

RN SHETTY TRUST ®



ESTD.: 2001
An Institute with a Difference

RNS INSTITUTE OF TECHNOLOGY

Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi

Approved By AICTE, New Delhi. Accredited by NAAC 'A+' Grade

RR Nagar, Dr. Vishnuvardhan Road, Bengaluru - 560 098

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Dr. R N Shetty
Founder



DEPARTMENT OF CSE - AI & ML

BACHELOR OF ENGINEERING

Scheme and Syllabus of V - VIII Semesters

2024 SCHEME



www.rnsit.ac.in



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An Autonomous Institution, Affiliated to VTU,
Accredited with NAAC A+ Grade

Department of Computer
Science and Engineering
(AI & ML)

Autonomous Scheme (Effective
from Academic Year 2024 – 25)



Scheme and Syllabus **Batch 2024 - 2028**

(As per NEP-2020)

(Effective from the academic year 2024 – 25)



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About RNSIT

RNS Institute of Technology, familiar as RNSIT was established in the year 2001. It is the brainchild of Dr. R. N. Shetty, a well-known industrialist, and a great philanthropist. The institution was established with the sole purpose of imparting quality education in Engineering, Technology and Management. Being one of the premier engineering colleges in the country RNSIT is marching towards placing itself on the global map by excelling in academics and placements.

Lush green campus, state of the art infrastructure, well equipped laboratories, hundreds of activities, numerous new initiatives, consistent VTU ranks, path breaking placements, cultural extravaganza, Sports events, 5600+ students and 300+ faculty – with all these RNSIT has become dream destination for engineering aspirants across the country.

Vision

Building RNSIT into a World Class Institution

Mission

To impart high quality education in Engineering, Technology and Management with a difference, enabling students to excel in their career by

- Attracting quality Students and preparing them with a strong foundation in fundamentals so as to achieve distinctions in various walks of life leading to outstanding contributions
- Imparting value based, need based, choice based and skill based professional education to the aspiring youth and carving them into disciplined, World class Professionals with social responsibility.
- Promoting excellence in Teaching, Research and Consultancy that galvanizes academic consciousness among Faculty and Students
- Exposing Students to emerging frontiers of knowledge in various domains and make them suitable for Industry, Entrepreneurship, Higher studies, and Research & Development
- Providing freedom of action and choice for all the Stakeholders with better visibility



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About CSE (AI & ML)

The Department of Artificial Intelligence and Machine learning Engineering at RNSIT was established in the year 2020, aiding learning in the booming field of AI. The Department provides an excellent learning ambience which encourages the students to do deep research in this field.

RNSIT has established a very supportive learning culture along with excellent infrastructure which meets all the requirements of the students to have a blissful experience in their learning journey. AI & ML, being the most trending topic in the industry is turning heads and attracting more people into this field. The department has conducted and hosted many insightful webinars, seminars, workshops, certification courses, expert talks, etc. which broaden the students' knowledge. The department integrates Traditional Teaching with Coursera, NASSCOM, IBM Cognitive Class and Infosys Springboard which enables students to get the most out of their study time. Student development programs are organised to train students on current industry requirements like AI, Machine Learning, Data Science, IOT, Python Programming, Cloud Computing, Android Development, Web Technologies etc.

Artificial Intelligence and Machine Learning are as much a part of our lives as smart phones now. Every walk of life, every job now has AI & ML intertwined with it. Every global company that needs engineers also needs them to have considerable skills in AI & ML. At AI & ML RNSIT, the students are prepared for the future where AI & ML hold the key to success. The department has an ecosystem which enables teaching, nurturing and training the AI & ML graduates to be formidable engineers who can identify, define, and solve problems using the state-of-the-art technology to develop the society as well as the world into a seamlessly connected ecosystem.

Vision

Empowering AI & ML Engineers to seamlessly integrate society and technology

Mission

- To Inculcate, strong mathematical foundations as applied to AI & ML domain.
- To Equip AI & ML graduates with skills to meet Industrial and Societal challenges.
- To Foster ethical values & engineering norms and standards in AI & ML graduates.



Programme Educational Objectives

AI & ML graduates are required to:

- **PEO1:** Demonstrate their AI & ML expertise and skills in solving contemporary problems.
- **PEO2:** Pursue their professional career and/or higher studies in the domain of AI & ML.
- **PEO3:** Communicate effectively, show proactive involvement, have ethical and professional behaviour while working in multi-disciplinary/ diverse teams.

Programme Outcomes (Revised)

1. **PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **PO4: Conduct Investigations of Complex Problems:** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. **PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)



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8. **PO8: Individual and Collaborative Teamwork:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences. (WK8)
10. **PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. (WK8)
11. **PO11: Life-Long Learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Programme Specific Outcomes (PSOs)

The CSE –AI &ML graduates will have

- **PSO1:** Apply their knowledge and skills in various walks of industry and society to solve emerging problems.
- **PSO2:** Become successful AI & ML engineers and responsible citizens of the country.
- **PSO3:** Contribute in solving the Global IT as well as other industry needs of the hour using state-of-the-art technologies with ease.



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Knowledge and Attitude Profile (WK)

- WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- WK9:** Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitude.



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B.E. in Computer Science and Engineering (AI & ML) : Autonomous Scheme and Syllabus

5th Semester

Sl. No.	Course	Course Code	Course Title	TD/PSB	Teaching Hours Per Week			(Tw + Sl) /Sem	Examination				Credits
					Theory Lecture (L)	Tutorial (T)	Practical (P)		Duration In Hours	CIE Marks	SEE Marks	Total Marks	
1	HSMS	BCI501	AI In Software Engineering and Management	CSE (AI&ML)	3	2	0	45	3	50	50	100	4
2	IPCC	BCI502	Data Engineering for AI and Data Visualization	CSE (AI&ML)	3	0	2	45	3	50	50	100	4
3	IPCC	BCI503	Artificial Intelligence and Machine Learning	CSE (AI&ML)	3	0	2	45	3	50	50	100	4
4	PCCL	BCIL504	Cloud Native Technology Lab	CSE (AI&ML)	0	0	2	0	3	50	50	100	1
5	PEC	BCI515X	Professional Elective: List - C	CSE (AI&ML)	3	0	0	45	3	50	50	100	3
6	PROJ	BCI586	Mini Project	CSE (AI&ML)	0	0	2	30	3	100	0	100	2
7	BSC	BENS507/ BBOE507	Environmental Studies / Biology for Engineers	CSE (AI&ML)	2	0	0	30	2	50	50	100	2
8	AEC	BRMK557	Research Methodology & IPR	ANY	2	0	0	30	2	50	50	100	2
9	NCMC	BNSK559	National Service Scheme (NSS)	ANY	0	0	2	0		100	0	100	0
		BPEK559	Physical Education (PE) (Sports & Athletics)										
		BYOK559	Yoga										
TOTAL										550	350	900	22

NOTE: 1st SEMESTER CHEMISTRY CYCLE SECTIONS WILL STUDY "ENVIRONMENTAL STUDIES" IN 4th SEMESTER & "Biology for Engineers" IN 5th SEMESTER

NOTE: 1st SEMESTER PHYSICS CYCLE SECTIONS WILL STUDY "Biology for Engineers" IN 4th SEMESTER & "ENVIRONMENTAL STUDIES" IN 5th SEMESTER

Professional Elective Courses BCI515X : LIST - C	
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BCI515A	Computer Vision
BCI515B	Cloud Computing and Security
BCI515C	AI for Cybersecurity
BCI515D	Edge AI and AIoT

Note: Courses similar to earlier or later semester courses should not be offered



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B.E. in Computer Science and Engineering (AI & ML) : Autonomous Scheme and Syllabus 6th Semester

Sl. No.	Course	Course Code	Course Title	TD/PSB	Teaching Hours Per Week			(Tw + Sl) /Sem	Examination				Credits	
					Theory Lecture (L)	Tutorial (T)	Practical (P)		Duration In Hours	CIE Marks	SEE Marks	Total Marks		
1	IPCC	BCI601	Speech & Natural Language Processing	CSE (AI&ML)	3	0	2	45	3	50	50	100	4	
2	PCC	BCI602	Advanced Machine Learning	CSE (AI&ML)	3	2	0	45	3	50	50	100	4	
3	PEC	BCI613X	Professional Elective: List D	CSE (AI&ML)	3	0	0	45	3	50	50	100	3	
4	OEC	BCX654X	Open Elective : List - E	ANY	3	0	0	45	3	50	50	100	3	
5	PROJ	BCI685	MAJOR PROJECT PHASE-1	CSE (AI&ML)	0	0	4	0	3	100	0	100	2	
6	PCCL	BCIL606	Advanced Machine Learning Lab	CSE (AI&ML)	0	0	2	0	3	50	50	100	1	
7	AEC/ SEC	BCIT/ L657X	AEC/SEC ELECTIVE: List - F	CSE (AI&ML)	IF COURSE IS THEORY				2	50	50	100	1	
				1	0	0	15							
				CSE (AI&ML)	IF COURSE IS PRACTICAL				3					
				0	0	2	0							
8	NCMC	BIKS608	INDIAN KNOWLEDGE SYSTEM	CSE (AI&ML)	1	0	0	0	2	100		100	0	
9	NCMC	BNSK659	National Service Scheme (NSS)	ANY	0	0	2	0		100	0	100	0	
		BPEK659	Physical Education (PE) (Sports & Athletics)											
		BYOK659	Yoga											
TOTAL											600	300	900	18

NOTE: 1st SEMESTER CHEMISTRY CYCLE SECTIONS WILL STUDY "ENVIRONMENTAL STUDIES" IN 4th SEMESTER & "Biology for Engineers" IN 5th SEMESTER

NOTE: 1st SEMESTER PHYSICS CYCLE SECTIONS WILL STUDY "Biology for Engineers" IN 4th SEMESTER & "ENVIRONMENTAL STUDIES" IN 5th SEMESTER

Professional Elective Courses BCI613X : LIST – D	
BCI613A	AI Ethics, Sustainability and Societal Impact
BCI613B	Time Series Analysis for AI Applications
BCI613C	Emotional Intelligence in Affective Computing
BCI613D	Hybrid Intelligence and LLM

Open Elective BXX654X – LIST - E	
BCS654A	Introduction to Data Structures
BCY654B	Fundamentals of Operating Systems
BCI654C	Introduction to DBMS
BCD654D	Foundations of Data Science

AEC/SEC Elective Courses - BCIL657X : LIST – F	
BCIL657A	UI / UX
BCIL657B	DEV OPS
BCIL657C	GEN AI
BCIL657D	Video Analytics using OpenGL
BCIL657E	Computer Networks

Note: Courses similar to earlier or later semester courses should not be offered



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B.E. in Computer Science and Engineering (AI & ML) : Autonomous Scheme and Syllabus 7th Semester

Sl. No.	Course	Course Code	Course Title	TD/PSB	Teaching Hours Per Week			(Tw + Sl) /Sem	Examination				Credits
					Theory Lecture (L)	Tutorial (T)	Practical (P)		Duration In Hours	CIE Marks	SEE Marks	Total Marks	
1	IPCC	BCI701	Foundational AI Models	CSE (AI&ML)	3	0	2	45	3	50	50	100	4
2	IPCC	BCI702	AI System Engineering	CSE (AI&ML)	3	0	2	45	3	50	50	100	4
3	PCC	BCI703	Agentic & Emerging AI	CSE (AI&ML)	3	2	0	45	3	50	50	100	4
4	PEC	BCI714X	Professional Elective: List G	CSE (AI&ML)	3	0	0	45	3	50	50	100	3
5	OEC	BCX755X	Open Elective : List H	ANY	3	0	0	45	3	50	50	100	3
6	PROJ	BCI786	MAJOR PROJECT PHASE-2	CSE (AI&ML)	0	0	12	0	3	100	100	200	6
TOTAL										350	350	700	24

Professional Elective Courses - BCI714X: LIST – G	
BCI714A	AI in Business Analytics
BCI714B	Domain Applications in Gen AI
BCI714C	Social Network Analysis
BCI714D	Physical AI

Open Elective Courses - BXXI755X: LIST - H	
BCS755A	Introduction to Algorithms
BCY755B	Foundations of Information Security
BCD755C	Full Stack Web Development
BCI755D	Introduction to Machine Learning

Note: Courses similar to earlier or later semester courses should not be offered



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B.E. in Computer Science and Engineering (AI & ML): Autonomous Scheme and Syllabus 8thSemester

Sl. No.	Course	Course Code	Course Title	TD/PSB	Teaching & Learning Scheme				Examination				Credits
					CI		LI	TW& SL	Durati on In Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P						
1	PEC	BCI811x	Professional Elective – AIML Bucket List - I (NPTEL/VTU Online Course)	Online	3	0	0	45	3	50	50	100	3
2	OEC	BCI852x	Open Elective – AIML Bucket List - J (NPTEL/VTU Online Course)	Online	3	0	0	45	3	50	50	100	3
3	INT	BCIIN803X	Internship (15 weeks or 90 working days)	CSE (AI&ML)	0	0	20	0	3	100	100	200	10
TOTAL										200	200	400	16



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PEC BCI811x (Online Courses)- AIML Bucket List - I

BCI811A	NPTEL/VTU Online Course
BCI811B	NPTEL/VTU Online Course
BCI811C	NPTEL/VTU Online Course
BCI811D	NPTEL/VTU Online Course

OEC BCI852x (Online Courses) - AIML Bucket List - J

BCI852A	NPTEL/VTU Online Course
BCI852B	NPTEL/VTU Online Course
BCI852C	NPTEL/VTU Online Course
BCI852D	Foreign Language (NPTEL/SWAYAM/online VTU)



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V SEMESTER SUBJECTS



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title	AI in Software Engineering and Management		
Course Code	BCI501	CIE MARKS	50
(L: T: P) + SL	3:2:0 + (45 Hours / Sem)	SEE MARKS	50
Credits:	4	EXAM HOURS	3

COURSE LEARNING OBJECTIVES:

The purpose of the course is to facilitate the learner to:

1. Understand software engineering fundamentals including software processes, requirements engineering, and testing principles.
2. Analyse and compare software process models, including prescriptive, agile, and specialized models.
3. Apply project management techniques such as planning, scheduling, risk management, and DevOps practices in software projects.
4. Explore AI-driven approaches in project management and evaluate their impact, benefits, and ethical considerations.
5. Understand MLOps frameworks and architectures for managing machine learning lifecycle and deployment in real-world systems.

Module-1

9 Hours

Software and Software Engineering – The Nature of Software, Software Engineering, The Software Process, Software Engineering Practice. Functional and non-functional requirements, Requirements engineering processes, Requirements elicitation and analysis, Requirements validation, Requirements management, Design and Implementation, Software testing.

Textbook 1: Chapter 4 (4.1,4.4 to 4.7), Chapter 7 (7.1 to 7.4), Chapter 8 (8.1 to 8.4)

Textbook 2: Chapter 1(1.1,1.3,1.4,1.5)

Module-2

9 Hours

Process Models - Prescriptive Process Models- The waterfall model, Incremental process models, Evolutionary process models, and Concurrent models.

Specialized Process Models – Component based development, The format methods model, and Aspect-oriented software development.

Agile software development - What Is Agility, Agility and the Cost of Change, What Is an Agile Process, Extreme Programming (XP), Other Agile Process Models – Adaptive software development, Scrum, Dynamic systems Development method, Crystal, Feature driven development, Lean software development, Agile modelling, Agile unified process.

Textbook 2: Chapter 2(2.3,2.4), Chapter 3 (3.1, 3.2,3.3,3.4,3.5)



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Module-3	9 Hours
Software Project Management - Project Management - Risk management, Managing people, Teamwork. Project planning - Software pricing, Plan-driven development, Project scheduling, Agile planning, Configuration management - Change management, Version management, System building. The DevOps Culture and Infrastructure as Code Practices - Getting started with DevOps, Implementing CI/CD and continuous deployment. Textbook 1: Chapter 22(22.1 to 22.3), Chapter 23(23.1 to 3.4), Chapter 25(25.1 to 25.3) Reference Book 1: Chapter 1	
Module-4	9 Hours
AI-Driven Project Management - An Introduction to AI, LLMs, and Agents - The Basics of Large Language Models, Prompt Engineering, Special LLM Features, LLM Workflows, AI Agents, ReAct Agents. AI-Driven Predictive Approach to Project Management, AI-Driven Agile and Hybrid Approaches to Project Management, The Implications of AI in Project Management, Navigating Ethical Challenges in PM-AI. Textbook 3: Chapter 2 to Chapter 6 Reference Book 3: Chapter 1	
Module-5	9 Hours
MLOps Management Framework - Introduction, Fundamentals of MLOps- Semantics of dev, staging and prod, ML deployment patterns. MLOps Architecture and Process - Architecture components, Reference architecture Reference Book 2 : Chapter 1 to Chapter 3	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the fundamentals of software engineering, software processes, and requirements engineering techniques.
CO2	Analyze different software process models, including agile methodologies like Extreme Programming (XP), and select appropriate models for given scenarios
CO3	Apply software project management principles including risk management, scheduling, configuration management, and DevOps practices.
CO4	Evaluate AI-driven project management approaches and assess ethical implications in software project environments.
CO5	Design and interpret MLOps frameworks and architectures for deploying and managing machine learning systems.



ASSESSMENT AND EVALUATION REGULATIONS OF HSMS

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks:

1. Ian Sommerville, Software Engineering, 10th Edition, Pearson, 2015, ISBN: 978-0-13-394303-0.
2. Roger S. Pressman and Bruce R. Maxim, Software Engineering: A Practitioner's Approach, 8th Edition, McGraw-Hill Education, 2014, ISBN: 978-0-07-802212-8.
3. Kristian Bainey, AI-Driven Project Management: Harnessing the Power of AI and ChatGPT, 1st Edition, Packt Publishing, 2023, ISBN: 978-1-80461-867-7.

Reference Books:

1. Mikael Krief, *Learning DevOps: A Comprehensive Guide to Accelerating DevOps Culture Adoption with Terraform, Azure DevOps, Kubernetes, and Jenkins*, 2nd Edition, Packt Publishing, 2021, ISBN: 978-1800563551.
2. Joseph Bradley, Niall Turbitt, Michael Shtelma, Rafi Kurlansik, and Matthew Thomson, *The Big Book of MLOps: A Data-Centric Guide*, 2nd Edition, Databricks, 2023, ISBN: 979-8391734260.
3. Pascal Bornet, *Building Agentic AI: Autonomous Systems for Intelligent Business Applications*, 1st Edition, Packt Publishing, 2024, ISBN: 978-1835084397.



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Web Links:

1. <https://nptel.ac.in/courses/106105182>
2. <https://agilemanifesto.org>
3. <https://aws.amazon.com/devops/what-is-devops/>
4. <https://www.promptingguide.ai>
5. <https://cloud.google.com/architecture/mlops-continuous-delivery-and-automation-pipelines-in-machine-learning>

Self-Study Topics

- AI-based code generation
- Intelligent code completion
- Automated debugging systems
- AI pair programming tools
- Software documentation generation using AI
- AI in Software Testing
- Recommendation Systems

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Mini Project:

- Flipped Classroom
- Role Play
- Group Discussion (GD)
- Model Building / Concept Mapping
- Peer Teaching / Student Seminars
- Project Based Learning



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SEMESTER – V

Course Title	Data Engineering for AI and Data Visualization		
Course Code	BCI502	CIE MARKS	50
(L : T : P) + SL	(3:0:2) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the Data Engineering Lifecycle and modern data systems. 2. Apply data ingestion, streaming, and transformation techniques. 3. Design data models and serve data for analytics and machine learning. 4. Explain Big Data concepts, Hadoop ecosystem, and analytics techniques. 5. Demonstrate distributed data processing using Apache Spark and APIs.			
Module-1			9 Hours
The Data Engineering Lifecycle - What is the Data Engineering Lifecycle, The Data Lifecycle versus the Data Engineering Lifecycle, Generation: Source Systems, Storage, Ingestion, Transformation, Serving Data, Major Undercurrents across the Data Engineering Lifecycle: Security, Data Management, DataOps, Data Architecture, Orchestration, Software Engineering Textbook 1: Chapter 2			
Module-2			9 Hours
Data Generation and Ingestion - Data Generation in Source Systems, Source Systems, Files and Unstructured Data, APIs, Application Databases (OLTP Systems), Online Analytical Processing System, Change Data Capture, Logs and Database Logs, Messages and Streams, Ingestion, Batch Ingestion, Streaming Ingestion, Direct Database Connection, Change Data Capture, Message Queues and Event-Streaming Platforms Textbook 1: Chapters: 5, 7			
Module-3			9 Hours
Queries, Modelling, Transformation, and Serving Data - Queries, Data Modeling, Transformation - Batch transformation, Stream Transformation, General Considerations for Serving Data, Analytics, Machine Learning, What a Data Engineer Should Know About ML, Ways to Serve Data for Analytics and ML, Reverse ETL. Textbook 1: Chapters: 8, 9			



Module-4	9 Hours
Introduction to Big Data - Classification of data, Characteristics, Evolution and definition of Big data, What is Big data, Why Big data, Traditional Business Intelligence Vs Big Data, Typical data warehouse and Hadoop environment. Big Data Analytics - What is Big data Analytics, Classification of Analytics, Importance of Big Data Analytics, Technologies used in Big data Environments, Few Top Analytical Tools. Textbook 2: Chapter 1: 1.1, Chapter 2: 2.1-2.5,2.7,2.9,2.10,2.11, Chapter 3: 3.2,3.5,3.8,3.12, 3.14	
Module-5	9 Hours
What Is Apache Spark? The Big Data Problem – A Unified Computing Engine – Spark’s Philosophy – The Spark Ecosystem – A Brief History of Spark A Gentle Introduction to Spark - Spark’s Basic Architecture – Spark Applications – Spark’s Language APIs – The SparkSession – DataFrames – Partitions – Transformations – Lazy Evaluation – Actions – Spark UI – An End-to-End Example – DataFrames and SQL. Structured APIs - What Is a Structured API? – DataFrames and Datasets – Schema – Columns and Expressions – Rows – DataFrame Transformations – Logical and Physical Plans. Textbook 3: Chapters 1,2 and 4	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
1	Data Exploration using Python Load a CSV dataset (e.g., sales data) using Pandas and perform exploratory analysis. Display: i. Number of rows and columns ii. Data types iii. Summary statistics iv. Count of missing values
2	Data Cleaning and Pre-processing Using the dataset from Experiment 1: i. Handle missing values ii. Remove duplicate records iii. Convert categorical columns into proper format iv. Save the cleaned dataset
3	Real-Time Data Streaming using Apache Kafka



	i. Install and start Kafka and Apache ZooKeeper ii. Create a Kafka topic (e.g., test-topic) iii. Develop a Producer to send messages iv. Develop a Consumer to receive messages v. Display real-time streaming output
4	Introduction to PySpark Create a Spark application to: i. Initialize SparkSession ii. Load a dataset into a DataFrame iii. Perform select and filter operations
5	Spark Data Processing with SQL and MongoDB Integration using PySpark Using PySpark: i. Load data from MongoDB into a PySpark DataFrame ii. Perform groupBy operations and aggregation (such as sum, average, count) iii. Create a temporary view from the DataFrame iv. Execute Spark SQL queries to extract meaningful insights v. Store the processed results back into MongoDB
6	Basic Visualization using Python Using a dataset: i. Create bar chart, line chart, and scatter plot ii. Interpret trends and patterns iii. Histogram iv. Box plot v. Heatmap (correlation matrix) Analyze relationships between variables
7	Getting Started with Tableau Using the Employee dataset in Tableau: i. Explore the Tableau workspace and understand basic functionalities. ii. Create and format different types of charts. iii. Apply filters and create calculated fields and parameters. iv. Design a dashboard by organizing worksheets using containers. v. Implement different types of action filters to make the dashboard interactive.
8	Analysis of GDP / Population Dataset using Tableau Using Tableau, perform data analysis and visualization on the GDP/Population dataset and present insights through an interactive dashboard. i. Visualize country-wise data using symbol maps based on latitude and longitude along with country names. ii. Create a bar chart to compare the GDP of Belgium from 2006 to 2026. iii. Use a pie chart to visualize the GDP of India, Nepal, Romania, South Asia, and Singapore for the year 2010. iv. Compare the GDP of Bhutan and Costa Rica using an appropriate visualization technique.



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	v. Create a scatter plot or circle view to analyze GDP of Mexico, Algeria, Fiji, and Estonia from 2004 to 2006. vi. Build an interactive dashboard incorporating the above visualizations with filters. vii. Prepare a PPT/Word report using data storytelling to present the analysis and key insights.
9	Data Visualization and Dashboard Creation using Power BI Using Power BI, perform end-to-end data visualization by integrating data from multiple sources and building an interactive dashboard. i. Connect to Customer Master (Excel) and Invoice (CSV) datasets using Power Query Editor. ii. Perform data cleaning and transformation operations. iii. Design reports using appropriate chart types (bar, line, pie chart) with proper titles and formatting using the HR dataset. iv. Create an interactive dashboard by applying filters, slicers, and formatting options.
10	Analysis of revenue in sales dataset using Power BI i. Create a choropleth map (fill the map) to spot the special trends to show the state which has the highest revenue. ii. Create a line chart to show the revenue based on the month of the year. iii. Create a bin of size 10 for the age measure to create a new dimension to show the revenue. iv. Create a donut chart view to show the percentage of revenue per region by creating zero access in the calculated field. v. Create a butterfly chart by reversing the bar chart to compare female & male revenue based on product category. vi. Create a calculated field to show the average revenue per state & display profitable & non-profitable state. vii. Build a dashboard.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the data engineering lifecycle, including data generation, ingestion, transformation, and serving.
CO2	Apply techniques for data generation, ingestion, and handling of structured and unstructured data sources.
CO3	Analyze and implement data transformation and data modelling strategies.
CO4	Explain Big Data concepts, analytics techniques, and technologies used in Big Data environments.
CO5	Demonstrate the use of Apache Spark and data visualization tools to process data and generate insights.



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ASSESSMENT AND EVALUATION REGULATIONS OF IPCC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D

The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.

Textbooks

1. Joe Reis and Matt Housley, *Fundamentals of Data Engineering: Plan and Build Robust Data Systems*, 1st Edition, O'Reilly Media, 2022, **ISBN: 978-1098108304**.
2. Seema Acharya and Subhashini Chellappan, *Big Data and Analytics*, 2nd Edition, Wiley India, 2019, **ISBN: 978-8126563432**.
3. Bill Chambers and Matei Zaharia, *Spark: The Definitive Guide: Big Data Processing Made Simple*, 1st Edition, O'Reilly Media, 2018, **ISBN: 978-1491912218**.



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Reference Books

1. Martin Kleppmann, *Designing Data-Intensive Applications*, 1st Edition, O'Reilly Media, 2017, **ISBN: 978-1449373320**.
2. Claus O. Wilke, *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*, 1st Edition, O'Reilly Media, 2019, **ISBN: 978-1492031086**.
3. Jules S. Damji, Brooke Wenig, Tathagata Das, and Denny Lee, *Learning Spark: Lightning-Fast Data Analytics*, 2nd Edition, O'Reilly Media, 2020, **ISBN: 978-1492050049**.
4. Jack Dougherty and Ilya Ilyankou, *Hands-On Data Visualization*, 1st Edition, O'Reilly Media, 2021, **ISBN: 978-1492097396**.

Weblinks:

1. <https://www.coursera.org/programs/rns-faculty-learning-program-xtx08/learn/introduction-to-data-engineering?source=search>
2. <https://www.coursera.org/programs/rns-faculty-learning-program-xtx08/professional-certificates/ibm-data-engineer?source=search>
3. <https://spark.apache.org/docs/latest/>
4. <https://matplotlib.org/stable/users/index.html>
5. <https://www.kaggle.com/learn>
6. https://onlinecourses.nptel.ac.in/noc22_cs65

Self – Study topics:

- Introduction to DataOps and MLOps concepts
- Basics of NoSQL databases (MongoDB, Cassandra)
- Introduction to data lakes and data warehouses
- Basics of real-time data streaming (Kafka)
- Introduction to dashboard tools (Tableau/Power BI)
- Overview of synthetic data generation techniques

Activity Based Learning

- Quizzes
- Assignments
- Infosys Springboard Courses
- Seminar



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title	Artificial Intelligence & Machine Learning		
Course Code	BCI503	CIE MARKS	50
(L :T : P) + SL	(3:0:2) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
The objectives of the course are to facilitate the learners to			
1. Provide foundational knowledge of Artificial Intelligence, intelligent agents, and propositional logic for reasoning. 2. Introduce First-Order Logic for knowledge representation and inference. 3. Provide foundational knowledge of machine learning, data analysis, and dimensionality reduction techniques. 4. Introduce learning theory and similarity-based learning techniques. 5. Introduce regression techniques and decision tree learning methods.			
Module-1			9 Hours
INTRODUCTION TO AI: What is AI, State of the Art (Applications of AI). Intelligent Agents: Agent and Environment, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents. Knowledge and Reasoning - Logical Agents: Knowledge-Based Agents; Logic, Propositional Logic: A Very Simple Logic (Knowledge Representation Language, Syntax and Semantics; Logical Reasoning: Entailment and Inference), Propositional Theorem Proving using Case Study of Wumpus world. Textbook 1: Chapter 1:1.1, 1.4, Chapter 2 : 2.1- 2.4, Chapter 7 : 7.1 - 7.5			
Module-2			9 Hours
Knowledge and Reasoning - First-Order Logic: Representation Revisited (representation languages in general), Syntax and Semantics of First-Order Logic (Models, Symbols and interpretations, atomic and Complex sentences, Quantifiers), Using First-Order Logic (Assertions and queries, The kinship domain, Numbers, sets, and lists, case study – The wumpus world), Inference in First-Order Logic: Propositional vs First-Order Inference, Unification, Forward and Backward Chaining. Textbook 1: Chapter 8: 8.1- 8.3, Chapter 9: 9.1, 9.2.1, 9.2.2, 9.3.1, 9.3.2, 9.4.1,9.4.2			
Module-3			9 Hours
Foundations of Machine Learning & Data Preprocessing Introduction: Need for Machine Learning, Machine Learning Explained, Machine Learning in Relation to other Fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process, Machine Learning Applications.			



Understanding Data: What is Data? Big Data Analytics and Types of Analytics, Big Data Analysis Framework: Data Collection and Preprocessing, Descriptive Statistics, Univariate Data Analysis and Visualization, Bivariate Data and Multivariate Data, Multivariate Statistics, Essential Mathematics for Multivariate Data: Linear Systems and Gaussian Elimination for Multivariate Data, Matrix Decompositions, Machine Learning and Importance of Probability and statistics. Feature Engineering and Dimensionality Reduction Techniques: Stepwise Forward Selection, Stepwise Backward Elimination, Principal Component Analysis, Linear Discriminant Analysis, Singular Value Decomposition.

Textbook 2: Chapter 1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 Chapter 2: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8

Module-4**9 Hours**

Learning Theory & Instance-Based Learning - Basics of Learning theory: Introduction to Learning and its Types, Introduction to Computation Learning Theory, Design of a Learning System, Introduction to Concept of Learning.

Similarity based Learning: Introduction to Similarity or Instance Based Learning, Nearest Neighbour Learning, Weighted K- Nearest Neighbor Algorithm, Nearest Centroid Classifier.

Textbook 2: Chapter 3: 3.1, 3.2, 3.3, 3.4 Chapter 4: 4.1, 4.2, 4.3, 4.4, 4.5

Module-5**9 Hours**

Supervised Learning - Regression Analysis: Introduction to Regression, Introduction to Linearity Correlation and causation, Introduction to Linear Regression, Multiple Linear Regression, Polynomial Regression, Logistic Regression.

Decision Tree Learning: Introduction to Decision Tree Learning Model, Structure of a decision Tree, Fundamentals of Entropy, Decision Tree Induction Algorithms, ID3 tree Construction, C4.5 Construction, classification and Regression Trees Construction, Regression Trees, Validation and Pruning of Decision Trees.

Textbook 2- Chapter 5: 5.1, 5.2, 5.3, 5.5, 5.6, 5.7 Chapter 6: 6.1, 6.1, 6.2, 6.3

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
1.	Implement a simple Knowledge-Based Agent using Propositional Logic for a Medical Diagnosis System. The agent should store symptoms as facts in a knowledge base and use logical rules to infer possible diseases based on the given symptoms. The system should answer queries about whether a particular disease can be inferred from the symptoms provided.



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2.	Write a Python program to demonstrate models and interpretations in First-Order Logic using a library management system, where books, authors, and borrowers are represented as objects in a domain and queries are evaluated
3.	Develop a Python program demonstrating the use of universal ($\forall$) and existential ($\exists$) quantifiers in a hospital patient monitoring system to represent statements like: All patients with high fever must be monitored. There exists a doctor available for emergency treatment.
4.	Develop a Python program that implements Forward Chaining and Backward Chaining in First-Order Logic to infer new facts from a knowledge base using logical rules. The program should simulate a medical expert system where symptoms are used to infer possible diseases automatically.
5.	Develop a program to create histograms for all numerical features and analyse the distribution of each feature. Generate box plots for all numerical features and identify any outliers. Use California Housing dataset.
6.	Develop a program to Compute the correlation matrix to understand the relationships between pairs of features. Visualize the correlation matrix using a heatmap to know which variables have strong positive/negative correlations. Create a pair plot to visualize pairwise relationships between features. Use California Housing dataset.
7.	Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of the Iris dataset from 4 features to 2.
8.	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Find-S algorithm to output a description of the set of all hypotheses consistent with the training examples.
9.	Develop a program to implement k-Nearest Neighbour algorithm to classify the randomly generated 100 values of x in the range of $[0,1]$. Perform the following based on dataset generated. 1. Label the first 50 points $\{x_1, \dots, x_{50}\}$ as follows: if $(x_i \leq 0.5)$, then $x_i \in \text{Class1}$, else $x_i \in \text{Class2}$ 2. Classify the remaining points, $x_{51}, \dots, x_{100}$ using KNN. Perform this for $k=1,2,3,4,5,20,30$
10.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
11.	Develop a program to demonstrate the working of Linear Regression and Polynomial Regression. Use Boston Housing Dataset for Linear



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	Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression.
12.	Develop a program to demonstrate the working of the decision tree algorithm. Use Breast Cancer Data set for building the decision tree and apply this knowledge to classify a new sample.

COURSE OUTCOMES:*After successfully completing the course, the student will be able to:*

CO1	Explain fundamentals of AI, intelligent agents, rationality, and environments.
CO2	Formulate and solve AI problems using uninformed and informed search strategies
CO3	Describe Machine Learning concepts, types, processes, challenges, and applications.
CO4	Analyse and preprocess data using statistical methods, feature engineering, and dimensionality reduction techniques.
CO5	Apply similarity-based methods, regression models, and decision trees to build ML models.

ASSESSMENT AND EVALUATION REGULATIONS OF IPCC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.



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SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D

The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.

Textbooks:

1. Stuart J. Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Pearson, 2015, **ISBN: 978-0136042594**.
2. S. Sridhar and M. Vijayalakshmi, Machine Learning, 1st Edition, Oxford University Press, 2021, **ISBN: 978-0199494545**.

Reference Books:

1. Elaine Rich and Kevin Knight, *Artificial Intelligence*, 3rd Edition, Tata McGraw-Hill, 2013, **ISBN: 978-0070087705**.
2. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 5th Edition, Pearson Education, 2011, **ISBN: 978-0321545893**.
3. M. N. Murty and V. S. Ananthanarayana, *Machine Learning: Theory and Practice*, Universities Press, 2024, **ISBN: 978-8197220562**.
4. Tom M. Mitchell, *Machine Learning*, 1st Edition, McGraw-Hill, 1997, **ISBN: 978-0070428072**.

Web links and Video Lectures (e-Resources):

- <https://www.geeksforgeeks.org/machine-learning/search-algorithms-in-ai/>
- https://onlinecourses.nptel.ac.in/noc26_cs10
- <https://www.kdnuggets.com/2019/11/10-free-must-read-books-ai.html>
- <https://www.universitiespress.com/resources?id=9789393330697>
- https://www.drssridhar.com/?page_id=1053
- Machine Learning Tutorials: <https://www.geeksforgeeks.org/machine-learning/>
- Machine Learning Tutorials: https://www.tutorialspoint.com/machine_learning/index.htm
- Python for Machine Learning: https://www.w3schools.com/python/python_ml_getting_started.asp
- Introduction to Machine Learning: https://onlinecourses.nptel.ac.in/noc22_cs29/preview

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments



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- NPTEL Swayam Course / Infosys Spring Board Courses
- Seminar
- Mini Projects

Self-Study Component

NPTEL / SWAYAM / Infosys Springboard Certification Course

Students shall complete any one certification course related to:

- Artificial Intelligence
- Machine Learning
- Data Analytics
- Suggested Platforms:
- Infosys Springboard
- Coursera
- Google AI resources

Mini Project / Problem Solving Activity

Students shall implement a small AI/ML-based application using Python libraries.

Example Topics:

- House Price Prediction
- Spam Detection
- Student Performance Prediction
- Disease Prediction
- Movie Recommendation



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title	Cloud Native Technology Lab		
Course Code	BCIL504	CIE MARKS	50
(L :T : P) + SL	0:0:2	SEE MARKS	50
Credits	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to 1. Understand and apply the fundamentals of virtualization by installing and managing hypervisors and virtual machines 2. Configure and manage virtual machine features such as snapshots, cloning, and networking modes 3. Demonstrate the use of containerization technology using Docker for building, running, and managing containers. 4. Develop and deploy containerized applications using Dockerfiles, volumes, and Docker Compose. 5. Understand and implement container orchestration concepts using Kubernetes and Minikube. 6. Deploy, manage, and scale applications in Kubernetes using pods, deployments, services, and rolling updates.			
Experiments			
Program 1 – Virtualization - Installation of a hypervisor and creation of a virtual machine: Install a virtualization platform and create a virtual machine by allocating system resources and installing an operating system using an ISO file.			
Program 2 – Snapshot and Cloning - To perform snapshot and cloning of a VM: Save the current state of a virtual machine to restore it later and create an exact copy of the virtual machine for independent usage.			
Program 3 – Virtual Networking - To configure different networking modes: Configure different networking modes in a virtual machine and test connectivity to ensure proper communication with the host and external networks.			
Program 4 – Docker Engine Installation - To install Docker Engine: Install a containerization platform to develop and run applications in isolated environments.			
Program 5 – Docker Commands - To execute basic Docker operations: Perform basic container operations such as pulling images, running containers, listing active containers, stopping, and removing them.			
Program 6 – Dockerfile Creation - To create a custom Docker image: Create a custom Docker image using a Dockerfile to automate application deployment.			
Program 7 – Docker Command - Implementation of persistent storage: Implement persistent storage so that data remains available even after the container is stopped or removed.			
Program 8 – Docker Compose - To deploy multi-container applications: Manage and deploy multiple containers together as a single application using a configuration file.			



Program 9 – Kubernetes - To install a Kubernetes cluster locally: Set up a local Kubernetes cluster to manage containerized applications.

Program 10 – Kubectl Commands - To practice Kubernetes CLI : Interact with Kubernetes using command-line tools to manage and monitor cluster resources.

Program 11 – Pod Creation - To create and manage a Pod : Deploy a containerized application in Kubernetes using a Pod configuration file.

Program 12 – Deployment and Scaling - To create deployment and scale application
Deploy an application in Kubernetes and scale it to handle multiple instances.

Program 13 – Services in Kubernetes - To expose a deployed Kubernetes application using services for external access. Expose a deployed application to external users through Kubernetes services.

Program 14 – Rolling Update - To perform updates and rollback: Update an application in Kubernetes without downtime and roll back changes if required.

Mini Project List

1. Amazon Virtual Private Cloud (VPC): Create VPC and attach an Internet Gateway, add a subnet and then define routing for the VPC so that traffic can flow between the subnet and the Internet gateway.
2. Amazon EC2 instance: Demonstrate the Creation, launching, resizing, managing, and monitoring of EC2.
3. AWS Lambda: Deployment of Lambda function in an event-driven environment.
4. Amazon DynamoDB: To create, query, view and delete a table in the AWS Management Console.
5. API Gateway: Creation of the microservice that will return a JSON object containing a random question and answer pair using an API Gateway endpoint that invokes a Lambda function.
6. Amazon S3 bucket: Demonstrates how to use an Amazon S3 bucket and manage files, or object, that are stored in the bucket i.e., creation of a bucket, add an object, view an object, move an object, and delete an object and bucket in the AWS Management Console.
7. Demonstrate on how to manage access and permissions to your AWS services using AWS Identity and Access Management (IAM).
8. AWS Key Management Service: Demonstrate the basic steps required to get started with Key Management Service, creating keys, assigning management and usage permissions for the keys, encrypting data and monitoring the access and usage of keys



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Accredited with NAAC A+ GradeDepartment of Computer
Science and Engineering
(AI & ML)Autonomous Scheme (Effective
from Academic Year 2024 – 25)**COURSE OUTCOMES:***After successfully completing the course, the student will be able to:*

CO1	Understand: Explain the concepts of virtualization and configure virtual machines using hypervisors.
CO2	Apply: Apply VM management techniques such as snapshots, cloning, and virtual networking.
CO3	Apply: Use Docker to create, manage, and run containerized applications.
CO4	Apply: Analyze and build Docker images using Dockerfiles, volumes, and Docker Compose.
CO5	Apply: Implement container orchestration using Kubernetes and Minikube.
CO6	Apply: Analyze and manage Kubernetes resources such as pods, deployments, services, and scaling.

ASSESSMENT AND EVALUATION REGULATIONS OF PCCL

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	20	-	Marks Awarded for weekly Conduction of Laboratory Experiments and Submission of records, scaled to 20 marks.
CIE Practical Test+ Mini project(B)	20 +10	-	Average marks of Two tests, each conducted for 100. Marks covering all experiments, scaled to 20 + Mini Project (10 marks)
Total CIE Practical (A+B)	50	20	Sum of Marks of experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam conducted for 100 marks and scaled down to 50 marks.Exam duration shall be for 3 hours .
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/106105167>
2. <https://docs.docker.com>
3. <https://kubernetes.io/docs>



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4. <https://www.virtualbox.org/wiki/Documentation>
5. <https://minikube.sigs.k8s.io/docs>
6. <https://skillbuilder.aws/learning-plan/>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar



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**Department of Computer
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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title	Computer Vision		
Course Code	BCI515A	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to: 1. Understand the fundamentals of computer vision and image processing techniques. 2. Introduce the processes involved in feature detection and matching techniques. 3. Understand the segmentation and object recognition models. 4. Explore the knowledge of deep learning approaches in computer vision. 5. Develop real-world computer vision applications using modern tools and frameworks.			
Module-1			9 Hours
Image Formation & Processing - Introduction: What is computer vision? Image formation: Geometric primitives and transformations, Photometric image formation, Digital Camera, Image Processing: Linear filtering, More neighborhood operators. Practical Component - Implement image reading & display using OpenCV. Apply filters (blur, sharpen) and Edge detection using Canny detection algorithm. Textbook: Chapter 1: 1.1, Chapter 2 : 2.1–2.3, Chapter 3 : 3.2–3.3			
Module-2			9 Hours
Feature Detection & Matching: Points and patches, Edges and contours, Contour tracking, Line detection and vanishing points. Practical Component - Detect key points using ORB Match features between two images (Panorama stitching). Textbook: Chapter 7: 7.1 -7.4			
Module-3			9 Hours
Segmentation & Object Recognition: Instance recognition, Image classification, Object detection, Semantic segmentation, Video understanding. Practical Component - Image segmentation using thresholding K-means clustering on images, Simple object classification (ML model) Textbook : Chapter 6: 6.1 - 6.5			



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Module-4	9 Hours
Deep Learning for Vision : Supervised learning, Unsupervised learning, Deep neural networks, Convolutional neural networks Practical Component - Build CNN using TensorFlow/Keras Train on CIFAR-10 dataset of transfer learning using pre-trained model. Textbook : Chapter 5 : 5.1 - 5.4	
Module-5	9 Hours
Motion Estimation : Translational alignment, Parametric motion, Optical flow, Layered Motion Practical Component - Face detection using Haar Cascade method. Textbook : Chapter 9 : 9.1 - 9.4	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the fundamental concepts of image formation, representation, and basic image processing techniques.
CO2	Apply feature detection and extraction techniques for identifying key points and matching features in images.
CO3	Analyze image segmentation and object recognition methods for interpreting visual data.
CO4	Implement deep learning models such as CNNs for image classification and object detection tasks.
CO5	Develop real-world computer vision applications using modern tools and frameworks.

ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.



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Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
IE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook:

1. Richard Szeliski, *Computer Vision: Algorithms and Applications (Texts in Computer Science)*, 2nd Edition, Springer, 2022, **ISBN: 978-3031343773**.

Reference books:

1. David A. Forsyth and Jean Ponce, *Computer Vision: A Modern Approach*, 2nd Edition, Pearson, 2015, **ISBN: 978-0136085928**.
2. Reinhard Klette, *Concise Computer Vision: An Introduction into Theory and Algorithms*, 2nd Edition, Springer, 2014, **ISBN: 978-1447163190**.
3. Adrian Rosebrock, *Deep Learning for Computer Vision with Python*, 1st Edition, PyImageSearch, 2017, **ISBN: 978-0999471517**.

Web links and Video Lectures (e-Resources):

1. <https://www.ibm.com/think/topics/computer-vision>
2. https://onlinecourses.nptel.ac.in/noc26_ee31/preview
3. <https://opencv.org>
4. <https://pyimagesearch.com>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Mini projects
- Assignments
- NPTEL Courses
- Seminar

Self Study Components:

1. Image Captioning
2. Pose Estimation
3. Motion Detection
4. Optical Flow



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B.E. in Computer Science and Engineering
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title:	Cloud Computing and Security		
Course Code:	BCI515B	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Introduce the rationale behind the cloud computing revolution and the business drivers 2. Understand various models, types and challenges of cloud computing 3. Understand the design of cloud native applications, the necessary tools and the design tradeoffs. 4. Realize the importance of Cloud Virtualization, Abstractions, Enabling Technologies and cloud security			
Module-1			9 Hours
Distributed System Models and Enabling Technologies: Scalable Computing Over the Internet, Technologies for Network Based Systems, System Models for Distributed and Cloud Computing, Software Environments for Distributed Systems and Clouds, Performance, Security and Energy Efficiency.			
Textbook 1: Chapter 1: 1.1 - 1.5			
Module-2			9 Hours
Virtual Machines and Virtualization of Clusters and Data Centers: Implementation Levels of Virtualization, Virtualization Structure/Tools and Mechanisms, Virtualization of CPU/Memory and I/O devices, Virtual Clusters and Resource Management, Virtualization for Data Center Automation.			
Textbook 1: Chapter 3: 3.1 - 3.5			
Module-3			9 Hours
Cloud Platform Architecture over Virtualized Datacenters: Cloud Computing and Service Models, Data Center Design and Interconnection Networks, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms: GAE, AWS and Azure, Inter-Cloud Resource Management.			
Textbook 1: Chapter 4: 4.1 - 4.5			
Module-4			9 Hours
Cloud Security: Top concern for cloud users, Risks, Privacy Impact Assessment, Cloud Data Encryption, Security of Database Services, OS security, VM Security, Security Risks Posed by Shared Images and Management OS, XOAR, A Trusted Hypervisor, Mobile Devices and Cloud Security.			
Cloud Security and Trust Management: Cloud Security Defense Strategies,			



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Distributed Intrusion/Anomaly Detection, Data and Software Protection Techniques, Reputation-Guided Protection of Data Centers.

Textbook 2: Chapter 11: 11.1 to 11.3, 11.5 to 11.8, 11.10 to 11.14

Textbook 1: Chapter 4: 4.6

Textbook 1: Chapter 8: 8.1 to 8.5, 10.1 to 10.2

Module-5

9 Hours

Cloud Programming and Software Environments:

Features of Cloud and Grid Platforms, Parallel and Distributed Computing Paradigms, Programming Support for Google App Engine, Programming on Amazon AWS and Microsoft, Emerging Cloud Software Environments.

Textbook 1: Chapter 6: 6.1 to 6.5

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe various cloud computing platforms and service providers.
CO2	Illustrate the significance of various types of virtualization.
CO3	Identify the architecture, delivery models and industrial platforms for cloud computing based applications.
CO4	Analyze the role of security aspects in cloud computing.
CO5	Demonstrate cloud applications in various fields using suitable cloud platforms.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE	100	40	Final marks shall be the sum of



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(A+B+C)			marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Textbooks:

- 1) Kai Hwang, Geoffrey C Fox, and Jack J Dongarra, Distributed and Cloud Computing, Morgan Kaufmann, Elsevier 2012
- 2) Dan C. Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, 2nd Edition, Elsevier 2018
- 3) Google Cloud Teaching Resources – LMS [for practical component]
- 4) AWS Cloud Developing – AWS Academy Courses [for practical component]

Reference Books:

- 1) Rajkumar Buyya, Christian Vecchiola, and Thamrai Selvi, Mastering Cloud Computing McGrawHill Education, 1st Edition, 2017
- 2) Toby Velte, Anthony Velte, Cloud Computing: A Practical Approach, McGraw-Hill Education, 2017.
- 3) George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud,
- 4) O'Reilly Publication, 1st Edition, 2009
- 5) John Rhoton, Cloud Computing Explained: Implementation Handbook for Enterprises, Recursive Press, 2nd Edition, 2009.

Weblinks and Video Lectures (e-Resources):

- <https://freevideolectures.com/course/4639/nptel-cloud-computing>
- <https://www.youtube.com/playlist?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J>
- https://www.youtube.com/watch?v=EN4fEbcFZ_E
- <https://www.youtube.com/watch?v=RWgW-CgdIk0>
- <https://www.geeksforgeeks.org/virtualization-cloud-computing-types/>
- <https://www.javatpoint.com/cloud-service-provider-companies>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Group Discussion
- Project Based Learning
- Student Seminar



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title	AI FOR CYBER SECURITY		
Course Code	BCI515C	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to: 1. Explain the fundamental concepts of Artificial Intelligence, Machine Learning, and their applications in cybersecurity. 2. Apply AI and machine learning techniques for detecting spam, phishing, malware, and other cybersecurity threats. 3. Analyze malware behavior using static and dynamic analysis techniques along with clustering and classification algorithms. 4. Evaluate AI-driven network anomaly detection and intrusion detection techniques for identifying cyberattacks and botnet activities. 5. Design intelligent fraud detection and prevention systems while understanding vulnerabilities and adversarial attacks in deep neural networks.			
Module-1			9 Hours
Introduction to AI for Cybersecurity Professionals - Applying AI in Cybersecurity, Evolution in AI: from expert systems to data mining, A brief introduction to expert systems, Reflecting the indeterministic nature of reality, Going beyond statistics toward machine learning Mining data for models. Detecting Cybersecurity Threats with AI - Ham or Spam? Detecting Email Cybersecurity, Threats with AI Detecting spam with Perceptron, Meet NNs at their purest – the Perceptron, Spam filters in a nutshell, Spam filters in action, Detecting spam with linear classifiers, How the Perceptron learns, A simple Perceptron-based spam filter, Pros and cons of Perceptrons. Spam detection with SVMs: SVM optimization strategy, SVM spam filter example, Image spam detection with SVMs, Phishing detection with logistic regression and decision trees.			
Textbook 1: Chapter: 1.1 - 1.4,1.6 Chapter: 3.1 to 3.15			
Module-2			9 Hours
Malware Threat Detection: Artificial intelligence for malware detection: Malware goes by many names, Malware analysis tools of the trade, Malware detection strategies Static malware analysis, Static analysis methodology, Difficulties of static malware analysis How to perform static analysis, Hardware requirements for static analysis Dynamic malware analysis, Anti-analysis tricks. Hacking the PE file format, The PE file format as a potential vector of infection, Overview, header structure, Extracting malware artifacts in a dataset			
Textbook 1: Chapter 4.1 - 4.19			



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Module-3	9 Hours
Clustering algorithms- Evaluating clustering with the Silhouette coefficient, K-Means in depth, Clustering malware with K-Means, Decision tree malware detectors, Classification strategy, Detecting malwares with decision trees Random Forest Malware Classifier, How malware circumvents detection?, Polymorphic malware detection strategies, HMM fundamentals, Advanced malware detection with deep learning. Advanced malware detection with deep learning From images to malware, Why should we use images for malware detection?,	
Textbook 1: Chapter 4: 4.24-4.41	
Module-4	9 Hours
Network Anomaly Detection with AI: Network anomaly detection techniques, Anomaly detection rationales, Intrusion Detection Systems, Host Intrusion Detection Systems, Network Intrusion Detection Systems, Anomaly-driven IDS, turning service logs into datasets, How to classify network attacks, Most common network attacks, Anomaly detection strategies, assumptions and challenges, Detecting botnet topology, The botnet kill chain, Different ML algorithms for botnet detection, False alarm management in anomaly detection.	
Textbook 1: Chapter 5: 5.1 -5.21	
Module-5	9 Hours
Fraud Prevention with Cloud AI Solutions: Introducing fraud detection algorithms, Dealing with credit card fraud, Machine learning for fraud detection and prevention systems, Expert-driven predictive models, Data-driven predictive models, FDPS – the best of both worlds. The math behind GANs, Neural network vulnerabilities , Deep neural network attacks, Network attack via model substitution.	
Textbook 1: Chapter: 7.1 -7.7, Chapter 8: 8.8, 8.12, 8.13, 8.19	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the evolution of Artificial Intelligence and its significance in cybersecurity, including expert systems, machine learning, and data mining techniques for cyber threat detection.
CO2	Apply AI and machine learning algorithms such as Perceptron, SVM, logistic regression, and decision trees to detect spam, phishing, and other cybersecurity threats
CO3	Analyze malware using static and dynamic analysis methods, clustering algorithms, decision trees, random forests, and deep learning techniques for
CO4	Evaluate AI-based network anomaly detection and intrusion detection systems for identifying cyberattacks, botnet activities, and false alarm
CO5	Design AI-enabled fraud detection and prevention systems while assessing vulnerabilities and adversarial attacks on deep neural networks.



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ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks:

1. Alessandro Parisi, *Hands-On Artificial Intelligence for Cybersecurity: Implement Smart AI Systems for Preventing Cyber Attacks and Detecting Threats and Network Anomalies*, 1st Edition, Packt Publishing, 2019, **ISBN: 978-1789804027**.

Reference Books:

1. Ahmed Abdelgawad, Mariya Ouaisa, and Mariyam Ouaisa, *AI-Driven Cybersecurity*, 1st Edition, CRC Press, 2025, **ISBN: 978-1041050339**.
2. Caroline Wong, *The AI Cybersecurity Handbook*, 1st Edition, John Wiley & Sons, 2026, **ISBN: 978-1394340866**.

Web links and Video Lectures (e-Resources):

- https://www.coursera.org/learn/introduction-to-ai-for-cybersecurity?utm_source=chatgpt.com
- <https://www.coursera.org/learn/ai-for-cybersecurity>
- <https://www.mindluster.com/certificate/11919/AI-techniques-for-Cybersecurity-video>



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Self-Study Topics

1. Applications of Artificial Intelligence and Machine Learning in Cybersecurity
2. Malware Analysis and Detection Techniques
3. Advanced AI Techniques for Malware Classification
4. AI-Driven Network Anomaly and Intrusion Detection Systems
5. AI-Based Fraud Detection and Neural Network Security

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- NPTEL Swayam Course/ Course era / Infosys Spring Board Courses
- Seminar



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title:	EDGE AI AND AIoT		
Course Code:	BCI515D	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners: 1. To understand fundamentals of Edge Computing and Artificial Intelligence of Things (AIoT). 2. To learn machine learning techniques suitable for edge devices. 3. To implement TinyML models on embedded platforms. 4. To design AI-enabled IoT applications for real-world systems. 5. To analyze the performance, security, and energy efficiency of AIoT systems deployed at the edge.			
Module-1			9 Hours
Introduction, Fundamentals of Edge Computing, Hardware for Edge Computing, Edge Computing Frameworks. Virtualizing the Edge, Value Scenarios for Edge Computing, Fundamentals of Artificial Intelligence Textbook 1: Chapter 1.1-1.4 Chapter 2.1-2.5, Chapter 3.1-3.3			
Module-2			9 Hours
Artificial Intelligence Applications on Edge: Real-time Video Analytic, Autonomous Internet of Vehicles, Intelligent Manufacturing, Smart Home and City. Artificial Intelligence Training at Edge: Distributed Training at Edge, Vanilla Federated Learning at Edge, A Case Study for Training DRL at Edge. Textbook 1: Chapter 4.1-4.4 Chapter 6.6.2.to 6.6			
Module-3			9 Hours
Edge Computing for Artificial Intelligence: Edge Hardware for AI, Edge Data Analysis for Edge AI, Communication and Computation Modes for Edge AI, Tailoring Edge Frameworks for AI, Performance Evaluation for Edge AI. AI for Adaptive Edge Caching, AI for Optimizing Edge Task Offloading, AI for Edge Management and Maintenance. A Practical Case for Adaptive Edge Caching Textbook 1: Chapter 7.1-7.5 Chapter 8.1 to 8.4			



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Module-4	9 Hours
Introduction to AIoT for smart environments: From IoT to AIoT, smart IoT, AI implementation and business cases of AIoT, AI capable IoT platforms, AIoT practical applications, AIoT concerns and challenges, Components in smart environment.	
Textbook 2: Chapter 1.1-1.6, Chapter 2.4,2.5.	
Module-5	9 Hours
Applications of AIOT: Smart cities overview and AIoT, The frame work deployment and architecture of Smart City, AIoT- powered Smart City transformation Functions and features of SmartCities. Instruments that aid in the creation of a Smart City AIoT and challenges in building Smart City. AIoT- based water management: Smart water management, Smart irrigation, AIoT-based e-commerce.	
Textbook 2: Chapter 3.2-3.7, Chapter 6.1-6.8, Chapter12.1,12.2	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain architecture and concepts of Edge AI and AIoT systems.
CO2	Apply machine learning techniques for IoT data analysis.
CO3	Analyze hardware platforms used for Edge AI applications.
CO4	Implement TinyML models on edge devices
CO5	Design AI-enabled IoT solutions for practical applications.

ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks



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SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks:

1. X. Wang, Y. Han, V. C. M. Leung, D. Niyato, X. Yan, and X. Chen, *Edge AI: Convergence of Edge Computing and Artificial Intelligence*, 1st Edition, Springer Nature, 2020, **ISBN: 978-3030411442**.
2. M. Alazab, M. Gupta, and S. Ahmed (Eds.), *AIoT Technologies and Applications for Smart Environments*, 1st Edition, The Institution of Engineering and Technology, 2022, **ISBN: 978-1839533624**.

Reference Books:

1. Nisrine Bnouhanna and Rute C. Sofia, *IoT Things to Service Matchmaking at the Edge*, in *Shaping the Future of IoT with Edge Intelligence: How Edge Computing Enables the Next Generation of IoT Applications*, 1st Edition, River Publishers, 2023, **ISBN: 978-8770040273**.
2. Ovidiu Vermesan and Dave Marples (Eds.), *Advancing Edge Artificial Intelligence: System Contexts*, 1st Edition, River Publishers, 2023, **ISBN: 978-8770041027**.

Web Link:

1. <https://www.edge-ai-vision.com/>
2. <https://www.tensorflow.org/>
3. <https://learn.microsoft.com/en-us/azure/iot/>
4. <https://www.edgeimpulse.com/>

Self-Study Topics:

1. Fundamentals of Edge Computing and Fog Computing.
2. TinyML frameworks and deployment techniques.
3. Security and privacy issues in AIoT systems.
4. Federated Learning in Edge AI applications.
5. Real-time operating systems (RTOS) for IoT devices.
6. Smart healthcare, agriculture, and industrial AIoT case studies.
7. Low-power neural network optimization techniques.



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Activity based Learning

1. Develop a simple sensor-based IoT system with real-time edge analytics.
2. Train and deploy a ~~TinyML~~ model for gesture or sound recognition on a microcontroller.
3. Build an AI-enabled smart home monitoring prototype using Raspberry Pi/ESP32.
4. Compare cloud-based AI processing with edge AI processing in terms of latency and power consumption.
5. Implement image classification on embedded hardware using TensorFlow Lite.
6. Create a mini project on predictive maintenance using IoT sensor data.
7. Conduct experiments on energy-efficient AI model optimization for edge devices.



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SEMESTER – V

Course Title	ENVIRONMENTAL STUDIES		
Course Code	BENS407 / 507	CIE MARKS	50
(L : T : P)+ SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits:	2	EXAM HOURS	2
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is to facilitate the learner to:</i>			
1. Introduce the basic concepts of ecology and ecosystem functioning, including biodiversity and biogeochemical cycles.			
2. Understand various types of environmental pollution, their sources, impacts, and preventive measures.			
3. Explore causes of environmental degradation and methods of conservation with special emphasis on Indian biodiversity.			
4. Create awareness about climate change, global warming, environmental legislation, and significant environmental movements in India.			
Module-1		6 Hours	
Ecology: Basic concepts of ecosystem. Ecosystems (structure and function)- forest, desert, wetlands, river, oceanic and lake. Biotic and Abiotic components; Food chain; Ecological pyramid.			
Biogeochemical Cycles: carbon cycle, nitrogen cycle, phosphorus cycle, water cycle			
Sustainability: 17 Sustainable Development Goals (SDG)- history, targets, implementation, capacity development.			
Module-2		6 Hours	
Environmental Pollution: Surface and ground water pollution, noise pollution, soil pollution, air pollution and marine pollution - sources, impacts on living beings, impacts on environment, preventive measures. case-study on marine pollution.			
Water Chemistry: Significance and effect of pH, total dissolved solids and hardness. Case study on impact of fluoride on human health.			
Module-3		6 Hours	
Environmental Degradation: Causes and effects of deforestation, desertification, soil erosion and glacier melting.			



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Environmental Conservation: Significance and key features of national parks, wildlife sanctuaries, reserved forest and mangrove forest. Importance of western ghats as biodiversity hotspot (flora and fauna)

Module-4

6 Hours

Indian Monsoon and Global Warming

Climate- Impact on monsoons, significance of El Nino and La Nina on India climate.

Global warming: causes, greenhouse gases, effects on environment and human health. Causes and effects of acid rain and ozone depletion. Air sampler and its importance in assessing pollutants.

Module-5

6 Hours

Environmental Legislation: Environmental Protection Act 1984: Definition, Significance and key features.

Indian Environmental Movements: Bishnoi Movement, Chipko & Appiko movement.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe the components and functions of ecosystems and explain major biogeochemical cycles and sustainability goals.
CO2	Understand various forms of pollution and environmental degradation, along with their impacts on ecosystems and human health.
CO3	Demonstrate awareness of climate issues, Indian environmental legislation, and the role of community-based movements in

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Three Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.



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Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration should be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

Textbooks

1. Benny Joseph, “Environmental studies”, 3rd ed., Tata McGraw-Hill, 2017.
2. S M Prakash, “Environmental studies”, 3rd ed., Pristine publishing house, 2018.

Reference Books: -

1. M.Anji Reddy, “Textbook of environmental science and Technology”, revised ed., BS publications, 2014.
2. Dr. B.S Chauhan, “Environmental studies”, 1st ed., University of science press, 2008.



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SEMESTER – V

Course Title	BIOLOGY FOR ENGINEERS		
Course Code	BBOE407/507	CIE MARKS	50
(L : T : P) + SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits	2	EXAM HOURS	2

COURSE LEARNING OBJECTIVES

The purpose of the course is to facilitate the learner to:

1. Familiarize students with basic biological concepts and their engineering applications.
2. Enable students to understand bio-design principles for creating novel devices and structures.
3. Provide an understanding of how biological systems can be redesigned as substitute products for natural systems.
4. Motivate students to develop an interdisciplinary vision of biological engineering.

Module-1		6 Hours
Introduction to Fundamentals of Life: Structure and functions of a cell. Biomolecules: Properties and functions of carbohydrates, nucleic acids, proteins, enzymes, and lipids.		
Module-2		6 Hours
Applications of Biomolecules: Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, nucleic acids in vaccines and diagnosis, proteins in food production, enzymes in biosensors fabrication and food processing, enzymes in biobleaching, lipids in biodiesel and detergents production.		
Module-3		6 Hours
Bioengineering Design Inspired by Anatomy: Brain as a CPU system, eye as a camera system, heart as a pump system, lungs as a purification system, kidney as a filtration system.		
Module-4		6 Hours
Nature-Inspired Biomaterials and Mechanisms: Echolocation, photosynthesis, bird fly-ing, lotus leaf effect, plant burrs, shark skin, kingfisher beak.		



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Artificial Blood: Haemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

Module-5

6 Hours

Trends in Bioengineering: Tissue engineering, stem cells and their applications, bioprinting techniques and materials. Electrical tongue and electrical nose in food science, DNA origami and biocomputing, bioimaging and artificial intelligence for disease diagnosis, bioconcrete.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Corroborate the concepts of biomimetics for specific requirements.
CO2	Understand basic biological concepts for relevant industrial applications.
CO3	Evaluate design and development principles to apply engineering knowledge in bio-logical systems.
CO4	Think critically to explore innovative bio-based solutions for socially relevant problems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30		Average of three Internal Assessment Tests, each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A + B)	50	20	CIE evaluation is done for a maximum of 50 marks.
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be 3 hours.
CIE + SEE (A + B + C)	100	40	Final marks shall be the sum of marks scored in Components A, B, and C.



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The minimum marks to be secured in CIE is 20 out of 50 to appear for SEE, with a minimum of 40% scored in every component of CIE.

Textbooks

1. Basuchandra's Biology for Engineers, Chandrashekara B.M., Basavaraju B.C., 2025.
2. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.

Reference Books

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook, 16th Edition, 2022.
2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W. Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
3. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011.
4. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall, 2011.
5. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
6. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st Edition, CRC Press, 2012.
7. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
8. Bioremediation of Heavy Metals: Bacterial Participation, C.R. Sunilkumar, N. Geetha, A.C. Udayashankar, Lambert Academic Publishing, 2019.



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SEMESTER – V

Course Title	RESEARCH METHODOLOGY AND IPR		
Course Code	BRMK557	CIE MARKS	50
(L : T : P) + SL	(2:0:0)+(30 Hours/Sem)	SEE MARKS	50
Credits	2	EXAM HOURS	2

COURSE LEARNING OBJECTIVES

The purpose of the course is to facilitate the learner to:

1. Understand the fundamental concepts of research and its various types.
2. Apply the principles of literature review, technical reading, attribution, and citation in aca-demic research.
3. Demonstrate awareness of ethical practices in engineering research.
4. Explain the concepts and significance of Intellectual Property Rights (IPR) in engineering.

Module-1**6 Hours**

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Prob-lem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Textbook : Chapter 1

Module-2**6 Hours**

Literature Review and Technical Reading: Introduction to literature review and technical reading, understanding new and existing knowledge, and techniques for analysis and synthesis of prior art. Overview of bibliographic databases such as Web of Science, Google, and Google Scholar. Effective search strategies and approaches for technical reading. Conceptualizing re-search through critical and creative reading practices

Attributions and Citations: Importance of giving proper credit through attributions and citations. Functions and attributes of citations, and the role of titles and keywords in enhancing citation impact. Understanding knowledge flow through citations and the practice of citing datasets. Overview of citation styles, along with guidelines for acknowledgments and proper attribution in academic writing

Module-3**6 Hours**

Introduction To Intellectual Property: Role of IP in the Economic and Cultural Develop-ment of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India.

Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting



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Module-4	6 Hours
Process of Patenting: Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained? Do I Need First to File a Patent in India? Patent Related Forms. Fee Structure Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright.	
Module-5	6 Hours
Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd. Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co. Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Comprehend the fundamental principles of research and its various classifications.
CO2	Analyze and apply concepts of literature review, technical reading, attribution, and citation in research contexts.
CO3	Demonstrate an understanding of ethical practices in engineering research.
CO4	Interpret and explain the role and significance of Intellectual Property Rights (IPR) in engineering and innovation.
CO5	Understanding the basic principles of design rights.

ASSESSMENT DETAILS (Both CIE and SEE

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
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CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests (MCQs) each conducted for 30 marks
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2, scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (C)	50	18	Question papers having 50 MCQs with each question carrying 01 mark, and Exam duration shall be for 2 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook

1. Dr. Santosh M Nejekar, Dr. Harish Bendigeri “Research Methodology and Intellectual Property Rights”, ISBN 978-93-5987-928-4, Edition: 2023.

Reference Book:

1. David V. Thiel “Research Methods for Engineers” Cambridge University Press, 978-1-107-03488-4
2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

1. Quizzes
2. Assignments
3. Seminars

Web Link

1. <https://www.wipo.int/portal/en/index.html>
2. <https://researcheracademy.elsevier.com>

Self Study

1. Technical paper writing and report preparation
2. Statistical tools for research analysis
3. Preparation of research proposals and dissertations
4. IPR issues in software and digital content
5. Licensing, technology transfer, and commercialization
6. Case studies on IPR disputes



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B.E. in Computer Science and Engineering (AI & ML)
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SEMESTER – V

Course Title	NSS-National Service Scheme		
Course Code	BNSK559	CIE MARKS	100
L : T : P	0:0:0:30	SEE MARKS	0
Credits	0	EXAM HOURS	-
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is to facilitate the learner to:</i>			
1. Identify the needs and problems of the community and involve the problem-solving.			
2. Develop among them a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.			
3. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilising community participation to acquire leadership qualities and democratic attitudes.			
Module-1			
Waste management– Public, Private and Govt organization, 5 R's.			
Module-2			
Automation of local Activities			
Module-3			
Organic farming, Indian Agriculture (Past, Present and Future), Connectivity for marketing.			
Module-4			
Spreading public awareness under rural outreach Programs.			
Module-5			
Food preservation and Packaging			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the motto and concepts of NSS
CO2	Develop overall personality of volunteers and make them as leaders and responsible citizens of our nation
CO3	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO4	Communicate effectively with the community and with the officials.



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ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
Evaluation based on Reports (A)	100	-	5 modules Reports, 5 modules X 10 M each = 50 M
Total CIE Theory (A)	100	40	
SEE (B)	-	-	-
CIE+SEE (A+B)	100	40	Final marks shall be the marks scored in Components A
• No SEE for this subject			

Suggested Learning Resources:

Reference Books:

- 1) NSS Course Manual, Published by NSS Cell, VTU Belagavi.
- 2) Government of Karnataka, NSS cell, activities reports and its manual.
- 3) Government of India, NSS cell, Activities reports and its manual.

Web links:

- 1) <https://nss.gov.in/>
- 2) <https://pledge.mygov.in/>



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SEMESTER – V

Course Title	Physical Education		
Course Code	BPEK559	CIE MARKS	100
L: T: P: S	0:0:2: 0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the fundamental concepts of Physical Education, games and sports skills, Health, Nutrition and Fitness 2. Familiarization of health-related Exercises, Sports for overall growth and development 3. Participate in the competition at regional/state / national / international levels. 4. Create consciousness among the students on Health, Fitness and Wellness in			
Module-1: Title: Athletics – Track Events - 110 & 400 Mtrs Hurdles		3 HOURS	
110 Mtrs and 400Mtrs: Hurdling Technique: Lead leg Technique, Trail leg Technique Crouch start (its variations) use of Starting Block.			
Module-2: Title: Athletics - Jumps		3 HOURS	
High Jump A) Approach Run B) Take-off C) Bar Clearance (Straddle) D) Landing			
Module-3: Title: Athletics - Throws		3 HOURS	
Discuss Throw A) Holding the Discus B) Initial Stance Primary Swing C) Rotation D) Release and Recovery (Rotation in the circle)			



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Module-4: Title: Football

3 HOURS

A. Fundamental skills

1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.
2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot.
3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot.
4. Heading: In standing, running and jumping condition.
5. Throw-in: Standing throw-in and Running throw-in.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping: Collection of Ball, Ball clearance- kicking, throwing and deflecting.
8. Game practice with application of Rules and Regulations

B. Rules and their interpretation and duties of the officials

Module-5: Title: Hockey

3 HOURS

A. Fundamental skills

1. Passing: Short pass, Long pass , push pass, hit
2. Trapping.
3. Dribbling and Dozing.
4. Penalty stroke practice.
5. Penalty corner practice.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping, Ball clearance- kicking, and deflecting.
8. Game practice with application of Rules and Regulations

B. Rules and their interpretation and duties of the officials

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand and demonstrate fundamental techniques of track events including 110m and 400m hurdles, with proper use of starting blocks and hurdling skills.
CO2	Apply technical knowledge of athletic jumps , particularly high jump, including approach run, take-off, bar clearance, and landing techniques.
CO3	Develop skills and perform throwing events , specifically discus throw, with correct techniques such as grip, stance, rotation, release, and recovery.



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C04	Demonstrate fundamental skills of football such as kicking, trapping, dribbling, heading, throw-in, tackling, and goalkeeping along with understanding rules and officiating.
C05	Exhibit basic skills and techniques in hockey , including passing, trapping, dribbling, tackling, penalty strokes/corners, and understand rules and duties of officials.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	---	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
• The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Textbooks:-

1. Health and Physical Education by V.K. Sharma
2. Introduction to Physical Education, Fitness, and Sport by Daryl Siedentop
3. Physical Education Activities, Sports and Games: The Origin and Background, Rules of Play, Teaching Hints and Fundamentals by Louis E. Means

Reference Books: -

1. Saraswati Health and Physical Education Textbook
2. Foundations of Physical Education, Exercise Science and Sport by Deborah A. Wuest



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

Course Title:	Yoga		
Course Code:	BYOK559	CIE MARKS	100
L: T: P: S	0:0:2:0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Physical, Mental & spiritual Objectives of Yoga 2. Explain the meaning of Yoga. 3. Discuss the importance of the Yoga and its scope. 4. Describe the aims and objectives of Yoga. 5. Clarify the misconceptions on Yoga			
Module-1: Title: Suryanamaskara			3 HOURS
Suryanamaskar 12 count 6 rounds a) Suryanamaskar prayer. b) Meaning, need & Importance c) Benefits of Suryanamaskara			
Module-2: Title: Yoga			3 HOURS
a) Meaning and definition. b) Brief introduction of yogic practices for the common man c) Rules and regulations d) Misconceptions of Yoga			
Module-3: Title: Asanas - Sitting & Standing:			3 HOURS
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. - Sitting 1. Ardha Ushtrasana 2. Yogamudra in Padmasana - Standing 1. Hastapadasana 2. Utkatasana			
Module-4: Title: Asanas - Supine line			3 HOURS
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. - Supine line 1. Sarvangasana 2. Chakraasana			



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Module-5: Title: Pranayama

3 HOURS

Kapalabhati - Revision of practice 40 strokes/min - 3 rounds

Pranayama -- 1. Ujjayi
2. Sheetal

Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the meaning, definition, scope, and objectives of Yoga and its role in physical, mental, and spiritual well-being.
CO2	Demonstrate Suryanamaskara (12 counts, 6 rounds) with correct technique and understand its importance and benefits.
CO3	Apply knowledge of yogic practices, rules, and regulations while identifying and correcting common misconceptions of Yoga.
CO4	Perform sitting, standing, and supine Asanas with proper technique, precautions, and awareness of their benefits.
CO5	Practice Pranayama techniques (Kapalabhati, Ujjayi, Sheetal) to improve breathing control, concentration, and overall health.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	----	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	----	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Textbooks

1. The Yoga Sutras of Patanjali – Sri Swami Satchidananda.
2. Light on Yoga — B.K.S Iyengar.

Reference Books: -

1. The Heart of Yoga — T.K.V Desikachar.
2. Asana Pranayama Mudra Bandha by Swami Satyananda Saraswati.



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VI SEMESTER SUBJECTS



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	Speech and Natural Language Processing		
Course Code	BCI601	CIE MARKS	50
(L :T : P) + SL	(3:0:2) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
Course Learning Objectives: <i>The purpose of the course is to facilitate the learner to:</i> 1. Learn the importance of natural language modelling 2. Understand the Applications of natural language processing 3. Understand lexical resources and vector semantics for natural language processing. 4. Understand ASR architectures, self-supervised models, and evaluate performance using WER. 5. Understand the fundamentals of Text-to-Speech (TTS)			
Module-1			9 Hours
Introduction: What is Natural Language Processing? Origins of NLP, Language and Knowledge, The Challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications. Language Modeling: Statistical Language Model, Paninion Framework, Karaka theory, N-gram model. Textbook 1: Chapter 1.1-1.7, Chapter 2.2.5, 2.3.1			
Module-2			9 Hours
Word Level Analysis: Introduction, Regular Expressions, Finite-State Automata, Morphological Parsing, Spelling Error Detection and Correction, Words and Word Classes, Part-of Speech Tagging. Syntactic Analysis: Introduction, Context-Free Grammar, Constituency, Top-down and Bottom-up Parsing, CYK Parsing. Textbook 1: Chapter 3.1-3.7, Chapter 4.1, 4.2, 4.3, 4.4.1, 4.4.2, 4.4.5			
Module-3			9 Hours
Lexical Resources: Introduction, WordNet, FrameNet, Stemmers, Parts-of-Speech Tagger, Research Corpora. Embeddings: Vector Semantics: The Intuition, Simple count-based embeddings, Cosine for measuring similarity, Word2vec, Visualizing Embeddings, Semantic properties of embeddings. Textbook 1: Chapter 9.1-9.6, Chapter 12.1-12.6 Textbook 2: Chapter 5: 5.1-5.4,5.5.1,5.5.2,5.7			



Module-4	9 Hours
Automatic Speech Recognition: The Automatic Speech Recognition Task, Convolutional Neural Networks, The Encoder-Decoder Architecture for ASR, Self-supervised models: HuBERT, Connectionist Temporal Classification (CTC), ASR Evaluation: Word Error Rate.	
Textbook 2: Chapter 15: 15.1,15.2,15.3.1,15.4,15.5.2,15.5.3,15.6,15.7	
Module-5	9 Hours
Text-to-Speech (TTS): TTS overview, Using a codec to learn discrete audio tokens, VALL-E: Generating audio with 2-stage LM, TTS Evaluation, Other speech tasks, Spoken Language Models.	
Textbook 2: Chapter 16: 16.1-16.6	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
1	Write a program for the following preprocessing of text in NLP: • Tokenization • Filtration • Script Validation • Stop Word Removal • Stemming
2	Demonstrate the N-gram modeling to analyze and establish the probability distribution across sentences and explore the utilization of unigrams, bigrams, and trigrams in diverse English sentences to illustrate the impact of varying n-gram orders on the calculated probabilities.
3	Investigate the Minimum Edit Distance (MED) algorithm and its application in string comparison and the goal is to understand how the algorithm efficiently computes the minimum number of edit operations required to transform one string into another. • Test the algorithm on strings with different type of variations (e.g., typos, substitutions, insertions, deletions) • Evaluate its adaptability to different types of input variations
4	Write a program to implement top-down and bottom-up parser using appropriate context free grammar.
5	Write a program using FrameNet from the <i>nltk.corpus.framenet</i> module



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6	Demonstrate the following using appropriate programming tool which illustrates the use of information retrieval in NLP: • Study the various Corpus – Brown, Inaugural, Reuters, udhr with various methods like fileds, raw, words, sents, categories 3 • Create and use your own corpora (plaintext, categorical) • Study Conditional frequency distributions • Study of tagged corpora with methods like tagged_sents, tagged_words • Write a program to find the most frequent noun tags • Map Words to Properties Using Python Dictionaries • Study Rule based tagger, Unigram Tagger Find different words from a given plain text without any space by comparing this text with a given corpus of words. Also find the score of words.
7	Write a Python program to find synonyms and antonyms of the word "active" using WordNet.
8	Write a Python program to demonstrate the basic concept of Automatic Speech Recognition (ASR) by converting speech input from the microphone into text output using a speech recognition library.
Mini project 1. Develop an NLP-based system to classify news articles as Fake or Real using text preprocessing and feature extraction techniques. 2. Develop an NLP-based system to classify product reviews as Positive or Negative using text preprocessing and word embedding techniques. 3. Develop an NLP-based chatbot that understands user queries and provides appropriate responses using text preprocessing and natural language processing techniques. 4. Develop an AI-based Resume Analyzer that extracts key information from resumes and compares it with a job description using NLP techniques.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the fundamentals of Natural Language Processing, language modeling techniques, grammar concepts, and applications of NLP
CO2	Apply word-level and syntactic analysis techniques for natural language processing tasks.
CO3	Apply lexical resources and vector semantics for natural language processing.
CO4	Understand ASR architectures, self-supervised models, and evaluate performance using WER.
CO5	Demonstrate and understanding of Text-to-Speech (TTS) systems.



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RNS INSTITUTE OF TECHNOLOGYAn Autonomous Institution, Affiliated to VTU,
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from Academic Year 2024 – 25)**ASSESSMENT AND EVALUATION REGULATIONS OF IPCC**

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be before 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.			



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Textbooks

1. Tanveer Siddiqui and U. S. Tiwary, *Natural Language Processing and Information Retrieval*, 1st Edition, Oxford University Press, 2008, **ISBN: 978-0195692327**.
2. Daniel Jurafsky and James H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models*, 3rd Edition, 2026.

Reference Books

1. Akshay Kulkarni and Adarsha Shivananda, *Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning Using Python*, 1st Edition, Apress, 2019, **ISBN: 978-1484242667**.
2. T. V. Geetha, *Understanding Natural Language Processing: Machine Learning and Deep Learning Perspectives*, 1st Edition, Pearson, 2024, **ISBN: 978-9353946920**.

Web links and Video Lectures (e-Resources):

- <https://www.youtube.com/watch?v=M7SWr5xObkA>
- <https://youtu.be/02QWRAhGc7g>
- <https://www.youtube.com/watch?v=CMrHM8a3hqw>
- https://onlinecourses.nptel.ac.in/noc23_cs45/preview
- <https://archive.nptel.ac.in/courses/106/106/106106211/>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar

Self-Learning

1. Study NLP applications in healthcare, education, and translation.
2. Explore Indian language processing tools.
3. Develop simple applications such as chatbots, sentiment analyzers, speech-to-text, and text-to-speech systems.



B.E. in Computer Science and Engineering (AI & ML)
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 SEMESTER – VI

Course Title	Advanced Machine Learning		
Course Code	BCI602	CIE MARKS	50
(L : T : P) + SL	(3:2:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is to facilitate the learner to:</i>			
1. Understand the fundamentals of Artificial Neural Networks (ANNs), including perceptron, multilayer networks, and backpropagation. 2. Acquire knowledge of supervised deep learning techniques with focus on CNN architecture and training. 3. Explain sequence modeling using RNNs, LSTM, and gated architectures. 4. Understand probabilistic and Bayesian learning techniques for modelling uncertainty. 5. Gain insights into reinforcement learning concepts for sequential decision-making.			
Module-1		9 Hours	
Artificial Neural Networks: Introduction, Neural Network Representation, Appropriate Problems for Neural Network Learning, Perceptron, Multilayer Networks and the Backpropagation Algorithm, Remarks on Backpropagation Algorithm.			
Textbook 1: Chapter 4.1- 4.6			
Module-2		9 Hours	
Basics of Supervised Deep Learning - Introduction, Convolution Neural Network, Evolution of Convolution Neural Network, Convolution Operation, Architecture of CNN, Training Supervised Deep Learning Networks - Training Convolution Neural Networks, Loss Functions and Softmax Classifier, Gradient Descent-Based Optimization Techniques, Challenges in Training Deep Networks.			
Textbook 2: Chapter-2.1- 2.5 and Chapter 3.2 - 3.5			
Module-3		9 Hours	
Recurrent and Recursive Neural Networks - Unfolding Computational Graphs, Recurrent Neural Network, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory, Gated RNNs.			
Textbook 3- Chapter- 10.1, 10.3, 10.5, 10.6, 10.10			
Module-4		9 Hours	
Module 4: Probabilistic & Bayesian Learning - Introduction, Bayes Theorem, Bayes Theorem and Concept Learning, Maximum Likelihood and Least-Squared Error Hypotheses, Maximum Likelihood Hypotheses for predicting Probabilities, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, An Example: Learning to classify Text, Bayesian Belief Networks, The EM Algorithm.			



Textbook 1- Chapter 6.1- 6.12

Module-5

9 Hours

Module 5: Reinforcement Learning & Sequential Decision Making

Introduction, The Learning Task, Q Learning, Non deterministic Rewards and Actions, Temporal Difference Learning, Generalizing from Examples, Relationship to Dynamic Programming

Textbook 1- Chapter- 13.1- 13.7

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the fundamentals of Artificial Neural Networks (ANN), perceptrons, multilayer neural networks, and backpropagation learning algorithms.
CO2	Develop and train Convolutional Neural Network (CNN) models for supervised learning and image-based applications.
CO3	Apply Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and gated network architectures for sequential and time-series data analysis.
CO4	Analyse and implement Bayesian learning methods for probabilistic reasoning, prediction, and classification tasks.
CO5	Apply reinforcement learning techniques to model and solve sequential decision-making problems in intelligent systems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE IA-Tests(A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20		Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			



Textbooks

1. Tom M. Mitchell, *Machine Learning*, 1st Edition, McGraw-Hill, 1997, **ISBN: 978-0070428072**.
2. M. Arif Wani, Farooq Ahmad Bhat, Saduf Afzal, and Asif Iqbal Khan, *Advances in Deep Learning*, 1st Edition, Springer, 2020, **ISBN: 978-9811367939**.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, 1st Edition, MIT Press, 2016, **ISBN: 978-0262035613**.

Reference Books

1. M. N. Murty and V. S. Ananthanarayana, *Machine Learning: Theory and Practice*, 1st Edition, Universities Press, 2024, **ISBN: 978-8197220562**.
2. S. Sridhar and M. Vijayalakshmi, *Machine Learning*, 1st Edition, Oxford University Press, 2021, **ISBN: 978-0199494545**.
3. Charu C. Aggarwal, *Neural Networks and Deep Learning*, 1st Edition, Springer, 2018, **ISBN: 978-3319944623**.
4. Simon Haykin, *Neural Networks: A Comprehensive Foundation*, 2nd Edition, Prentice Hall, 1999, **ISBN: 978-0132733502**.

Web links and Video Lectures (e-Resources):

- <https://www.geeksforgeeks.org/machine-learning/search-algorithms-in-ai/>
- https://onlinecourses.nptel.ac.in/noc26_cs10
- <https://www.kdnuggets.com/2019/11/10-free-must-read-books-ai.html>
- <https://www.universitiespress.com/resources?id=9789393330697>
- https://www.drssridhar.com/?page_id=1053
- Machine Learning Tutorials: <https://www.geeksforgeeks.org/machine-learning/>
- Machine Learning Tutorials: https://www.tutorialspoint.com/machine_learning/index.htm
- Python for Machine Learning: https://www.w3schools.com/python/python_ml_getting_started.asp
- https://onlinecourses.nptel.ac.in/noc26_ee53
- <https://www.coursera.org/learn/deep-learning>

SELF Learning

- Activation Functions and Optimization Techniques in ANN.
- Transfer Learning using Pre-trained CNN Models
- Comparative Study of RNN, LSTM, and GRU Networks
- Applications of Bayesian Networks in Intelligent Systems
- Q-Learning and Deep Reinforcement Learning Techniques

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- NPTEL Swayam Course / Infosys Spring Board Courses
- Seminar
- Mini Projects



B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	AI Ethics, Sustainability and Societal Impact		
Course Code	BCI613A	CIE MARKS	50
(L:T:P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the foundational ethical principles governing the design, deployment, and governance of AI systems. 2. Analyse real-world case studies involving AI bias, fairness, accountability, and transparency across different societal domains. 3. Evaluate the environmental footprint of AI and large-scale machine learning systems and explore green AI practices. 4. Examine the societal and economic impact of AI-driven automation on employment, education, healthcare, and democratic institutions. 5. Apply ethical frameworks and regulatory guidelines to propose responsible AI solutions for complex, real-world challenges.			
Module-1		9 Hours	
Foundations of AI Ethics- Introduction to AI ethics and its importance, Historical context: from rule-based systems to modern AI, Core ethical principles: fairness, accountability, transparency, and privacy (FATP), Ethical theories and their application to AI (utilitarianism, deontology, virtue ethics), Moral agency and responsibility in autonomous systems, Human-centered AI design, Value alignment problem, Ethical decision-making frameworks for AI practitioners. Textbook 1: Chapter – 1 (1.1-1.4), Chapter – 2 (2.1-2.5), Chapter – 3 (3.1-3.4) Textbook 2: Chapter – 1 (1.1-1.6)			
Module-2		9 Hours	
Bias, Fairness and Accountability in AI- Sources and types of bias in data and algorithms, Measuring and mitigating algorithmic bias, Fairness metrics: individual vs. group fairness, Explainable AI (XAI) and interpretability techniques, AI accountability frameworks and audit mechanisms, Case studies: bias in hiring tools, facial recognition, and credit scoring, Transparency in black-box models, Responsible AI toolkits and best practices.			



Textbook 1: Chapter – 4 (4.1-4.5), Chapter – 5 (5.1-5.4), Chapter – 6 (6.1-6.3)
Textbook 3: Chapter – 2 (2.1-2.4), Chapter – 3 (3.1-3.3)

Module-3

9 Hours

AI, Privacy and Regulatory Landscape- Data privacy principles and AI: GDPR, PDPA, and global frameworks, Consent, data minimization, and purpose limitation in ML pipelines, Surveillance technologies and civil liberties, Deepfakes, synthetic media, and misinformation, Intellectual property and AI-generated content, AI governance frameworks: EU AI Act, IEEE Ethically Aligned Design, National AI policies and international cooperation, Ethics by design: embedding ethics in the AI development lifecycle.

Textbook 2: Chapter – 3 (3.1-3.5), Chapter – 4 (4.1-4.6), Chapter – 5 (5.1-5.4)
Textbook 3: Chapter – 4 (4.1-4.5)

Module-4

9 Hours

AI Sustainability and Environmental Impact- Carbon footprint of AI model training: compute, energy, and emissions, Green AI: efficient architectures, model compression, and pruning, Energy-aware machine learning and hardware considerations, AI for climate change: applications in environmental monitoring, disaster prediction, and renewable energy, Sustainable data centres and responsible compute, Life cycle assessment of AI systems, Circular economy principles applied to AI hardware, Balancing performance and environmental responsibility.

Textbook 4: Chapter – 1 (1.1-1.5), Chapter – 2 (2.1-2.6), Chapter – 3 (3.1-3.4), Chapter – 4 (4.1-4.3) **Textbook 2:** Chapter – 6 (6.1-6.4)

Module-5

9 Hours

Societal Impact, Future of Work and AI Governance- AI and the future of employment: automation, displacement, and reskilling, Impact of AI on healthcare, education, agriculture, and governance, AI in criminal justice: predictive policing and recidivism models, Autonomous weapons and AI in warfare: ethical dimensions, Digital divide and equitable access to AI benefits, Social media algorithms and democratic discourse, Building inclusive AI: diversity in teams and in datasets, Global AI governance and the road to beneficial AGI.

Textbook 1: Chapter – 8 (8.1-8.5), Chapter – 9 (9.1-9.4), Chapter – 10 (10.1-10.3)
Textbook 3: Chapter – 5 (5.1-5.5), Chapter – 6 (6.1-6.4)

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:



CO1	Articulate and apply core ethical principles—fairness, accountability, transparency, and privacy—to the design and evaluation of AI systems.
CO2	Identify, measure, and propose mitigation strategies for algorithmic bias and fairness violations in real-world AI applications.
CO3	Critically analyze AI-related privacy concerns and evaluate regulatory frameworks and governance models for responsible AI deployment.
CO4	Assess the environmental cost of AI systems and propose green AI strategies to reduce carbon footprint and promote sustainable computing.
CO5	Evaluate the societal and economic impacts of AI-driven automation and formulate policy-aware, inclusive, and ethically grounded AI solutions.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam



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			duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Textbooks:

1. Virginia Eubanks, *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor*, 1st Edition, St. Martin's Press, 2018, **ISBN: 978-1250074317**.
2. Kate Crawford, *Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence*, 1st Edition, Yale University Press, 2021, **ISBN: 978-0300209570**.
3. Cathy O'Neil, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*, 1st Edition, Crown, 2016, **ISBN: 978-0553418811**.
4. Sasha Luccioni, Yacine Jernite, and Emma Strubell, *Estimating the Carbon Footprint of BLOOM*, *Journal of Machine Learning Research*, Vol. 24, 2023, **ISSN: 1533-7928**.

Reference Books:

1. Stuart Russell, *Human Compatible: Artificial Intelligence and the Problem of Control*, 1st Edition, Viking, 2019, **ISBN: 978-0525558613**.
2. Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence*, 1st Edition, Alfred A. Knopf, 2017, **ISBN: 978-1101946596**.
3. European Commission High-Level Expert Group on Artificial Intelligence, *Ethics Guidelines for Trustworthy AI*, 1st Edition, European Commission, 2019,
4. UNESCO, *Recommendation on the Ethics of Artificial Intelligence*, 1st Edition, UNESCO Publishing, 2021, **ISBN: 978-9231004780**.

Web Links and Video Lectures (e-Resources):

1. <https://ethics.fast.ai> – Practical AI Ethics course by fast.ai
2. <https://aiethics.princeton.edu> – Princeton Dialogues on AI and Ethics
3. <https://www.partnershiponai.org> – Partnership on AI resources and case studies
4. <https://elearn.nptel.ac.in> – NPTEL courses on AI Ethics and Society



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Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

1. Quizzes
2. Assignments and Case Study Reports
3. NPTEL Swayam Course / Coursera / edX Courses on AI Ethics and Responsible AI
4. Seminar / Group Debates on AI policy and societal impact topics
5. Role-play exercises: AI ethics board reviews for real-world AI product proposals

Self-Study Topics

- **Foundations of AI Ethics and Philosophical Frameworks**
Ethical theories (utilitarianism, deontology, virtue ethics) and their mapping to AI decisions, value alignment, and the nature of moral agency in autonomous systems.
- **Bias, Fairness, and Explainability in Machine Learning**
Types of algorithmic bias, fairness metrics (demographic parity, equalized odds), explainability methods (LIME, SHAP), and AI audit methodologies.
- **Privacy, Data Governance, and Regulatory Compliance**
GDPR provisions relevant to ML, purpose limitation, data minimization, right to explanation, AI Act risk classifications, and IEEE Ethically Aligned Design principles.
- **Green AI and Sustainable Machine Learning**
Measuring CO2 equivalents of model training, model compression techniques, knowledge distillation, federated learning for privacy-preserving sustainability, and AI for climate science.
- **Societal Impact and the Future of Work**
Economic theories on automation and labor displacement, Universal Basic Income debates, inclusive AI design, AI in healthcare equity, and global governance frameworks for beneficial AGI.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	TIME SERIES ANALYSIS FOR AI APPLICATIONS		
Course Code	BCI613B	CIE MARKS	50
(L :T : P) + SL	(3:0:0) (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
Course Learning Objectives:			
<i>The purpose of the course is to facilitate the learner to:</i>			
1. Learn the importance of time series analysis on the data.			
2. Identify approaches to handle linear, stationary, and non-stationary models.			
3. Analyse ways of model building and parameter estimation.			
4. Recognize methods to handle multivariate time series data.			
5. Develop skills to apply time series forecasting techniques for real-world data analysis and decision-making.			
Module-1		9 Hours	
Introduction: Five Important Practical Problems, Autocorrelation Function and Spectrum of Stationary Processes: Autocorrelation Properties of Stationary Models, Spectral Properties of Stationary Models, Linear Stationary Models: General Linear Process, Autoregressive Processes, Moving Average Processes.			
Textbook 1: <u>Chapter</u> 1.1, Chapter 2.1,2.2 Chapter 3.1,3.2,3.3,3.4			
Module-2		9 Hours	
Linear Nonstationary Models: Autoregressive Integrated Moving Average Processes, Three Explicit Forms for the ARIMA Model, Integrated Moving Average Processes. Forecasting: Minimum Mean Square Error Forecasts and Their Properties, Calculating Forecasts and Probability Limits, Examples of Forecast Functions and Their Updating.			
Textbook 1: <u>Chapter</u> 4.1,4.2,4.3, <u>Chapter</u> 5.1,5.2,5.3,5.4,5.5.			
Module-3		9 Hours	
Model Identification: Objectives of Identification, Identification Techniques, Initial Estimates for the Parameters, Model Multiplicity.			
Parameter Estimation: Study of the Likelihood and Sum-of-Squares Functions, Nonlinear Estimation, Some Estimation Results for Specific Models, Likelihood Function Based on the State-Space Model.			
Textbook 1: <u>Chapter</u> . 6.1,6.2,6.3,6.4 <u>Chapter</u> . 7.1,7.2,7.3,7.4,7.5.			
Module-4		9 Hours	
Model Diagnostic Checking: Checking the Stochastic Model, Overfitting, Diagnostic Checks Applied to Residuals, Use of Residuals to Modify the Model,			
Analysis of Seasonal Time Series: Parsimonious Models for Seasonal Time Series, Some Aspects of More General Seasonal ARIMA Models, Structural Component Models and Deterministic Seasonal Components.			
Text Book 1: Chapter. 8.1,8.2,8.3 Chapter: 9.1,9.2,9.3,9.4,9.5			



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Module-5	9 Hours
Multivariate Time Series Analysis: Stationary Multivariate Time Series, Vector Autoregressive Models, Vector Moving Average Models, Vector Autoregressive--Moving Average Models, Forecasting for Vector Autoregressive--Moving Average Processes, State Space Form of the VARMA Model.	
Text Book 1: Chapter 14.1-14.6,14.8	

COURSE OUTCOMES:*After successfully completing the course, the student will be able to:*

CO1	Apply the fundamental concept of Time series analysis for Autocorrelation Function and spectrum on linear stationary models.
CO2	Develop non-linear stationary models and perform forecasting.
CO3	Identify models and estimate the various parameters
CO4	Recognize ways to perform model diagnostic checking and analyze the seasonal time series .
CO5	Analyze multivariate time series data.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. **If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.**



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Textbooks

1. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, and Greta M. Ljung, *Time Series Analysis: Forecasting and Control*, 5th Edition, John Wiley & Sons, 2016, **ISBN: 978-1118675021**.

Reference Books

1. Paul S. P. Cowpertwait and Andrew V. Metcalfe, *Introductory Time Series with R*, 1st Edition, Springer, 2009, **ISBN: 978-0387886978**.
2. Rob J. Hyndman and George Athanasopoulos, *Forecasting: Principles and Practice*, 3rd Edition, OTexts (Open Access Textbook), 2021, **ISBN: 978-0987507112**.

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/courses/103106123>
- <https://www.youtube.com/watch?v=GE3JOFwTWVM>
- <https://www.youtube.com/watch?v=tepxdcepTbY>
- <https://www.youtube.com/watch?v=rDwczdWB1TA>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar

Self-Learning

- Applications of ARIMA and SARIMA Models in Forecasting
- Time Series Analysis using Python/R Tools
- Financial and Stock Market Time Series Prediction
- Multivariate Time Series Modelling and Applications



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	EMOTIONAL INTELLIGENCE IN AFFECTIVE COMPUTING		
Course Code	BCI613C	CIE MARKS	50
(L : T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the foundations of affective computing and emotional signal processing 2. Learn emotion detection using facial, speech, and physiological signals 3. Explore affective modelling, sentiment analysis, and emotion representation frameworks 4. Analyse emotion-aware systems and empathetic human–AI interaction 5. Understand ethical, privacy, and societal aspects of Emotion AI			
Module-1		9 Hours	
Introduction to Emotion, Cognition and Intelligence : Introduction to emotions, emotion and cognition, emotional intelligence, songs vs. laws, emotion and perception, limbic perception, limbic-cortical interaction, emotion and attention, emotion and memory, emotion and learning, role of emotions in intelligent behaviour.			
Textbook 1: Chapter–1 (1.1, 1.2, 1.3, 1.4, 1.5, 1.6)			
Module-2		9 Hours	
Emotion and Decision Making : Reevaluating decision making, thinking-feeling axis, rationality and emotion, cognitive appraisal, emotion and motivation, emotion and creativity, emotion in problem solving, emotional influences on decision making, implications for intelligent systems.			
Textbook 1: Chapter–1 (1.7, 1.8, 1.9, 1.10, 1.11, 1.12)			
Module-3		9 Hours	
Foundations of Affective Computing : Introduction to affective computing, affective intelligence, emotionally intelligent machines, recognizing emotions, expressing			



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emotions, emotional communication, human-computer interaction, applications of affective computing in education, healthcare and entertainment.

Textbook 1: Chapter–2 (2.1, 2.2, 2.3, 2.4), Chapter–3 (3.1, 3.2, 3.3, 3.4)

Module-4

9 Hours

Emotion Recognition and Affective Interfaces : Human emotion recognition, facial expressions, vocal expressions, physiological signals, affective pattern recognition, emotion representation, communicating affect, emotion-aware interfaces, adaptive systems, personalized interaction.

Textbook 1: Chapter–6 (6.1, 6.2, 6.3, 6.4, 6.5), Chapter–7 (7.1, 7.2, 7.3, 7.4), Chapter–8 (8.1, 8.2, 8.3, 8.4)

Module-5

9 Hours

Wearable Affective Computing and Applications : Introduction to wearable affective computing, Wearable sensors for emotion recognition, Physiological signal monitoring, Context-aware affective systems, Personal affective computing, Human-centered intelligent systems, Applications in healthcare, Applications in education, Applications in human-computer interaction, Future directions in affective computing.

Textbook 1: Chapter–8 (8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10)

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate understanding of emotion theories, affective computing principles, and emotional signal processing
CO2	Apply machine learning techniques for multimodal emotion detection using facial, speech, and physiological data
CO3	Build affective models and perform sentiment/emotion analysis using structured and unstructured data
CO4	Design emotion-aware interfaces and empathetic AI systems
CO5	Evaluate ethical considerations, bias, fairness, and privacy in affective computing applications



ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	–	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	–	One Assignment on case study / Mini project evaluated for 20 Marks
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE are 20 (40%) out of allotted 50 marks to appear for SEE, with minimum 40% scored in every component of CIE.			

Textbooks

1. Rosalind W. Picard, *Affective Computing*, Paperback Edition (Reprint 2022), MIT Press, 1997, **ISBN: 978-0262661157**.
2. Rafael A. Calvo and Sidney D'Mello (Eds.), *The Oxford Handbook of Affective Computing*, 1st Edition, Oxford University Press, 2015, **ISBN: 978-0199942237**.

Reference Books

1. X. Huang, *Affective Computing: Fundamentals and Applications*, 1st Edition, Springer, 2021, **ISBN: 978-3030727536**.
2. Ramón Zatarain Cabada, Héctor Manuel Cárdenas López, and Hugo Jair Escalante, *Multimodal Affective Computing: Technologies and Applications in Learning Environments*, 1st Edition, Springer, 2023, **ISBN: 978-3031325410**.
3. Mohamed Elgendy, *Deep Learning for Vision Systems*, 1st Edition, Manning Publications, 2020, **ISBN: 978-1617296192**.



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Web Link

- <https://www.youtube.com/playlist?list=PL91673C6313776018>
- https://www.youtube.com/watch?v=WSj26ncU_po
- <https://www.youtube.com/watch?v=kq0VO1FqE6I>

Self Study

- Case Study 1: Smart Classroom Emotion Monitoring
- Case Study 2: Emotion-Aware Recruitment System
- Case Study 3: AI-Based Driver Fatigue Detection
- Case Study 4: Emotion-Aware Chatbot in Healthcare

Activity Based

Mini projects (Examples, not restricted to):

- Emotion-aware attendance system
- AI tutor
- Stress detection app



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B.E. (CSE and Allied Branches)			
[As per Outcome Based Education (OBE) and Choice Based Credit System (CBCS)]			
SEMESTER – VI			
Course Title:	Hybrid Intelligence and Large Language Models (LLM)		
Course Code:	BCI613D	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
Course Learning Objectives: The purpose of the course is to facilitate the learner to:			
1. Understand the principles and architectures of Large Language Models and Transformers.			
2. Understand the architecture, attention mechanisms, training, and scaling of Transformer-based language models.			
3. Understand masked language models, bidirectional encoders, contextual embeddings, and fine-tuning techniques for NLP tasks.			
4. Explore retrieval-based systems and Retrieval-Augmented Generation techniques.			
5. Study machine translation models and their evaluation methodologies.			
Module-1		9 Hours	
Training and Prompting of Large Language Models: Three architectures for language models, Conditional Generation of Text, Prompting, Generation and Sampling, Training Large Language Models, Evaluating Large Language Models, Ethical and Safety Issues with Language Models			
Textbook 1: Chapter 7: 7.1-7.6			
Module-2		9 Hours	
Transformers: Attention, Transformer Blocks, Parallelizing computation using a single matrix X, input: embeddings for token and position, The Language Modeling Head, More on Sampling, Training, Dealing with Scale, Interpreting the Transformer.			
Textbook 1: Chapter 8: 8.1-8.8			
Module-3		9 Hours	
Masked Language Models: Bidirectional Transformer Encoders, Training Bidirectional Encoders, Contextual Embeddings, Fine-Tuning for Classification, Fine-Tuning for Sequence Labeling: Named Entity Recognition.			
Textbook 1: Chapter 9: 9.1-9.5			
Module-4		9 Hours	
Retrieval-based Models: Information Retrieval, Evaluation of Information-Retrieval Systems, Information Retrieval with Dense Vectors, Retrieval-Augmented Generation (RAG), Datasets, Evaluating Question Answering			



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Textbook 1: Chapter 11: 11.1-11.6

Module-5

9 Hours

Machine Translation: Language Divergences and Typology, Machine Translation using Encoder-Decoder, Details of the Encoder-Decoder Model, Decoding in MT: Beam Search, Translating in low-resource situations, MT Evaluation, Bias and Ethical Issues.

Textbook 1: Chapter 12: 12.1-12.7

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the architectures, prompting strategies, training processes, evaluation methods with Large Language Models.
CO2	Apply transformer-based architectures by utilizing attention mechanisms, embeddings, sampling techniques, and training strategies to develop and interpret scalable language models.
CO3	Apply masked language models and fine-tuning methods for text classification and sequence labeling tasks.
CO4	Analyze and apply retrieval-based models and RAG techniques for information retrieval and question-answering tasks.
CO5	Analyze and apply machine translation models using encoder-decoder architectures and beam search while evaluating translation quality and addressing ethical concerns.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to			



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appear for SEE.

- **If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.**

Textbooks

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models”, Pearson, 3rd Edition, 2026.

Reference Books

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing, Prentice Hall/Pearson, 2nd Edition, 2009.
2. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, 2009.
3. Kevin P Murphy, Machine Learning: A Probabilistic Perspective, 2012.

Web links and Video Lectures (e-Resources):

- <https://web.stanford.edu/class/cs224n/>
- <https://huggingface.co/docs/transformers>
- <https://www.deeplearning.ai/short-courses/>
- <https://developers.google.com/machine-learning/crash-course>
- <https://web.stanford.edu/~jurafsky/slp3/>
- <https://nlp.stanford.edu/>
- <https://www.mit.edu/~jda/teaching/6.864/>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar

Self Learning

LLMs:

- GPT
- BERT
- Gemini
- Llama

Hands-On Large Language Models

- Prompt engineering
- RAG systems
- LLM-powered applications
- Human-AI collaborative systems



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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title:	INTRODUCTION TO DATA STRUCTURES		
Course Code:	BCS654A	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Introduce elementary data structures. 2. Analyze Linear Data Structures: Stack, Queues, Linked list 3. Analyze Non-Linear Data Structures: Trees, graphs 4. Assess appropriate data structure during program development/Problem Solving.			
Module-1			9 Hours
Introduction to arrays and pointer: Introduction, Linear Arrays, Representation of Linear Arrays in Memory, Traversing Linear Arrays, Inserting and Deleting, Pointers: Pointer Arrays. Strings: Introduction – Reading and writing Strings, Operations on strings, Arrays of strings, Pointers and String Textbook 2: Chapter 4 (4.1 - 4.5,4.10) Text book 1: Chapter 4(4.1-4.4)			
Module-2			9 Hours
Structures and unions: Introduction, Nested Structure, Array of Structure, Self-referential Structures, Unions. Stacks: Introduction, Array representation of stacks, Operations on Stack-Push, Pop and Peek operation Textbook 1: Chapter 5(5.1 – 5.3,5.5,5.6), Chapter 7(7.1 – 7.3)			
Module-3			9 Hours
Queue: Introduction, Array representation of Queues, Linked Representation of Queues, Types of Queue-Circular Queue and Deques Linked List: Introduction, singly linked list, Circular linked list Textbook 1: Chapter 8(8.1.8.2,8.4),Chapter 6(6.1 - 6.3)			
Module-4			9 Hours
Linked List Contd..: Doubly linked List-Insert and Delete operation Trees: Introduction, Types of Trees, create a Binary Tree from a General Tree, Traversing a Binary tree, Application of Trees. Textbook 1: Chapter 6 (6.4) Chapter 9(9.1 - 9.4,9.6)			



Module-5	9 Hours
Graph - Introduction, Graph Terminology, Representations of Graphs, Graph Traversal Algorithm, Application of Graph. Searching and Sorting -Introduction to searching, Linear Search, Binary Search, Bubble Sort, Insertion Sort	
Textbook 1: Chapter 13(13.1-13.2,13.5,13.6,13.9) , Chapter 14(14.1-14.3,14.7,14.8)	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Implement fundamental data structures and perform operations using arrays, pointers, and structure
CO2	Apply stacks and queues to evaluate expressions and solve linear data structure problems.
CO3	Develop memory-efficient programs using singly and circular linked lists.
CO4	Construct and traverse tree-based and Graph structures to model and analyses hierarchical relationships.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall before 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.



The minimum marks to be secured in CIE are 20 (40%) out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.

Textbooks:

1. Reema Thareja, Data Structure using C, Third Edition, OXFORD University Press, 2023
2. Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill, 2014.

Reference Books:

1. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, 2nd Ed, Universities Press, 2014.
2. E. Balagurusamy, C Programming and Data Structures, 4th Edition, McGraw-Hill, 2007.

Web links and Video Lectures (e-Resources):

1. https://youtu.be/S47aSEqm_0I?si=34alu47wCWGdsxwN
2. <https://ds2-iiith.vlabs.ac.in/exp/selection-sort/index.html>
3. <https://ds1-iiith.vlabs.ac.in/exp/stacks-queues/index.html>
4. <https://ds1-iiith.vlabs.ac.in/exp/linked-list/basics/overview.html>
5. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>
6. <https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/index.html>
7. https://onlinecourses-archive.nptel.ac.in/noc18_cs25/preview

Self-Study Topics:

Applications of Data Structures

- Organization of data in operating systems
- Organization of data in databases
- Organization of data in real-world problems

Sorting Techniques

- Selection sort
- Merge Sort
- Quick Sort

Advanced Tree Structure

AVL Trees, Red-Black Trees, B-Trees, B+ Trees

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Demonstration of projects developed using Linear/Non-linear data structures.



B.E. in Computer Science and Engineering
 Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
 SEMESTER – VI

Course Title	Fundamentals of Operating Systems		
Course Code	BCY654B	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the fundamental concepts and architecture of operating systems, including system structure, services, and system calls. 2. Analyse and apply concepts of process, thread, and CPU scheduling, along with inter- process communication and synchronization techniques. 3. Explain and evaluate memory management strategies, including paging, segmentation, and virtual memory techniques. 4. Demonstrate knowledge of file systems, storage structures, and protection mechanisms, and use relevant system-level commands and APIs for managing OS resources.			
Module-1		9 Hours	
Introduction: What operating systems do, Computer System organization, Computer System architecture, Operating System operations, Resource Management. Operating System Structures: Operating System Servies, User - Operating System interface, System calls, System services, Operating system design and implementation, Operating System structure. Textbook 1: Chapter-1 (1.1-1.5), Chapter-2 (2.1-2.4, 2.7-2.8)			
Module-2		9 Hours	
Processes: Process concept, Process scheduling, Operations on processes, Inter process communication. Threads & Concurrency: Overview, Multithreading models, Thread Libraries, Threading issues. CPU Scheduling: Basic concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-processor scheduling. Textbook 1: Chapter-3(3.1-3.4), Chapter-4(4.1,4.3-4.4,4.6), Chapter-5(5.1 - 5.3,5.5)			
Module-3		9 Hours	



Synchronization Tools: Background, The critical section problem, Peterson's solution, Hardware Support for Synchronization Mutex Locks, Semaphores.

Synchronization Examples: Classical problems of synchronization.

Deadlocks: System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, recovery from deadlock.

Textbook 1: Chapter-6 (6.1-6.6), Chapter-7(7.1), Chapter-8(8.1,8.3 -8.8)

Module-4

9 Hours

Main Memory: Background, Contiguous memory allocation, Paging, Structure of page table, Swapping.

Virtual Memory: Background, Demand paging, Copy-on-write, Page replacement, Allocation of frames, Thrashing.

Textbook 1: Chapter -9(9.1-9.5), Chapter 10(10.1-10.6)

Module-5

9 Hours

File System Interface: File concept, Access methods, Directory structure. **File system Implementation:** File system structure, File system operations, Directory implementation, Allocation methods, Free space management. **Protection:** Goals of protection, Principles of protection, Domain of protection, Access matrix.

Textbook 1: Chapter-13(13.1-13.3) , Chapter-14(14.1-14.5), Chapter-17(17.1-17.2,17.4-17.5)

COURSE OUTCOMES

After successfully completing the course, the student will be able to:

CO1	Interpret and explain the interactions among operating system components, including kernel functions, system calls, and user interfaces, within typical system operations.
CO2	Apply CPU Scheduling algorithms and process synchronization mechanisms to manage concurrent execution.
CO3	Analyse memory management techniques such as paging and segmentation to optimize memory utilization.
CO4	Evaluate file system structures and I/O management strategies to enhance overall system performance.
CO5	Simulate key operating system functionalities and system-level tasks using software tools and utilities.



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ASSESSMENT AND EVALUATION

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Alternate Assessment (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE are 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

Textbooks

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, “ Operating System Concepts”, 9th Edition, Wiley-India, 2015.

Reference Books

1. P.C.P. Bhatt, “An Introduction to Operating Systems: Concepts and Practice”, 4th Edition, PHI(EEE), 2014.
2. William Stallings, “Operating Systems: Internals and Design Principles”, 6th Edition, Pearson.
3. A.S. Tanenbaum, H. Bos ,2014, “Modern Operating Systems”, 4th Edition, Prentice-Hall of India, New Delhi.



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Weblink

1. <https://pages.cs.wisc.edu/~remzi/OSTEP/>
2. <https://www.geeksforgeeks.org/operating-systems/>
3. https://www.tutorialspoint.com/operating_system/index.htm
4. <https://www.scaler.com/topics/operating-system/>
5. <https://www.youtube.com/watch?v=yK1uBHPdp30>
6. <https://www.youtube.com/watch?app=desktop&t=1s&v=dOiA2nNJpc0>

Activity-Based Learning

1. Quizzes
2. Assignments
3. Seminar

Self-Learning Topics

1. Virtual Machines
Study the concept of virtualization, including the architecture and functionality of virtual machines (VMs), and understand how VMs help in efficient resource utilization and system isolation.
2. Basic Linux Commands
Gain hands-on experience with essential Linux terminal commands used for file management, user permissions, process control, and system monitoring.
3. Multithreading Demonstration using Programming Languages Implement and compare multithreading concepts using:
 - a. Java – via Thread class and Runnable interface
 - b. Python – using the threading module
4. C Programming – using POSIX threads (pthreads) Overview of Different Operating Systems
Compare architecture, scheduling, memory management, and file systems across these OS types: Linux, Windows, Unix, Android, MacOS, iOS, RTOS, Chrome OS, Solaris, Haiku OS, TinyOS



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B.E. in Computer Science and Engineering
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	Introduction to DBMS		
Course Code	BCI654C	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is to facilitate the learner to:</i>			
1. Provide a strong foundation in database concepts, technology, and practice.			
2. Practice SQL programming through a variety of database problems.			
3. Understand the relational database design principles			
4. Apply normalization techniques to create well-structured relational database schemas.			
Module-1		9 Hours	
Introduction to Databases: Introduction, Characteristics of database approach, Actors on the Scene, Workers behind the Scene, Advantages of using the DBMS approach, Representing Complex Relationships among Data			
Overview of Database Languages and Architectures: Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment, Centralized and Client/Server Architectures for DBMSs, Classification of Database Management Systems.			
Textbook 1: Chapter 1(1.1 to 1.6.7), Chapter 2(2.1 to 2.4)			
Module-2		9 Hours	
Conceptual Data Modeling using Entities and Relationships: Entity Types, Entity Sets, Attributes, and Keys Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, Refining the ER Design for the COMPANY Database, ER Diagrams, Naming Conventions, and Design Issues, Relationship Types of Degree Higher than Two, Another Example: A UNIVERSITY Database.			
Textbook 1: Chapter 3 (3.3 to 3.7, 3.9 to 3.10)			
Module-3		9 Hours	
Mapping Conceptual Design into a Logical Design: Relational Database Design using ER-to-Relational mapping.			
Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations.			
Textbook 1: Chapter 9 (9.1 to 9.2), Chapter 5 (5.1 to 5.3)			



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Module-4	9 Hours
Relational Algebra: Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations: JOIN and DIVISION. additional relational operations (aggregate, grouping, etc.) Examples of Queries in relational algebra. SQL: SQL data definition and data types, Schema change statements in SQL, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL	
Textbook 1: Chapter 9 (8.1 to 8.5), Chapter 6 (6.1 to 6.5)	
Module-5	9 Hours
Basics of Functional Dependencies and Normalization for Relational Databases: Informal design guidelines for relation schema, Functional Dependencies , Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form.	
Textbook 1: Chapter 14 (14.1 to 14.7)	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the fundamental concepts, architecture, and components of Database Management Systems (DBMS).
CO2	Understand real-world problem scenarios by designing Entity-Relationship (ER) models.
CO3	Apply ER-to-relational mapping techniques to transform conceptual designs into logical database schemas. Analyze and use SQL queries for efficient database definition, creation, and data manipulation..
CO4	Apply relational algebra operations to formulate SQL statements for DDL and DML.
CO5	Evaluate relational schemas using functional dependencies and apply normalization to eliminate anomalies.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.



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Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks:

1. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, 7th ed. Boston, MA: Pearson, 2017. ISBN: 9780133970777.

Reference Books:

1. R. Ramakrishnan and J. Gehrke, *Database Management Systems*, 3rd ed. New York, NY: McGraw-Hill, 2014. ISBN: 9780072465631.
2. C. J. Date, A. Kannan, and S. Swamynathan, *An Introduction to Database Systems*, 8th ed. Noida, India: Pearson, 2006. ISBN: 9788131705674.

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar

Self – Study topics:

- 1) Advanced Queries: Specifying constraints as assertions and action triggers, Views.
- 2) NOSQL Databases, Document-Based NOSQL Systems and MongoDB
- 3) Column-Based NOSQL Systems and Graph Databases.
- 4) Transaction Processing, Concurrency Control, and Recovery



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Department of Computer
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Autonomous Scheme (Effective
from Academic Year 2024 – 25)



B.E. in Computer Science and Engineering
Outcome Based Education (OBE) and Choice Based Credit System(CBCS)
SEMESTER – VI

Course Title	Foundations of Data Science		
Course Code	BCD654D	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours / Sem)	SEE MARKS	50
Credits	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Understand the fundamental concepts of data science. - Explain statistical and probabilistic concepts for data-driven decision making. - Apply the data science methodology and analytics life cycle to solve real-world problems. - Analyse and implement core machine learning techniques. - Explore and apply text mining and basic natural language processing techniques.			
Module-1			9 Hours
Importance of Data Science: Importance of Data Science, Need for Data Science, What Is Data Science, Data Science Process, Business Intelligence and Data Science, Prerequisites for a Data Scientist, Components of Data Science, Tools and Skills Needed. Data Science Tool: Basics of Python for Data Science, Python Libraries: DataFrame Manipulation with pandas and NumPy Textbook 1: Chapter- 1 (1.1-1.8), Chapter- 7 (7.1-7.2)			
Module-2			9 Hours
Statistics and Probability: Data Types, Variable Types, Statistics, Sampling Techniques and Probability, Information Gain and Entropy, Probability Theory, Probability Types, Probability Distribution Functions, Bayes' Theorem, Inferential Statistics. Textbook 1: Chapter- 2 (2.1-2.11)			
Module-3			9 Hours
Data Science Methodology: Analytics for Data Science, Examples of Data Analytics, Data Analytics Life Cycle: Data Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, operationalization. Textbook 1: Chapter - 4 (4.1-4.4)			
Module-4			9 Hours
Data Science Methods and Machine Learning: Regression Analysis, Linear Regression, Logistic regression, Multimodal logistic regression, Time-series model, Machine Learning: Decision trees, naive bayes, support vector, machines, nearest neighbour learning, clustering, Confusion matrix. Textbook 1: Chapter- 5 (5.1-5.3)			



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Module-5	9 Hours
Data Analysis and Text Mining: Text Analytics: Text analytics subtasks, Cleaning and parsing, searching and retrieval, Text mining, Part-of-speech tagging, Stemming, Lemmatization, Basic text analysis steps, Introduction to Natural Language Processing.	
Textbook-1: Chapter 6 (6.1-6.4)	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the fundamental concepts of Data Science, including its importance, process, components, and the role of SQL in data analysis and decision-making.
CO2	Apply statistical methods, probability distributions, and Bayes' Theorem to analyze data types and calculate metrics like Entropy and Information Gain.
CO3	Execute the Data Analytics Life Cycle, from initial data discovery and preparation to model building and the operationalization of results.
CO4	Analyze model performance using evaluation metrics such as the confusion matrix and interpret the results to assess predictive accuracy.
CO5	Demonstrate the ability to use basic Natural Language Processing (NLP) techniques and tools for real-world text analysis applications.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.



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- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.

Textbooks:

1. **Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare,** “Fundamentals of Data Science”, 1st Edition, CRC press, 2021.

Reference Books:

1. **Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani,** “An Introduction to Statistical Learning: with Applications in R”, Springer, 1st edition, 2013
2. **Peter Bruce, Andrew Bruce,** “Practical Statistics for Data Scientists”, 2017, O'Reilly
3. **Cathy O Neil, Rachel Schutt,** “Doing Data Science-Straight Talk from the Frontline”, O'Reilly Media, 2013.

Web links:

1. [https://www.udemy.com/course/data-science-for-the-beginner/?couponCode= PMNVD2025](https://www.udemy.com/course/data-science-for-the-beginner/?couponCode=PMNVD2025)
2. <https://www.oreilly.com/library/view/doing-data-science/9781449363871/toc01.html>
3. <https://docs.python.org/3/tutorial/>
4. npTEL.ac.in/courses/106106212

Self-Study Topics:

1. Difference between Data Science vs Business Intelligence vs AI
2. Central Limit Theorem (intuitive understanding)
3. CRISP-DM vs Data Analytics Life Cycle
4. Comparison of ML algorithms and analyze datasets.



B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title:	Advanced Machine Learning Lab		
Course Code:	BCIL606	CIE MARKS	50
L: T: P	0:0:2	SEE MARKS	50
Credits:	1	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Provide foundational knowledge of neural networks 2. Introduce deep learning architectures 3. Develop understanding of sequential and probabilistic learning models. 4. Introduce reinforcement learning concepts 5. Enable the application of deep learning techniques in real-world intelligent systems and problem-solving.			
Program 1			
Design and implement a three-layer feedforward neural network for classification task and compare its performance with a single-layer neural network using accuracy and loss measures.			
Program 2			
Design and implement a gradient-based learning algorithm for training a neural network. Analyse and compare the effect of different learning rates on the convergence behaviour of the network using appropriate performance metrics.			
Program 3			
Design and implement a convolutional neural network with convolution, pooling, and fully connected layers to perform image classification on a benchmark dataset.			
Program 4			
Develop a program to visualize feature maps extracted from the convolution layers of a trained convolutional neural network.			
Program 5			
Design and implement a standard Convolutional Neural Network (CNN) for image classification. Train the CNN using different optimization techniques and compare their performance based on convergence speed, training loss, and classification accuracy.			
Program 6			
Write a program to enable pre-train models to classify a given image dataset.			
Program 7			
Implement a long short-term memory (LSTM) network for forecasting univariate time-series data and evaluate prediction error.			



Program 8
Design and implement a Naïve Bayes Classifier for text classification and evaluate its performance.
Program 9
Design and implement a Bayesian Belief Network (BBN) for probabilistic reasoning under uncertainty.
Program 10
Design and implement a two-dimensional grid-world environment where an agent learns to reach a goal while avoiding obstacles.
Program 11
Design and implement a reinforcement learning model for autonomous navigation and evaluate its performance using cumulative rewards.
Program 12
Develop a Python program to implement the Q-Learning algorithm for solving a simple navigation problem, where the agent learns the optimal path using reward feedback.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Design and implement neural network models and evaluate their performance using appropriate metrics.
CO2	Apply deep learning techniques such as CNNs, feature map visualization, and pre-trained models for image classification tasks.
CO3	Analyze and implement sequential and probabilistic models including LSTM for time-series forecasting and Bayesian learning methods
CO4	Develop reinforcement learning solutions including grid-world environments and Q-learning for decision-making and navigation tasks.
CO5	Evaluate and compare different learning algorithms and optimization techniques based on accuracy, convergence behavior, and computational performance.

ASSESSMENT AND EVALUATION REGULATIONS OF PCCL

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.



Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C .
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Weblinks:

- Coursera – Deep Learning Specialization:
<https://www.coursera.org/specializations/deep-learning>
- DeepLearning.AI – Practical Deep Learning Courses -
<https://www.deeplearning.ai>
- TensorFlow Tutorials - <https://www.tensorflow.org/tutorials>
- PyTorch Tutorials - <https://pytorch.org/tutorials>
- OpenAI Gym-<https://gym.openai.com>

Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning Mini Project:

Case Study Discussion

- Study real-world applications of CNN (medical imaging, agriculture)

Reinforcement Learning Simulation

- Simulate a grid-world problem manually
- Students act as agents and learn reward-based decisions



B.E. in Computer Science and Engineering (AI & ML)
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SEMESTER – VI

Course Title	UI/UX Lab		
Course Code	BCIL657A	CIE MARKS	50
L :T : P	0:0:2	SEE MARKS	50
Credits	01	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Explore and understand the nuances of User Experience and User Interface. 2. Gain mastery over the usage of Figma for designing and prototyping UI/UX. 3. Understand user requirement and translate it into UI/UX prototype. 4. Analyse apps and websites and understand how they can be continually improved. 5. Understand the UI components and interactions being used in different apps and websites			
Program 1			
Getting Started - Figma. Chat App Redesign: Create a Wireframe and redesign any popular chat app.			
Program 2			
Food App: Create a wireframe, Design and Prototype the UI Pages for the food application.			
Program 3			
Social Media App: Create a wireframe, Design and Prototype social media photo sharing app.			
Program 4			
Product Website: Design and prototype a product website page. Create web pages and rollovers for the web pages.			
Program 5			
Travel Agency Website: Create a wireframe, Design and prototype the UI for the website including design for Home Page with search bar, Activities page, Client Testimonial Page, Image Gallery.			



Program 6
UI/UX Designer Portfolio Design: Create a wireframe, Design and prototype a UI for a portfolio including design for About page, Work showcase page, Blog page, contact page.
Program 7
Dashboard Design: Create a wireframe, Design and Prototype Dashboard UI page, add some Dashboard details, statistics and graphs, Add dropdown options for some dashboard details
Program 8
E-Commerce Website: Create a wireframe, Design and prototype Web pages including product category pages (example: mobiles, gaming consoles, Speakers), product pages in each category, buy now page, add to cart page.
Program 9
Educational Website: Create a wireframe, Design and Prototype the UI for an educational website – Include a Homepage with footer, About Us Page, Programs page, Instructors page, Pricing page, Payment's page with radial buttons. Design dropdowns for programs button.
Program 10
Music Player App: Create a wireframe, Design and prototype the pages with a background and a Rollover button, and Song selection Page with a Home Rollover button. The third page may include animated play and pause button, play music animation, timer animation.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Apply the basics of wireframing in designing apps and Websites.
CO2	Make use of Figma for designing and prototyping UI/UX for different types of apps and Websites.
CO3	Analyse user requirements and translate the requirements to design prototypes.
CO4	Demonstrate the UI/UX concepts applied when designing the prototype of apps and Websites.
CO5	Develop (redesign) the existing apps & Websites with customized design.



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ASSESSMENT DETAILS (Both CIE and SEE) - 1-Credit Lab Course

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

Suggested Learning Resources:

1. <https://www.figma.com/>
2. UX Programming for Beginners, August, 2022
3. <https://www.udemy.com/course/learn-figma-web-design>
4. <https://www.udemy.com/course/figma-2023-master-class-realtime-uiux-web-projects>



B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	Dev Ops		
Course Code	BCIL657B	CIE MARKS	50
L: T: P	0:0:2	SEE MARKS	50
Credits	01	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Introduce DevOps terminology, definition and concepts 2. Understand the different Version control tools like Git, Mercurial 3. Understand the concepts of continuous Integration/ Continuous Testing/ Continuous deployment 4. Understand Configuration management using Ansible 5. Illustrate the benefits and drive the adoption of cloud-based DevOps tools to solve real world problems			
Program 1			
Build Automation Fundamentals: Study the role of build automation (Maven, Gradle & Build Tool Ecosystem): Explore the build tools ecosystem, compare Maven and Gradle, installation, Introduction to build Lifecycle and Repositories.			
Program 2			
Maven Build Automation: Create a Java project using Maven. Analyze the structure of a Maven project, configure the POM file, Dependency Management, Plugins, Multi-Module projects.			
Program 3			
Gradle-Based Build System: Develop a Gradle Project, Write build scripts using Groovy/Kotlin DSL, Tasks & Dependency Resolution, Using Gradle Wrapper to ensure build consistency across environments.			
Program 4			
Build Exercise: Build and execute a Java application using Maven. Migrate the same project and optimize the build process using Gradle.			
Program 5			
Continuous Integration(CI) concepts and Jenkins Overview: Understand Continuous Integration(CI) concepts, Install Jenkins on a local or cloud environment, Overview of plugins, Initial Setup and Global Configuration.			



Program 6
CI Pipeline Automation using Jenkins: Setup a Jenkins-based CI pipeline. Integrate Code Repositories, Run Automated Builds and Tests, Code Quality Tools such as Checkstyle/PMD.
Program 7
Configuration Management with Ansible : Introduction to Ansible Inventories, Playbooks, Modules, Automating server Configurations, Writing and Executing Playbooks.
Program 8
Exercise: CI/CD Integration and Artifact Management : SetUp Jenkins pipeline using Maven, Deploy Artifacts with Ansible, Introduction to Artifact Repositories (Nexus/Artifactory).
Program 9
Azure DevOps Platform Overview : Study Azure DevOps services and components. Create projects, manage repositories, configure pipelines, use boards for work tracking, and understand artifact management in Azure DevOps.
Program 10
Build Pipelines using Azure DevOps : Create build pipelines for Java applications using Maven or Gradle. Integrate GitHub or Azure Repos, execute automated tests, and publish build artifacts within Azure DevOps.
Program 11
Release Pipelines and Deployment: Deploy Apps to Azure App Services, Manage Secrets Using Azure Key Vault, Hands-on Continuous Deployment and Basic Application Monitoring using Logs and Health Checks.
Program 12
Integrated DevOps Pipeline and Review: Design and demonstrate a complete CI/CD pipeline integrating build, test, and deployment stages. Compare Azure Pipelines with GitHub Actions and discuss DevOps best practices and Q/A.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate different actions performed through Version control tools like Git.
CO2	Perform continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle.
CO3	Experiment with configuration management using Ansible.
CO4	Demonstrate Cloud-based DevOps tools using Azure DevOps.



CO5	Apply containerization and orchestration techniques using Docker and Kubernetes for scalable application deployment.
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ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 2 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

- <https://www.geeksforgeeks.org/devops-tutorial/>
- <https://www.javapoint.com/devops>
- <https://www.youtube.com/watch?v=2N-59wUIPVI>
- <https://www.youtube.com/watch?v=87ZqwoFe088>



B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	GEN AI		
Course Code	BCIL657C	CIE MARKS	50
(L :T : P)	(0:0:2)	SEE MARKS	50
Credits	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the principles and concepts behind generative AI models 2. Explain the knowledge gained to implement generative models using Prompt design frameworks. 3. Apply various Generative AI applications for increasing productivity. 4. Develop Large Language Model-based Apps.			
PROGRAM 1			
Explore pre-trained word vectors. Explore word relationships using vector arithmetic. Perform arithmetic operations and analyze results.			
PROGRAM 2			
Use dimensionality reduction (e.g., PCA or t-SNE) to visualize word embeddings for Q1. Select 10 words from a specific domain (e.g., sports, technology) and visualize their embeddings. Analyze clusters and relationships. Generate contextually rich outputs using embeddings. Write a program to generate 5 semantically similar words for a given input.			
PROGRAM 3			
Train a custom Word2Vec model on a small dataset. Train embeddings on a domain-specific corpus (e.g., legal, medical) and analyze how embeddings capture domain-specific semantics.			
PROGRAM 4			
Use word embeddings to improve prompts for Generative AI model. Retrieve similar words using word embeddings. Use the similar words to enrich a GenAI prompt. Use the AI model to generate responses for the original and enriched prompts. Compare the outputs in terms of detail and relevance.			
PROGRAM 5			
Use word embeddings to create meaningful sentences for creative tasks. Retrieve similar words for a seed word. Create a sentence or story using these words as a starting point. Write a program that: Takes a seed word. Generates similar words. Constructs a short paragraph using these words.			



PROGRAM 6
Use a pre-trained Hugging Face model to analyze sentiment in text. Assume a real-world application, Load the sentiment analysis pipeline. Analyze the sentiment by giving sentences to input.
PROGRAM 7
Summarize long texts using a pre-trained summarization model using Hugging face model. Load the summarization pipeline. Take a passage as input and obtain the summarized text.
PROGRAM 8
Install langchain, cohere (for key), langchain-community. Get the api key (By logging into Cohere and obtaining the cohere key). Load a text document from your google drive . Create a prompt template to display the output in a particular manner.
PROGRAM 9
Take the Institution name as input. Use Pydantic to define the schema for the desired output and create a custom output parser. Invoke the Chain and Fetch Results. Extract the below Institution related details from Wikipedia: The founder of the Institution. When it was founded. The current branches in the institution . How many employees are working in it. A brief 4-line summary of the institution.
PROGRAM 10
Build a chatbot for the Indian Penal Code. We'll start by downloading the official Indian Penal Code document, and then we'll create a chatbot that can interact with it. Users will be able to ask questions about the Indian Penal Code and have a conversation with it.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

C01	Analyze and visualize word embeddings using vector representations, similarity measures, and dimensionality reduction techniques to understand semantic relationships between words.
C02	Apply prompt engineering techniques for real-world natural language processing tasks such as information retrieval, text generation, and question answering.
C03	Utilize pre-trained Hugging Face models for practical applications including sentiment analysis, text summarization, and language understanding tasks.
C04	Examine the architectures of Large Language Models (LLMs), including transformers, and evaluate their advantages, limitations, and applications.
C05	Develop and implement NLP-based applications using Large Language Models for intelligent text processing and conversational AI systems.



ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 2 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources: Books:

1. Modern Generative AI with ChatGPT and OpenAI Models: Leverage the Capabilities of OpenAI's LLM for Productivity and Innovation with GPT3 and GPT4, by Valentina Alto, Packt Publishing Ltd, 2023.
2. Generative AI for Cloud Solutions: Architect modern AI LLMs in secure, scalable, and ethical cloud environments, by Paul Singh, Anurag Karuparti, Packt Publishing Ltd, 2024.

Web links and Video Lectures (e-Resources):

- https://www.w3schools.com/gen_ai/index.php
- <https://youtu.be/eTPiL3DF27U>



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI

Course Title	Video Analytics using Open GL		
Course Code	BCIL657D	CIE MARKS	50
(L :T : P)	(0:0:2)	SEE MARKS	50
Credits	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Set up and execute OpenGL-based programs for video frame capture and display. 2. Apply image filtering and feature extraction techniques hands-on using GPU shaders. 3. Implement and test motion detection, optical flow, and object tracking algorithms on real video data. 4. Build and demonstrate a mini video analytics application integrating multiple pipeline stages. 5. Evaluate and document the performance of video analytics solutions through structured lab experiments			
Set – 1 : Exercise			
Environment Setup and Image Fundamentals – • Setting up the OpenGL development environment (GLFW, GLEW, OpenCV). • Writing the first OpenGL program: window creation and render loop. • Loading and displaying video frames as OpenGL textures. • Pixel-level operations: brightness, contrast, and channel manipulation. • Implementing 2D convolution on image data. • Hands-on exercises: grayscale conversion, histogram computation, and pixel statistics on live or recorded video. Textbook 1 - Chapters 1-2, Textbook 3 - Chapters 1-2			
Set – 2 : Exercise			
Lab: OpenGL Rendering Pipeline and Shader Programming- • Writing and compiling vertex and fragment shaders using GLSL. • Passing video frame data as uniform textures to shaders. • Implementing geometric transformations on video frames (scale, rotate, translate). • Using framebuffer objects (FBOs) for off-screen rendering. • Lab exercises: multi-pass rendering pipeline, blending and masking operations, shader-based color space conversion (RGB to HSV/YUV). Textbook 1 - Chapters 3-4, 8			
Set – 3 : Exercise			
Lab: GPU-Based Image Filtering and Feature Extraction- • Implementing Gaussian blur and Sobel edge detection as GLSL fragment shaders. • Canny edge detection pipeline on video frames using OpenGL.			



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- Harris corner detection and keypoint visualization.
- Implementing histogram equalization and adaptive thresholding via shaders.
- Lab exercises: real-time filter comparison (Gaussian vs. bilateral), feature point overlay on live video, texture-based lookup table (LUT) for tone mapping.

Textbook 1 - Chapters 9-10, Textbook 3 - Chapter 3

Set – 4 : Exercise

Lab: Motion Detection, Optical Flow and Object Tracking-

- Frame differencing and background subtraction (MOG2) implementation.
- Dense and sparse optical flow using Lucas-Kanade method visualized with OpenGL overlays.
- Feature-based tracking: implementing KLT tracker with OpenGL display.
- Kalman filter integration for trajectory smoothing.
- Lab exercises: motion heatmap generation, object trajectory plotting, multi-object count in surveillance video clips.

Textbook 2 - Chapters 8-9

Set – 5 : Exercise

Lab: End-to-End Video Analytics Application Development-

- Integrating the full pipeline: capture, preprocess, detect, track, and annotate. Implementing a real-time pedestrian detection and counting system using OpenGL and OpenCV.
- Performance profiling: measuring frame rate, latency, and GPU utilization. Exporting annotated video output with bounding boxes and analytics overlays.
- Mini-project: designing and demonstrating a custom video analytics application (e.g., traffic monitoring, crowd density estimation, or fall detection).

Textbook 2 - Chapters 12-14

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Set up an OpenGL development environment and implement basic video frame loading, display, and pixel-level operations.
CO2	Write GLSL vertex and fragment shaders to perform GPU-based geometric transformations and multi-pass rendering on video data.
CO3	Implement real-time image filtering and feature extraction pipelines (Gaussian, Sobel, Harris, Canny) using OpenGL shaders.
CO4	Develop motion detection, optical flow, and object tracking solutions with OpenGL-based visualization overlays.
CO5	Design and demonstrate an end-to-end real-time video analytics application integrating detection, tracking, and annotated output generation.



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ASSESSMENT DETAILS (Both CIE and SEE)			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – Lab Tests (A)	30	-	Two lab tests each of 50 marks shall be conducted. Average of the two tests scaled down to 30 marks.
Continuous Assessment – Lab Records and Viva (B)	20	-	Lab record submission, weekly viva-voce, and mini-project demonstration, scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	20	SEE is a practical exam conducted for 50 marks. Exam duration shall be 2 hours. Students execute a lab program and present results with viva.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks:

1. Dave Shreiner, Graham Sellers, John Kessenich, and Bill Licea-Kane, *OpenGL Programming Guide*, 9th Edition, Addison-Wesley Professional, 2016, **ISBN: 978-0134495491**.
2. Richard Szeliski, *Computer Vision: Algorithms and Applications*, 2nd Edition, Springer, 2022, **ISBN: 978-3031343773**.
3. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, 4th Edition, Pearson, 2018, **ISBN: 978-0133356724**.

Reference Books:

1. Jason L. McKesson, *Learning Modern 3D Graphics Programming*, 1st Edition, Self-Published, 2012, **ISBN: N/A (Online Edition)**.
2. Gary Bradski and Adrian Kaehler, *Learning OpenCV: Computer Vision with the OpenCV Library*, 1st Edition, O'Reilly Media, 2008, **ISBN: 978-0596516130**.
3. Alan Watt, *3D Computer Graphics*, 3rd Edition, Addison-Wesley, 2000, **ISBN: 978-0201398557**.



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Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Weekly lab exercises with structured observation and result recording
- Viva-voce at the end of each lab session
- Mini-project: end-to-end video analytics application development and demonstration
- NPTEL Swayam / Coursera / Infosys Springboard online lab supplements
- Peer review of lab records and mini-project outputs

Self-Study Topics

- **OpenGL Environment and GLSL Shader Basics**
Installing and configuring GLFW, GLEW, and OpenCV; understanding the GLSL compilation and linking pipeline; studying shader variable types and built-in functions.
- **Image Processing Theory Supporting Lab Experiments**
Mathematical foundations of convolution, Fourier transforms for filtering, edge detection theory (Canny, Sobel, Harris), and color space transformations.
- **Motion Estimation and Tracking Algorithms**
Lucas-Kanade optical flow derivation, background subtraction models (MOG2, KNN), Kalman filter state-space formulation, and Hungarian algorithm for multi-object association.
- **Performance Optimization for Real-Time Video Processing**
GPU memory management, texture formats and compression, pipeline bottleneck analysis, and techniques for maintaining target frame rates in real-time analytics systems.
- **Emerging Tools and Frameworks**
Introduction to CUDA for GPU-accelerated vision, OpenCL portability, and modern alternatives to classic OpenGL pipelines (Vulkan, WebGPU) for video analytics.



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**B.E. (Common to CSE & Allied Branches)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VI**

Course Title	Computer Networks		
Course Code	BCIL657E	CIE MARKS	50
(L: T: P) + SL	0:0:2	SEE MARKS	50
Credits	1	EXAM HOURS	2

COURSE LEARNING OBJECTIVES:

The purpose of the course is to facilitate the learner to:

- 1: Introduce fundamental concepts of computer networks through practical implementation and simulation.
- 2: Familiarize students with network communication concepts including transmission, routing, congestion control, and addressing mechanisms.
- 3: Develop proficiency in implementing network protocols and socket-based communication applications.
- 4: Enable students to analyze network performance using simulation and packet analysis tools.
- 5: Provide hands-on experience in developing and evaluating basic networking and network security applications.

Implement the following program using any one of the programming languages: C++, Java or Python

Experiment 1.

Study and analyze basic networking utilities such as **ping, traceroute, netstat, ifconfig/ipconfig, and nslookup**, and capture network packets using a protocol analyzer.

Experiment 2.

Develop and simulate any one of the following network scenarios:

- a) Create a Local Area Network (LAN) consisting of three or more nodes and demonstrate communication between connected devices.
- b) Create a Star Topology network consisting of three or more nodes and observe packet transmission between nodes.
- c) Create a Wireless Local Area Network (WLAN) using two Access Points and demonstrate communication between wireless devices.
- d) Create a simple network consisting of one router and multiple end devices and observe data transmission.

Experiment 3.

Write a program to perform **DNS name and address conversion** using different functions for different sets of DNS records.

Experiment 4.

Simulate the transmission of **ping and traceroute messages** over a network topology and analyze packet transmission and congestion behaviour.

Experiment 5.

Develop and simulate a **three-node point-to-point network with duplex links**, vary the queue size and bandwidth, and determine the number of packets dropped.



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Experiment 6.

Design and implement an **Ethernet LAN using multiple nodes**, generate network traffic, and observe congestion window behaviour.

Experiment 7.

Develop a program to implement **error detection using the CRC–CCITT (16-bit) technique**.

Experiment 8.

Develop a program to simulate the **Sliding Window Protocol** for reliable data transmission in the Data Link Layer.

Experiment 9.

Develop a program to determine the **shortest path between vertices using the Bellman–Ford routing algorithm**.

Experiment 10.

Develop a **client–server application using UDP sockets** to transmit and display messages between communicating systems.

Experiment 11.

Develop a **client–server application using TCP sockets** to request and transfer file contents between systems.

Experiment 12.

Develop a program to implement **congestion control using the Leaky Bucket Algorithm**.

Experiment 13.

Develop a program to implement a **simple RSA algorithm for encryption and decryption of data**.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand fundamental concepts of computer networks and network communication principles.
CO2	Apply routing, addressing, and transmission control concepts to solve networking problems.
CO3	Develop client–server applications and implement network protocols using programming techniques.
CO4	Analyze network behaviour and evaluate performance using simulation and packet analysis tools.
CO5	Design and implement basic network security and congestion control mechanisms.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.



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CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Suggested Learning Resources:

- Behrouz A. Forouzan, *Data Communications and Networking*, McGraw Hill, 5th Edition.
- Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, Pearson, 5th Edition.
- Kurose and Ross, *Computer Networking: A Top-Down Approach*, Pearson, 8th Edition.
- NS3 Documentation and User Guide.
- Java Socket Programming Documentation.



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VII SEMESTER SUBJECTS



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	Foundational AI Models		
Course Code	BCI701	CIE MARKS	50
(L : T : P) + SL	(3:0:2) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Introduce the concept and evolution of foundational AI models. 2. Understand architectures behind large-scale AI models such as transformers. 3. Learn training strategies, datasets, and scaling laws used in foundation models. 4. Explore applications such as NLP, vision, and multimodal AI systems. 5. Provide hands-on exposure to fine-tuning and deploying pretrained models.			
Module-1			9 Hours
1. Introduction to Building AI Applications with Foundation Models: Introduction to Building AI Applications with Foundation Models, Foundation Model Use Cases, Planning AI Applications, The AI Engineering Stack.			
Textbook 1: Chapter 1 (1.1 to 1.4)			
Module-2			9 Hours
Understanding Foundation Models.: Training Data, Multilingual Models, Domain-Specific Models, Model Architecture, Model Size, Post-Training, Supervised Finetuning, Preference Finetuning, Sampling Fundamentals, Sampling Strategies, Test Time Compute, Structured Outputs, The Probabilistic Nature of AI.			
Textbook 1: Chapter 2 (2.1 to 2.4)			
Module-3			9 Hours
Evaluation Methodology: Challenges of Evaluating Foundation Models, Understanding Language Modelling Metrics, Entropy, Cross Entropy, Bits-per-Character and Bits-per-Byte, Perplexity, Perplexity Interpretation and Use Cases, Exact Evaluation, Functional Correctness, Similarity Measurements Against Reference Data, AI as a Judge, Ranking Models with Comparative Evaluation.			
Textbook 1: Chapter 3 (3.1 to 3.5)			



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Module-4	9 Hours
Prompt Engineering: Introduction to Prompting, In-Context Learning: Zero-Shot and Few-Shot, System Prompt and User Prompt, Context Length and Context Efficiency, Prompt Engineering Best Practices, Write Clear and Explicit Instructions, Provide Sufficient Context, Break Complex Tasks into Simpler Subtasks, Give the Model Time to Think, Iterate on Your Prompts, Evaluate Prompt Engineering Tools, Organize and Version Prompts, Defensive Prompt Engineering, Proprietary Prompts and Reverse Prompt Engineering, Jailbreaking and Prompt Injection, Information Extraction, Defences Against Prompt Attacks.	
Textbook1: Chapter 5 (5.1 to 5.3)	
Module-5	9 Hours
Retrieval-Augmented Generation (RAG) and Agents: RAG Architecture, Retrieval Algorithms, Retrieval Optimization, RAG Beyond Texts, Agents, Agent Overview, Tools, Planning, Agent Failure Modes and Evaluation, Memory	
Textbook 1: Chapter 6 (6.1 to 6.3)	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
1	Lab 1 – Sentiment Analysis for Product Reviews Scenario: An e-commerce company wants to automatically analyze customer reviews to understand whether feedback is positive or negative. Task: Build a sentiment analysis model using BERT to classify Amazon/Flipkart product reviews. Expected Outcome: Predict whether a review is Positive / Negative.
2	Lab 2 – Tokenization Analysis for Indian Languages Scenario: A company is building a chatbot that supports English + Kannada + Hindi. Task: Compare WordPiece, BPE, SentencePiece tokenization for multilingual text. Expected Outcome: Analyze token counts and efficiency for Indian languages.
3	Lab 3 – Resume Screening using Embeddings Scenario: HR wants to shortlist resumes based on job description similarity. Task: Convert resumes and job descriptions into embeddings and compute similarity. Expected Outcome: Rank resumes based on similarity score.
4	Lab 4 – Prompt Engineering for Email Summarization Scenario: A manager receives long emails and wants automatic summaries. Task: Use zero-shot and few-shot prompting to summarize emails. Expected Outcome: Compare summary quality for different prompts.
5	Lab 5 – Spam Detection using Fine-Tuning Scenario: A company wants to detect spam emails automatically. Task: Fine-tune DistilBERT on spam/ham dataset. Expected Outcome: Build a spam classifier.



6	Lab 6 – Named Entity Recognition for News Articles Scenario: A news agency wants to extract names of people, locations, and organizations automatically. Task: Use NER model to extract entities from news text. Expected Outcome: Identify entities like Person, Location, Organization.
7	Lab 7 – Question Answering for College Website Scenario: Students ask questions like “What is the fee for CSE?”, “What is the placement percentage?” Task: Build a QA system using a college FAQ document. Expected Outcome: System answers questions from given document.
8	Lab 8 – RAG for University Regulations Scenario: Students ask questions from VTU/AICTE regulations PDF. Task: Build a RAG system that retrieves relevant regulation text and generates answers. Expected Outcome: Accurate answers from documents.
9	Lab 9 – Text Generation for Report Writing Scenario: Automatically generate a project abstract from project title. Task: Use GPT to generate project abstracts. Expected Outcome: Generate meaningful academic text.
10	Lab 10 – AI Agent for Student Assistant Scenario: Build a Student Assistant that can: • Answer questions • Calculate CGPA • Search Wikipedia • Summarize PDF notes Task: Build an AI agent using tools (calculator + search + summarizer). Expected Outcome: Multi-tool AI assistant.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the concept and evolution of foundation models.
CO2	Understand transformer architectures and attention mechanisms.
CO3	Apply pretrained models for NLP and computer vision tasks.
CO4	Implement fine-tuning and prompt engineering techniques.
CO5	Evaluate RAG models.

ASSESSMENT AND EVALUATION REGULATIONS OF IPCC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.



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Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.			

Textbook

1. Chip Huyen, *AI Engineering: Building Applications with Foundation Models*, 1st Edition, O'Reilly Media, 2025, **ISBN: 978-1098166304**.

Reference Books

1. Jeff Prorise, *Applied Machine Learning and AI for Engineers*, 1st Edition, O'Reilly Media, 2022, **ISBN: 978-1492098058**.
2. Jay Alammar and Maarten Grootendorst, *Hands-On Large Language Models*, 1st Edition, O'Reilly Media, 2024, **ISBN: 978-1098150969**.

Web links and e-learning resources:

- <https://professional.du.edu/content/aws-academy-generative-ai-foundations>
- <https://bootcamp.engin.umich.edu/certifications/ai-and-machine-learning-course>

Self – Study topics:

- The Transformer Revolution & Attention Mechanics
- Large Language Model (LLM) Pre-training & Scaling
- Alignment & Post-Training Fine-Tuning
- Latent Diffusion & Multimodal Models and LLM-Ops



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Activity Based Learning

- Flipped Classroom
- Student Seminars
- Project Based Learning



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	AI System Engineering		
Course Code	BCI702	CIE MARKS	50
(L : T : P) + SL	(3:0:2) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: After completing this course, the learner will be able to: 1. Understand the architecture and system-level design of AI systems for model deployment and inference. 2. Analyze hardware architectures such as CPU, GPU, TPU, SoC and AI accelerators used for AI workloads. 3. Apply AI deployment frameworks and model optimization techniques for efficient inference. 4. Design scalable edge-to-cloud AI deployment pipelines for real-world applications. 5. Evaluate the performance, scalability, and energy efficiency of AI systems across diverse deployment environments.			
Module-1			9 Hours
Foundations of AI System Engineering: Introduction to AI systems engineering, AI system lifecycle, training Vs inference workflow, system architecture for AI applications, production challenges in AI systems, model serving architectures, edge-to-cloud AI systems, scalability challenges in AI deployment. Textbook 1: Chapter 1 (1.1–1.4), Chapter 2 (2.1–2.4)			
Module-2			9 Hours
Hardware Platforms for AI Inference: Overview of AI hardware architectures, CPU-based inference systems, GPU acceleration for deep learning workloads, Tensor Processing Units (TPU), System-on-Chip (SoC) architectures, Neural Processing Units (NPU), specialized AI accelerators for edge devices, hardware–software co-design considerations. Textbook 2: Chapter-1 (1.1–1.4), Chapter-2 (2.1–2.3)			
Module-3			9 Hours
AI Model Deployment Frameworks: AI deployment frameworks and tools, PyTorch inference frameworks, TorchScript and ONNX export formats, portability and interoperability of AI models, containerized AI deployments, scalable AI deployment strategies in cloud platforms. Textbook 1: Chapter 3 (3.1–3.4), Chapter 4 (4.1–4.3)			



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Module-4	9 Hours
AI Model Optimization for Efficient Inference: Model pruning techniques, quantization strategies, model compression approaches, hardware-aware optimization techniques, trade-offs between accuracy, latency, and efficiency, benchmarking AI inference performance. Textbook 1: Chapter 7 (7.1–7.4)	
Module-5	9 Hours
Edge AI and Large-Scale AI Systems: Edge intelligence and embedded AI systems, TinyML for constrained devices, AI inference pipelines on edge platforms, real-time AI inference systems, benchmarking AI performance, inference considerations at data center scale, large language model (LLM) deployment challenges. Textbook 2: Chapter 4 (4.1–4.4), Chapter 5 (5.1–5.4)	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
PART A	
1	Installation and configuration of NVIDIA Jetson platform
2	CUDA programming and GPU acceleration basics
3	GPU-accelerated image processing using OpenCV
4	Edge-based object detection using YOLO / SSD
5	Inference optimization using TensorRT
6	Real-time video analytics on edge devices
PART B	
7	Performance profiling and power analysis .
8	Edge-to-cloud communication using MQTT / REST
9	Mini Project: Smart Surveillance
10	Mini Project: Health care Solutions.



OPEN ENDED EXPERIMENTS

1	Design and implement an edge-to-cloud AI deployment pipeline for a real-world application.
2	Implement an AI-powered real-time application such as object detection on an embedded device.
3	Analyze and compare model optimization techniques (quantization, pruning, compression) on performance and accuracy.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the fundamental concepts of AI system architecture, model deployment pipelines, and AI inference workflows.
CO2	Analyze hardware architectures such as CPU, GPU, TPU, SoC, and AI accelerators used for AI model inference.
CO3	Evaluate AI deployment frameworks, model portability techniques, and scalable AI infrastructure.
CO4	Apply model optimization techniques such as pruning, quantization, and compression to improve AI inference efficiency.
CO5	Design and implement AI inference pipelines for edge devices and cloud-based AI systems.

ASSESSMENT AND EVALUATION REGULATIONS OF IPCC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.



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CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.			

Textbooks

1. Chip Huyen, *Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications*, 1st Edition, O'Reilly Media, 2022, **ISBN: 978-1098107963**.
2. Pete Warden and Daniel Situnayake, *TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Devices*, 1st Edition, O'Reilly Media, 2019, **ISBN: 978-1492052043**.

Reference Books

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 3rd Edition, O'Reilly Media, 2022, **ISBN: 978-1098125974**.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, 1st Edition, MIT Press, 2016, **ISBN: 978-0262035613**.
3. David A. Patterson and John L. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*, 5th Edition, Morgan Kaufmann, 2017, **ISBN: 978-0124077263**.



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Web Resources for Further Learning

1. **NPTEL Online Course – Machine Learning and AI Systems**

<https://onlinecourses.nptel.ac.in/>

2. **Coursera – MLOps and AI Deployment Courses**

<https://www.coursera.org/>

Self-Study Topics

- **Analyze** the impact of model quantization and pruning techniques on AI inference performance.
- **Compare** edge AI deployment and cloud-based AI deployment architectures.
- **Study** the challenges of deploying large language models (LLMs) in production environments.

Activity-Based Learning

- **Skill-based certifications** through NPTEL, NVIDIA Deep Learning Institute, and Coursera.
- **Mini-projects** on AI model deployment and optimization.
- **Case studies** on real-world AI systems used in industry.
- **Group discussions** on emerging AI infrastructure technologies.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	Agentic and Emerging AI		
Course Code	BCI703	CIE MARKS	50
(L : T : P) + SL	(3:2:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	4	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
The objectives of the course are to facilitate the learners to			
1. Understand the agent concepts, components, and the principles of agentic systems. 2. Explain the agent architectures, multi-agent systems, and tool use with planning techniques. 3. Apply planning algorithms and design collaborative agent systems using the CWD approach. 4. Design efficient agentic systems with memory, context management, and workflow optimization. 5. Explore real-world applications and frameworks for building agentic AI systems.			
Module-1		9 Hours	
Introduction to Agents : Defining the Agents, understanding the Components of an Agent, Examining the rise of the Agent Era, peeling back the AI interface, Navigating the Agent landscape.			
Principles of Agentic System : Understanding self-governance, agency, and autonomy: Self-governance, Agency, Autonomy, Example of agency and autonomy in agents.			
Textbook 1: Chapter 1- 1.1 1.2 1.3 1.4, 1.5			
Textbook 2: Chapter 2			
Module-2		9 Hours	
Principles of Agentic System: Reviewing intelligent agents and their characteristics, Exploring the architecture of agentic systems: Deliberative architectures, Reactive architectures, Hybrid architectures, Understanding multi-agent systems: Definition and characteristics of MASs, Interaction mechanisms in MASs.			
Enabling Tool Use and Planning in Agents: Understanding the concept of tool use in agents: Tool and function calling, Defining tools for agents, Types of tools, The significance of tools in agentic systems, Planning algorithms for agents: Less practical planning algorithms			
Textbook 2: Chapter 2, Chapter 5			



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Module-3	9 Hours
Enabling Tool Use and Planning in Agents: Moderately practical planning algorithm – FF, most practical planning algorithms, integrating tool use and planning: Reasolanning for tool use. Exploring practical implementations: CrewAI example, AutoGen example, LangGraph example. Exploring the Coordinator, Worker, and Delegator Approach : Understanding the CWD model: Key principles of the CWD model, The CWD model for the intelligent travel agent, designing agents with role assignments: Roles and responsibilities of each agent, Communication and collaboration between agents: Communication, Coordination mechanism, Negotiation and conflict resolution Knowledge sharing. Textbook 2: Chapter 5, Chapter 6	
Module-4	9 Hours
Exploring the Coordinator, Worker, and Delegator Approach : Implementing the CWD approach in generative AI systems: System prompts and agent behaviour, Instruction formatting, Interaction patterns. Effective Agentic System Design Techniques : Agent memory architecture and context management, Short-term memory (working memory), Long-term memory (knowledge base), Episodic memory (interaction history), Context management, Integration with decision-making, Sequential and parallel processing in agentic workflows: Sequential processing, Parallel processing, Workflow optimization. Textbook 2: Chapter 6, Chapter 7	
Module-5	9 Hours
Common Use Cases and Applications: Creative and artistic applications: Evolution of creative and artistic agents, Real-world applications, Natural language processing and conversational agents: Evolution of language agents, Real-world applications, Robotics and autonomous systems: Evolution of robotic agents, Real-world applications, Decision support and optimization: Evolution of decision support agents, Real-world applications. Agentic Frameworks: Model Context Protocol : Introduction, AI Tooling, MCP Architecture: Core Components, Transport Layer and Communication, MCP Server Lifecycle, Current Landscape: Ecosystem Overview, Use Cases. Text Book 2: Chapter 10 Text Book 3(Article): Section 2: 2.1, Section 3: 3.1,3.2,3.3, Section 4: 4.1, 4.2	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:



CO1	Explain agent concepts, components, and principles of agentic systems.
CO2	Analyse agent architectures, multi-agent systems, and tool-based planning approaches.
CO3	Apply planning algorithms and design collaborative agent systems using the CWD model.
CO4	Design agentic systems with effective memory, context management, and optimized workflows.
CO5	Implement agentic AI solutions using appropriate frameworks for real-world applications.

ASSESSMENT AND EVALUATION REGULATIONS OF PCC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	18	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks

1. Michael Lanham, AI Agents in Action, 1st Edition, Manning Publications, 2025, **ISBN: 978-1633436343.**
2. Anjanava Biswas and Wrick Talukdar, Building Agentic AI Systems, 1st Edition, Packt Publishing, 2025, **ISBN: 978-1803238753.**



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3. Xinyi Hou, Yanjie Zhao, Shenao Wang, and Haoyu Wang, Model Context Protocol (MCP): Landscape, Security Threats, and Future Research Directions, arXiv, 2025, DOI: 10.48550/arXiv.2503.23278.

Reference Books

1. Hayden Van Der Post, *AI Agents with Python: Build Autonomous Systems That Think, Learn, and Act*, 1st Edition, Reactive Publishing, 2025, **ISBN: 979-8315553311**.
2. Ken Huang, *Agentic AI: Theories and Practices*, 1st Edition, Springer Nature, 2025, **ISBN: 978-3031900259**.

Weblinks:

1. <https://learn.deeplearning.ai/courses/agentic-ai/information>
2. <https://dfl.iiit.ac.in/programs/cert/aai>
3. <https://www.geeksforgeeks.org/artificial-intelligence/agentic-ai-tutorial/>
4. <https://www.coursera.org/learn/ibm-rag-and-agentic-ai>
5. <https://www.coursera.org/learn/agentic-ai-with-langchain-and-langgraph>

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- NPTEL Swayam Course / Infosys Spring Board Courses
- Seminar
- Mini Projects

Self Learning

- **Exploring Autonomous AI Agents using LangChain and CrewAI**
Study how autonomous agents are created, coordinated, and deployed using modern agentic AI frameworks.
- **Multi-Agent Collaboration and Task Planning in Agentic Systems**
Learn collaborative decision-making, tool usage, workflow orchestration, and planning strategies in multi-agent environments.
- **Memory and Context Management Techniques for Agentic AI Applications**
Investigate short-term memory, long-term memory, retrieval mechanisms, and context optimization methods used in intelligent agents.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title:	AI in Business Analytics		
Course Code:	BCI714A	CIE MARKS	50
(L : T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the concepts of Business Intelligence, Business Analytics, and Decision Support Systems for data-driven organizational decision making. 2. Learn decision-making models, analytical techniques, and management support systems used for solving business problems under certainty, uncertainty, and risk. 3. Gain knowledge of data warehousing architectures, ETL processes, business reporting, and data visualization techniques for effective analytics and reporting. 4. Explore knowledge management systems, collaborative technologies, and computerized group decision-support systems used in organizations. 5. Analyse emerging trends in business analytics such as recommendation systems, social network analytics, cloud-based BI, and ethical issues related to AI, privacy, and data security.			
Module-1			9 Hours
Business Intelligence, Data Analytics and Decision Support: Changing Business Environments and Computerized Decision Support, Managerial Decision Making, Information systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems (DSS), A framework for Business Intelligence (BI), A Work System View of Decision Support, Overview of Business Analytics, Introduction to Big Data Analytics. Textbook 1: Chapter 1 (1.2-1.9)			
Module-2			9 Hours
Decision Making Technologies: Decision Making, Models, Phases of the Decision-Making Process, The Intelligence Phase, The Design Phase, The Choice Phase, The Implementation Phase, How Decisions Are Supported, DSS - Capabilities, Classifications and Components. Modeling and Analysis: Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Management Support Systems, Multiple Goals, Sensitivity Analysis, What-If Analysis, and Goal Seeking. Textbook 1: Chapter 2 (2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,2.10,2.11) Chapter 9 (9.3,9.4, 9.7)			



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Module-3	9 Hours
Data Warehousing: Data Warehousing Definitions and Concepts, Data Warehousing Process Overview, Data Warehousing Architectures, Data Integration and the Extraction, Transformation, and Load (ETL) Processes, Data Warehouse - Development, Implementation Issues, Administration, Security Issues and Future Trends. Business Reporting, Data Visualization, Different Types of Charts and Graphs, The Emergence of Visual Analytics, Information Dashboards. Textbook 1: Chapter 3 (3.2,3.3,3.4,3.5,3.6,3.7, 3.9) Chapter (4.2,4.3,4.4,4.5,4.6)	
Module-4	9 Hours
Knowledge Management and Collaborative Systems: Introduction to Knowledge Management, Approaches to Knowledge Management, Information Technology (IT) In Knowledge Management, Making Decisions in Groups, Supporting Group work with Computerized Systems, Tools for indirect support of Decision Making, Direct Computerized Support for Decision Making. Textbook 1: Chapter 12 (12.2,12.3,12.4,12.5,12.6,12.7,12.8)	
Module-5	9 Hours
Business Analytics for Emerging Trends and Future Impacts: Location based Analytics for Organizations, Analytics Applications for Consumers, Recommendation Engines, Web 2.0 and Online Social Networking, Cloud computing and BI, Impact of Analytics in Organizations, Issues of - Legacy, Privacy and Ethics; An Overview of Analytics Ecosystem. Textbook 1: Chapter 14 (14.2,14.3,14.4,14.5,14.6,14.7,14.8,14.9)	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the concepts of Business Intelligence, Business Analytics, and decision support systems for organizational decision making.
CO2	Analyse decision-making models and technologies used in Decision Support Systems (DSS) for solving business problems.
CO3	Apply data warehousing concepts, ETL processes, and data visualization techniques for effective business reporting and analytics.
CO4	Examine the role of knowledge management systems and collaborative technologies in supporting organizational decision-making.
CO5	Evaluate emerging trends in business analytics, including recommendation systems, social network analytics, and ethical issues related to data privacy and AI.



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ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook:

1. Ramesh Sharda, Dursun Delen, and Efraim Turban, *Business Intelligence, Analytics, and Data Science: A Managerial Perspective*, 10th Edition, Pearson, 2015, **ISBN: 978-0134633282**.

Reference Books:

1. Michael J. A. Berry and Gordon S. Linoff, *Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management*, 2nd Edition, Wiley Publishing, 2004, **ISBN: 978-0471470649**.
2. Bernard Marr and Matt Ward, *Artificial Intelligence in Practice: How 50 Successful Companies Used AI and Machine Learning to Solve Problems*, 1st Edition, Wiley, 2019, **ISBN: 978-1119548218**.
3. Foster Provost and Tom Fawcett, *Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking*, 1st Edition, O'Reilly Media, 2013, **ISBN: 978-1449361327**.



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Weblinks:

1. https://onlinecourses.nptel.ac.in/noc24_cs65/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs45/preview
3. <https://www.geeksforgeeks.org/what-is-data-analytics/>
4. https://onlinecourses.nptel.ac.in/noc20_mg11/preview
5. https://onlinecourses.nptel.ac.in/noc23_mg104/preview
6. https://onlinecourses.nptel.ac.in/noc20_mg24/preview
7. <https://in.coursera.org/projects/power-bi-for-beginners-introduction-to-business-intelligence>
8. <https://in.coursera.org/specializations/analytics>

Self – Study topics:

- Study real-world business analytics applications in marketing, finance, healthcare, and supply chain decision-making
- Explore popular visualization tools such as Tableau, Power BI, and Excel, and learn best practices for effective dashboards.
- Learn the basics of machine learning techniques used in business analytics, such as classification, clustering, and prediction.
- Understand data privacy, data security, bias, and ethical challenges in analytics-driven business decisions.

Activity Based Learning

- Quizzes
- Assignments
- Infosys Spring Board Courses
- Seminar



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title:	Domain Applications of Generative AI		
Course Code:	BCI714B	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to 1. Understand the fundamentals of generative AI, including differences between discriminative and generative models, and the role of probability in modeling data. 2. Analyze and implement generative models such as GANs, including their variants and practical challenges in image generation. 3. Explore text generation techniques using deep learning models like LSTMs and understand language modeling and decoding strategies. 4. Apply generative models for creative domains such as music generation using LSTMs and GAN-based architectures. 5. Examine emerging real-world applications of generative AI in domains like healthcare, scientific computing, and multimedia generation.			
Module-1		9 Hours	
An Introduction to Generative AI: "Drawing" Data from Models- Applications of AI Discriminative and generative models ,Implementing generative models,, The rules of probability , Discriminative and generative modeling and Bayes' theorem, Why use generative models? The promise of deep learning, Unique challenges of generative models. Painting Pictures with Neural- Networks Using VAEs, Creating separable encodings of images, The variational objective, Inverse Autoregressive Flow.			
Textbook 1- Chapter 1.1-1.9 5.1-5.4			
Module-2		9 Hours	
Image Generation with Generative Adversarial Network (GANs)- The taxonomy of generative models, Generative adversarial networks, Vanilla GAN, Improved GANs, Conditional GAN, Wasserstein GAN, Progressive GAN, Progressive growth-smooth fade-in, Challenges			
Textbook 1: Chapter 6.1-6.9			



Module-3	9 Hours
The Rise of Methods for Text Generation- Representing text, Distributed representation, Text generation and the magic of LSTMs, Language modelling, Hands-on: Character-level language model, Decoding strategies, LSTM variants and convolutions for text, Convolutions and text Textbook 1: Chapter 9.1-9.8	
Module-4	9 Hours
Composing Music with Generative Models- Getting started with music generation, Representing music, Music generation using LSTMs, LSTM model for music generation, Music generation using GANs, MuseGAN – polyphonic music generation Textbook 1: Chapter 11.1- 11.6	
Module-5	9 Hours
Emerging Applications in Generative AI- Finding new drugs with generative models, Folding proteins with generative models, Solving partial differential equations with generative modelling, Few shot learning for creating videos from images, Generating recipes with deep learning. Textbook 1: Chapter 13.1- 13..6	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate a comprehensive understanding of generative AI concepts by distinguishing between discriminative and generative models, and applying probabilistic reasoning, including Bayes' theorem, to data modeling.
CO2	Design, implement, and critically evaluate various GAN architectures—Vanilla GAN, Conditional GAN, Wasserstein GAN, and Progressive GAN—for image generation, addressing key challenges such as training instability and mode collapse.
CO3	Develop and optimize deep learning-based text generation models using LSTM architectures, and assess their performance using appropriate language modeling and decoding techniques.
CO4	Design and analyze generative models for music composition using LSTM and GAN-based approaches (e.g., MuseGAN), with an emphasis on sequence modeling and polyphonic music generation.
CO5	Investigate and apply generative AI methodologies to solve complex real-world problems in domains such as healthcare, scientific computing, and multimedia generation.



ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks:

1. Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models” , Joseph Babcock and Raghav Bali , Packt Publishing Ltd., 2024, ISBN 978-1-80020-088-3

Reference Books:

1. Altaf Rehmani, *Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology*, 1st Edition, Rehmani Publishing, 2024, ISBN: 978-9887042402.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, 1st Edition, MIT Press, 2016, ISBN: 978-0262035613.
3. Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, 1st Edition, Springer, 2018, ISBN: 978-3319944623.
4. Josh Kalin, *Generative Adversarial Networks Cookbook: Over 100 Recipes to Build Generative Models Using Python, TensorFlow, and Keras*, 1st Edition, Packt Publishing, 2019, ISBN: 978-1789139907.
5. Jesse Sprinter, *Generative AI in Software Development: Beyond the Limitations of Traditional Coding*, 1st Edition, Apress, 2024, ISBN: 978-1484299005.



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Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- NPTEL Swayam Course/ Course era / Infosys Spring Board Courses
- Seminar

Web & E-sources:

1. <https://elearn.nptel.ac.in/shop/iit-workshops/completed/leveraging-generative-ai-for-teaching-programming-courses/?v=c86ee0d9d7ed>
2. <https://elearn.nptel.ac.in/shop/iit-workshops/completed/introduction-to-language-models/?v=c86ee0d9d7ed>

Self-Learning Topics

1. **Fundamentals of Generative AI and Probabilistic Modeling**
 - Discriminative vs. generative models, Bayes' theorem, probability rules, applications of generative AI, and challenges in deep generative learning.
2. **Variational Autoencoders (VAEs) and Image Representation Learning**
 - Image encoding and latent space representation, variational objective, inverse autoregressive flow, and applications of VAEs in image generation.
3. **Generative Adversarial Networks (GANs) for Image Synthesis**
 - Vanilla GAN, Conditional GAN, Wasserstein GAN, Progressive GAN, GAN training challenges, and real-world image generation applications.
4. **Text and Music Generation using Deep Learning Models**
 - Text representation, language modeling, LSTMs for text generation, decoding strategies, music generation using LSTMs and MuseGAN, and sequence modeling techniques.
5. **Emerging Applications of Generative AI**
 - Drug discovery, protein folding, AI for scientific computing, video generation from images, recipe generation, and ethical considerations in generative AI systems.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	SOCIAL NETWORK ANALYSIS		
Course Code	BCI714C	CIE MARKS	50
(L :T : P) +SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	3	EXAM HOURS	3
Course Learning Objectives: <i>The objectives of the course are to facilitate the learners to:</i> 1. Understand the concept of Social Network Analysis. 2. Learn Network centrality components like density, reachability, connectivity and reciprocity. 3. Understand similarity and structural equivalence in Social Network Analysis. 4. Understand two modes of networks in Social Network Analysis. 5. Learn the visualization of social networks.			
Module-1			9 Hours
Introduction to the Semantic Web and Social Networks: The Semantic Web, Limitations of the current Web, The semantic solution, Development of the Semantic Web and the emergence of the social web. Textbook 1: Chapter 1.1, 1.2, 1.3, 1.4, 1.5.			
Module-2			9 Hours
Social Network Analysis: What is network analysis, Development of Social Network Analysis: Key concepts and measures in network analysis, The global structure of networks, The macro-structure of social networks. Personal networks. Textbook 1: Chapter 2.1, 2.2, 2.3, 2.4.			
Module-3			9 Hours
Centrality and power: Centrality and centralization in SNA: Introduction: The several faces of power, Degree centrality, Degree: Freeman's approach, Closeness centrality, Closeness: Path distances, Closeness: Reach Closeness: Eigenvector of geodesic distances, Betweenness Centrality, Betweenness: Freeman's approach to binary relations. Textbook 2: Chapter 10.1,10.2,10.3, 10.4, 10.5.			
Module-4			9 Hours
Two-mode networks for SNA : Understanding mode networks- Bi-partite data structures, visualizing two-mode data, quantitative analysis using two-mode Singular value decomposition (SVD) analysis two-mode factor analysis, two-mode correspondence analysis.			



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Textbook 2: Chapter 17.1, 17.2, 17.3, 17.4, 17.5, 17.6

Module-5

9 Hours

VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS : Graph theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrix-based representations – Matrix and Node-Link Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – Co-Citation networks.

Textbook 3: Chapter 27, 28, 29.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Ability to design and develop semantic web related applications
CO2	Ability to represent knowledge using ontology
CO3	Ability to predict human behaviour in social web and related communities
CO4	Ability to represent two-mode networks in Social Network Analysis.
CO5	Ability to visualize social networks

ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks



SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks

1. Peter Mika, *Social Networks and the Semantic Web*, 2nd Edition, Springer, 2015, **ISBN: 978-0387710006**.
2. Robert A. Hanneman and Mark Riddle, *Introduction to Social Network Methods*, 1st Edition, University of California, Riverside, 2005, **ISBN: N/A (Online Textbook)**.
3. Borko Furht (Ed.), *Handbook of Social Network Technologies and Applications*, 1st Edition, Springer, 2010, **ISBN: 978-1441971418**.

Reference Books

1. Ajith Abraham and Aboul-Ella Hassanien (Eds.), *Computational Social Networks: Tools, Perspectives and Applications*, 1st Edition, Springer, 2012, **ISBN: 978-1441971401**.
2. Dion H. Goh and Schubert Foo, *Social Information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively*, 1st Edition, IGI Global, 2008, **ISBN: 978-1599045436**.
3. Eric D. Kolaczyk and Gábor Csárdi, *Statistical Analysis of Network Data with R*, 1st Edition, Springer, 2014, **ISBN: 978-1493909827**.
4. Stanley Wasserman and Katherine Faust, *Social Network Analysis: Methods and Applications*, 1st Edition, Cambridge University Press, 1994, **ISBN: 978-0521387071**.

Web links and Video Lectures (e-Resources):

- <http://faculty.ucr.edu/~hanneman/nettext/index.html>
- https://onlinecourses.nptel.ac.in/noc22_cs117/preview
- <https://nptel.ac.in/courses/106106239>
- <https://www.coursera.org/learn/social-network-analysis>



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Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar

Self – Study topics:

- Study concepts such as modularity, clustering coefficient, and community structures.
- Study diffusion models such as Independent Cascade Model and Linear Threshold Model.
- Learn how information, rumours, and trends spread through networks.
- Understand node importance using Degree, Betweenness, Closeness, and Eigenvector centrality.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	Physical AI		
Course Code	BCI714D	CIE MARKS	50
(L : T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: (ADD one more + Reframe)			
After completing this course, the learner will be able to:			
1. Understand the fundamentals of robotics and autonomous systems used in Physical AI. 2. Analyze sensor technologies, perception systems, and sensor fusion techniques for robotic applications. 3. Apply navigation algorithms and simulation environments for autonomous systems. 4. Design intelligent robotic systems using ROS/ROS2 frameworks and physics-based AI models. 5. Evaluate real-world applications of Physical AI in industrial automation, autonomous robots, and smart robotic systems.			
Module-1			9 Hours
Introduction to Physical AI and Robotics: Introduction to Physical AI, fundamentals of robotics and autonomous systems, components of robotic systems, robot architectures, kinematics basics, applications of robotics in industry and autonomous systems.			
Textbook 1: Chapter-1 (1.1–1.4), Chapter-2 (2.1–2.3)			
Module-2			9 Hours
Sensors and Perception in Robotics: Sensors used in robotic systems, camera sensors, LiDAR, ultrasonic and IMU sensors, perception systems, environmental perception, sensor fusion techniques, perception pipelines for autonomous robots.			
Textbook 1: Chapter-4 (4.1–4.4)			
Module-3			9 Hours
Navigation and Autonomous Systems: Robot navigation techniques, localization methods, path planning algorithms, obstacle avoidance, SLAM (Simultaneous Localization and Mapping), decision making in autonomous robots.			
Textbook 1: Chapter-6 (6.1–6.4)			



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Module-4	9 Hours
Simulation and Virtual Training Environments: Simulation environments for robotics, physics-based simulation systems, data formats used in robotic simulation, training robots in virtual environments, digital twins for robotics, simulation tools such as Gazebo and Webots. Textbook 2: Chapter-4 (4.1–4.3), Chapter-5 (5.1–5.3)	
Module-5	9 Hours
Physics-Informed AI and ROS Applications: Physics-Informed Neural Networks (PINNs), integrating physics with machine learning models, ROS architecture, ROS2 framework, communication in ROS (nodes, topics, services), advanced robotics applications using ROS. Textbook 2: Chapter-2 (2.1–2.4), Chapter-3 (3.1–3.4)	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the fundamental concepts of robotics, autonomous systems, and Physical AI architectures.
CO2	Analyze sensors, perception systems, and sensor fusion techniques used in robotic systems.
CO3	Evaluate robot navigation algorithms and autonomous system decision-making techniques.
CO4	Apply simulation tools and physics-based models for developing intelligent robotic systems.
CO5	Design robotic applications using ROS/ROS2 frameworks and AI-based control systems.

ASSESSMENT AND EVALUATION REGULATIONS OF PEC

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.



Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B, and C
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbooks

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*, 2nd Edition, John Wiley & Sons, 2020, **ISBN: 978-1119523994**.
2. Morgan Quigley, Brian Gerkey, and William D. Smart, *Programming Robots with ROS: A Practical Introduction to the Robot Operating System*, 1st Edition, O'Reilly Media, 2016, **ISBN: 978-1492022985**.

Reference Books

1. Bruno Siciliano and Oussama Khatib (Eds.), *Springer Handbook of Robotics*, 2nd Edition, Springer Nature, 2016, **ISBN: 978-3319325507**.
2. Kevin M. Lynch and Frank C. Park, *Modern Robotics: Mechanics, Planning, and Control*, 1st Edition, Cambridge University Press, 2017, **ISBN: 978-1107156302**.
3. Richard Szeliski, *Computer Vision: Algorithms and Applications*, 1st Edition, Springer, 2011, **ISBN: 978-1848829343**.

Web Resources for Further Learning

1. NPTEL Online Course – Introduction to Robotics
<https://onlinecourses.nptel.ac.in/>
2. ROS Official Tutorials – Robot Operating System (ROS & ROS2)
<https://docs.ros.org/>
3. Coursera – Robotics Specialization
<https://www.coursera.org/>

Self-Study Topics

1. **Analyze** different robot navigation techniques such as A, Dijkstra, and SLAM* used in autonomous systems.
2. **Compare** various sensors used in robotics such as LiDAR, camera, ultrasonic, and IMU sensors, and evaluate their role in robotic perception.



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3. **Study** the applications of Physics-Informed Neural Networks (PINNs) in robotics and autonomous systems.

Activity-Based Learning

- **Skill-based** certifications through NPTEL Robotics courses, ROS training programs, and online robotics workshops.
- **Hands-on mini projects** involving robot navigation, sensor integration, and autonomous system development.
- **Case studies** on real-world robotic systems such as self-driving vehicles, industrial robots, and humanoid robots.
- **Group discussions and presentations** on emerging trends in robotics, autonomous systems, and Physical AI technologies.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	Introduction to Algorithms		
Course Code	BCS755A	CIE MARKS	50
(L :T : P): SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the methods of analyzing algorithms and to analyze evaluating their performance. 2. Apply algorithm's efficiencies using asymptotic notations. 3. Solve problems using various algorithm design methods, including brute force, greedy, divide and conquer, decrease and conquer, transform and conquer and dynamic programming. 4. Design the appropriate data structure and algorithm design method for a specified application.			
Module-1			9 Hours
Introduction: What is an Algorithm? Fundamentals of Algorithmic Problem Solving, Important problem Types, Fundamental Data Structures. Fundamentals of the Analysis of Algorithm Efficiency: Analysis Framework, Asymptotic Notations and Basic Efficiency Classes. Textbook 1: Chapter 1 (1.1 - 1.4), Chapter 2 (2.1, 2.2)			
Module-2			9 Hours
Fundamentals of the Analysis of Algorithm Efficiency: Mathematical Analysis of Non- recursive Algorithms, Mathematical Analysis of Recursive Algorithms. Brute Force: Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching. Textbook 1: Chapter 2(2.3,2.4), Chapter 3(3.1,3.2)			



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Module-3	9 Hours
Exhaustive Search: Travelling Salesman problem and Knapsack Problem, Depth First search and Breadth First search. Decrease-and-Conquer: Insertion Sort, Topological Sorting. Divide and Conquer: Merge Sort, Quick sort, Binary Tree Traversals. Textbook 1: Chapter 3(3.4,3.5), Chapter 4(4.1,4.2), Chapter 5(5.1 - 5.3)	
Module-4	9 Hours
The Greedy Method: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees and Codes. Dynamic Programming: Three basic examples, The Knapsack Problem and Memory Functions. Textbook 1: Chapter 9(9.1 – 9.4) , Chapter 8(8.1 – 8.2)	
Module-5	9 Hours
Transform-and-Conquer: Heap and Heapsort. Space and Time Trade-offs: Sorting by Counting: Comparison counting sort, Input Enhancement in String Matching: Horspool's Algorithm. Textbook 1: Chapter 6(6.4), Chapter 7(7.1, 7.2)	

COURSE OUTCOMES

After successfully completing the course, the student will be able to:

CO1	Apply fundamental concepts of algorithmic problem solving, analyse algorithm Efficiency using asymptotic notations.
CO2	Analyse brute-force, decrease-and-conquer, and divide-and-conquer algorithms to solve basic sorting, searching, and matrix problems.
CO3	Design algorithms for optimization problems using greedy and dynamic programming paradigms to solve real world problems.
CO4	Solve transform-and-conquer and space-time trade-off strategies to analyze algorithmic performance in sorting and string-matching using counting and input-enhanced techniques.



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ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook:

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin, 3rd Edition (Indian), 2014, Pearson.

Reference Books:

1. Computer Algorithms/C++, Ellis Horowitz, Sartaj Sahni, and Rajasekaran, 2nd Edition, 2014, Universities Press.
2. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 3rd Edition, 2009, MIT Press.
3. Analysis and Design of Algorithms, Padma Reddy, 1st Edition, 2009, Sri Nandi Publications.



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Web links and Video Lectures (e-Resources):

1. <https://youtu.be/xGYsEqe9VI0?si=3jEs4gVR26vc5ryL>
2. <https://youtu.be/A03oI0znAoc?si=7zscRiJX40HIyZUO>
3. [Design and Analysis of Algorithms | Coursera](#)
4. [Design and Analysis of Algorithms](#) (Udemy)

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

1. Quizzes
2. Assignments
3. Seminar

Self-Learning

1. Identify algorithms used in daily life (ATM, Google Maps).
2. Compare two sorting algorithms based on time complexity.
3. Write pseudocode for a simple problem.
4. Trace Fibonacci / searching algorithms manually
5. Explore algorithm visualization tools online.



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title:	Foundations of Information Security		
Course Code:	BCY755B	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is to facilitate the learner to:</i>			
1. Provide an overview of information security concepts, threats, and defense strategies. 2. Present identification, authentication, and access control concepts for securing system access. 3. Introduce auditing, accountability, and cryptographic concepts for securing information systems. 4. Outline operations, human, and physical security concepts for protecting information systems. 5. Illustrate network and operating system security concepts for system protection.			
Module-1			9 Hours
What is Information Security? Defining Information Security, When Are You Secure? Models for Discussing Security Issues, Attacks, Défense in Depth. Textbook 1: Chapter-1 (pg:1-20)			
Module-2			9 Hours
Identification and Authentication: Identification, Authentication, Common Identification and Authentication methods. Authorization and Access Controls: What are Access Controls? Implementing Access Controls, Access Control Models. Textbook 1: Chapter-2 (pg:23-33), Chapter-3 (pg:35-50)			
Module-3			9 Hours
Auditing and Accountability: Accountability, Security Benefits of Accountability, Auditing.			



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Cryptography: The History of Cryptography, Modern Cryptographic Tools, Protecting Data at Rest, in Motion and in Use.

Textbook 1: Chapter-4 (pg:51-58), Textbook: Chapter-5 (pg:61-77)

Module-4

9 Hours

Operations Security: The Operations Security Process, Laws of Operation Security.

Human Element Security: Gathering Information for Social Engineering Attacks, Types of Social Engineering Attacks.

Physical Security: Identifying Physical Threats, Physical Security Controls, Protecting People, Protecting Data, Protecting Equipment.

Textbook 1: Chapter-7 (pg:95-100), Chapter-8 (pg:107-116) Chapter-9 (pg:121-132)

Module-5

9 Hours

Network Security: Protecting Networks, Protecting Network Traffic, Network Security Tools

Operating System Security: Operating System Hardening, Protecting against Malware, Operating System Security Tools.

Textbook 1: Chapter-10 (pg:133-144), Chapter-11 (pg:145-156)

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate information security concepts, attack types, and defense-in-depth principles.
CO2	Apply identification, authentication, and access control mechanisms for regulated system access.
CO3	Implement auditing mechanisms and cryptographic techniques for ensuring security and data protection.
CO4	Assess operational, human, and physical security threats and controls for system protection.
CO5	Utilize network and operating system security measures to protect systems and data.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of



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			Two Internal Assessment Tests shall be scaled down to 30 marks.
Alternate Assessment (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Text Book:

1. **Jason. Andress**, Foundations of Information Security: A Straightforward Introduction. San Francisco, CA, USA: No Starch Press, 2019, ISBN: 978-1718500044.

Reference Books:

1. **M. E. Whitman and H. J. Mattord**, Principles of Information Security, 7th ed. Boston, MA, USA: Cengage Learning, 2022, ISBN: 978-0357508328.
2. **M. Stamp**, Information Security: Principles and Practice. Hoboken, NJ, USA: John Wiley & Sons, Inc., 2006, ISBN: 978-0471738484.

Web links and Video Lectures (e-Resources):

1. Cryptography and Network Security:
https://onlinecourses.nptel.ac.in/noc25_cs16
2. Introduction to Cryptology: https://onlinecourses-archive.nptel.ac.in/noc17_cs36
3. Computer Networks and Internet Protocol:
https://onlinecourses.nptel.ac.in/noc20_cs23
4. Cyber Security Full Course for Beginner: PY AG VS09 AG 16 9



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5. Neso academy: [Introduction to Cryptography and Network Security - YouTube](#)

6. Cryptography and System Security: [AI CH AI714 UV 16x9.mp4](#)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Cryptography Demonstration Activity: Demonstration of basic encryption techniques using simple tools like Online AES / RSA demo tools.
2. Network Security Demo (Visualization Based): Demonstration of: Firewall working, Packet filtering using tools such as Cisco Packet Tracer

Self-Study Topics:

1. Zero Trust security model and architecture
2. Cloud security fundamentals and shared responsibility model
3. Security standards and frameworks (ISO 27001, NIST)
4. Ethical hacking and penetration testing basics
5. Blockchain and its role in information security



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title	Full Stack Web Development		
Course Code	BCD755C	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the essential JavaScript concepts for web development. 2. Distinguish different types of events and their roles in interactive web applications. 3. Utilize React JS to build front end User Interface. 4. Understand the usage of API's to create web applications using Express JS. 5. Store and model data in a no sql database.			
Module-1			9 Hours
Basic JavaScript Instructions: Statements, Comments, Variables, Data Types, Arrays, String operator, Functions, Methods & Objects, Decisions & Loops. Textbook 1: Chapter-2, Chapter-3, Chapter-4			
Module-2			9 Hours
Document Object Model: DOM, DOM Tree, Accessing Elements, Selecting Elements, Adding Elements using DOM Manipulation, Adding an element to the DOM Tree, Removing elements via DOM Manipulation, Removing elements from the DOM Tree, CROSS-SITE scripting attacks, Attribute nodes. Events: Different Types of Events, How to bind an event to an element, Event Listeners, Event Delegation. Textbook 1: Chapter-5, Chapter-6			
Module-3			9 Hours
Form enhancement and validation: Helper Functions, The form element, Form controls, Submitting forms, HTML5 elements & Attributes. Introduction: MERN, MERN components, Why MERN. Hello World: Server- Less Hello world, Express, Separate Script File, JSX Transform, Older Browsers Support, Automate. React Components: Issue Tracker, React Classes, Composing Components, Passing Data using Properties, Passing Data Using Children, Dynamic Composition.			



Textbook 1: Chapter-13	
Textbook 2: Chapter-1, Chapter-2, Chapter-3	
Module-4	9 Hours
React State: Initial State, Async State Initialization, Updating State, Lifting State Up, Event Handling, Stateless Components, Designing Components. Express and GraphQL: Express, REST API, GraphQL. Textbook 2: Chapter-4, Chapter-5	
Module-5	9 Hours
MongoDB: MongoDB Basics, MongoDB CRUD Operations, MongoDB Node.js Driver, Schema Initialization, Reading from MongoDB, Writing to MongoDB. Modularization and Webpack: Back-End Modules, Front-End Modules and Webpack, Transform and Bundle, Libraries Bundle. Textbook 2: Chapter-6, Chapter-8	

COURSE OUTCOMES

After successfully completing the course, the student will be able to:

CO1	Understand JavaScript to build dynamic and interactive Web projects.
CO2	Implement user interface components for JavaScript-based Web using React.JS
CO3	Apply Express/Node to build web applications on the server side.
CO4	Develop data model in an open-source NoSQL database.
CO5	Demonstrate modularization and packing of the front-end modules.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based,



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			one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Textbooks:

1. **Jon Duckett**, "JavaScript & jQuery: Interactive Front-End Web Development", Wiley, 2014.
2. **Vasan Subramanian**, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node", Second edition, Apress, 2019.

Web links and Video Lectures (e-Resources):

1. <https://github.com/vasansr/pro-mern-stack>
2. <https://nptel.ac.in/courses/106106156>
3. <https://archive.nptel.ac.in/courses/106/105/106105084/>

Activity Based Learning:

Course Project: Build Web applications using MERN stack. Students (group of 2) can choose any real-world problem from domains such as finance, marketing, medical, or enterprise projects.

Self-study topics:

1. Microservices architecture
2. GraphQL vs REST
3. WebSockets (real-time apps)
4. Full-stack AI integration (LLM APIs)
5. DevOps for MERN (Docker, CI/CD)



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B.E. in Computer Science and Engineering (AI & ML)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

Course Title:	Introduction to Machine Learning		
Course Code:	BCI755D	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to: 1. Introduce the fundamental concepts and techniques of machine learning. 2. Understand the types of machine learning and the challenges faced in real world applications. 3. Familiarize the machine learning algorithms such as regression, decision trees, Bayesian models, clustering, and neural networks. 4. Explore advanced concept like reinforcement learning and provide practical insight into its applications. 5. Enable students to model and evaluate machine learning solutions for different types of problems.			
Module-1			9 Hours
Introduction to Machine Learning: Need for Machine Learning, Machine Learning Explained, Machine Learning in Relation to other Fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process, Machine Learning Applications.			
Understanding Data: Introduction, Big Data Analysis Framework, Descriptive Statistics, Univariate Data Analysis and Visualization.			
Textbook 1: Chapter 1 (1.1-1.7), Chapter 2 (2.1-2.5)			
Module-2			9 Hours
Understanding Data: Bivariate Data and Multivariate Data, Multivariate Statistics, Essential Mathematics for Multivariate Data, Feature Engineering and Dimensionality Reduction Techniques.			
Basic Learning Theory: Design of Learning System, Introduction to Concept of Learning, Modelling in Machine Learning.			
Textbook 1: Chapter 2 (2.6-2.8, 2.10), Chapter 3 (3.3-3.4, 3.6)			



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Module-3	9 Hours
Similarity-based Learning: Nearest-Neighbour Learning, Weighted K-Nearest-Neighbor Algorithm, Nearest Centroid Classifier, Locally Weighted Regression (LWR). Regression Analysis: Introduction to Regression, Introduction to Linear Regression, Multiple Linear Regression, Polynomial Regression, Logistic Regression. Decision Tree Learning: Introduction to Decision Tree Learning Model, ID3 Tree Construction. Textbook 1: Chapter 4 (4.2-4.5), Chapter 5 (5.1-5.3, 5.5-5.7), Chapter 6 (6.1, 6.2.1)	
Module-4	9 Hours
Bayesian Learning: Introduction to Probability-based Learning, Fundamentals of Bayes Theorem, Classification Using Bayes Model, Naïve Bayes Algorithm for Continuous Attributes. Artificial Neural Networks: Introduction, Biological Neurons, Artificial Neurons, Perceptron and Learning Theory, Types of Artificial Neural Networks, Popular Applications of Artificial Neural Networks, Advantages and Disadvantages of ANN, Challenges of ANN. Textbook 1: Chapter 8 (8.1-8.4), Chapter 10 (10.1-10.5, 10.9-10.11)	
Module-5	9 Hours
Clustering Algorithms: Introduction to Clustering Approaches, Proximity Measures, Hierarchical Clustering Algorithms, Partitional Clustering Algorithm, Density-based Methods, Grid-based Approach. Reinforcement Learning: Overview of Reinforcement Learning, Scope of Reinforcement Learning, Reinforcement Learning as Machine Learning, Components of Reinforcement Learning, Markov Decision Process, Multi-Arm Bandit Problem and Reinforcement Problem Types, Model-based Learning. Textbook 1: Chapter 13 (13.1-13.6), Chapter 14 (14.1-14.7)	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe the machine learning techniques, their types and data analysis framework.
CO2	Apply mathematical concepts for feature engineering and perform dimensionality reduction to enhance model performance.
CO3	Develop similarity-based learning models and regression models for solving classification and prediction tasks.



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CO4	Build probabilistic learning models and design neural network models using perceptron's and multilayer architectures
CO5	Utilize clustering algorithms to identify patterns in data and implement reinforcement learning techniques

ASSESSMENT DETAILS (Both CIE and SEE)			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook:

1. Sridhar, S., and M. Vijayalakshmi. Machine Learning. 1st ed., Oxford University Press, 2021. ISBN: 9780190127275.

Reference Books:

1. M. N. Murty and V. S. Ananthanarayana, *Machine Learning: Theory and Practice*. Hyderabad: Universities Press, 2024. ISBN: 9788197427602.
2. T M. Mitchell, *Machine Learning*. New York: McGraw-Hill, 1997. ISBN: 9780070428072.
3. Burkov, *The Hundred-Page Machine Learning Book*, vol. 1. Quebec City, Canada: Andriy Burkov, 2019. ISBN: 9781999579500.



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Web links and Video Lectures(e-Resources):

- <https://www.universitiespress.com/resources?id=9789393330697>
- https://www.drssridhar.com/?page_id=1053
- Machine Learning Tutorials: <https://www.geeksforgeeks.org/machine-learning/>
- Machine Learning Tutorials:
https://www.tutorialspoint.com/machine_learning/index.htm
- Introduction to Machine Learning:
https://onlinecourses.nptel.ac.in/noc22_cs29/preview

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- NPTEL Swayam Course / Infosys Spring Board Courses
- Mini Projects

Self-Study Components:

1. Ensemble Learning
2. Optimization Techniques
3. Introduction to Deep Learning
4. Simple Real-World Use Cases:
5. Spam detection
6. Movie recommendation
7. Student marks prediction



VISION

Building RNSIT into a World Class Institution.



MISSION

To impart high quality education in Engineering, Technology and Management with a difference, enabling students to excel in their career by

- Attracting quality students and preparing them with a strong foundation in fundamentals so as to achieve distinctions in various walks of life leading to outstanding contributions.
- Imparting value based, need based, choice based and skill based professional education to the aspiring youth and carving them into disciplined, World class professionals with social responsibility.
- Promoting excellence in Teaching, Research and Consultancy that galvanizes academic consciousness among Faculty and Students.
- Exposing Students to emerging frontiers of knowledge in various domains and make them suitable for Industry, Entrepreneurship, Higher studies, and Research & Development.
- Providing freedom of action and choice for all the Stakeholders with better visibility.

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