Design‖, PHI, 2003.

(b) REFERENCES

1. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics, McGraw Hill, 2001.

2. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019.

3. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill, 2001.

4 Judith Jeffcoate, —Multimedia in practice: Technology and Applications‖, PHI, 1998.

v. COURSE PLAN

Module	Contents	Hours

I	Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems. Line drawing algorithms DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm.	8
II	Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling. Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.	**10**
III	Window to viewport transformation. Cohen Sutherland Line clipping algorithm. Sutherland Hodgeman Polygon clippingalgorithm. Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Depth buffer algorithm, Scan line algorithm.	**10**
IV	Multimedia basics − Multimedia applications − Multimedia system architecture – Evolving technologies for multimedia − Defining objects for multimedia systems − Multimedia data interface standards − Multimedia databases. Compression and decompression − Data and file format standards − Multimedia I/O technologies − Digital voice and audio − Video image and animation − Full motion video − Storage and retrieval technologies	**8**
V	Multimedia authoring and user interface - Hypermedia messaging - Mobile messaging − Hypermedia message component − Creating hypermedia message − Integrated multimedia message standards − Integrated document management − Distributed multimedia systems.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks

Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTL31A	**WEB TECHNOLOGY**	**PEC**	**2**	**1**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

This course introduces students to full-stack web development, covering frontend technologies like HTML, CSS, JavaScript, and React, as well as backend development with Node.js, Express, and MongoDB. It emphasizes API integration, real-time interactions, and DevOps practices to build scalable, responsive web applications.

ii. COURSE OUTCOMES

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

Course Outcomes	Course Outcomes	Level
CO 1	Develop semantic and responsive web pages using HTML5 and CSS3.	Apply
CO 2	Build interactive user interfaces and single-page applications (SPAs) using JavaScript and React.	Apply
CO 3	Design and implement backend services with Node.js, Express, and manage databases with MongoDB.	Apply
CO 4	Integrate third-party APIs, handle asynchronous data, and utilize JSON in web applications.	Apply
CO 5	Implement best practices for security, performance optimization, and deploy scalable web applications using DevOps tools.	Apply

iii. SYLLABUS

Introduction to Web Development and Frontend Foundations, React and SPA Development, Backend Development with Node.js & Express, APIs, Databases and Integration, Security, DevOps, and Deployment

iv (a) TEXTBOOKS

1 Philip Ackermann. (2022). *Full stack web development – The comprehensive guide*. SAP Press.

2 Ethan Brown. (2019). *Web development with Node and Express*. O'Reilly Media.

(b) REFERENCES

1 **Marijn Haverbeke.** (2024). *Eloquent JavaScript*. 4th ed., No Starch Press.

2 Carl Rippon. (2020). *Beginning React with Hooks*. Apress.

3 Kyle Simpson. *You Don't Know JS Yet: Get Started*. 2nd ed., Independently published, 2023.

4 Alex Banks and Eve Porcello. *Learning React: Modern Patterns for Developing React Apps*. 3rd ed., O'Reilly Media, 2023.

V. COURSE PLAN

Module	Contents	Hours
I	**Frontend Foundations** HTML5, CSS3, and Responsive Design Client-Server Model, Static vs. Dynamic Websites, HTML5 Tags and Attributes, Semantic Elements, Hyperlinks, Lists, Tables, Forms, Media Elements (Audio, Video, Images), CSS3 Selectors, Box Model, Styling, Positioning, Flexbox, Grid, Media Queries for Responsive Design	9
II	**JavaScript Programming and DOM Manipulation** JavaScript Variables, Data Types, Operators, Control Flow, Functions, Arrays, Objects, DOM Manipulation, Event Handling, Closures, Prototypes, Inheritance, Introduction to jQuery	9
III	React and Single Page Application (SPA) Development SPA vs MPA Architecture, React JSX, Components, Props, State, Lifecycle Methods, React Hooks (useState, useEffect), Event Handling, Conditional Rendering, React Router, Context API, Overview of AngularJS and Vue.js	9
IV	**Backend Development, APIs, and Full Stack Integration** Node.js Modules, Event Loop, Express.js Routing and Middleware, Form Handling, Sessions, Cookies, File System Access, Templating with EJS or Pug, REST API Design, HTTP Methods, Stateless Communication, JSON Parsing and Serialization, AJAX, Fetch API, MongoDB, Mongoose, Schema Design, CRUD Operations, Overview of PHP and Python for backend development.	9
V	**Security, Performance, DevOps and Deployment** HTTPS, CORS, OWASP Top 10 (SQL Injection, XSS), Code Splitting, Minification, Lazy Loading, Git, GitHub, Branching, Merging, Collaboration, GitHub Actions for CI/CD, Docker and Kubernetes (Conceptual), Hosting on Netlify, Vercel, Heroku, Performance Tools like Lighthouse, System Design Principles (Scalability, Maintainability)	9
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

SEMESTER VI

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL30D	**ALGORITHM ANALYSIS AND DESIGN**	**PCC**	**3**	**1**	**0**	**0**	**4**	**2023**

i. PRE-REQUISITE: 23CSL20A DATA STRUCTURES

ii. COURSE OVERVIEW

This course offers an introduction to the principles of computer algorithm design and analysis. These concepts form the theoretical foundation of computer science and are essential tools for any proficient programmer. The primary objective is to equip students with a strong understanding of the key categories of algorithms and their design strategies. By the end of the course, students will be capable of creating their own algorithmic solutions for various computational problems and evaluating their efficiency and effectiveness.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO1	Demonstrate the fundamental concepts and techniques used in algorithm design and analysis.	Understand
CO2	Analyze the time and space complexity of algorithms using asymptotic notations.	Analyze
CO3	Apply Graph algorithms and Advanced Data structures like AVL trees and Disjoint set operations in real world scenarios.	Apply
CO4	Apply algorithm design strategies such as divide and conquer, dynamic programming, greedy method, backtracking, and branch and bound to solve computational problems.	Apply
CO5	Develop efficient algorithms to solve a given problem.	Apply

iv. SYLLABUS

Introduction to algorithm analysis, Advanced data structures and graph algorithms, Various algorithm design techniques, Introduction to complexity theory and approximation algorithms.

v(a)TEXTBOOKS

1. T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 4nd Edition, Prentice-Hall India (2018)

2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", 2nd Edition, Orient Longman Universities Press (2008)

(b) REFERENCES

1. Sara Baase and Allen Van Gelder —Computer Algorithms, Introduction to Design and Analysis, 3rd Edition, Pearson Education (2009)
2. Jon Kleinberg, Eva Tardos, " Algorithm Design", First Edition, Pearson(2005)
3. Robert Sedgewick, Kevin Wayne, "Algorithms", 4th Edition Pearson(2011)
4. Steven S Sjiena, " The Algorithm Design Manual", 2nd Edition, Springer(2008)

vi. COURSE PLAN

Module	Contents	Hours
I	Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little- Omega (ω) and their properties. Classifying functions by their asymptotic growth rate, Time and Space Complexity Calculation of simple algorithms. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method and Master's Theorem (Proof not required).	**12**
II	Self-Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected); Disjoint Sets - Disjoint set operations, Union and find algorithms. DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.	**12**
III	The Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen's Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.	**12**
IV	Dynamic Programming- The Optimality Principle- Longest Common Subsequence - Analysis, All Pairs Shortest Path Algorithm – Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Backtracking – The N Queen's Problem. Branch and Bound Algorithm for Travelling Salesman Problem.	**12**

V	Tractable and Intractable Problems, Complexity Classes – P, NP, NP-Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms - Vertex Cover Problem, Graph Coloring. Randomized Algorithms (Definitions of Monte Carlo and Las Vegas algorithms), Randomized version of Quick Sort algorithm with analysis.	**12**
	Total Hours	**60**

vii. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

ix. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTB30D	Deep learning	PCC	3	0	2	0	4	2023

i. Prerequisite – Introduction to Machine learning 23CTB30C

ii. COURSE OVERVIEW

This course provides the learners an overview of the concepts and algorithms involved in deep learning. The course covers the basic concepts in neural networks, deep learning, optimization techniques, regularization techniques, convolutional neural networks, recurrent neural networks, autoencoders, and generative models. The students will be able to implement deep learning algorithms to solve real-world problems.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the basic concepts of deep learning.	Understand
CO 2	Make use of deep learning techniques for analysing tabular/structured data.	Apply
CO 3	Apply the standard regularization and optimization techniques for the effective training of deep neural networks.	Apply
CO 4	Apply convolutional Neural Network (CNN) models for different use cases.	Apply
CO 5	Apply the concepts of Recurrent Neural Network (RNN), Long Short Term Memory(LSTM), Gated Recurrent Unit (GRU).	Apply
CO 6	Implement the concepts of auto encoder, generative models, Transformers	**Apply**

iv. SYLLABUS

The Deep Learning course provides a comprehensive understanding of deep learning architectures, and their applications. It covers fundamental concepts, including activation

functions, loss functions, backpropagation, and challenges like overfitting and hyperparameter tuning. The course explores training deep models, focusing on optimization techniques (SGD, Adam), regularization methods (dropout, batch normalization), and ensemble learning. Advanced topics include Convolutional Neural Networks (CNNs) for image processing, Recurrent Neural Networks (RNNs) for sequential data, and generative models such as Autoencoders, GANs, and transformers. The course also discusses attention mechanisms and state-of-the-art architectures used in modern deep learning applications.

v (a) TEXT BOOKS

1. **Ian Goodfellow, Yoshua Bengio, and Aaron Courville,** *Deep Learning*, MIT Press, **2016.**
2. **Charu C. Aggarwal**, *Neural Networks and Deep Learning*, Springer International Publishing, part of Springer Nature**, 2018.**
3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., and Polosukhin, I., *Attention Is All You Need*, NeurIPS, 2017

(b) REFERENCES

1. **Nikhil Buduma and Nicholas Locascio**, *Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms*, 1st Edition, O'Reilly Media, Inc., **2017.**
2. **M. Gopal,** *Deep Learning: Core Concepts, Methods and Applications*, Pearson Education, **2022.**

vi. COURSE PLAN

Module	Contents	Hours
I	**Introduction to Deep learning and training Deep models** Introduction to deep learning. Deep feed forward network. Setup and initialization- Weight intializations, Vanishing and exploding gradient problems, Optimization techniques - Gradient Descent (GD), Stochastic GD, GD with momentum, GD with Nesterov momentum, AdaGrad, RMSProp, Adam., Regularization Techniques—L1 and L2 regularization, Early stopping,	**10**

	Dataset augmentation, Parameter sharing, Ensemble methods, Dropout, Batch normalization.	
II	**Deep Learning for Structured Data** Introduction to Deep Learning for Structured Data. Feedforward Neural Networks (MLPs) for Tabular Data. Preprocessing techniques: feature scaling, embeddings for categorical variables. Model optimization for tabular datasets. Evaluation metrics and overfitting in tabular models. Comparison with traditional machine learning methods (e.g., Decision Trees, Random Forest, XGBoost). Hybrid Approaches: Combining Deep Learning with Classical ML models.	**7**
III	**Convolutional Neural Network-CNN** Convolutional Neural Networks: Basic Architecture, Convolution Operation, Motivation, 3D Convolution , Padding, Stride, Pooling. Variants of convolution functions, efficient convolution algorithms, sparse connections, and weight sharing. Training CNN, Transfer learning, Applications of Convolutional Networks, Pre-trained Convolutional Architectures : Google Net, VGG, ResNet, EfficientNet. Object detection- RCNN, YOLO.	**11**
IV	**Sequential Models** Neural Machine Translation Applications of sequential models, Architectures -Recurrent neural networks, LSTM, GRU. Encoder-Decoder Models. Attention Mechanism. NLP-Language Modeling (GPT, BERT) Sequence-to-Sequence Learning (Transformer models). Text Classification— Named Entity Recognition (NER), Text Embedding & Representation Learning - Word2Vec, BERT Embedding. Generative Text Models	**9**
V	**Encoder decoder models and Generative models** Autoencoders, Types of autoencoders: Variational Auto-Encoder, under complete auto-encoder, stochastic encoder, denoising encoder. Image Segmentation- UNet. Generative models: generative adversarial networks (GAN). Applications of GAN.	**8**
	Total Hours	**45**

Module	Contents	Hours
1	Implement Feed forward neural network with three hidden layers for classification on CIFAR-10 dataset and visualize weights and activations.	2
2	Analyze the impact of optimization, weight initialization techniques, dropout and regularization techniques and visualize the change in performance.	2
3	Digit classification using CNN architecture for MNIST dataset.	2
4	Digit classification using pre-trained networks like VGGnet-19 or ResNet for MNIST dataset and analyze and visualize performance improvement.	3
5	Object detection using YOLO and Faster RCNN.	3
6	Implement a simple RNN. Analyze and visualize the performance change while using LSTM and GRU instead of simple RNN.	3
7	Implement a shallow autoencoder for image reconstruction using MNIST dataset.	3
8	Implement image generation using GAN.	3
9	Implement sentence prediction using BERT.	3
10	Implement Micro project	6
	Total Hours	30

vii. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60: 40

Continuous Assessment		
Attendance	:	5 marks
Assessment through Tests	:	20 marks
Assessment of Lab Work	:	25 marks
Lab Exam	:	10 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

Final Lab Assessment–2 hours exam for 40 marks

viii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02

- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

ix. CONTINUOUS ASSESSMENT TEST

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTL30D	**ROBOTICS AND INTELLIGENT SYSTEMS**	**PCC**	**3**	**1**	**0**	**0**	**4**	**2023**

i. COURSE OVERVIEW

This course enables the learners to understand the fundamental concepts and algorithms in Robotics and Intelligent systems. The course covers the standard hardware and kinematic concepts for robot design. Standard algorithms for localization, mapping, path planning, navigation and obstacle avoidance, to incorporate intelligence in robots are included in the course. This course helps the students to design robots with intelligence in a real world environment.

ii. COURSE OUTCOMES

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

Course Outcomes	Course Outcomes	Level
CO 1	Explain the concepts of manipulator,mobile robotics and robotic vision intelligence.	**Understand**
CO 2	Choose the suitable sensors, actuators and control for robot design.	**Apply**
CO 3	Develop a kinematic model of a mobile robot.	**Apply**
CO 4	Make use of the localization and mapping methods in robotics.	**Apply**
CO 5	Plan the path and navigation of robot by applying artificial intelligence algorithm.	**Apply**

iii. SYLLABUS

Introduction to robotics - Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots. Dynamic characteristics. Introduction to End effectors, Ethics in robotics - 3 laws - applications of robots. Sensor classification, Internal sensors- External sensors, Digital, Sensor characteristics. Actuators. Control - On-Off Control -PID Control. Robotic Vision: Camera sensor hardware interfacing.

Representation of Transformations, Pure Rotation about an Axis - Combined Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot. Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization Probabilistic map- based localization, Path Planning and Navigation.

iv (a) TEXT BOOKS

1. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots , MIT Press, USA, 2011.
2. Thomas Bräunl - Embedded Robotics,Mobile Robot Design and Applications with Embedded Systems-Springer , 2006.
3. S.G. Tzafestas - Introduction to Mobile Robot Control-Elsevier, 2014.
4. Francis X. Govers - Artificial Intelligence for Robotics-Packt Publishing, 2018.

(b) REFERENCES

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005.
2. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education, 2014.
3. Peter Corke - Robotics, Vision and Control_ Fundamental Algorithms in MATLAB® - Springer-Verlag Berlin Heidelberg, 2021.

v. COURSE PLAN

Module	Contents	Hours
I	Introduction to robotics – Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots . Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.	**12**
II	Sensor classification- touch, force, proximity, vision sensors. Internal sensors- Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors – Servos, Hydraulic & pneumatic actuators. Control - On-Off Control - PID Control.	**12**
III	Robotic Vision: Sensing, Pre-processing, Segmentation, Description, Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame. Basic understanding of Differential-Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot, Degree of	**12**

	freedom and manoeuvrability, Degree of steerability, Degree of mobility - different wheel configurations, holonomic and nonholonomic robots. Omnidirectional Wheeled Mobile Robots.	
IV	Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - An error model for odometric position estimation Map Representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition of SLAM - Visual SLAM with a single camera - Graph-based SLAM - Particle filter SLAM - Open challenges in SLAM.	**12**
V	Path Planning- Graph search, deterministic graph search - breadth first search - depth first search- Dijkstra' s algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity for code reuse and sharing - Control localization - Techniques for decomposition. Alternatives for navigation - Neural networks - Processing the image - Training the neural network for navigation - Convolutional neural network robot control implementation.	**12**
	Total Hours	**60**

vii. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60: 40

Continuous Assessment		
Attendance	:	5 marks
Assessment through Tests	:	20 marks
Project Work	:	15 marks
Assessment of Lab Work	:	10 marks
Lab Exam	:	10 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

Final Lab Assessment–2 hours exam for 40 marks

viii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30

- Test Duration: 1 ½ hours

- Topics: 2 ½ modules

ix. CONTINUOUS ASSESSMENT TEST

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTP30B	Robotics lab	PCC	0	0	2	0	1	2023

i. COURSE OVERVIEW

Robotics lab provides students with exposure to the common sensor and actuator interfacing, setting up mobile robots and familiarizing intelligent systems.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO1	Interface different peripherals to the arduino board.	Apply
CO2	Assemble a mobile robot with different sensors and actuators.	Apply
CO3	Impart intelligence to robots using standard algorithms.	Apply
CO4	Apply localisation and navigation techniques for autonomous mobile robot movement.	Apply

iii (a) TEXT BOOKS

1. Siegwart, Roland, Introduction to Autonomous Mobile Robots, Cambridge, Mass. : MIT Press, 2nd ed., 2011.
2. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer 2021
3. John. J. Craig, Introduction to Robotics (Mechanics and control), Pearson Education Asia 2002.
4. S K Saha, Introduction to Robotics by Mc Graw Hill Education, 2014.

(b) REFERENCES

1. https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation
2. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.
3. Dahiya, Ravinder S., Valle, Maurizio, Robotic Tactile Sensing, Springer, 2013.

iv. COURSE PLAN

Exp.No	Experiments	Hours
Interfacing sensors and actuators		
1	Familiarisation of Arduino IDE, Arduino microcontroller I/O interfacing(LED, LCD, Serial Monitor).	6

2	Interfacing IR and Ultrasonic sensor with Arduino.	**6**
3	Interfacing DC motors with arduino - speed and direction control.	**6**
4	Interfacing Servo Motors with Arduino - angle of rotation.	**3**
Intelligent systems		
5	Touch Sensors interfacing and feedback system.	**3**
6	Line following Robot using IR sensor.	**6**
7	Object detection using any one standard algorithm.	**3**
8	Localization of a mobile robot using LIDAR (ROS 2).	**6**
9	Navigation simulation using turtlebot using ROS.	**6**
	Total Hours	**45**

v. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 60 : 40

Continuous Assessment

Attendance	:	5 marks
Continuous Evaluation	:	30 marks
Viva	:	10 marks
Internal Test	:	15 marks
Total Continuous Assessment	:	**60 marks**
Final Lab Assessment	:	**40 marks**
Total	:	**100 Marks**

vi. FINAL LAB ASSESSMENT

- Maximum Marks: 40
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTS38A	SEMINAR	PWS	0	0	4	0	2	2023

i) COURSE OVERVIEW

The course involves exploring academic literature to select a relevant document in the student's area of interest and, under a seminar guide's supervision, develop skills in presenting and preparing technical reports. The course aims to enhance students ability to engage critically with scholarly work and communicate technical information effectively.

ii) COURSE OUTCOMES

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

CO 1	Investigate and synthesize information from diverse sources to gain a comprehensive understanding of a chosen technical topic.	Apply
CO 2	Interpret technical content to explore the practical implications and applications of emerging technologies in the field of engineering.	Apply
CO3	Utilize communication skills to articulate complex technical information through oral presentations and written report.	Apply
CO 4	Engage in constructive discussions and respond to questions and feedback.	Apply
CO 5	Investigate and synthesize information from diverse sources to gain a comprehensive understanding of a chosen technical topic.	Apply

iii) GENERAL GUIDELINES

- An Internal Evaluation Committee (IEC) shall be constituted by the department, comprising the program's HoD / Senior Faculty as Chairperson, along with the seminar coordinator and the student's seminar guide as members. All IEC members must be present during each student's seminar presentation.
- Formation of IEC and guide allotment shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- The seminar topic should be current and broad-based/narrowly focused on specific research. Ideally, it should be closely related to the student's final year project area. Team members may select or be assigned seminar topics that cover different aspects of their common project theme.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.

- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

iv. EVALUATION PATTERN

Total Marks	CIE Marks
100	100

CONTINUOUS ASSESSMENT EVALUATION PATTERN

Seminar Guide (20 Marks):

Background Knowledge – 10 marks (based on the student's understanding of the selected topic).

Relevance of Topic – 10 marks (based on the suitability and significance of the s elected paper/topic).

Seminar Coordinator (15 Marks):

Seminar Diary – 10 marks (weekly progress tracked and approved by the guide).

Attendance – 5 marks.

Evaluation of Presentation by IEC (45 Marks):

Clarity of Presentation – 10 marks.

Interaction – 10 marks (ability to answer questions).

Overall Participation – 10 marks (engagement during others' presentations).

Quality of the content – 15 marks.

Marks awarded by IEC for report (20 Marks)

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTJ38B	MINI PROJECT	PWS	0	0	4	0	2	2023

i.COURSE OVERVIEW:

The objective of this course is to enable students to apply the fundamental principles of Computer Sciecnce and Engineering-AI in the effective development of an application or research-oriented project. It guides learners through the essential phases of the problem identification, literature review, determination of methodology and its implementation for design and development of appropriate solution.

ii.COURSE OUTCOMES:

After the completion of the course the student will be able to

CO1	Identify problems that are socially relevant, technically feasible and economically viable.	Apply
CO2	Make use of relevant literature to explore existing solutions and established processes.	Apply
CO3	Identify appropriate design approaches, using modern tools with a strong commitment to professional ethics.	Apply
CO 4	Deduce innovative interpretation of the study outcomes, using engineering and management principles to generate novel insights or improvements.	Evaluate
CO5	Apply appropriate communication techniques to prepare presentations and reports that convey project outcomes effectively	Apply
CO 6	Develop the ability to manage tasks independently and engage collaboratively in team environments to achieve shared goals	Apply

iii.GUIDELINES:

Student groups consisting of three to four members are required to select a topic of interest in consultation with their Project Supervisor. They should conduct a thorough literature review and identify a problem to address the gaps identified, related to the chosen topic. Clear objectives must be defined, and a suitable methodology should be developed to achieve them. The project should incorporate innovative design concepts,

while considering important factors such as performance, scalability, reliability, aesthetics, ergonomics, user experience, and security.

The progress of the mini project is evaluated based on three reviews. The first review is to check the feasibility in implementation of the project. The second review is to evaluate the progress of the work. The third review will evaluate the completed work. The review committee will be constituted by the Head of the Department comprising of HoD or a senior faculty member, Mini Project coordinator and project supervisor. The evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by the review committee. A project report is required at the end of the semester. The project has to be demonstrated for its full design specifications.

iv.MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks
100	60	40

v.CONTINOUS ASSESSMENT EVALUATION PATTERN

First Review and Second Review	**60 marks**
Attendance	5 marks
Marks awarded by Project Supervisor	10 marks
Marks awarded by Review Committee	45 marks
Final Review	**40 marks**
Project Report	10 marks
Marks awarded by Review Committee	30 marks

PROGRAM ELECTIVE 2

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL32A	CLOUD COMPUTING	PEC2	2	1	0	0	3	2023

i. PRE-**REQUISITE: Nil**

ii. COURSE OVERVIEW

This course provides a comprehensive introduction to cloud computing, focusing on configuring cloud environments, deploying virtual machines, and working with containerization tools such as Docker. Learners will gain hands-on experience with leading cloud platforms to build a strong foundation in managing cloud resources efficiently. In addition, the course emphasizes the importance of security in the cloud. It equips learners with the knowledge to identify and mitigate common security threats, implement cloud security best practices, and ensure application safety and regulatory compliance in various deployment scenarios. They also learn how to integrate artificial intelligence (AI) and machine learning (ML) with cloud services.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the limitations of traditional computing and the fundamental concepts, models, and characteristics of cloud computing.	Understand
CO 2	Apply knowledge of cloud service and deployment models to configure and utilize open-source cloud platforms and implement basic cloud programming using tools like Hadoop and Spark.	Apply
CO 3	Describe the role of cloud-enabling technologies and explain the fundamentals of virtualization and containerization, including container types and their components.	Understand
CO 4	Explain the techniques used in cloud resource management and describe various cloud storage systems, file system architectures, and scaling strategies.	Understand
CO 5	Describe the services offered by major cloud providers and explain the basic features of cloud-based AI/ML platforms such as AWS SageMaker, Azure Machine Learning, and Google AI Platform.	Understand

iv. SYLLABUS

Introduction to Cloud Computing: Provides a foundational understanding of cloud computing by

exploring its evolution, core concepts, layered architecture, characteristics, and the limitations of traditional computing that drive cloud adoption.

Cloud Service and Deployment Models: Cloud delivery and deployment models, open-source cloud platforms, and introduces cloud programming paradigms using tools like Hadoop and Spark.

Cloud-Enabling Technologies and Containerization: Explores the foundational technologies that enable cloud computing and introduces the concepts, architecture, and types of virtualization and containerization.

Cloud Resource Management and Storage Systems: Examines resource management, scaling strategies, and diverse cloud storage architectures, including HPC integration in cloud environments.

Exploring Cloud Providers and Cloud-Based AI/ML Services: Introduces leading cloud platforms and their AI/ML services.

v (a) TEXT BOOKS

1. Thomas E. Cloud Computing: Concepts, Technology, Security, and Architecture. Pearson Education.; Second Edition, 2023.
2. Cloud Computing, Sandeep Bhowmik, Cambridge University Press, First edition, 2017.

(b) REFERENCES

1. Arshdeep Bahga , Vijay Madisetti Cloud Computing: A Hands-On Approach, First edition, 2024.
2. Dan C. Marinescu, Morgan Kaufman. Cloud Computing: Theory and Practice, Third Edition, 2023.
3. Toby Velte , Anthony Velte and Robert Elsenpeter, Cloud Computing, A Practical Approach, McGraw Hill Education, Second Edition,2017.
4. Rajkumar Buyya , Christian Vecchiola , S.Thamarai Selvi , Mastering Cloud Computing: Foundations and Applications Programming, First edition, 2013.

vi. COURSE PLAN

Module	Contents	Hours
I	**Module 1: Introduction to Cloud Computing:** Limitations of Traditional Computing and the Need for Cloud-Based Solutions, Evolution of Cloud Computing and Enabling Technologies, Three Layers of Computing: Infrastructure, Platform, and Software, Fundamental Concepts and Models in Cloud Computing, Roles and Boundaries in Cloud Environments, Cloud Characteristics, Benefits and Challenges of Cloud Adoption.	8

II	**Module 2: Cloud Service and Deployment Models:** Cloud Delivery Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Cloud Deployment Models: Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud. Open-source software platforms for private cloud: OpenStack, Cloud Stack, Basics of Eucalyptus, Open-Nebula, Nimbus, Cloud Programming: Parallel Computing and Programming Paradigms, Map Reduce, Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.	**10**
III	**Module 3: Cloud-Enabling Technologies and Containerization:** Cloud-Enabling Technologies: Network and Internet Architecture, Cloud Data Center Technology, Modern Virtualization and Multitenant Architecture, Service-Oriented Technology and Service APIs, Understanding Containerization: Drivers and Influencers of Containerization, Basics of Virtualization and Containerization, Understanding Containers and Container Images, Multi-container Types.	**10**
IV	**Module 4: Cloud Resource Management and Storage Systems:** Resource Management in Cloud Environments: Resource Pooling, Sharing, and Provisioning Techniques, Cloud Scaling Strategies (Horizontal & Vertical),Capacity Planning in Cloud Systems, Cloud Storage and File Systems: Storage Challenges and File System Management, Cloud-Native File Systems and Deployment Models, Storage Types: Block, Object, and File Storage, Popular Cloud Storage Services (e.g., AWS S3, Azure Blob), Introduction to High-Performance Computing (HPC) in Cloud.	**9**
V	**Module 5: Exploring Cloud Providers and Cloud-Based AI/ML Services:** Overview of Major Cloud Providers: Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), Introduction to Cloud-Based AI/ML Services: AWS SageMaker, Azure Machine Learning, Google AI Platform.	**8**
	Total Hours	**45**

vii. ASSESSMENT PATTERN

Continuous Assessment		
Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL32B	APPLIED DATA SCIENCE WITH PYTHON	PEC	2	1	0	0	3	2023

i) PRE-REQUISITE:

23MAL10A: Linear Algebra and Calculus, 23ESB10H: Programming using Python, 23MAL20D: Probability, Statistics and Numerical Methods

ii) COURSE OVERVIEW

Data Science course is a comprehensive journey designed to equip you with the knowledge, skills, and tools necessary to thrive in today's data-driven world. This course serves as a bridge between theoretical foundations and real-world applications, offering you the hands-on experience required to tackle actual data challenges.

iii) COURSE OUTCOMES

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

CO1	Apply Pandas functionalities to process structured datasets using real-world examples.	Apply
CO2	Design data preprocessing pipelines using feature engineering to improve model performance.	Apply
CO3	Build, evaluate, and interpret regression and classification models.	Apply
CO4	Apply supervised and unsupervised machine learning techniques for predictive modeling, pattern recognition, and dimensionality reduction.	Apply
CO5	Develop models using Time series data to solve real world problems.	Apply

iv) SYLLABUS

Python for Data Manipulation – Pandas Series and DataFrames, indexing and selection, data cleaning, aggregation, merging, reshaping, time-series handling, Advanced Data Wrangling and Feature Engineering – outlier detection, encoding categorical variables, scaling and transformations, feature construction and selection, handling imbalanced data, Regression and Model Evaluation – linear and logistic regression, regularization techniques, evaluation metrics, feature selection, model validation, Supervised and Unsupervised Learning – decision trees, random forests, boosting (XGBoost, LightGBM), SVM, clustering methods, dimensionality reduction, Time Series and Emerging Areas – ARIMA, Prophet, time-series forecasting, deep learning basics with Keras/TensorFlow, basic NLP, ethics in AI.

v) a) TEXTBOOKS

4. McKinney, Wes. Python for data analysis: Data wrangling with pandas, numpy, and jupyter. " O'Reilly Media, Inc.", 2022.
5. Zheng, Alice, and Amanda Casari. Feature engineering for machine learning: principles and techniques for data scientists. " O'Reilly Media, Inc.", 2018.
6. Müller, Andreas C., and Sarah Guido. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc.", 2016.
7. Lane, Hobson, and Maria Dyshel. Natural language processing in action. Simon and Schuster, 2025.
8. Nielsen, Aileen. Practical time series analysis: Prediction with statistics and machine learning. O'Reilly Media, 2019.

b) REFERENCES

1. Jake, VanderPlas. "Python Data Science Handbook. Essential Tools for Working with Data." (2016).
2. Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. " O'Reilly Media, Inc.", 2022.
3. Goodfellow, Ian, et al. Deep learning. Vol. 1. No. 2. Cambridge: MIT press, 2016.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Python for Advanced Data Manipulation with Pandas:** **Getting Started with Pandas**: creating Series and DataFrames, Viewing and inspecting data - **Basic Pandas Operations**: indexing and selection, boolean filtering, handling missing data, changing data types, renaming and replacing values, string operations, sorting data – **Data Transformation and Aggregation**: arithmetic operations between columns, applying functions, grouping data, using aggregation functions – **Advanced Pandas Operations**: merging and joining datasets, pivoting and reshaping, creating and working with MultiIndex DataFrames – **Working with Dates and Time**: parsing dates, extracting date parts, resampling time-series data – **Hands-On Practice**: working with real datasets like Titanic, Iris, COVID-19, and performing operations such as cleaning, grouping, reshaping, and time-series analysis.	10
II	**Advanced Data Wrangling and Feature Engineering** – **Outlier Detection and Treatment**: identifying outliers using Interquartile Range (IQR), Z-score, and visualization techniques like boxplots, handling outliers with capping, flooring, or transformation methods – **Encoding Categorical Variables**: one-hot encoding, label encoding, ordinal encoding, frequency and target encoding, handling high-cardinality features effectively – **Feature Transformation**: scaling techniques such as Standardization and	10

	Min-Max Scaling, normalization using L2 norm, transformations for skewed data using log, square root, Box-Cox, and Yeo-Johnson methods – **Feature Construction**: deriving new features from text, dates, and interaction terms, creating polynomial features to model non-linearity, feature binning – **Feature Selection Techniques**: filter methods (correlation analysis, mutual information), wrapper methods (Recursive Feature Elimination), and embedded methods (Lasso, Tree-based feature importance) – **Handling Imbalanced Datasets**: identifying class imbalance, applying resampling methods such as Random Oversampling, SMOTE (Synthetic Minority Oversampling Technique), and undersampling techniques – **Real-World Implementation**: performing end-to-end feature engineering on practical datasets like fraud detection, loan approval, and customer churn for improved model performance.	
III	**Regression Analysis and Model Evaluation** – **Linear Regression**:– **Regularization Techniques**: Lasso, Ridge, and Elastic Net regression, **Polynomial Regression**: fitting non-linear relationships using higher-order terms. **Supervised and Unsupervised Learning Techniques** **Random Forests**: **Boosting Algorithms**: AdaBoost, Gradient Boosting, and advanced models like XGBoost and LightGBM, handling overfitting through early stopping and regularization – **Hyperparameter Tuning**: grid search, randomized search, and cross-validation techniques using GridSearchCV and RandomizedSearchCV	9
IV	**Clustering Techniques**: Density-based clustering – Categorical Clustering **Dimensionality Reduction**: LDA, Wavelet transform, SVD **Model Evaluation for Clustering**: silhouette score, Davies-Bouldin index, and visual validation methods. Recommendation Systems- Content based Recommendation Systems, Collaborative Filtering ,Evaluating Recommender systems.	9
V	**Time Series Analysis and Introduction to Emerging Areas** – **Time Series Forecasting**: understanding time series components, working with datetime indices, resampling, shifting, and rolling statistics – **Forecasting Models**: ARIMA and Seasonal ARIMA (SARIMA), model selection using AIC/BIC, exponential smoothing methods, and Prophet for robust forecasting – **Model Diagnostics**: ACF and PACF plots, stationarity tests (ADF, KPSS), residual analysis – **End-to-End Data Science Project**. **Introduction to Deep Learning**: overview of neural networks, structure of a perceptron, basic Keras/TensorFlow implementation **Ethics and Fairness in AI**: awareness of bias in data and models, transparency, and responsible data science practices.	7
	Total	**45 hours**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

x) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL32D	VIRTUAL AND AUGMENTED REALITY SYSTEMS	PEC	2	1	0	0	3	2023

i. COURSE OVERVIEW

This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems. This course provides a foundation to the fast growing field of AR and make the students aware of the various AR devices.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain how VR systems work and list the applications of VR.	Understand
CO 2	Demonstrate the system of human vision and its implication on perception and rendering.	Understand
CO 3	Explain the importance of interaction and audio in VR systems.	Understand
CO 4	Apply the working of various state of the art AR devices	Apply
CO 5	Make use of computer vision concepts for AR and describe AR techniques	Apply

iii. SYLLABUS

Defining Virtual Reality- Representation of the Virtual World- Geometric Models- Visual Perception- Interaction.

Augmented Reality Concepts- Augmented Reality Hardware- Computer Vision for Augmented Reality- AR Components- Introduction to mixed reality

iv(a)TEXTBOOKS

1. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002

2. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978 1484236178

(b) REFERENCES

1. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494

2. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

v. COURSE PLAN

Module	Contents	Hours
I	Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality. Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR. Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.	8
II	Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates. Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies. Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering.	9
III	Augmented Reality - Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality Augmented Reality Concepts- How	9

	Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience. Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model.	
IV	Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion. Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software. Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application. Marker-based approach.	**9**
V	Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication Marker types- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real world examples Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialisation and recovery. AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene AR Devices – Optical See- Through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, Video see-through systems. Introduction to mixed reality.	**10**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60

• Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTL32A	**NATURAL LANGUAGE PROCESSING**	**PEC**	**2**	**1**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

This course introduces the fundamentals of Natural Language Processing, covering linguistic basics to advanced deep learning models. It equips students to build NLP applications and explore recent trends like large language models and ethical AI.

ii. PREREQUISITE: Basic knowledge of probability and statistics, linear algebra, and foundational concepts in machine learning.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the foundational concepts of Natural Language Processing and apply basic linguistic techniques such as tokenization, stemming, and POS tagging.	Understand
CO 2	Apply statistical and machine learning approaches to perform tasks like text classification, language modeling, and named entity recognition.	Apply
CO 3	Explain sentence structures and perform syntactic and semantic processing using parsing techniques and lexical resources.	Understand
CO 4	Use deep learning models for NLP tasks using embeddings, RNNs, and transformer-based architectures.	Apply
CO 5	Apply the current NLP technologies, including large language models, and discuss ethical considerations in their deployment.	Apply

iii. SYLLABUS

Fundamentals of NLP and Linguistic Concepts: NLP applications and challenges – Linguistic levels: morphology – syntax – semantics – pragmatics – Word sense disambiguation – Semantic role labeling – Coreference resolution – Discourse analysis – Lexical resources: WordNet – FrameNet. **Text Processing and Preprocessing Techniques:** Tokenization – Stemming – Lemmatization – Stop word removal – Normalization – Part-of-Speech (POS) tagging – Bag-of-Words – TF-IDF. **Statistical and Traditional Machine Learning Approaches:** N-gram models –

Smoothing – Perplexity – Text classification using Naive Bayes – Logistic Regression – Support Vector Machines (SVM) – Hidden Markov Models (HMMs) – Conditional Random Fields (CRFs). **Parsing and Syntactic Structures:** Constituency parsing – Dependency parsing – Context-Free Grammars (CFGs) – Probabilistic CFGs – Syntax-semantics interface. **Deep Learning for NLP:** Word2Vec – GloVe – fastText – Contextual embeddings – Feedforward networks – RNNs – LSTMs – GRUs – Sequence-to-sequence models – Attention mechanisms – Transformer architecture – BERT – GPT – T5 – Fine-tuning – Transfer learning – Prompt engineering. **Evaluation, Applications, and Ethical Considerations:** Accuracy – Precision – Recall – F1-score – BLEU – ROUGE – Bias – Fairness – Privacy – Safety – Responsible deployment of NLP systems and LLMs.

iv (a) TEXT BOOKS	
1.	*Speech and language processing* (3rd ed., draft). Jurafsky, D., & Martin, J. H. (2023). Pearson Education.
2.	*Natural language processing with Python: Analyzing text with the natural language toolkit*. Bird, S., Klein, E., & Loper, E. (2009). O'Reilly Media.
3.	*Deep learning for natural language processing*. Goyal, P., Pandey, S., & Jain, K. (2018). Apress.
(b) REFERENCES	
1.	*Foundations of statistical natural language processing*. Manning, C. D., & Schütze, H. (1999). MIT Press.
2.	*Transformers for natural language processing: Build and train state-of-the-art natural language processing models using the Transformers library*. Rothman, D. (2021). Packt Publishing.

v. COURSE PLAN

Module	Contents	Hours
I	**Module I: Introduction to NLP and Linguistic Essentials** **Introduction to NLP**: Definition, Importance, Applications, Challenges in NLP, Levels of NLP: Phonology, Morphology, Syntax, Semantics, Pragmatics, Discourse. **Linguistic Background**: Words, Sentences, Grammar, Syntax and Parsing, Morphological Analysis: Lemmatization vs. Stemming, POS (Part of Speech) Tagging. **Text Processing Techniques**: Tokenization, Sentence Segmentation, Normalization, Stop-word Removal. **Corpora and Annotation**: Types of Corpora, Annotation Standards and Schemes.	**9**
II	**Module II: Statistical and Machine Learning Approaches** **N-Grams and Language Models:** Unigrams, Bigrams, Trigrams, Smoothing Techniques: Laplace, Good-Turing, Perplexity and Evaluation. **Text Classification**: Bag of Words and TF-IDF, Naïve Bayes Classifier, Logistic Regression and SVMs, Evaluation Metrics: Precision, Recall, F1 Score.	**9**

	Sequence Labeling Tasks: Named Entity Recognition (NER), POS Tagging using HMMs and CRFs. **Spelling Correction and Edit Distance**: Minimum Edit Distance, Soundex, Norvig's Algorithm.	
III	**Module III: Syntax, Semantics, and Structured Representations** **Syntactic Parsing:** Dependency Parsing**,** Constituency Parsing**,** CYK Algorithm and Parse Trees**. Semantic Analysis:** Word Sense Disambiguation**,** Semantic Role Labeling**,** Lexical Resources: WordNet, VerbNet**. Discourse and Pragmatics:** Coreference Resolution, Discourse Coherence and Structure. **Knowledge Representation**: First-order Predicate Logic, Ontologies in NLP.	**9**
IV	**Module IV: Deep Learning for NLP** **Neural Networks for NLP:** Word Embeddings: Word2Vec, GloVe, FastText**,** Recurrent Neural Networks (RNNs), LSTMs, GRUs**. Sequence-to-Sequence Models:** Encoder-Decoder Architectures**,** Attention Mechanism**,** Applications: Text Summarization, Machine Translation**. Contextual Embeddings:** ELMo**,** Transformer Architecture**,** BERT and Variants (RoBERTa, DistilBERT)**. Text Generation:** Language Generation Techniques**,** Text Completion and Dialogue Systems**.**	**9**
V	**Module V: Advances and Trends in NLP** **Large Language Models (LLMs):** GPT Series (GPT-3, GPT-4)**,** Instruction-tuned Models and Prompt Engineering**,** Few-shot, Zero-shot Learning**. Multilingual and Cross-lingual NLP:** Challenges in Multilinguality**,** mBERT, XLM-R**. Ethics and Fairness in NLP:** Bias in Language Models**,** Explainability and Responsible AI**.** **Recent Research and Industry Applications:** NLP in Healthcare, Finance, Legal Tech**,** Conversational Agents (e.g., Chatbots, Virtual Assistants)**,** NLP in Social Media and Sentiment Analysis**.**	**9**
	Total Hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

xi) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL32B	**FOUNDATIONS OF SECURITY IN COMPUTING**	**PEC**	2	1	0	0	3	2023

i) COURSE OVERVIEW

The purpose of this course is to create awareness among learners about the fundamentals of security and number theory. This course covers Integer Arithmetic, Primes numbers and factorization for ensuring security in computing systems. The concepts covered in this course enable the learners to identify the security threats in computing.

ii) COURSE OUTCOMES

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

CO1	Use the operations and properties of algebraic structures, integer arithmetic and modular arithmetic.	Apply
CO2	Use of the concepts of prime numbers and factorization for ensuring security in computing systems .	Apply
CO3	Explain the threats and attacks related to computer and program security..	Understand
CO4	Explain the key aspects of operating system and database security	Understand
CO5	Describe Intrusion detection and Intrusion prevention	Understand

iii) SYLLABUS

Integer arithmetic- Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations, Modular arithmetic operations, Properties of modular arithmetic, Groups, Finite fields.

Prime Numbers and Factorization- Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications.

Computer and Program Security- Introduction to computer security – Threats, Vulnerabilities, Controls. Introduction to program security - Non-malicious programming oversights, Malware.

Operating System and Database Security-Database security, Security requirements of databases, Reliability and integrity, Database disclosure.

Intrusion detection and Intrusion prevention-Host -Based Intrusion Detection

iv) a) TEXTBOOKS

1.Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.

2. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.

3. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007

c) REFERENCES

1.William Stallings, Cryptography and Network Security Principles and Practices, 4/e, Pearson Ed.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Modular Arithmetic: Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2n).	10
II	Prime Numbers and Factorization:Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications.	**9**
III	Computer and Program Security: Introduction to computer security – CIA Triad,Threats, Vulnerabilities, Controls. Types of attack , Web attacks targeting users, Email attack types. Introduction to program security - Non-malicious programming oversights, Malware	**9**

IV	Operating System and Database Security: Operating system security – Security in operating system, Security in design of operating system. Database security – Security requirements of databases, Reliability and integrity, Database disclosure.	**8**
V	Intrusion detection and Intrusion prevention: Host -Based Intrusion Detection – Network -Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots Intrusion Prevention Systems: Need for Firewalls – Firewall Characteristics and Access Policy – Types of Firewalls	**9**
	Total	**45 hours**

vii) Assessment Pattern

Continuous Assessment		
Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL32C	**DATA ANALYTICS**	PCC	2	1	0	0	3	2023

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

This course helps the learner to understand the basic concepts of data analytics. This course covers mathematics for data analytics, predictive and descriptive analytics of data, Big data and its applications, techniques for managing big data and data analysis & visualization using programming tool. It enables the learners to perform data analysis on a real world scenario using appropriate tools.

iii) COURSE OUTCOMES

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

CO1	Use the mathematical concepts for data analytics .	Apply
CO2	Apply the concepts of data analytics algorithms in real world data.	Understand
CO3	Use the concepts of Hadoop and Map Reduce paradigm for Big Data Analytics	Apply
CO4	Explain the Concepts of Data Analytics for text data	Understand

iv) SYLLABUS

Descriptive statistics, Association of two variables, Ordinal and Continuous variable, Probability calculus, Inductive statistics, Interval estimation, Hypothesis Testing, t- test. Introduction to Data Analysis, Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview. Basics of data collection, sampling, preprocessing and dimensionality reduction. Supervised Learning. Unsupervised Learning. Association Rule Mining - Apriori algorithm. Big Data Overview, Example Applications. Big Data Analytics using Map Reduce and Apache Hadoop. Data Analytics for text data.

v) a) TEXTBOOKS

9. Bart Baesens," Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.
10. David Dietrich, "EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, 2015.
11. Jaiwei Han, Micheline Kamber, "Data Mining Concepts and Techniques'', Elsevier, 2006.
12. Christian Heumann and Michael Schomaker, "Introduction to Statistics and DataAnalysis", Springer, 2016
13. Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, 2015

b) REFERENCES

3. Margaret H. Dunham, Data Mining: Introductory and Advanced Topics. Pearson, 2012.
4. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
5. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "Big Data for Dummies", John Wiley & Sons, Inc., 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Descriptive statistics - Measures of central tendency and dispersion, Association of two variables - Discrete variables, Ordinal and Continuous variable, Probability calculus - probability distributions, Inductive statistics - Point estimation, Interval estimation, Hypothesis Testing - Basic definitions, t- test	9
II	Introduction to Data Analysis - Analytics, Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview. Introduction to Machine learning: Linear Regression – Clustering – Collaborative filtering – Association rule mining – Decision tree. Basics of data collection, sampling, pre-processing and dimensionality reduction	**6**
III	Introduction to Big Data: Types of Digital Data-Characteristics of Data – Evolution of Big Data– Business Intelligence vs. Big Data – Data warehouse and Hadoop environment Big Data Analytics: Classification of analytics – Data Science – Terminologies in Big Data – CAP Theorem – BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL – SQL vs. NOSQL vs NewSQL. Introduction to Hadoop: Features – Advantages – Versions – Overview of Hadoop Eco systems – Hadoop distributions – Hadoop vs. SQL – RDBMS vs. Hadoop – Hadoop Components – Architecture – HDFS – Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression. Hadoop 2 (YARN): Architecture – Interacting with Hadoop Eco systems.	**10**
IV	Hadoop Eco systems: Hive – Architecture – data type – File format – HQL – SerDe – User defined functions – Pig: Features – Anatomy – Pig on Hadoop – Pig Philosophy – Pig Latin overview – Data types – Running pig – Execution modes of Pig – HDFS commands – Relational operators – Eval Functions – Complex data type – Piggy Bank – User defined Functions – Parameter substitution – Diagnostic operator. Jasper Report: Introduction – Connecting to Mongo DB – Connecting to Cassandra	**10**
V	Data Analytics for Text- Major Text Mining Areas – Information Retrieval – Data Mining – Natural Language Processing NLP) – Text analytics tasks: Cleaning and Parsing, Searching, Retrieval, Text Mining, Part-of-Speech Tagging, Stemming, Text Analytics Pipeline. NLP: Major components of NLP, stages of NLP, and NLP applications.	**10**
	Total	**45 hours**

vii) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

xii) END SEMESTER EXAMINATION

For Theory Courses

- Maximum Marks: 60

Institute Elective 1

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31E	**Data Science for Engineers**	**IEC**	**3**	**0**	**0**	**0**	**3**	**2023**

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW

The course is designed to provide fundamental knowledge on data science and to help learners understand the role of statistics and optimization in performing mathematical operations relevant to the field. It aims to equip students with the skills necessary to handle heterogeneous data and effectively visualize it for better interpretation and decision-making. Additionally, the course introduces various open-source data science tools, offering foundational knowledge of their functionalities and practical applications in solving real-world industrial problems.

iii) COURSE OUTCOMES

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

CO1	Demonstrate the ability to obtain fundamental knowledge on data science .	Understand
CO2	Demonstrate proficiency in statistical analysis of data.	Understand
CO3	Apply basic tools and techniques of Exploratory Data Analysis (EDA) to explore, summarize, and visualize datasets.	Apply
CO4	Apply the various types of data and visualize them using through programming for knowledge representation.	Apply
CO5	Make use of numerous open source data science tools to solve real-world problems through industrial case studies.	Apply

iv) SYLLABUS

Introduction to data science, beginning with the typology of problems and the foundational importance of linear algebra, statistics, and optimization. It emphasizes structured thinking in solving both structured and unstructured data problems. Core statistical concepts such as descriptive statistics, statistical features, outlier analysis, data summarization, and various forms of distribution and plotting are covered, along with advanced topics like dimensionality reduction, sampling techniques, Bayesian statistics, and statistical modeling. The Python programming component includes basics like variables, data types, control structures, string operations, and core data structures such as lists, tuples, dictionaries, sets, and regular expressions. Exploratory Data Analysis (EDA) is explored in depth, covering its motivation, steps, basic tools, data types, and the data analytics lifecycle. The syllabus also covers data acquisition, pre-processing, quality transformation, and text data handling. Students are introduced to principles of data

visualization, including workflows, abstraction techniques, task validation, and a variety of chart types. The course concludes with hands-on exposure to open-source tools such as R, Octave, Scilab, and Python libraries like SciPy, scikit-learn, PyBrain, Pylearn2, and Weka for real-world data science applications.

v) a) TEXTBOOKS

14. R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 8th Ed., 2. Pearson Education India, 2019.
15. Avrim Blum, John Hopcroft, Ravindran Kannan, “Foundations of Data Science”, Cambridge University Press, 2020.
16. Hossein Pishro-Nik, “Introduction to Probability, Statistics, and Random Processes”, Kappa Research, LLC, 2014.

b) REFERENCES

6. Ani Adhikari and John DeNero, „Computational and Inferential Thinking: The Foundations of 2 Data Science“ , GitBook, 2019.
7. Cathy O“Neil and Rachel Schutt, „Doing Data Science: Straight Talk from the Frontline“, O“Reilly Media, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems, Structured and unstructured data	9
II	Descriptive statistics, Statistical Features, summarizing the data, outlier analysis, Understanding distributions and plots, Univariate statistical plots and usage, Bivariate and multivariate statistics, Dimensionality Reduction,	**6**
III	Recap- Introduction to Python Programming, Types, Expressions and Variables, String Operations, selection, iteration, Data Structures- Strings, Regular Expression, List and Tuples, Dictionaries, Sets; Exploratory Data Analysis (EDA) - Definition, Motivation, Steps in data exploration, The basic datatypes, Data type Portability, Basic Tools of EDA, Data Analytics Life cycle, Discovery, Data Acquisition, Data Pre-processing and Preparation, Data Quality and Transformation, Handling Text Data;	**10**
IV	Introduction to data visualization, Introduction to Dimensions and Measures, Bar Chart, Line Chart, Table, Heat Map, Treemap, Packed Bubble, Tooltip Visualization workflow: describing data visualization workflow, Visualization Periodic Table; Data Abstraction -Analysis: Four Levels for	**10**

	Validation- Task Abstraction - Analysis: Four Levels for Validation Data Representation: chart types: categorical, hierarchical, relational, temporal & spatial	
V	Overview and Demonstration of Open source tools such as R, Octave, Scilab. Python libraries: SciPy and sci-kitLearn, PyBrain, Pylearn2; Weka.	**10**
	Total	**45 hours**

vii) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

xiii) END SEMESTER EXAMINATION

For Theory Courses

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31F	INTRODUCTION TO MOBILE APPLICATION	IEC	3	0	0	0	3	2023

i. COURSE OVERVIEW

This course introduces students to the fundamentals of mobile application development with a focus on the Android platform. It is designed to provide an in-depth understanding of Android architecture, application lifecycle, UI/UX design principles, advanced UI components, data persistence, networking, and app deployment. Students will gain practical experience in building, testing, and publishing Android applications, enabling them to create feature-rich, user-friendly mobile apps. By the end of the course, students will have the skills to develop and publish applications on the Android platform.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain mobile app types, Android architecture, and development tools, including MIT App Inventor basics.	Understand
CO 2	Describe the design of user interfaces using Activities, Intents, Layouts, and UI components.	Understand
CO 3	Discuss advanced UI features and data storage techniques using shared preferences, files, and SQLite.	Understand
CO 4	Illustrate content sharing, messaging, and networking concepts in Android apps.	Understand
CO 5	Outline location-based services and the process of publishing Android applications.	Understand

iii. SYLLABUS

Introduction to Android Development: Mobile app types: Native, Hybrid, Web-based App lifecycle and structure - Android features, architecture, and development tools - Basic components of an Android application - Introduction to MIT App Inventor: Interface, setup, and real-time testing

Designing User Interfaces: Activities and their lifecycle - Styling, theming, and dialog windows - Linking activities using Intents - Views, ViewGroups, and basic layouts (Linear, Relative, Table) - UI components: TextView, Button, EditText, CheckBox, ListView, Spinner, etc.

Advanced UI: Image Views: Gallery, ImageSwitcher, GridView - Menus: Options Menu, Context Menu - Data persistence: SharedPreferences, file storage (internal & external) - SQLite database: Create, retrieve, update, delete data

Content Providers and Networking: Content Providers: Data sharing and custom providers - Messaging: Sending and receiving SMS using BroadcastReceiver - Networking: Downloading data, accessing web services

Location-Based Services and App Publishing: Google Maps: Displaying maps, markers, and handling location data - Geocoding and navigation - App publishing: Versioning, signing APK, deploying on the Play Store

iv(a)TEXTBOOKS

1. Lee, Wei-Meng. Beginning android 4 application Development. John Wiley & Sons, 2012.
2. Hardy, Brian, and Bill Phillips. Android programming: the big nerd ranch guide. Addison-Wesley Professional, 2013.
3. Learning MIT App Inventor: A Hands-On Guide to Building Your Own Android Apps: Derek Walter and Mark Sherman, First Edition, 2015

(b) REFERENCES

1. Lauren Darcey and Shane Conder, “Android Wireless Application Development”, Pearson Education, 2nd ed. (2011)
2. Reto Meier, “Professional Android 2 Application Development”, Wiley India Pvt Ltd, First Edition, 2010
3. App Inventor 2: Create Your Own Android Apps: David Wolber, Hal Abelson, Ellen Spertus, and Liz Looney, Second Edition, 2014

v. COURSE PLAN

Module	Contents	Hours
I	**Introduction to Android Development** **Overview of Mobile App Development:** Types of mobile apps: Native, Hybrid, and Web-based apps - Basic app lifecycle and structure. **Introduction to Android:** Android Features - Architecture of Android – Android Development Tools – Basic components of an Android application. **Introduction to MIT App Inventor:** Setting up your account on MIT App Inventor - Exploring the App Inventor interface: Designer and Blocks Editor - Connecting devices for real-time testing (via AI2 Companion App or Emulator).	**8**
II	**Designing User Interfaces** **Activities:** Understanding Activities and their Lifecycle - Applying Styles and Themes to Activity - Hiding the Activity Title, Displaying a Dialog Window, Progress Dialog - Linking Activities Using Intents - Passing Data Using Intent Object. **User Interface Basics:** Understanding Views and ViewGroups - Basic Layouts: LinearLayout, RelativeLayout, TableLayout - Adapting to Display Orientation. **UI Components and Layout Design:** TextView, Button, ImageButton, EditText, CheckBox, ToggleButton**,** RadioButton, RadioGroup**,** ListView, Spinner, and AutoCompleteTextView**,** ProgressBar, TimePicker, DatePicker Views.	**14**
III	**Advanced UI** **Advanced UI Elements:** Using Image Views to Display Pictures (Gallery, ImageSwitcher, GridView) - Using Menus with Views: Options Menu, Context Menu. **Managing State and Data Persistence:** Saving and Loading User Preferences using SharedPreferences - Persisting Data to Files (Internal and External Storage) **Working with SQLite Databases:** Creating a Database - Retrieving, Updating, and Deleting Data	**14**
IV	**Content Providers and Networking** **Content Providers:** Introduction to Content Providers - Sharing Data Using a Content Provider - Creating Custom Content Providers.	**14**

	Messaging and Networking: Sending SMS Messages Programmatically - Receiving SMS and Updating Activities Using BroadcastReceiver - Networking: Downloading Binary Data, Text Files, Accessing Web Services	
V	**Location based Services and Publishing Android Applications** **Working with Google Maps:** Displaying Maps and Adding Markers - Handling Location Data (Geocoding, Reverse Geocoding) - Monitoring Location and Navigation. **App Publishing:** Preparing Apps for Publishing - Versioning and Digitally Signing APK - Deploying and Publishing Apps on the Android Market	**10**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31G	INTRODUCTION TO CYBER SECURITY AND ETHICAL HACKING	IEC	3	0	0	0	3	2023

i. COURSE OVERVIEW

This course provides a foundational understanding of cyber security principles and an introduction to ethical hacking methodologies. The course focuses on the growing importance of cyber security in protecting digital assets, understanding vulnerabilities, and applying risk management strategies. It covers essential concepts such as cryptography, network security, and incident response. It also introduces ethical hacking as a critical skill for identifying and mitigating security risks. Students will explore hacking methodologies, penetration testing techniques, and the ethical and legal frameworks that govern cybersecurity practices.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the fundamental concepts of cybersecurity and its vulnerabilities.	Understand
CO 2	Explain about cryptography and network security practices.	Understand
CO 3	Demonstrate the Knowledge of Vulnerabilities and Risk Management.	Understand
CO 4	Explain ethical hacking fundamentals and methodologies.	Understand
CO 5	Apply ethical hacking tools to perform security assessments and study real-world cybersecurity incidents through case studies.	Apply

iii. SYLLABUS

Introduction to cybersecurity: Overview of cybersecurity, importance, and challenges. Types of cyber threats. Understanding vulnerabilities. Basic cyber defense mechanisms.

Cryptography and Network Security: Fundamentals of cryptography, Network security principles, Common network attacks, Wireless security

Cyber Security Frameworks and Risk Management:Cybersecurity frameworks. Risk assessment and mitigation. Incident response and recovery.

Ethical Hacking Fundamentals and Legal Aspects: Introduction to ethical hacking and its scope. Hacking methodologies, Types of hackers-white hat, black hat, grey hat) Ethical hacking process .

Ethical hacking tools – Kali Linux, Metasploit, Nmap, Wireshark, Burp Suite, John the Ripper. Case studies on ethical hacking practices.

iv(a)TEXTBOOKS

1. Principles of Information Security, Michael E. Whitman and Herbert J. Mattord, Publisher: Cengage Learning, 7th edition, 2021.

2. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley, 2011.

3. Ethical Hacking and Penetration Testing Guide**,** Rafay Baloch,Publisher: CRC Press, 2014.

(b) REFERENCES

1. Cyber Security: Understanding Cyber Crimes, Computer Forensics, and Legal Perspectives, Nina Godbole and Sunit Belapure, Publisher: Wiley , 2011.

2. Cryptography and Network Security: Principles and Practice, William Stallings, Publisher: Pearson Education, 2017.

3. Ethical Hacking, Ankit Fadia 2nd Edition, Macmillan India Ltd, 2006.

4. Hacking: The Art of Exploitation (2nd Edition) by Jon Erickson, 2007.

5. Information Warfare and Security, Dorothy F Denning, Addison Wesley, 1998.

v. COURSE PLAN

Module	Contents	Hours

I	Introduction to Cyber Security: Overview of Cyber Security-Importance, Scope, and Challenges, Types of Cyber Threats-Malware, Phishing, Ransomware, Social Engineering, Understanding Vulnerabilities-Web Application Security Vulnerabilities, Common Vulnerabilities and Exposures (CVE), Basic Cyber Defense Mechanisms-Antivirus, Firewalls, Patching.	**9**
II	Cryptography and Network Security: Cryptography Fundamentals-Symmetric vs Asymmetric Cryptography, Public Key Infrastructure (PKI), Digital Signatures, Network Security Principles-Basics of Firewalls, IDS/IPS, Virtual Private Networks (VPNs, Attack Vectors in Networks-Denial of Service (DoS), Man-in-the-Middle (MITM), DNS Spoofing, Wireless Security-WPA2, Common Wi-Fi Attacks.	**9**
III	Cyber Security Frameworks and Risk Management: Cybersecurity Frameworks, NIST, CIS Controls, Risk Assessment and Management-Analyzing, and Mitigating Risks, Incident Response and Recovery-Phases of Incident Handling, Business Continuity Planning,	**9**
IV	Ethical Hacking Fundamentals and Legal Aspects: Introduction, Need and Scope, Hacking Methodologies-Reconnaissance, Scanning, Exploitation, Post-Exploitation, Types of Hackers, Ethical Hacking Process-Vulnerability Identification and Exploitation. Legal Frameworks and Policies-IT Act 2000 (India), Cybercrime Laws, Ethical Considerations-Responsible Disclosure, Consequences of Unethical Practices, Privacy and Data Protection-Ensuring Compliance with Regulations.	**10**
V	Ethical hacking tools – Kali Linux, Metasploit, Nmap, Wireshark, Burp Suite, John the Ripper. Case Studies-Notable Cybersecurity Incidents. Case Studies in Ethical Hacking-Real-World Examples of Ethical Hacking Practices.	**8**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks

Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31H	DIGITAL MARKETING AND E-COMMERCE	IEC	3	0	0	0	3	2023

i. COURSE OVERVIEW

This course is designed to equip students with the essential skills and knowledge required to navigate and succeed in the rapidly evolving fields of digital marketing and e-commerce. With a focus on both theoretical concepts and practical applications, the course provides students with a comprehensive understanding of the digital landscape and its impact on business strategies and consumer behaviour.

Students will explore various facets of digital marketing, including search engine optimization (SEO), social media marketing, content creation, and online advertising. They will also gain insights into e-commerce business models, platforms, and technologies that drive online commerce and digital transactions.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts, strategies, and tools of digital marketing, and differentiate between traditional and digital marketing approaches.	Understand
CO 2	Develop basic marketing strategies using various digital marketing channels.	Apply
CO 3	Build e-commerce website incorporating various features.	Apply
CO 4	Apply social media marketing techniques, content strategies, and tools to create effective campaigns that drive customer engagement and business outcomes.	Apply

CO 5	Explain advanced digital marketing techniques, affiliate marketing and mobile optimization	Understand

iii. SYLLABUS

Introduction to Digital Marketing, Overview of Digital Marketing, Digital Marketing Channels, Tools and Platforms,

Search Engine Optimization (SEO) and Content Marketing, SEO Basics, Content Marketing Strategy, SEO Tools and Techniques,

Social Media Marketing and Advertising, Social Media Platforms Overview, Social Media Content & Campaigns, Paid Social Advertising, Emerging Trends in Social Media,

E-Commerce Fundamentals and Platforms, Building an E-Commerce Website, E-Commerce Marketing, E-Commerce Analytics,

Advanced Digital Marketing and Emerging Trends, Affiliate Marketing, Mobile Marketing and App Store Optimization (ASO), Digital Marketing Automation, Emerging Trends in Digital Marketing, Ethics and Legal Aspects of Digital Marketing.

iv(a)TEXTBOOKS

1. Digital marketing: Strategy, implementation and practice, Chaffey, D. and Ellis-Chadwick, F, 8th Edition. Harlow: Pearson,2022.
2. E-Commerce 2023: Business, Technology, Society, Kenneth C. Laudon and Carol Guercio Traver, 17th Edition, 2023
3. Digital marketing: Strategy, implementation and practice, Chaffey, D. and Ellis-Chadwick, F, 8th Edition. Harlow: Pearson,2022.

(b) REFERENCES

1. Social Media Marketing: A Strategic Approach ,Melissa Barker, Donald I. Barker, and Nicholas F. P. Ojha, South Western Publications, 2012
2. The New Rules of Marketing and PR, David Meerman Scott, John Wiley & Sons Publications, 2015

3. Social Media Marketing Workbook: How to Use Social Media for Business, Jason McDonald, 2016

v. COURSE PLAN

Module	Contents	Hours
I	**Introduction to Digital Marketing** **Overview of Digital Marketing-**Traditional vs. Digital Marketing, Importance of Digital Marketing in today's world, Key Concepts and Terminologies, Digital Marketing Strategy and Planning, Role of Technology in Digital Marketing **Digital Marketing Channels-**Search Engine Optimization (SEO), Content Marketing, Social Media Marketing (SMM), Email Marketing, Online Advertising (PPC, Display Ads, Google Ads, Social Ads) **Tools and Platforms-** Google Analytics, Social Media Analytics, SEO Tools (Moz, SEMrush, Ahrefs), Marketing Automation Tools (HubSpot, MailChimp)	9
II	**Search Engine Optimization (SEO) and Content Marketing** **SEO Basics-** Understanding Search Engines and Ranking Algorithms, On-Page SEO: Keywords, Meta Tags, Content Optimization, Off-Page SEO: Link Building, Social Signals. Technical SEO: Site Speed, Mobile Optimization, Crawling & Indexing. **Content Marketing Strategy-** Content Creation and Curation, Blogging and Video Marketing, Visual Content and Storytelling, Content Distribution and Promotion, Content ROI Measurement. **SEO Tools and Techniques-** Google Search Console, Keyword Research Tools, Content Optimization with AI tools.	10
III	**Social Media Marketing and Advertising** **Social Media Platforms Overview-** Facebook, Instagram, Twitter, LinkedIn, Pinterest, TikTok, Choosing the Right Platform for Business, Building a Social Media Strategy. **Social Media Content & Campaigns-** Content Creation, Scheduling, and Engagement, Influencer Marketing, Social Media Analytics and Metrics. **Paid Social Advertising-**Facebook and Instagram Ads, LinkedIn Ads, Twitter Ads, Ad Campaign Structuring and Budgeting, Campaign Optimization and A/B Testing.	9

	Emerging Trends in Social Media- Short-form Video Content (e.g., TikTok, Reels),Social Commerce	
IV	**E-Commerce Fundamentals and Platforms** **Introduction to E-Commerce-** E-Commerce Business Models (B2B, B2C, C2C), E-Commerce Industry Trends, E-Commerce Platforms Overview: Shopify, WooCommerce, Magento, BigCommerce. **Building an E-Commerce Website-** E-Commerce Website Design and UX/UI Best Practices, Integrating Payment Gateways, Product Catalog Management. **E-Commerce Marketing-** Conversion Rate Optimization (CRO), Retargeting and Remarketing Strategies, Customer Journey Mapping and Personalization, Customer Reviews and Testimonials. **E-Commerce Analytics-** Google Analytics for E-Commerce, E-Commerce KPIs (Average Order Value, Cart Abandonment Rate), Analyzing and Improving Sales Performance.	**8**
V	**Advanced Digital Marketing and Emerging Trends** **Affiliate Marketing-** Basics of Affiliate Marketing, Affiliate Networks and Programs, Commission Structures and Strategies. **Mobile Marketing and App Store Optimization (ASO)-** Mobile Marketing Strategies, App Marketing and User Acquisition, App Store Optimization Techniques. **Digital Marketing Automation-** Marketing Automation Platforms (HubSpot, Marketo), Workflow Automation and Lead Scoring, Personalized Marketing at Scale. **Emerging Trends in Digital Marketing-** Artificial Intelligence (AI) in Marketing, Voice Search Optimization, Blockchain in E-Commerce. Virtual Reality (VR) and Augmented Reality (AR) in Retail **Ethics and Legal Aspects of Digital Marketing-** Privacy Policies, Data Protection (GDPR), Digital Marketing Ethics, Online Reputation Management.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSS38A	SEMINAR	PWS	0	0	4	0	2	2023

i. COURSE OVERVIEW

The course involves exploring academic literature to select a relevant document in the student's area of interest and, under a seminar guide's supervision, develop skills in presenting and preparing technical reports. The course aims to enhance students ability to engage critically with scholarly work and communicate technical information effectively.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Investigate and synthesize information from diverse sources to gain a comprehensive understanding of a chosen technical topic.	Apply
CO 2	Interpret technical content to explore the practical implications and applications of emerging technologies in the field of engineering.	Apply
CO 3	Utilize communication skills to articulate complex technical information through oral presentations and written report.	Apply
CO 4	Engage in constructive discussions and respond to questions and feedback.	Apply
CO 5	Investigate and synthesize information from diverse sources to gain a comprehensive understanding of a chosen technical topic.	Apply

iii. GENERAL GUIDELINES

- An Internal Evaluation Committee (IEC) shall be constituted by the department, comprising the program's HoD / Senior Faculty as Chairperson, along with the seminar coordinator and the student's seminar guide as members. All IEC members must be present during each student's seminar presentation.
- Formation of IEC and guide allotment shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- The seminar topic should be current and broad-based/narrowly focused on specific research. Ideally, it should be closely related to the student's final year project area. Team members may select or be assigned seminar topics that cover different aspects of their common project theme.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

iv. EVALUATION PATTERN

Total Marks	CIE Marks
100	100

v. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Seminar Guide (20 Marks):

Background Knowledge – 10 marks (based on the student's understanding of the selected topic).

Relevance of Topic – 10 marks (based on the suitability and significance of the s elected paper/topic).

Seminar Coordinator (15 Marks):

Seminar Diary – 10 marks (weekly progress tracked and approved by the guide).

Attendance – 5 marks.

Evaluation of Presentation by IEC (45 Marks):

Clarity of Presentation – 10 marks.

Interaction – 10 marks (ability to answer questions).

Overall Participation – 10 marks (engagement during others' presentations).

Quality of the content – 15 marks.

Marks awarded by IEC for report (20 Marks)

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSJ38B	MINI PROJECT	PWS	0	0	4	0	2	2023

i. COURSE OVERVIEW

The objective of this course is to enable students to apply the fundamental principles of Computer Science and Engineering in the effective development of an application or research-oriented project. It guides learners through the essential phases of the problem identification, literature review, determination of methodology and its implementation for design and development of appropriate solution.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Identify problems that are socially relevant, technically feasible and economically viable.	Apply
CO 2	Make use of relevant literature to explore existing solutions and established processes.	Apply
CO 3	Identify appropriate design approaches, using modern tools with a strong commitment to professional ethics.	Apply
CO 4	Deduce innovative interpretation of the study outcomes, using engineering and management principles to generate novel insights or improvements.	Evaluate
CO 5	Apply appropriate communication techniques to prepare presentations and reports that convey project outcomes effectively	Apply
CO 6	Develop the ability to manage tasks independently and engage collaboratively in team environments to achieve shared goals	Apply

iii. GENERAL GUIDELINES

Student groups consisting of three to four members are required to select a topic of interest in consultation with their Project Supervisor. They should conduct a thorough literature review and identify a problem to address the gaps identified, related to the chosen topic. Clear objectives must be defined, and a suitable methodology should be developed to achieve them. The project should incorporate innovative design concepts, while considering important factors such as performance, scalability, reliability, aesthetics, ergonomics, user experience, and security.

The progress of the mini project is evaluated based on three reviews. The first review is to check the feasibility in implementation of the project. The second review is to evaluate the progress of the work. The third review will evaluate the completed work. The review committee will be constituted by the Head of the Department comprising of HoD or a senior faculty member, Mini Project coordinator and project supervisor. The evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by the review committee. A project report is required at the end of the semester. The project has to be demonstrated for its full design specifications.

iv. EVALUATION PATTERN

Total Marks	CIE Marks	ESE Marks
100	60	40

v. CONTINUOUS ASSESSMENT EVALUATION PATTERN

First Review and Second Review	**60 marks**
Attendance	5 marks
Marks awarded by Project Supervisor	10 marks
Marks awarded by Review Committee	45 marks
Final Review	**40 marks**
Project Report	10 marks
Marks awarded by Review Committee	30 marks

Minor Basket 1: SOFTWARE ENGINEERING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
CS0M 30A	**Concepts In Software Engineering**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

xi) COURSE OVERVIEW

This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance and Project Management concepts. This course enables the learners to apply state of the art industry practices in Software development.

xii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Differentiate Traditional and Agile Software Development approaches	Understand
CO 2	Develop Software Requirement Specification and Software Design for a given problem.	Apply
CO 3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project	Apply
CO 4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with proper application of SCRUM, Kanban and Lean frameworks.	Apply
CO 5	Utilize SQA practices, Process Improvement techniques and Technology improvements namely cloud based software model and containers & microservices in a Software Development Process.	Apply

xiii SYLLABUS

The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management.

Functional and non-functional requirements, Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design Template of a Design Document as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”.

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management
Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks

xiv a) TEXTBOOKS

17. Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
18. Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
19. Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

b) REFERENCES

4. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash,Addison-Wesley Signature Series, 2006
5. StarUML documentation - https://docs.staruml.io/
6. OpenProject documentation - https://docs.openproject.org/
7. BugZilla documentation - https://www.bugzilla.org/docs/
8. GitHub documentation - https://guides.github.com/
9. Jira documentation - https://www.atlassian.com/software/jira

xv) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Software Engineering:** Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies: An insulin pump control system. Mentcare - a patient information system for mental health care.	**9**
II	**Requirement Analysis and Design:** Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per "IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions". Case study: The Ariane 5 launcher failure**.**	**9**
III	**Implementation and Testing:** Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development -	**9**

	Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management – Code management, DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.	
IV	**Software Project Management:** Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.	**9**
V	**Software Quality and Process Improvement:** Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software.	**9**
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 2: MACHINE LEARNING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3MC	Concepts in Deep Learning	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Demonstrate basic concepts in machine learning.	**Understand**
CO 2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	**Understand**
CO 3	Demonstrate the concept of the feed forward neural network and its training process.	**Understand**
CO 4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	**Apply**
CO 5	Use different neural network/deep learning models for practical applications.	**Apply**

iii) SYLLABUS

Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.

Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Stochastic gradient descent, Building ML algorithms and challenges.

Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, structured outputs, data types, efficient convolution algorithms.

Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.

iv) a) TEXTBOOKS

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

b) REFERENCES

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014
2. Practical Convolutional Neural Networks by MohitSewak, Md. Rezaul Karim, PradeepPujari,Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.	9
II	**Optimization and Neural Networks :** Neural Networks – Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization,	9

	linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.	
III	**Convolutional Neural Network :** Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.	9
IV	**Recurrent Neural Network :** Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.	9
V	**Application Areas :** Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.	9
	Total	**45**

. vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 3: Networking

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL 3ME	CLIENT SERVER SYSTEMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the basics of client/server systems and the driving force behind the development of client/server systems**.**	Understand
CO 2	Outline the architecture and classifications of client/server systems.	Understand
CO 3	Summarize the client/server network services for an application.	Understand
CO 4	Explain management services and issues in network	Understand
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture	Understand

iii) SYLLABUS

Introduction-Client/Server Classification-Client/Server Application Components-Client/ Server Systems Services and Support-Client/Server Technology and Databases

iv) a) TEXTBOOKS

1. Patrick Smith &Steve Guengerich, Client / Server Computing, PHI

2. Subhash Chandra Yadav, Sanjay Kumar Singh, An Introduction to Client/Server Computing, New Age International Publishers

b) REFERENCES

1. Jeffrey D. Schank, “N0ovell’s Guide to Client-Server Application & Architecture” Novell Press

2. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition

3. Dawna Travis Dewire, Client Server Computing- McGraw Hill

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Client/Server computing - Basic Client/Server Computing Model, Server for Every Client- File Server, Print Server, Application Server, Mail Server, Directory Services Server, Web Server, Database Server, Transaction Servers. Client/Server-Fat or Thin, Stateless or Stateful, Servers and Mainframes, Client/Server Functions. Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective.	9
II	Client/Server Types-Single Client/Single Server, Multiple Clients/Single Server, Multiple Clients/Multiple Servers, Integration With Distributed Computing, Alternatives To Client/Server Systems. Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems. Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System.	9
III	Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services. Server- Detailed server functionality, Network operating system, Available platforms, Server operating system. Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and disadvantages of Client/Server computing, Applications of Client/Server.	9
IV	Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.	9
V	Client/Server Technology and Databases - Storing Data, Database System Architectures. Client/Server In Respect Of Databases- Client/Server Databases, Client/Server Database Computing, Database Computing Vs. Mainframe, PC/File Server Computing. Client/Server Database Architecture - Process-Per-Client Architecture, Multi-Threaded Architecture, Hybrid Architecture. Database Middleware Component - Application Programming Interface, Database Translator, Network Translator.	9

	Total	**45**

. vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 4 Data Science

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3MG	Natural Language Processing	VAC	3	0	0	0	3	2023

i. COURSE OVERVIEW

This course introduces the fundamentals of Natural Language Processing, covering linguistic basics to advanced deep learning models. It equips students to build NLP applications and explore recent trends like large language models and ethical AI.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the foundational concepts of Natural Language Processing and apply basic linguistic techniques such as tokenization, stemming, and POS tagging.	Understand
CO 2	Apply statistical and machine learning approaches to perform tasks like text classification, language modeling, and named entity recognition.	Apply
CO 3	Explain sentence structures and perform syntactic and semantic processing using parsing techniques and lexical resources.	Understand
CO 4	Use deep learning models for NLP tasks using embeddings, RNNs, and transformer-based architectures.	Apply
CO 5	Apply the current NLP technologies, including large language models, and discuss ethical considerations in their deployment.	Apply

iii. SYLLABUS

Fundamentals of NLP and Linguistic Concepts: NLP applications and challenges – Linguistic levels: morphology – syntax – semantics – pragmatics – Word sense disambiguation – Semantic role labeling – Coreference resolution – Discourse analysis – Lexical resources: WordNet – FrameNet. **Text Processing and Preprocessing Techniques:** Tokenization – Stemming – Lemmatization – Stop word removal – Normalization – Part-of-Speech (POS) tagging – Bag-of-Words – TF-IDF. **Statistical and Traditional Machine Learning Approaches:** N-gram models – Smoothing – Perplexity – Text classification using Naive Bayes – Logistic Regression – Support Vector Machines (SVM) – Hidden Markov Models (HMMs) – Conditional Random Fields (CRFs). **Parsing and Syntactic Structures:** Constituency parsing – Dependency parsing –

Context-Free Grammars (CFGs) – Probabilistic CFGs – Syntax-semantics interface. **Deep Learning for NLP:** Word2Vec – GloVe – fastText – Contextual embeddings – Feedforward networks – RNNs – LSTMs – GRUs – Sequence-to-sequence models – Attention mechanisms – Transformer architecture – BERT – GPT – T5 – Fine-tuning – Transfer learning – Prompt engineering. **Evaluation, Applications, and Ethical Considerations:** Accuracy – Precision – Recall – F1-score – BLEU – ROUGE – Bias – Fairness – Privacy – Safety – Responsible deployment of NLP systems and LLMs.

iv (a) TEXT BOOKS

1. Speech and language processing (3rd ed., draft). Jurafsky, D., & Martin, J. H. (2023). Pearson Education.
2. Natural language processing with Python: Analyzing text with the natural language toolkit. Bird, S., Klein, E., & Loper, E. (2009). O'Reilly Media.
3. Deep learning for natural language processing. Goyal, P., Pandey, S., & Jain, K. (2018). Apress.

(b) REFERENCES

1. Foundations of statistical natural language processing. Manning, C. D., & Schütze, H. (1999). MIT Press.
2. Transformers for natural language processing: Build and train state-of-the-art natural language processing models using the Transformers library. Rothman, D. (2021). Packt Publishing.

v. COURSE PLAN

Module	Contents	Hours
I	**Introduction to NLP**: Definition, Importance, Applications, Challenges in NLP, Levels of NLP: Phonology, Morphology, Syntax, Semantics, Pragmatics, Discourse. **Linguistic Background**: Words, Sentences, Grammar, Syntax and Parsing, Morphological Analysis: Lemmatization vs. Stemming, POS (Part of Speech) Tagging. **Text Processing Techniques**: Tokenization, Sentence Segmentation, Normalization, Stop-word Removal. **Corpora and Annotation**: Types of Corpora, Annotation Standards and Schemes.	**9**
II	**N-Grams and Language Models:** Unigrams, Bigrams, Trigrams, Smoothing Techniques: Laplace, Good-Turing, Perplexity and Evaluation. **Text Classification**: Bag of Words and TF-IDF, Naïve Bayes Classifier, Logistic Regression and SVMs, Evaluation Metrics: Precision, Recall, F1 Score.	**9**

	Sequence Labeling Tasks: Named Entity Recognition (NER), POS Tagging using HMMs and CRFs. **Spelling Correction and Edit Distance**: Minimum Edit Distance, Soundex, Norvig's Algorithm.	
III	**Syntactic Parsing:** Dependency Parsing**,** Constituency Parsing**,** CYK Algorithm and Parse Trees**. Semantic Analysis:** Word Sense Disambiguation**,** Semantic Role Labeling**,** Lexical Resources: WordNet, VerbNet**. Discourse and Pragmatics:** Coreference Resolution, Discourse Coherence and Structure. **Knowledge Representation**: First-order Predicate Logic, Ontologies in NLP.	**9**
IV	**Neural Networks for NLP:** Word Embeddings: Word2Vec, GloVe, FastText**,** Recurrent Neural Networks (RNNs), LSTMs, GRUs**. Sequence-to-Sequence Models:** Encoder-Decoder Architectures**,** Attention Mechanism**,** Applications: Text Summarization, Machine Translation**. Contextual Embeddings:** ELMo**,** Transformer Architecture**,** BERT and Variants (RoBERTa, DistilBERT)**. Text Generation:** Language Generation Techniques**,** Text Completion and Dialogue Systems**.**	**9**
V	**Large Language Models (LLMs):** GPT Series (GPT-3, GPT-4)**,** Instruction-tuned Models and Prompt Engineering**,** Few-shot, Zero-shot Learning**. Multilingual and Cross-lingual NLP:** Challenges in Multilinguality**,** mBERT, XLM-R**. Ethics and Fairness in NLP:** Bias in Language Models**,** Explainability and Responsible AI**.** **Recent Research and Industry Applications:** NLP in Healthcare, Finance, Legal Tech**,** Conversational Agents (e.g., Chatbots, Virtual Assistants)**,** NLP in Social Media and Sentiment Analysis**.**	**9**
	Total Hours	**45**

. vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 5 **Network Security**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL3MI	**Introduction to Blockchain Technologies**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

The purpose of this course is to create awareness and understanding among students on the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc. The course enables students to develop simple decentralized applications using blockchain networks such as Ethereum.

ii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate the cryptographic building blocks of blockchain technology	Understand
CO 2	Explain the fundamental concepts of blockchain technology.	Understand
CO 3	Summarize the classification of consensus algorithms.	Understand
CO 4	Explain the concepts of the first decentralized cryptocurrency bitcoin.	Understand
CO 5	Explain the use of smart contracts and its use cases.	Understand
CO6	Develop simple applications using Solidity language on Ethereum platform.	Apply

iii. SYLLABUS

Fundamentals of Cryptography: Introduction to cryptography, Digital signature algorithms, Applications of cryptographic hash functions – Merkle trees, Distributed hash tables. Fundamentals of Blockchain Technology: Elements of blockchain. Consensus. Decentralization. Consensus Algorithms and Bitcoin: Consensus Algorithms, Bitcoin, Transactions, Blockchain, Mining, Wallets. Smart Contracts and Use cases: Smart Contracts, Decentralization, Decentralized

applications. Ethereum and Solidity: Ethereum – The Ethereum network, The Ethereum Virtual Machine. The Solidity language, Smart contracts Case study.

iv(a)TEXTBOOKS

1. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Packt Publishing, Third edition, 2020.

(b) REFERENCES

1. Kumar Saurabh, Ashutosh Saxena,Blockchain Technology:Concepts and Applications, Wiley Publications, First edition,2020
2. Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the power of Cryptocurrencies, Smart Contracts and Decentralized Applications, O'Reilly Media, First Edition 2020
3. Andreas M Antonopoulous, Gavin Wood,Mastering Ethereum: Building Smart Contracts and Dapps, O'Reilly Media, First Edition 2018

v. COURSE PLAN

Module	Contents	Hours
I	Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography – RSA. Elliptic curve cryptography, Digital signatures – RSA digital signature algorithms. Secure Hash Algorithms – SHA-256. Applications of cryptographic hash functions – Merkle trees, Distributed hash tables.	9
II	Blockchain – Definition, architecture, elements of blockchain, benefits and limitations, types of blockchain. Consensus – definition, types, consensus in blockchain. Decentralization – Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization.	9
III	Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault- tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS. Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses. Transactions – Lifecycle, coinbase transactions, transaction validation. Blockchain – The genesis block. Mining – Tasks of miners, mining algorithm, hash rate. Wallets – Types of wallets.	9

IV	Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations. Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management. Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.	**9**
9V	Ethereum – The Ethereum network. Components of the Ethereum ecosystem – Keys and addresses, Accounts, Transactions and messages. The Ethereum Virtual Machine, Blocks and blockchain. The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types, control structures, events, inheritance, libraries, functions, error handling. Smart contracts Case study: Voting, Auction.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Honour Basket 1: Security in Computing

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3HA	CRYPTOGRAPHIC ALGORITHMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The course on Cryptographic Algorithms aims at exploring various algorithms deployed in offering confidentiality, integrity, authentication and non-repudiation services. This course covers classical encryption techniques, symmetric and public key crypto-system, key exchange and management, and authentication functions. The concepts covered in this course enable the learners in effective use of cryptographic algorithms for real life applications.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO1	Explain the security services provided for different types of security attacks.	Understand
CO2	Summarize the classical encryption techniques for information hiding.	Understand
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.	Understand
CO4	Explain key management techniques for secure communication.	Understand
CO5	Summarize message authentication functions in a secure communication scenario.	Understand

iii. SYLLABUS

Need for security, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques- Encrypting communication channels. Symmetric key cryptographic Algorithms, DES, Block cipher principles, Differential and Linear cryptanalysis, Block cipher modes of operation, IDEA, AES, Stream cipher, RC4. Principles of public key cryptosystems, RSA algorithm, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems. Key Distribution-Public key infrastructure. Authentication requirements, functions, Algorithms and Services.

iv. a) TEXTBOOKS

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.

2. BruiceSchneier, Applied Cryptography Protocols, Algorithms and source code in C, Wiley,2e.
3. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.

b) REFERENCES

1. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.
2. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.
3. DouglasR. Stinson, Cryptography Theory and Practice, 3e, Chapman& Hall/CRC, 2006.
4. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2011.

v. COURSE PLAN

Module	Contents	No. of hours
I	Need for security, Security approaches, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques - Substitution techniques, Transposition techniques. Stream cipher, Block cipher, Public key cryptosystems vs. Symmetric key cryptosystems, Encrypting communication channels.	9
II	Overview of symmetric key cryptography, Block cipher principles, Data Encryption Standard (DES), Differential and Linear cryptanalysis, Double DES, Triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Algorithm (AES),Block cipher modes of operation, Stream cipher, RC4.	9
III	Principles of public key cryptosystems, RSA algorithm, RSA illustration, Attacks, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems.	9
IV	Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, Generating keys, transferring keys, Verifying keys, Updating keys, Storing keys, Backup keys, Compromised keys, Public key infrastructure.	9
V	Authentication requirements, Authentication functions, Message authentication codes (MAC), Hash functions, Security of Hash functions and MAC, Message Digest 5 (MD5), Secure Hash Algorithm (SHA)-512, Hash-based Message Authentication Code (HMAC), Cipher-based Message Authentication Code (CMAC), X.509 Authentication services.	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Honour Basket 2: COMPUTATIONAL BIOLOGY

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL3HA	Computational Biology	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course helps the learners to understand concepts in Genomics, Proteomics Computational Biology, Next Generation Sequencing, NGS Data Analysis and Systems biology. It enables the learners to understand various Next Generation Sequencing Techniques, analysis and interpretation of the NGS Data. Also, course introduces computational and mathematical analysis and modeling of complex biological systems and Systems Biology

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the basic concepts of genomics, microarray, protein structure determination and prediction	**Understand**
CO 2	Explain the fundamental aspects drug discovery and molecular modelling	**Understand**
CO 3	Demonstrate Networks in Biology, types of networks and its representation	**Understand**
CO 4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis	**Understand**
CO 5	Illustrate Next Generation sequence analysis, Mapping approaches and algorithms	**Understand**

iii) SYLLABUS

Genomics and Proteomics, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure, Computer Aided Drug Discovery, Molecular modelling, Computer Aided Drug Discovery, Network Biology, (Next Generation Sequencing and analysis, NGS Data Analysis

iv) a) TEXTBOOKS

1. Goodfellow, I., Bengio, Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc

b) REFERENCES

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018

v) COURSE PLAN

Module	Contents	No. of hours
I	Genes, Genes in genomes, Genomes of prokaryotes and Eukaryotes, Protein-coding genes, RNA, Single-nucleotide polymorphisms, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure identification, computational methods for protein structure prediction, Homology modelling, Protein folding and fold recognition	9
II	Drug discovery pipeline, Drug target identification & validation, Active site identification, pharmacophore, Lead/Ligand identification, lead compound optimization, Binding energy calculation, Energy Minimization. Molecular modelling in drug discovery, concept of Molecular Dynamics, concept of Absorption, Distribution, Metabolism and Excretion (ADME), Quantitative Structure-Activity Relationships	9
III	Transcriptional Regulatory Networks, Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein-Protein Interactions, Visualization of Protein Interaction Networks, Metabolic Networks, Interacting Partners, Mathematical Representation	9
IV	A Typical NGS Experimental Workflow, Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing, RNA-sequencing (RNA Seq), Protein-DNA Interaction Analysis (ChIP-Seq)	**9**
V	Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms, Selection of Mapping Algorithms and Reference Genome Sequences, SAM/BAM as the Standard Mapping File Format, Mapping File Examination and Operation, Tertiary Analysis	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Honour Basket 3: COMPUTER VISION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL3HC	Advanced Concepts in Computer Vision	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course enables the learners to understand the advanced concepts in computer vision. The course covers the basics of image processing, imaging geometry, image segmentation, feature extraction, object recognition and classification and common applications of computer vision. This course helps the students to design solutions for complex real-life problems.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate the concepts of image formation and image model.	**Understand**
CO 2	Demonstrate various feature extraction and edge detection techniques.	**Understand**
CO 3	Apply edge-based and region-based image segmentation techniques.	**Apply**
CO 4	Implement image recognition and classification methods.	**Apply**
CO 5	Explain the various applications of computer vision	**Understand**

iii) SYLLABUS

Image Formation and Processing, Fundamentals of Image processing, Feature Extraction, Edges Image Segmentation, Image processing using OpenCV - blending, smoothing, and reshaping. Image Recognition and Classification, Object classification using CNNs, Applications,

iv) a) TEXTBOOKS

1. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.
3. Francesco Camastra, Alessandro Vinciarelli, “Machine Learning for Audio, Image and Video Analysis: Theory and Applications”, Springer 2015.

b) REFERENCES

1. Reinhard Klette, “Concise Computer Vision: An Introduction into Theory and Algorithms”, Springer London, 2014.
2. Olivier Faugeras, “Three-Dimensional Computer Vision”, The MIT Press, 1993.

v) COURSE PLAN

Module	Contents	No. of hours
I	Image formation and Image model- Components of a vision system- Cameras- camera model and camera calibration-Radiometry- Light in space- Light in surface - Sources, shadows and shading. Fundamentals of Image processing: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels	9
II	Points and Patches – Feature detectors, feature descriptors, feature matching, feature tracking. Edges – edge detection, edge linking. Lines - Successive approximation, Hough transforms, Vanishing points.	9
III	Classification of segmentation techniques, Edge detection, Edge linking, Thresholding, Region growing, Region splitting and merging, Watershed based segmentation. Shadow detection and removal. Image processing using OpenCV - blending, smoothing, and reshaping.	9
IV	Shape based object classification, Motion based object classification, Viola Jones Object Detection Framework, Object classification using CNNs, use of RCNN for object classification	9
V	Speech and Handwriting Recognition, Automatic Face Recognition, Video Segmentation and Keyframe Extraction, Real-Time Hand Pose Recognition.	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Semester 6

Minor Basket 1: SOFTWARE ENGINEERING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3 MB	**Introduction to Software Testing**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i) COURSE OVERVIEW

This is a course in theoretical computer science that includes test cases for white-box, black- box, and grey-box approaches. This course describes the various techniques for test case design used to test software artifacts, including requirements, design, and code. The course includes different techniques for test case design based on graphs, programming language syntaxes and inputs. The course also covers symbolic execution using PEX tool.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit.	**Understand**
CO 2	Explain mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	**Understand**
CO 3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program.	**Understand**
CO 4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.	**Understand**
CO 5	Illustrate the use of PEX tool with symbolic execution.	**Understand**

iii) SYLLABUS

Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.

Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse.

Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, Graph Coverage for Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.

Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the inputdomain

Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using Junit.

Introduction to Grey Box testing - An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

iv) a) TEXTBOOKS

1. Paul Ammann and JeffOffutt ,Introduction to Software Testing.
2. KshirasagarNaik and PriyadarshiTripathy, Software Testing And Quality Assurance: Theory And Practice.

b) REFERENCES

1. https://www.csc.ncsu.edu/academics/undergrad/honors/thesis/muclipsebinder.pdf - Muclipse tutorial.
2. King, James C, “Symbolic Execution and Program Testing”, Association for Computing Machinery, July 1976.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Software Testing :** Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.	9

II	**Unit Testing :** Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse.	9
III	**Unit Testing - White Box Approaches :** Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework	9
IV	**Unit Testing - Black Box Approaches :** Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the inputdomain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using Junit.	9
V	**Grey Box Testing Approaches :** Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 2: MACHINE LEARNING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3MD	Reinforcement Learning	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course covers fundamental principles, techniques and applications in reinforcement learning. Students gain insight into key concepts and modern algorithms in reinforcement learning. This course enables the learners to apply reinforcement learning on real world applications and research problems

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Solve computational problems using probability and random variables.	Apply
CO 2	Explain policy iteration and value iteration reinforcement learning algorithms.	Understand
CO 3	Make use of Monte Carlo reinforcement learning algorithms to solve real world problems.	Apply
CO 4	Summarize temporal-difference based reinforcement learning algorithms.	Understand
CO 5	Explain on-policy and off-policy reinforcement learning algorithms with function approximation.	Understand

iii) SYLLABUS

Review Of Probability Concepts, Markov Decision Process, Finite Markov Decision Processes, Prediction And Control, Temporal-Difference (TD) Methods For Model Free Prediction And Control, Sarsa, Function Approximation Method, Eligibility Traces ,Policy Gradient Methods, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient, REINFORCE with Baseline, Actor– Critic Methods

iv) a) TEXTBOOKS

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction,2nd Edition, 2014

2. Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition, 2007

b) REFERENCES

1. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, 2nd Edition,2012

2. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig,3rd Edition, 2009

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of Probability Concepts Axioms of probability, concepts of random variables, Probability mass function, Probability density function, Cumulative density functions, Expectation of random variables, Joint and multiple random variables, Conditional and marginal distributions Correlation and independence	9
II	Markov Decision Process Introduction to Reinforcement Learning(RL) terminology - Examples of RL, Elements of RL, Limitations and Scope of RL, Finite Markov Decision Processes, The Agent Environment Interface Goals and Rewards, Returns and Episodes, Policies and Value Functions, Optimal Policies and Optimal Value Functions, Optimal Policies and Optimal Value Functions	9
III	Prediction And Control Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-policy Monte Carlo Control	9
IV	Temporal-Difference (Td) Methods TB-1 TD Prediction, Advantages of TD Prediction Methods Optimality of TD (0), Sarsa: On-policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa, n-step TD Prediction, n-step Sarsa, n-step Off-policy Learning Off-policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm	9
V	Function Approximation Method TB-1 Value-function Approximation, The Prediction Objective, Stochastic- gradient Methods, Linear Methods, The Lambda-return , TD(Lambda), n- step Truncated Lambda-return Methods, Sarsa(Lambda), Policy Approximation and its	9

	Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient REINFORCE with Baseline, Actor–Critic Methods	
	Total	**45**

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vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 3 NETWORKING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
CS0M 30F	WIRELESS NETWORKS AND IoT APPLICATIONS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course equips the learners with fundamental wireless technologies for the Internet of Things(IoT) and the IoT ecosystem. It covers the underlying concepts in wireless networks, communication mechanisms, protocols, hardware, software, and the cloud platforms for IoT. The students will be able to design smart IoT applications for real world problems.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Recognize wireless technologies required for IoT ecosystem	**Understand**
CO 2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT	**Apply**
CO 3	Outline the hardware components used in IoT including Sensors, Actuators and development boards.	**Understand**
CO 4	Explain the software components of IoT	**Understand**
CO 5	Demonstrate the protocols used in IoT and build IoT Programs	**Understand**

iii) SYLLABUS

Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT. Protocol Stack - OSI Model, TCP/IP Model, IEEE 802 Reference Model, Protocols for Wireless IoT. Bluetooth - Transceiver, Frequency Channels, Typical Range, Access and Spread Spectrum, Modulation and Data Rate, Error Correction and Detection, Network Topology. ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification, Thread, WiFi, 6LowPAN, IPv6, LoRaWAN.

Internet of Things - IoT Architectural View, Technology Behind IoT - Server End Technology, Sources of Internet of Things, M2M Communication. IoT Application Areas. IoT Examples. IoT Data Management - Device Management Gateways. Design Principles for Web Connectivity - Web Communication Protocols for Connected Devices, Web

Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.

Data Acquiring and Storage for IoT Sevices- Organization of Data, Big data, Acquiring Methods, Management Techniques, Analytics, Storage Technologies. Cloud Computing for Data storage - IoT Cloud based Services using Xively, Nimbits, and Other Platforms. Sensor Technologies for IoT Devices - Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuators for Various Devices, Sensor Data Communication Protocols, Wireless Sensor network Technology

Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Intel Galileo, Intel Edison, Raspberry Pi, BeagleBone, mBed. Prototyping and Designing the Software for IoT Applications- Introduction, Prototyping Embedded DeviceSoftware- Programming using Arduino, Programming for an Arduino Controlled Traffic Control Lights at a Road Junction, Basic Arduino Programs to Blink LED, Find the Distance using Ultrasonic Sensor, Estimate Room Temperature, Measuring Soil Moisture Level

Business Models and Processes using IoT. Value Creation in the Internet of Things. Cloud PaaS- Xively, Nimbits, IBM Bluemix, CISCO IoT, AWS IoT, TCS Connected AWS Platform, Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture

iv) a) TEXTBOOKS

1. Daniel Chew, “Wireless Internet of Things -A Guide to the lower layers”, IEEE Standards and Association, IEEE Press, Wiley
2. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited.

b) REFERENCES

3. ArshadeepBahga, Vijay Madisetti, “Internet of Things: A hands-on approach”, University Press, 2015 (First edition)
4. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011
5. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013
6. Simon Monk, “Programming Arduino: Getting Started with Sketches”, McGraw Hill Publications

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to IoT and wireless technologies required for IoT :** Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT. Protocol Stack - OSI Model, TCP/IP Model, IEEE 802 Reference Model, Protocols for Wireless IoT. Bluetooth - Transceiver, Frequency Channels, Typical Range, Access and Spread Spectrum, Modulation and Data Rate, Error Correction and Detection, Network	9

	Topology. ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification, Thread, WiFi, 6LowPAN, IPv6, LoRaWAN.	
II	**IoT architecture, Data and Device management :** Internet of Things - IoT Architectural View, Technology Behind IoT - Server End Technology, Sources of Internet of Things, M2M Communication. IoT Application Areas. IoT Examples. IoT Data Management - Device Management Gateways. Design Principles for Web Connectivity - Web Communication Protocols for Connected Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	9
III	**Data Acquiring and Enabling Technologies :** Data Acquiring and Storage for IoT Sevices- Organization of Data, Big data, Acquiring Methods, Management Techniques, Analytics, Storage Technologies. Cloud Computing for Data storage - IoT Cloud based Services using Xively, Nimbits, and Other Platforms. Sensor Technologies for IoT Devices - Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuators for Various Devices, Sensor Data Communication Protocols, Wireless Sensor network Technology	9
IV	**Prototyping the Embedded Devices for IoT :** Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Intel Galileo, Intel Edison, Raspberry Pi, BeagleBone, mBed. Prototyping and Designing the Software for IoT Applications- Introduction, Prototyping Embedded DeviceSoftware- Programming using Arduino, Programming for an Arduino Controlled Traffic Control Lights at a Road Junction, Basic Arduino Programs to Blink LED, Find the Distance using Ultrasonic Sensor, Estimate Room Temperature, Measuring Soil Moisture Level	9
V	**Business Models and Case Studies :** Business Models and Processes using IoT. Value Creation in the Internet of Things. Cloud PaaS- Xively, Nimbits, IBM Bluemix, CISCO IoT, AWS IoT, TCS Connected AWS Platform, Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 4: DATASCIENCE

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3MH	**Deep Learning**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i) COURSE OVERVIEW

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Demonstrate basic concepts in machine learning.	**Understand**
CO 2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	**Understand**
CO 3	Demonstrate the concept of the feed forward neural network and its training process.	**Understand**
CO 4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	**Apply**
CO 5	Use different neural network/deep learning models for practical applications.	**Apply**

iii) SYLLABUS

(General Instructions: Instructors are to introduce students to any one software platform and demonstrate the working of the algorithms in the syllabus using suitable use cases and public datasets to give a better understanding of the concepts discussed. Tutorial hour may be used for this purpose)

Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.

Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.

Module -3 (Convolutional Neural Network)
Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.

Module- 4 (Recurrent Neural Network)
Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

Module-5 (Application Areas)
Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.

iv) a) TEXTBOOKS

4. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
5. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
6. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

b) REFERENCES

5. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014
6. Practical Convolutional Neural Networks by MohitSewak, Md. Rezaul Karim, PradeepPujari,Packt Publishing 2018
7. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
8. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting,	9

	underfitting, hyperparameters and validation sets, estimators, bias and variance.	
II	**Optimization and Neural Networks :** Neural Networks – Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.	9
III	**Convolutional Neural Network :** Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet.	9
IV	**Recurrent Neural Network :** Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.	9
V	**Application Areas :** Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours

- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Minor Basket 5 NETWORKING SECURITY

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL3MJ	Privacy and security in IoT	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

The course covers foundational concepts, ethical considerations, and practical implementation of security measures in AI systems. It also delves into the legal and regulatory frameworks governing data privacy and AI, including real-world applications and case studies

iii) COURSE OUTCOME:

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

Course Outcomes	Description	Level
CO 1	Explain the areas of cyber security for the Internet of Things.	Understand
CO 2	Explain the different security architecture in the Internet of Things	Understand
CO 3	Describe various privacy preservation techniques used in various IoT applications	Understand
CO 4	Apply Trust, Authentication and Data Security models for preserving IoT privacy and security.	Apply
CO 5	Explain Privacy and Trust is incorporated in various applications in IoT	Understand

iv) SYLLABUS

Introduction to Securing the Internet of Things, Security Concerns in IoT Applications – Basic Security Practices, Security architecture in the Internet of Things, Trust, Authentication and Data Security, User Centric Decentralized Governance Framework for Privacy and Trust in IoT in various domains.

v) (a)TEXTBOOKS:

1. Fei HU, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, andImplementations”, CRC Press,2016
2. Russell, Brian and Drew Van Duren, “Practical Internet of Things Security”, Packt Publishing, 2016.
3. Ollie Whitehouse, “Security of Things: An Implementers’ Guide to Cyber-Security forInternet of Things Devices and Beyond”, NCC Group, 2014

(**b) REFERENCES**:

1. Shancang Li, Li Da Xu, “Securing the Internet of Things,” Syngress (Elsevier)publication, 2017, ISBN: 978-0-12-804458-2.

2. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A Hands-on approach,” VPT Publishers, 2014, ISBN: 978-0996025515.

3. Alasdair Gilchris, “Iot Security Issues,” Walter de Gruyter GmbH & Co, 2017.

4. Sridipta Misra, Muthucumaru Maheswaran, Salman Hashmi, “Security Challenges and Approaches in Internet of Things,” Springer, 2016.

v) COURSE PLAN

Module	Contents	Hours
I	**Introduction: Securing the Internet of Things-** Security Requirements in IoT architectures – Security in Enabling Technologies – IoT Security Life Cycle – Cryptographic Fundamentals for IoT Security Engineering - Security Concerns in IoT Applications – Basic Security Practices.	9
II	**Security architecture in the Internet of Things-** Introduction – Security Requirements in IoT – Insufficient Authentication/Authorization – Insecure Access Control – Threads to Access Control, Privacy, and Availability – Attacks Specific to IoT – Malware Propagation and Control in Internet of Things.	9
III	**Privacy preservation-** Privacy Preservation Data Dissemination - Privacy Preservation for IoT used in Smart Building – Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles – Lightweight and Robust Schemes for Privacy Protection in Key personal IOT Applications: Mobile WBSN and Participatory Sensing.	9
IV	**Trust, Authentication and Data Security-** Trust and Trust Models for IoT – Emerging Architecture Model for IoT Security and Privacy – preventing Unauthorized Access to Sensor Data – Authentication in IoT – Computational Security for the IoT – Secure Path Generation Scheme for real-Time Green IoT – Security Protocols for IoT Access Networks.	9
V	**Social Awareness-** User Centric Decentralized Governance Framework for Privacy and Trust in IoT – Policy Based Approach for Informed Consent in IoT - Security and Impact of the IoT on Mobile Networks – Security Concerns in Social IoT – Security for IoT Based Healthcare – Smart cities.	9
	Total Hours	45

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Honour Basket 1: SECURITY IN COMPUTING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CSL3HB	NETWORK SECURITY	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios

ii) COURSE OUTCOMES

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

CO 1	Identify the key aspects of security, intrusion detection systems and digital signature schemes	**Apply**
CO 2	Explain the security standards used in network communication	**Understand**
CO 3	Identify the mechanisms in email security services	**Apply**
CO 4	Summarize the protocols used to provide web security	**Understand**
CO 5	Explain the fundamental concepts of wireless network security and firewalls	**Understand**

iii) SYLLABUS

(Network Security Basics) Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).

(Network Security Standards) Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-ofService protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

(Email Security) Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.

(Web Security) Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) –

Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.

(Wireless Network Security and Firewalls) IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.

iv) a) TEXTBOOKS

1. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", 2/e, PHI.
2. William Stallings, "Cryptography and Network Security Principles and Practice", 5/e, Pearson
3. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", 2/e, PHI.

b) REFERENCES

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3/e, Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill. 3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, Prentice Hall.
3. Schiller J., Mobile Communications, 2/e, Pearson Education
4. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).	9
II	Module – 2 (Network Security Standards) Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-ofService protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.	9
III	Module – 3 (Email Security) Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats.	9

	Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.	
IV	Module – 4 (Web Security) Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.	9
V	Module – 5 (Wireless Network Security and Firewalls) IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Honour Basket 2: COMPUTATIONAL BIOLOGY

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL3HB	**MACHINE LEARNING IN COMPUTATIONAL BIOLOGY**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i) COURSE OVERVIEW

This course is intended to provide the learners a outlook towards application of Machine learning algorithms in the field of computational biology. This course helps the learners to apply the Machine learning methods - clustering algorithms, dimensionality reduction, decision drees, Artificial Neural Network, Support Vector Machine to the computational biology problems. Also the course discuss Challenges of Machine Learning in Computational Biology and Future directions of Machine Learning in Computational Biology

ii) COURSE OUTCOMES

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

CO 1	Describe the basic concepts of Machine Leaning, Classification, regression and clustering problems, parameters and measures	Understand
CO 2	Demonstrate the clustering algorithm on computational biology problems	Understand
CO 3	Explain Dimensionality reduction techniques and Decision Trees in computational biology	Understand
CO 4	Illustrate Feature Extraction and Pattern recognition and Classification in the domain of Computational Biology analysis	Understand
CO 5	Explain the role and challenges of Machine Learning in Computational	Understand

iii) SYLLABUS

(Overview of Machine Learning) Overview of Machine Learning, fitting predictive models to data, Supervised and unsupervised learning, Classification, regression and clustering problems, Loss or cost functions. Parameters and hyperparameters, Training. validation and testing, Inductive bias and the bias variance trade-off, Use of clustering models.

(Clustering problems Computational Biology) Hierarchical Clustering, Partition Clustering, Overview Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of kMeans clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data.

(Supervised techniques for Computational Biology) Proteomics Dataset, Data Pre-processing Algorithms, Dimension and Feature Subset Selection, Dimensionality reduction - Principal Component Analysis (PCA), Partial Least Square (PLS), Linear Discriminant

Analysis (LDA), Protein Classification, Decision Trees in Bioinformatics, Proteomic Mass Spectra Classification Using Decision Tree Technique.

(Machine-Learning Algorithms for Computational Biology) Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Pattern recognition from sequence data, measures of a Feature. Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics, Designing ANN for Bioinformatics, ANN in Protein Bioinformatics, Support Vector Machine with Feature Elimination.

(Scope of Machine Learning in Computational Biology) Role of Machine Learning in Computational Biology, Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology, Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods, Future directions of Machine Learning in Computational Biology.

iv) a) TEXTBOOKS

1. Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications. Germany, Springer Singapore, 2020.
2. Yang, ZhengRong. Machine Learning Approaches to Bioinformatics. Singapore, World Scientific Publishing Company, 2010

b) REFERENCES

1. Izadkhah, Habib. Deep Learning in Bioinformatics: Techniques and Applications in Practice. Netherlands, Elsevier Science, 2022.
2. Agapito, Giuseppe, et al. Artificial Intelligence in Bioinformatics: From Omics Analysis to Deep Learning and Network Mining. Netherlands, Elsevier Science, 2022.
3. Data Analytics in Bioinformatics: A Machine Learning Perspective. United States, Wiley, 2021.
4. Michailidis, George, et al. Introduction to Machine Learning and Bioinformatics. United Kingdom, CRC Press, 2008.
5. Zhang, Yanqing, and Rajapakse, Jagath C, Machine Learning in Bioinformatics, Germany, Wiley, 2009.

v) COURSE PLAN

Module	Contents	No. of hours
I	Overview of Machine Learning- Overview of Machine Learning, fitting predictive models to data, Supervised and unsupervised learning, Classification, regression and clustering problems, Loss or cost functions. Parameters and hyperparameters, Training. validation and testing, Inductive bias and the bias variance trade-off, Use of clustering models.	9
II	Clustering problems Computational Biology Hierarchical Clustering, Partition Clustering, Overview Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of kMeans clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data.	9

III	Supervised techniques for Computational Biology- Proteomics Dataset, Data Pre-processing Algorithms, Dimension and Feature Subset Selection, Dimensionality reduction - Principal Component Analysis (PCA), Partial Least Square (PLS), Linear Discriminant Analysis (LDA), Protein Classification, Decision Trees in Bioinformatics, Proteomic Mass Spectra Classification Using Decision Tree Technique.	9
IV	Machine-Learning Algorithms for Computational Biology- Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Pattern recognition from sequence data, measures of a Feature. Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics, Designing ANN for Bioinformatics, ANN in Protein Bioinformatics, Support Vector Machine with Feature Elimination.	9
V	Scope of Machine Learning in Computational Biology-Role of Machine Learning in Computational Biology, Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology, Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods, Future directions of Machine Learning in Computational Biology.	9
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

vi) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours

- Topics: 3 modules each

vii) END SEMESTER EXAMINATION

- Maximum Marks: 40
- Exam Duration: 2 hours

Honour Basket 3: COMPUTER VISION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CTL3HD	IMAGE AND VIDEO PROCESSING	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course enables the learners to understand how digital images are stored and processed. The learners are exposed to different spatial and frequency domain methods for image enhancement, image restoration techniques, morphological operations that could be performed on digital images and also various image and video compression techniques. The course also gives an introduction to the basics of video processing and video segmentation.

ii) COURSE OUTCOMES

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

CO 1	Summarize the steps of digital image processing and pixel relationships.	Understand
CO 2	Apply spatial and frequency domain methods for image enhancement.	Apply
CO 3	Apply restoration techniques and morphological operations on digital images.	Apply
CO 4	Compare different methods for digital image and video compression.	Understand
CO 5	Explain the basics of video processing and video segmentation.	Understand

i) SYLLABUS

Module – 1 Fundamentals of Image processing: Basic steps of Image processing system, sampling and quantization of an Image, basic relationship between pixels and connectivity. Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters.

Module -2 Image Transforms: Unitary transforms, 2D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering.

Module - 3 Image Restoration: Image degradation/Restoration model, Noise models, Restoration in presence of noise only - spatial filtering, Periodic Noise reduction by frequency domain filtering. Morphological Operations: Erosion, Dilation, Opening, Closing, Hit-or-miss transformation, Boundary extraction.

Module - 4 Image compression fundamentals – Coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, JPEG standards.

Module - 5 Video processing: Basics of Video Processing: Analog video, Digital Video. Video segmentation: Introduction to video segmentation, Change detection. COMPUTER SCIENCE AND ENGINEERING(ARTIFICIAL INTELLIGENCE) Video Compression: Introduction to video compression, video compression based on motion compensation, Search for motion vectors, H.261 standard, Transform coding, predictive coding MPEG.

ii) a) TEXTBOOKS

1. Gonzalez and Woods , “Digital Image Processing”, 3rd edition , Pearson, 2009.
2. Li, Ze-Nian, Mark S. Drew, and Jiangchuan Liu. “Fundamentals of multimedia”, Pearson Prentice Hall, 2004.
3. Bovik, Alan C. “Handbook of image and video processing”, Academic press, 2010

b) REFERENCES

1. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.
3. Maheshkumar H Kolekar, “Intelligent Video Surveillance Systems: An Algorithmic Approach”, CRC Press.
4. Francesco Camastra, Alessandro Vinciarelli, “Machine Learning for Audio, Image and Video Analysis: Theory and Applications”, Springer 2015.
5. M. Tekalp ,”Digital video Processing”, Prentice Hall International
6. Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRC press Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Son
7. Yao wang, Joem Ostarmann and Ya – quin Zhang, ”Video processing and communication “,1st edition , PHI

iii) COURSE PLAN

Module	Contents	No. of hours
I	Module – 1 Fundamentals of Image processing: Basic steps of Image processing system, sampling and quantization of an Image, basic relationship between pixels and connectivity. Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters.	**9**
II	Module -2 Image Transforms: Unitary transforms, 2D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering	**9**
III	Module - 3 Image Restoration: Image degradation/Restoration model, Noise models, Restoration in presence of noise only - spatial filtering, Periodic Noise reduction by frequency domain filtering. Morphological	**9**

	Operations: Erosion, Dilation, Opening, Closing, Hit-or-miss transformation, Boundary extraction.	
IV	Module - 4 Image compression fundamentals – Coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, JPEG standards.	**9**
V	Module - 5 Video processing: Basics of Video Processing: Analog video, Digital Video. Video segmentation: Introduction to video segmentation, Change detection. COMPUTER SCIENCE AND ENGINEERING(ARTIFICIAL INTELLIGENCE) Video Compression: Introduction to video compression, video compression based on motion compensation, Search for motion vectors, H.261 standard, Transform coding, predictive codingMPEG.	**9**
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours