

RN SHETTY TRUST ®



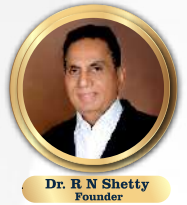
RNS INSTITUTE OF TECHNOLOGY

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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DEPARTMENT OF CSE - DATA SCIENCE

BACHELOR OF ENGINEERING

Scheme and Syllabus of V - VIII Semesters

2024 SCHEME



 www.rnsit.ac.in



Scheme and Syllabus Batch 2024 - 2028

(As per NEP-2020)
(Effective from the academic year 2024 – 25)

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 in 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

About CSE (Data Science)

Data Science is an offshoot of the Computer Science domain and its relevance and importance in solving today's technologically complex problems has been exponentially growing. With the present high-volume data and unstructured in many cases that is generated across domains, there is a strong need to train students in developing involved techniques in data analytics and derive intelligent inferences from these complex data. To cater to this demand, the CSE (Data Science) department was established in the academic year 2021-22. Presently, the department has an annual intake of 180 students. The department has highly qualified faculty from premier institutes in India. Many of the faculty have a very rich industry and R&D experience from within India and abroad. Students have an opportunity to involve in research during their UG and PG studies and this will pave the way for research-based career avenues for them. The high calibre teaching faculty and the excellent infrastructure creates a stimulating ambience for students to graduate to high quality data engineers and scientists.

Vision

Empowering students to solve complex real-time computing problems involving high volume multi-dimensional data.

Mission

- Provide quality undergraduate education in both theoretical and applied computer science to solve real world problems.
- Conduct research to develop algorithms that solve complex problems involving multi-dimensional high volume data through intelligent inferencing.
- Develop good linkages with industry and research organizations within India and abroad to expose students to global problems and find optimal solutions.
- Creating confident Graduates who can contribute to the nation through high levels of commitment following ethical practices and with integrity.

Programme Educational Objectives

A Graduate of CSE (Data Science) will be able to:

- Develop graduates who acquire knowledge and skills to apply the principles of Mathematics, basic Science and core computer science including data-driven analytics to solve real world inter-disciplinary problems.
- Develop graduates to pursue careers that help them to excel in the Data Science areas, to pursue entrepreneurship and also take up higher studies, all towards life-long learning.

- Develop graduates to inculcate cross-cultural appreciation, professional ethics and high levels of communication skills to apply their knowledge to solve problems of societal need.

Program 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:** Conduct investigations of complex engineering 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)
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
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.
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 (Data Science) graduates will have

1. Graduates will develop proficiency in logical and analytical skills to solve data intensive real world problems that encompass structured and unstructured high volume data.
2. Graduates will develop abilities to analyze and unearth the inter-relationships between data elements to come up with analytical/empirical models to develop intelligent Decision Support Systems.
3. Graduates will develop expertise in the Data Science areas that help in the development of intelligent algorithms to solve real world problems

B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 5th Semester

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/ PSB	TEACHING HOURS PER WEEK			Term Work (TW)+ Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE(L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	HSMS	BCS501	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	CSE - CD	3	2	0	45	3	50	50	100	4
2	IPCC	BCS502	COMPUTER NETWORKS	CSE - CD	3	0	2	45	3	50	50	100	4
3	IPCC	BCD503	FOUNDATIONS OF DATA SCIENCE	CSE - CD	3	0	2	45	3	50	50	100	4
4	PCCL	BCDL504	DATA ENGINEERING LABORATORY	CSE - CD	0	0	2	0	3	50	50	100	1
5	PEC	BCD515X	PROFESSIONAL ELECTIVE (BUCKET LIST E)	CSE - CD	3	0	0	45	3	50	50	100	3
6	PROJ	BCD586	MINI PROJECT	CSE - CD	0	0	2	30	3	100	0	100	2
7	BSC	BENS507/ BBOE507	ENVIRONMENTAL STUDIES / BIOLOGY FOR ENGINEERS	DEPT	2	0	0	30	2	50	50	100	2
8	AEC	BRMK557	RESEARCH METHODOLOGY AND IPR	ANY	2	0	0	30	2	50	50	100	2
9	MC	BNSK559	NATIONAL SERVICE SCHEME(NSS)	ANY	0	0	2	0	-	100	0	100	0
		BPEK559	PHYSICAL EDUCATION(PE)										
		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

BUCKET LIST E

PROFESSIONAL ELECTIVE BCD515X			
BCD515A	OPTIMISATION TECHNIQUES FOR DATA SCIENCE	BCD515D	DATA SECURITY AND PRIVACY
BCD515B	TIME SERIES ANALYSIS AND FORECASTING	BCD515E	COMPUTER VISION
BCD515C	THEORY OF COMPUTATION	BCD515F	ETHICS IN AI

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



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B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 6th Semester

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE(L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	IPCC	BCD601	BIG DATA ANALYTICS	CSE - CD	3	0	2	45	3	50	50	100	4
2	PCC	BCD602	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	CSE - CD	3	2	0	45	3	50	50	100	4
3	PEC	BCD613X	PROFESSIONAL ELECTIVE (PROVIDE LIST F)	CSE - CD	3	0	0	45	3	50	50	100	3
4	OEC	BXX654X	OPEN ELECTIVE (PROVIDE LIST G)	CSE& ALLIED	3	0	0	45	3	50	50	100	3
5	PROJ	BCD685	MAJOR PROJECT PHASE-1	CSE - CD	0	0	4	0	3	100	0	100	2
6	PCCL	BCDL606	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING LABORATORY	CSE - CD	0	0	2	0	3	50	50	100	1
7	AEC/SEC	BCDL657X	PROVIDE BUCKET LIST H	CSE - CD	IF COURSE IS THEORY				2	50	50	100	1
					1	0	0	15					
					IF COURSE IS PRACTICAL				3				
					0	0	2	0					
8	MC	BIKS608	INDIAN KNOWLEDGE SYSTEM	ANY	1	0	0	0	2	100		100	0
9	MC	BNSK659	NATIONAL SERVICE SCHEME(NSS)	ANY	0	0	2	0	2	100		100	0
		BPEK659	PHYSICAL EDUCATION(PE) (SPORTS AND ATHLETICS)										
		BYOK659	YOGA										
	TOTAL									600	300	900	18

BUCKET LIST F

PROFESSIONAL ELECTIVES			
BCD613A	LARGE LANGUAGE MODELS	BCD613C	SOCIAL NETWORK ANALYSIS
BCD613B	PATTERN RECOGNITION	BCD613D	QUANTUM MACHINE LEARNING

BUCKET LIST G

OPEN ELECTIVES			
BCS654A	INTRODUCTION TO DATA STRUCTURES	BCI654C	INTRODUCTION TO DBMS
BCY654B	FUNDAMENTALS OF OPERATING SYSTEMS	BCD654D	FOUNDATIONS OF DATA SCIENCE

BUCKET LIST H

ABILITY ENHANCEMENT COURSES			
BCDL657A	DEVOPS	BCDL657C	HEALTHCARE ANALYTICS
BCDL657B	GENAI	BCDL657D	FINANCIAL AND MARKETING

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



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Autonomous Scheme

(Effective from Academic Year 2024 – 25)



B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 7th Semester

SL NO	COURSE	COURS E CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	IPCC	BCD701	DEEP LEARNING AND REINFORCEMENT LEARNING	CSE - CD	3	0	2	45	3	50	50	100	4
2	IPCC	BCD702	BLOCK CHAIN TECHNOLOGY	CSE - CD	3	0	2	45	3	50	50	100	4
3	PCC	BCD703	CLOUD COMPUTING	CSE - CD	3	2	0	45	3	50	50	100	4
4	PEC	BCD71X	PROFESSIONAL ELECTIVE (PROVIDE LIST I)	CSE - CD	3	0	0	45	3	50	50	100	3
5	OEC	BXX755X	OPEN ELECTIVE (PROVIDE LIST J)	CSE & ALLIED	3	0	0	45	3	50	50	100	3
6	PROJ	BCD786	MAJOR PROJECT PHASE-2	CSE - CD	0	0	12	0	3	100	100	200	6
TOTAL										350	350	700	24

BUCKET LIST I

PROFESSIONAL ELECTIVE BCD714X

BCD714A	NATURAL LANGUAGE PROCESSING	BCD714C	APPLIED AI FOR DATA SCIENCE
BCD714B	COGNITIVE COMPUTING	BCD714D	DATA DRIVEN DECISION MAKING AND BUSSINESS INTELLIGENCE

BUCKET LIST J

OPEN ELECTIVE BXX755X

BCS755A	INTRODUCTION TO ALGORITHMS	BCD755C	FULL STACK WEB DEVELOPMENT
BCY755B	FOUNDATIONS OF INFORMATION SECURITY	BCI755D	INTRODUCTION TO MACHINE LEARNING

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B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 8th Semester

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL/ DRAWING (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	PEC	BCD811X	PROFESSIONAL ELECTIVE (PROVIDE LIST) (ONLINE)	CSE - CD	3	0	0	45	3	50	50	100	3
2	OEC	BCD852X	OPEN ELECTIVE (PROVIDE LIST) (ONLINE)	DEPT	3	0	0	45	3	50	50	100	3
3	INT	BCD803	INTERNSHIP (INDUSTRY / RESEARCH- MINIMUM 14 WEEKS)	CSE - CD	0	0	20	0	3	100	100	200	10
TOTAL										200	200	400	16

BUCKET LIST K

PROFESSIONAL ELECTIVE BCD811X			
BCD811A	BOS WILL PUBLISH COURSES BASED ON THE AVAILABILITY	BCD811C	
BCD811B		BCD811D	

BUCKET LIST L

OPEN ELECTIVE BCD852X			
BCD852A	BOS WILL PUBLISH COURSES BASED ON THE AVAILABILITY	BCD852C	
BCD852B		BCD852D	

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

B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 7th Semester

SCHEME - A - VII SEMESTER (Swappable VII and VIII SEMESTER)

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/ PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE(L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	IPCC	BCD701	DEEP LEARNING & REINFORCEMENT LEARNING	CSE - CD	3	0	2	45	3	50	50	100	4
2	IPCC	BCD702	BLOCK CHAIN TECHNOLOGY	CSE - CD	3	0	2	45	3	50	50	100	4
3	PCC	BCD703	CLOUD COMPUTING	CSE - CD	3	2	0	45	3	50	50	100	4
4	PEC	BCD714X	PROFESSIONAL ELECTIVE (BUCKET LIST I)	CSE - CD	3	0	0	45	3	50	50	100	3
5	OEC	BXX755X	OPEN ELECTIVE (BUCKET LIST J)	CSE & ALLIED	3	0	0	45	3	50	50	100	3
6	PROJ	BCD786	MAJOR PROJECT PHASE-2	CSE - CD	0	0	12	0	3	100	100	200	6
TOTAL										350	350	700	24



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BUCKET LIST I

PROFESSIONAL ELECTIVE BCD714X			
BCD714A	NATURAL LANGUAGE PROCESSING	BCD714C	APPLIED AI FOR DATA SCIENCE
BCD714B	COGNITIVE COMPUTING	BCD714D	DATA DRIVEN DECISION MAKING AND BUSINESS INTELLIGENCE

BUCKET LIST J

OPEN ELECTIVE BXX755X			
BCS755A	INTRODUCTION TO ALGORITHMS	BCD755C	FULL STACK WEB DEVELOPMENT
BCY755B	FOUNDATIONS OF INFORMATION SECURITY	BCI755D	INTRODUCTION TO MACHINE LEARNING

Abbreviations: PCC: Professional Core Course, PCCL: Professional Core Course Laboratory, PEC: Professional Elective Course, OEC: Open Elective Course, PR: Project Work, L: Lecture, T: Tutorial, P: Practical, SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation, TD: Teaching Department, PSB: Paper Setting Department, PROJ: Project Work.

Note: VII and VIII Semesters of IV Year of the Program

1. Institutions can swap the VII and VIII semester Schemes of Teaching and Examinations to accommodate research internships/industry internships after the VI semester.
2. Credits earned for the courses of VII and VIII semester Schemes of Teaching and Examinations shall be counted against the corresponding semesters, whether the VII or VIII semester is completed during the beginning of the IV year or the later part of the IV year of the program.

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



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B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 8th Semester

SCHEME - A - VIII SEMESTER (Swappable VII and VIII SEMESTER)

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/ PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	PEC	BCD811X	PROFESSIONAL ELECTIVE (BUCKET LIST K) (ONLINE)	ONLINE	3	0	0	45	3	50	50	100	3
2	OEC	BXX852X	OPEN ELECTIVE (BUCKET LIST L) (ONLINE)	ONLINE	3	0	0	45	3	50	50	100	3
3	INT	BCD803	INTERNSHIP (INDUSTRY/RESEARCH - MINIMUM 14 WEEKS)	CSE-DS	0	0	20	0	3	100	100	200	10
TOTAL										200	200	400	16

BUCKET LIST K

Professional Elective BCD801X			
BCD811A	BOS WILL PUBLISH COURSES BASED ON THE AVAILABILITY	BCD811C	
BCD811B		BCD811D	

BUCKET LIST L

Open Elective BCD802X			
BCD852A	BOS WILL PUBLISH COURSES BASED ON THE AVAILABILITY	BCD852C	
BCD852B		BCD852D	

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

B.E. in CSE (Data Science) : Autonomous Scheme and Syllabus 6th Semester

Scheme - B - VI SEMESTER for the candidates who seek a two - semester internship with project work/Start – up

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE(L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	IPCC	BCD601	BIG DATA ANALYTICS	CSE - CD	3	0	2	45	3	50	50	100	4
2	PCC	BCS602	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	CSE - CD	3	2	0	45	3	50	50	100	4
3	PEC	BCD613X	PROFESSIONAL ELECTIVE (BUCKET LIST F)	CSE - CD	3	0	0	45	3	50	50	100	3
4	OEC	BXX654X	OPEN ELECTIVE (BUCKET LIST G)	CSE& ALLIED	3	0	0	45	3	50	50	100	3
5	PCCL	BCDL606	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING LABORATORY	CSE - CD	0	0	2	0	3	50	50	100	1
6	AEC/SEC	BCST/L657X	(BUCKET LIST H)	CSE - CD	IF COURSE IS THEORY				2	50	50	100	1
					1	0	0	15					
					IF COURSE IS PRACTICAL				3				
					0	0	2	0					
7	MC	BIKS608	INDIAN KNOWLEDGE SYSTEM	ANY	1	0	0	0	2	100		100	0
8	MC	BNSK659	NATIONAL SERVICE SCHEME	ANY	0	0	2	0	2	100		100	0
		BPEK659	PHYSICAL EDUCATION										
		BYOK659	YOGA										
	TOTAL									500	300	800	16

PROVIDE BUCKET LIST F

PROFESSIONAL ELECTIVES			
BCD613A	LARGE LANGUAGE MODELS	BCD613C	SOCIAL NETWORK ANALYSIS
BCD613B	PATTERN RECOGNITION	BCD613D	QUANTUM MACHINE LEARNING

PROVIDE BUCKET LIST G

OPEN ELECTIVES			
BCS654A	INTRODUCTION TO DATA STRUCTURES	BCI654C	INTRODUCTION TO DBMS
BCY654B	FUNDAMENTALS OF OPERATING SYSTEMS	BCD654D	FOUNDATIONS OF DATA SCIENCE

PROVIDE BUCKET LIST H

ABILITY ENHANCEMENT COURSES			
BCDL657A	DEVOPS	BCDL657C	HEALTHCARE ANALYTICS
BCDL657B	GENAI	BCDL657D	FINANCIAL AND MARKETING

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

B.E. in CSE (Data Science): Autonomous Scheme and Syllabus 7th Semester

SCHEME - B - VII and VIII Semesters for the candidates who seek an internship with project work

SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term Work (TW) + Self Learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	IPCC	BCD701	TO BE COMPLETED IN 5TH/6TH SEMESTER	CSE - CD	3	0	2	45	3	50	50	100	4
2	IPCC	BCD702	TO BE COMPLETED IN 5TH/6TH SEMESTER	CSE - CD	3	0	2	45	3	50	50	100	4
3	PCC	BCD703	TO BE COMPLETED IN 5TH/6TH SEMESTER	CSE - CD	3	2	0	45	3	50	50	100	4
4	PEC	BCD714X	PROFESSIONAL ELECTIVE COURSE (MOOC COURSES)	CSE - CD	3	0	0	45	3	50	50	100	3
5	OEC	BXX755 X	OPEN ELECTIVE COURSES (MOOC COURSES)	CSE & ALLIED	3	0	0	45	3	50	50	100	3
1	PEC	BCD811X	PROFESSIONAL ELECTIVE COURSE (MOOC COURSES)	CSE - CD	3	0	0	45	3	50	50	100	3
2	OEC	BXX852 X	OPEN ELECTIVE COURSES (MOOC COURSES)	ANY	3	0	0	45	3	50	50	100	3
3	PROJ	BCD883	PROJECT-OUTCOME TRAINING	CSE-CD	0	0	12	0	3	100	100	200	9
4	INT	BCD804	INTERNSHIP (INDUSTRY/RESEARCH - (02 SEMESTERS)	CSE - CD	0	0	20	0	3	100	100	200	10
	TOTAL									550	550	1100	43



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BUCKET LIST K

PROFESSIONAL ELECTIVE BCD811X

BCD811A	BOS WILL PUBLISH COURSES BASED ON THE AVAILABILITY	BCD811C	
BCD811B		BCD811D	

BUCKET LIST L

OPEN ELECTIVE BCD852X

BCD852A	BOS WILL PUBLISH COURSES BASED ON THE AVAILABILITY	BCD852C	
BCD852B		BCD852D	

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

B.E. CSE (Data Science)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – V			
Course Title:	Software Engineering and Project Management		
Course Code:	BCS501	CIE MARKS	50
(L: T: P) + SL	(3:2:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	4	EXAM HOURS	3
Course Learning Objectives By the end of this course, students should be able to: 1. Understand the Fundamentals of Software Engineering, Principles of Software Engineering, Software Processes, and Process Models Used in Software Development. 2. Perform Requirements Engineering Activities and Develop Appropriate Software Requirement Models for Software Systems. 3. Apply Agile Development Practices, Scrum, and Software Configuration Management to Support Effective Software Development. 4. Plan and Manage Software Projects by Applying Project Management, Cost-Benefit Analysis, Risk Evaluation, and Stakeholder Management Techniques. 5. Assess Software Quality and Estimate Software Cost and Effort Using Software Quality Models, Testing Techniques, Reliability Concepts, Function Point Analysis and COCOMO II.			
Module – 1			9 Hours
Software and Software Engineering: The Nature of Software, Defining the Discipline, The Software Process, Software Engineering Practice. Process Models: A generic process model, Defining a Framework Activity, Identifying a Task Set, Prescriptive Process models, Product and Process Textbook 1: Chapter-1(1.1-1.4), Chapter-2(2.1-2.3,2.5-2.6)			
Module – 2			9 Hours
Understanding Requirements: Requirements Engineering, Establishing the Groundwork, Requirements Gathering, Developing Use Cases, Building Analysis Model, Negotiating Requirements, Requirements Monitoring, Validating Requirements. Requirements Modelling-A Recommended Approach: Requirement Analysis, Scenario Based Modelling, Class-Based Modelling, Functional Modelling, and Behavioural Modelling. Text book 1: Chapter-7 (7.1-7.8) Chapter-8 (8.1-8.5)			
Module – 3			9 Hours
Agility and Process: What is Agility? Agility and the Cost of Change, What is an Agile Process? Scrum, Other Agile Framework Principles that Guide Practice: Core Principles, Principles That Guide Each Framework Activity Software Configuration Management: Mobility and Agile Change Management Textbook 1: Chapter-3 (3.1-3.5) Chapter-6 (6.1-6.2) Chapter-22(22.6)			

Module – 4		9 Hours
Introduction to Software Project Management: Introduction, Why is Software Project Management Important? What is a Project? Software Project versus Other Types of Project, Contract Management and Technical Project Management, Activities Covered by Software Project Management, Plans, Methods and Methodologies, Some ways of Categorizing Software Projects, Stakeholders, Setting Objectives, The Business Case, Project Success and Failure, What is Management? Management Control, Traditional versus Modern Project Management Practices. Project Evaluation and Programme Management: Evaluation of Individual Projects, Cost-Benefit Evaluation Techniques, Risk Evaluation Textbook 2: Chapter-1 (1.1-1.15) Chapter-2 (2.4-2.6)		
Module – 5		9 Hours
Software Quality: Introduction, The Place of Software Quality in Project Planning, The Importance of Software Quality, Defining Software Quality, Product Versus Process Quality Management, Process Capability Models, Techniques to Help Enhance Software Quality, Testing, Software Reliability, Quality plans. Software Effort Estimation: Software Effort Estimation Techniques, Bottom-up Estimating, The Top-down Approach and Parametric Models, Expert Judgement, Albrecht Function Point Analysis, COSMIC Full Function Points, COCOMO II: Parametric Productivity Model, Cost Estimation, Staffing Pattern. Textbook 2: Chapter-13 (13.1-13.4,13.7,13.9-13.13) Chapter-5 (5.5-5.8, 5.10,5.12-5.15)		

COURSE OUTCOMES:

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

CO1	Understand the fundamental concepts of software, software engineering, software characteristics, and various software process models used in software development.
CO2	Apply requirements engineering principles to elicit, analyse, specify, validate, and manage software requirements.
CO3	Apply agile development principles, methodologies, and frameworks to manage software development processes.
CO4	Analyse software project management concepts and stakeholder management for successful project execution.
CO5	Analyse software quality attributes, software quality management practices, and software effort estimation techniques to evaluate software quality and project feasibility

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.			

Textbooks:

- Roger S. Pressman & Bruce R. Maxim:** “Software Engineering A Practitioner’s Approach” 9e 2023 Mc Graw Hill
- Bob Hughes, Mike Cotterell and Rajib Mall “Software Project Management” 5th edition 2011, Mc Graw Hill

Reference Books:

- Pankaj Jalote: An Integrated Approach to Software Engineering, 3rd Edition 2010 Narosa Publishing House
- Hans van Vliet: Software Engineering: Principles and Practice, 3rd Edition 2014 Wiley Publications

Web links:

- <https://www.geeksforgeeks.org/software-engineering/software-engineering/>
- <https://www.geeksforgeeks.org/business-studies/project-management/>
- <https://www.geeksforgeeks.org/software-engineering/scrum-software-development/>
- <https://confluence.atlassian.com/jira>

5. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs151
6. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs152
7. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs185

Self – Study topics:

1. **DevOps:** Learn about continuous integration/continuous delivery (CI/CD) pipelines, containerization (Docker), and infrastructure as code.
2. **Agile Methodologies:** Study agile frameworks like Scrum and Kanban for iterative and collaborative software development.

B.E. CSE (Data Science)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – V			
Course Title:	Computer Networks		
Course Code:	BCS502	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. Study the TCP/IP protocol suite, switching criteria and Medium Access Control protocols for reliable and noisy channels. 2. Learn network layer services and IP versions. 3. Discuss transport layer services and understand UDP and TCP protocols. 4. Demonstrate the working of different concepts of Application layer and multimedia networks.			
Module – 1			9 Hours
Introduction: Data Communications, Networks, Network Types, Network Models: Protocol Layering, TCP/IP Protocol suite, The OSI model, Introduction to Physical Layer: Transmission media: Guided Media, Unguided Media, Switching: Introduction, Circuit switched networks, Packet Switching.			
Textbook 1: Chapter-1 (1.1 - 1.3), Chapter-2 (2.1 - 2.3), Chapter-7 (7.2 – 7.3), Chapter-8 (8.1- 8.3)			
Module – 2			9 Hours
Data Link Layer: Error Detection and Correction: Introduction, Block Coding, Cyclic Codes, checksum, Data link control: DLC Services, Data link layer protocols, High Level Data Link Control, Media Access Control: Random Access, Controlled Access, Wired LANs: Ethernet: Standard Ethernet, IEEE 802.3, Wireless LANs: Introduction, IEEE 802.11 Project.			
Textbook 1: Chapter-10(10.1-10.4), Chapter-11 (11.1 -11.3), Chapter-12 (12.1 - 12.2), Chapter-13 (13.2), Chapter-15 (15.1-15.2.2)			
Module – 3			9 Hours
The Network layer: Data Plane: What's Inside a Router? Input Processing, Switching, Output Processing, Where Does Queuing Occur? The Internet Protocol: IPv4 Addressing, IPv6 and More, The Network layer: Control Plane: Introduction, Routing Algorithms, Intra-AS routing in the Internet: OSPF, Routing Among the ISPs: BGP.			
Textbook 2: Chapter-4 (4.2-4.3), Chapter-5 (5.1-5.4)			
Module – 4			9 Hours
Transport Layer: Introduction and Transport-Layer Services, Multiplexing and De multiplexing, Principles of Reliable Data Transfer, Connection-Oriented Transport TCP, Principles of Congestion Control, TCP Congestion Control.			
Textbook 2: Chapter-3 (3.1-3.7)			

Module-5	9 Hours
Application Layer: Principles of Network Applications, The Web and HTTP, Electronic Mail in the Internet, DNS, Peer-to-Peer file Distribution, Video Streaming and Content Distribution Networks, Socket Programming: creating Network Applications.	
Textbook 2: Chapter-2 (2.1-2.7)	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
PART A	
1	Develop a program for error detecting code using CRC-CCITT (16- bits).
2	Develop a program to implement a sliding window protocol in the data link layer.
3	Develop a program to find the shortest path between vertices using the Bellman-Ford routing algorithm.
4	Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present.
5	Develop a program on a datagram socket for client/server to display the messages on client side, typed at the server side.
6	Develop a program for congestion control using a leaky bucket algorithm.
PART B	
7	Test and verify Network configurations using Packet Tracer and explore static and dynamic routing algorithms.
8	Design a simple network topology and configure DHCP services using Cisco Packet Tracer
9	Design and simulate a Local Area Network (LAN) using Cisco Packet Tracer and configure an FTP server to allow file transfer between the server and client systems.
10	TCP/UDP Packet sniffing using Wire shark.
Open Ended Experiments	
1	HTTP Packet sniffing using Wire shark
2	Design and simulate a network using Cisco Packet Tracer and configure NAT services on a router to translate private IP addresses into public IP addresses.
3	Configure Inter VLAN network using Packet Tracer.

COURSE OUTCOMES:

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

CO1	Interpret and explain the fundamentals of data communications, network types, protocol layering, OSI and TCP/IP models, and switching techniques used in computer networks.
CO2	Analyze data link layer mechanisms including error detection and correction techniques, data link control protocols, and medium access control methods in wired and wireless LANs.

CO3	Apply network layer concepts to interpret router operations, IP addressing (IPv4 and IPv6), and routing algorithms including OSPF and BGP.
CO4	Evaluate transport layer protocols with respect to reliable data transfer, multiplexing, congestion control, and TCP performance.
CO5	Design and implement simple network applications using application layer protocols such as HTTP, FTP, DNS, Email, P2P systems, and socket programming concepts.

ASSESSMENT DETAILS (Both CIE and SEE)

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 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. Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, Tata McGraw-Hill, 2013.
2. James F Kurose and Keith W Ross, Computer Networking, A Top-Down Approach, Eighth edition, Pearson, 2023.

Reference Books:

1. Larry L. Peterson and Bruce S. Davie: Computer Networks – A Systems Approach, 4th Edition, Elsevier, 2019.
2. Nader F. Mir: Computer and Communication Networks, 2nd Edition, Pearson Education, 2015.
3. William Stallings, Data and Computer Communication 10th Edition, Pearson Education, Inc., 2014.
4. Multimedia Networks: Protocols, Design and Application Hans W. Barz, Gregory A. Bassett, WILEY publication, ISBN: 978-1-119-09013-7

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc25_cs125/preview
2. <https://www.coursera.org/learn/introduction-to-networking-nvidia>

Self-Study Topics:

1. Analyze various error detection and correction techniques.
2. Compare Distance Vector and Link State approaches, including Bellman-Ford and OSPF, with respect to convergence, scalability, and routing efficiency.
3. **Performance characteristics of TCP and UDP protocols** and examine their suitability for different network applications such as real-time streaming and reliable data transfer.

Activity Based Learning

1. Certifications (Skill based): Industry recognized certifications (NPTEL, CISCO, Infosys Springboard).
2. Quiz/Assignments.
3. Group Activities/Peer Learning.

B.E. CSE (DATA SCIENCE) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Foundations of Data Science		
Course Code:	BCD503	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> - Understand the fundamental concepts of data science. - Explain statistical and probabilistic concepts such as data types, sampling techniques, probability distributions, and inferential statistics for data-driven decision making. - Apply the data science methodology and analytics life cycle to solve real-world problems through structured stages like data discovery, preparation, modelling, and result communication. - Analyse and implement core machine learning techniques such as regression, classification, clustering, and evaluation methods. - Explore and apply text mining and basic natural language processing techniques.			
Module – 1			9 Hours
Introduction to 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. Textbook 1: Chapter 1			
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			
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			

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	
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	

Sl. No	EXPERIMENTS
1	A) Write a Python program to import a structured dataset representing organizational sales performance over multiple time periods. Ensure the dataset is loaded correctly and display its basic information. B) Write a Python program to create a Data Frame from the imported dataset and perform data exploration. Compute summary statistics, examine the dataset's structure, and identify key characteristics to understand the sales data.
2	A) Write a Python program to compute Key Performance Indicators (KPIs) for organizational sales data, including: Monthly average sales, Identification of peak performing and underperforming months. B) Write a Python program to calculate the percentage growth rate in sales across consecutive months using the same sales dataset, and interpret the results to understand sales trends and support data-driven decision-making.
3	A) Choose a dataset from Kaggle (e.g., Titanic, Customer Churn, or House Prices). Load the dataset in Python, inspect its structure, understand the features, and perform preliminary exploration to identify data types, missing values, and basic statistics. B) Using a selected Kaggle dataset, write a Python program to determine the total number of records (rows) and features (columns), and identify the data type of each feature, classifying it as numerical or categorical.
4	A) Write a Python program to load a sample dataset (e.g., CSV or Excel file) and display the data types of all columns. Analyze the output to determine which columns are numerical, categorical, or object type, which will help in selecting appropriate data processing and analysis techniques. B) Write a Python program to load a dataset, detect any missing values in each column, and calculate summary statistics (mean, median, standard deviation, minimum, maximum) for numerical features. Analyze the results to understand data quality and distribution before further processing.
5	A) Write a Python program to compute the mean and median of a given set of students' marks. Analyze the results and comment on any differences observed between the mean and median values, highlighting possible skewness in the dataset. B) Write a Python program to determine the skewness of a dataset containing students' marks. Use the calculated skewness to explain whether the data is positively skewed,

	negatively skewed, or symmetric, and discuss the implications for data interpretation.
6	A) Write a Python program to create a line chart that represents sales data over time. Use a sample dataset and plot the sales trend to analyze variations across the given time period. B) Write a Python program to create a bar chart that displays sales values for multiple products. Use a sample dataset and visualize the comparison to identify products with higher or lower sales.
7	A) Write a Python program to create a scatter plot that visualizes the relationship between two continuous variables (e.g., height vs. weight). Use a sample dataset to observe patterns, correlations, or trends between the variables. B) Write a Python program to create a pie chart that displays the proportion of different categories of household expenses (e.g., rent, groceries, utilities, transportation). Use a sample dataset to visualize how expenses are distributed across categories.
8	A) Write a Python program to create a histogram that represents the distribution of marks obtained by students in an examination. Use a sample dataset to identify patterns such as range, skewness, and concentration of marks. B) Write a Python program to create a density plot (KDE) that represents the distribution of salaries in a dataset. Use a sample dataset to observe the shape of the distribution and identify salary concentration regions.
9	A) Write a Python program to create a bar chart that represents sales values of multiple products. Use a sample dataset to analyze which products have higher or lower sales. B) Write a Python program to create a pie chart that displays the market share percentages of companies in a given sector. Use a sample dataset to compare the relative share of each company.
10	A) Write a Python program to create a stacked bar chart that visualizes monthly expenses divided into categories such as rent, groceries, utilities, and transportation. Use a sample dataset to analyze how each category contributes to the total expenses per month. B) Write a Python program to create a stacked area chart that displays yearly rainfall data categorized by regions. Use a sample dataset to analyze how the rainfall contribution of each region adds up to the total rainfall over time.

COURSE OUTCOMES:

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

CO1	Explain the Data Science ecosystem, distinguish it from Business Intelligence, and identify the essential tools and roles of a Data Scientist.
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)	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 test 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 8.
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 amaximum 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 and C.
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:

- Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare, “Fundamentals of Data Science”, 1st Edition, 2021, CRC press.
- Cathy O Neil, Rachel Schutt, “Doing Data Science-Straight Talk from the Frontline”, 2013, O'Reilly Media.

Reference Books:

1. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013
2. Peter Bruce, Andrew Bruce, “Practical Statistics for Data Scientists”, 2017, O'Reilly

Web links and Video Lectures (e-Resources):

1. <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. <https://nptel.ac.in/courses/106106212>

Alternate Assessment Methods:

1. Certifications (Skill Based)- industry recognized certifications. (Eg: CISCO, NPTEL, Infosys Springboard).
2. Assignments/ problem solving.
3. Quiz.
4. Mini Projects.
5. Group Activities / Peer Learning.
6. Presentations / Tech Talks.

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 (when to use what?)
5. Analyze a dataset and present insights

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System(CBCS) SEMESTER – V			
Course Title:	Data Engineering Laboratory		
Course Code:	BCDL504	CIE MARKS	50
(L :T : P) + SL	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> - Understand the fundamental concepts of data engineering and the role of data pipelines in modern data-driven systems. - Apply Python tools and libraries to clean, transform, and process various forms of datasets. - Analyze data workflows and select appropriate batch or streaming architectures for real-world scenarios. - Create automated, reliable ETL/ELT pipelines using modern tools such as Airflow, Spark, SQL and NoSQL systems.			
Program 1 – Data Ingestion and Exploration using Python			
To ingest and explore structured datasets such as the Iris Flower Dataset (CSV), Global Superstore Sales Dataset (Excel), and Employee Records Dataset (JSON) using Python by analyzing their structure, schema, data types, and descriptive statistics in order to understand the fundamental characteristics of the data.			
Program 2 –Data Cleaning and Preprocessing			
To clean and preprocess the Titanic Passenger Dataset (CSV) by handling missing values, removing duplicate records, detecting and treating outliers, and performing appropriate data type conversions in order to prepare the dataset for reliable downstream data engineering and analytical tasks.			
Program 3- Handling Semi-Structured Data (JSON & Logs)			
To ingest and process semi-structured datasets such as the E-Commerce Order Transactions Dataset (Nested JSON) and Apache Web Server Access Logs Dataset using Python by flattening nested data structures and transforming log records into a structured format suitable for efficient storage and downstream data engineering and analytical applications.			
Program 4 - Feature Engineering for Analytics			
Apply essential feature engineering techniques on a given Bike Sharing Dataset by creating, transforming, and encoding variables to enhance data quality and improve the effectiveness of subsequent analytical and machine learning tasks.			
Program 5 - Working with SQL for Data Operations			
Perform fundamental data operations using SQL, including table creation, data loading, querying, filtering, aggregation, and joining, in order to manage and analyse structured datasets effectively.			
Program 6 - NoSQL Data Handling (MongoDB)			
Perform essential data operations using a NoSQL database system by inserting, updating, querying, and aggregating semi-structured data to support flexible and scalable data storage requirements.			

Program 7 - Data Ingestion Pipeline (Batch)
Design and implement a batch data ingestion workflow that collects data from multiple sources and stores it in a structured or semi-structured repository for downstream processing using Retail Transactions Dataset.
Program 8 – ETL Pipeline using Apache Airflow
Build and schedule an ETL workflow using Apache Airflow by creating DAGs, defining task dependencies, and automating extract-transform-load operations using Daily Weather Dataset.
Program 9 - Data Transformation using PySpark
Perform distributed data processing and transformation tasks using PySpark through operations such as filtering, joining, aggregation, and writing results to storage on Network Logs Dataset.
Program 10 - Data Quality and Validation Pipeline
Assess and ensure data quality by applying schema validation, integrity checks, and automated data testing techniques using appropriate validation tools on Bank Loan Prediction Dataset.
Mini Project
- Students must form teams of 2 to 3 members. - Each team must identify and finalize a real-world problem for which End-to-End Data Engineering Pipeline can be applied. - Teams must ingest the data, store it in an appropriate database, perform Data Cleaning, apply Feature Engineering, orchestrate data pipelines, create data visualisation reports while maintaining data quality. - The complete project including source code, README file with instructions, and sample output screenshots must be uploaded to a public GitHub repository. - A mini project report (soft bound) must be prepared and submitted as per department guidelines. - Teams will present their project and undergo a viva voce as part of the final evaluation.

COURSE OUTCOMES

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

CO1	Explain fundamental concepts of data engineering, data processing paradigms, and the role of data pipelines in data-driven systems.
CO2	Apply Python tools and libraries to perform data ingestion, cleaning, transformation, and processing on diverse datasets.
CO3	Analyze data workflows and determine appropriate batch or streaming architectures for real-world data engineering scenarios.
CO4	Design and implement automated, reliable ETL/ELT pipelines using modern tools such as Airflow, Spark, SQL and NoSQL systems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Mark	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.			

Reference Books:

1. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
2. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media.
3. Hadley Wickham & Garrett Grolemund, *R for Data Science*, O'Reilly (for EDA concepts).

Web links:

1. Pandas Documentation (EDA & Data Handling): <https://pandas.pydata.org/docs/>
2. Scikit-learn (Data Analysis & Preprocessing): <https://scikit-learn.org/stable/>
3. Apache Spark (Big Data Processing with PySpark): <https://spark.apache.org/docs/latest/>
4. Apache Airflow (ETL Pipeline Orchestration): <https://airflow.apache.org/docs/>
5. MongoDB Documentation (NoSQL Data Handling): <https://www.mongodb.com/docs/>

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Optimization Techniques for Data Science		
Course Code:	BCD515A	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. To introduce the fundamental concepts of optimization, mathematical formulation, derivatives, gradients, and optimality conditions for engineering applications. 2. To understand numerical optimization methods such as bracketing, local descent, line search, and trust region approaches for solving single-variable and multivariable problems. 3. To explore and analyze first-order and second-order gradient-based optimization algorithms used in scientific and machine learning domains. 4. To apply direct search, stochastic search, population-based evolutionary algorithms, and constraint-based optimization techniques to real-world optimization problems.			
Module – 1			9 Hours
Introduction: A History, Optimization Process, Mathematical Formulation, Applications, Minima, Optimality conditions. Derivatives and Gradients: Derivatives, Derivatives in Multiple Dimensions, Numerical Differentiation, Automatic Differentiation, Regression Gradient, Simultaneous Perturbation, Stochastic Gradient Approximation. Textbook 1: Chapter-1 (1.1-1.6), Chapter-2 (2.1-2.6)			
Module – 2			9 Hours
Bracketing: Unimodality, Finding an Initial Bracket, Fibonacci Search, Golden Section Search, Quadratic Fit Search, Shubert-Piyavskii Method, Bisection Method. Local Descent: Descent Direction Iteration, Step Factors, Line Search, Approximate Line Search, Trust Region Methods, Termination Conditions. Textbook: Chapter-3 (3.1-3.7), Chapter-4 (4.1-4.6)			
Module – 3			9 Hours
First-Order Methods: Gradient Descent, Conjugate Gradient, Momentum, Nesterov Momentum, AdaGrad, RMSProp, Adadelata, Adam, Hypergradient Descent. Second-Order Methods: Newton's Method, Secant Method, Levenberg-Marquardt Algorithm, Levenberg-Marquardt for Sum of Squares, Quasi-Newton Methods. Textbook: Chapter-5 (5.1-5.9), Chapter-6 (6.1-6.5)			

Module – 4	9 Hours
Direct Methods: Cyclic Coordinate Search, Powell's Methods, Hooke-Jeeves, Generalized Pattern Search, Nelder-Mead Simplex Method, Divided Rectangles. Stochastic Methods: Noisy Descent, Mesh Adaptive Direct Search, Memory-Efficient Zeroth-Order Optimization, Simulated Annealing, Cross-Entropy Method. Textbook: Chapter-7 (7.1-7.6), Chapter-8 (8.1-8.5)	
Module – 5	9 Hours
Population Methods: Population Iteration, Genetic Algorithms, Differential Evolution, Particle Swarm Optimization, Firefly Algorithm, Cuckoo Search, Hybrid Methods Constraints: Constrained Optimization, Constraint Types, Transformer to Remove Constraints, Removing Affine Equality Constraints. Textbook: Chapter-9 (9.1-9.7), Chapter-10 (10.1-10.4)	

COURSE OUTCOMES:

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

CO1	Understand fundamentals and gradient principles
CO2	Apply bracketing and descent-based optimization techniques
CO3	Analyze first & second-order learning algorithms
CO4	Apply direct and stochastic optimization methods
CO5	Evaluate population-based and constrained optimization techniques for real-world problems

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.			

Textbook:

- Mykel J. Kochenderfer, Tim A. Wheeler, “Algorithms for Optimization”, MIT Press Cambridge, 2nd Edition, 2019.

Reference Books:

- Andries P. Engelbrecht, “Computational Intelligence An Introduction”, John Wiley & Sons, Ltd Publisher, 2002.
- Edwin K. P. Chong, Stanislaw, H. Zak, “An Introduction to Optimization”, Second Edition, John Wiley & Sons, Ltd Publisher, 2004.

Web links:

- Lovekush Chaurasia, Amol Borse, “Optimization Algorithms for Machine Learning Models”, Global Logic Publisher, 2020
- URL: <https://www.globallogic.com/wp-content/uploads/2020/02/Optimization-Algorithms-for-Machine-Learning-1.pdf>

Self – Study topics:

- Gradient Descent:** Learn batch, stochastic, and mini-batch gradient descent methods and their role in training machine learning models.
- Convex Optimization:** Study convex functions and why they ensure finding global optimal solutions.
- Hyperparameter Tuning:** Explore techniques like grid search and random search to improve model performance.

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Time Series Analysis and Forecasting		
Course Code:	BCD515B	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: 1. To explain the fundamental advantages and the necessity of forecasting in business, engineering, and real-world decision-making situations. 2. To understand and determine how to choose an appropriate forecasting method based on the characteristics of the environment and nature of available data. 3. To collect relevant data and apply different forecasting techniques—both qualitative and quantitative—using suitable statistical or analytical software. 4. To evaluate and compare forecasting results using statistical accuracy measures to determine the effectiveness of models. 5. To enhance forecasting accuracy by building improved statistical models through rigorous analysis, model diagnostics, and refinement.			
Module – 1			9 Hours
An Introduction to Forecasting: Forecasting and Data. Forecasting Methods. Errors in Forecasting. Choosing a Forecasting Technique. An Overview of Quantitative Forecasting Techniques. Regression Analysis: The Simple Linear Regression Model. The Least Squares Point Estimates. Point Estimates and Point Predictions. Model Assumptions and the Standard Error. Testing the Significance of the Slope and y Intercept. Confidence and Prediction Intervals. Simple Coefficients of Determination and Correlation. An F Test for the Model. Textbook 1: Chapter 1 & 2 (Part-I)			
Module – 2			9 Hours
Multiple Linear Regressions: The Linear Regression Model. The Least Squares Estimates, and Point Estimation and Prediction. The Mean Square Error and the Standard Error. Model Utility: R ² , Adjusted R ² , and the Overall F Test. Model Building and Residual Analysis: Model Building and the Effects of Multicollinearity. Residual Analysis in Simple Regression. Residual Analysis in Multiple Regressions. Diagnostics for Detecting Outlying and Influential Observations. Textbook 1: Chapter 3, 4 & 5 (Part-II)			
Module – 3			9 Hours
Time Series Regression: Modeling Trend by Using Polynomial Functions. Detecting Autocorrelation. Types of Seasonal Variation. Modeling Seasonal Variation by Using Dummy Variables and Trigonometric Functions. Growth Curves. Handling First-Order Autocorrelation. Decomposition Methods: Multiplicative Decomposition. Additive Decomposition. The X-12-ARIMA Seasonal Adjustment Method. Exercises. Exponential Smoothing: Simple Exponential			

Smoothing. Tracking Signals. Holt's Trend Corrected Exponential Smoothing. Holt-Winters Methods. Damped Trends and Other Exponential.

Textbook 1: Chapter 6, 7 & 8 (Part- III)

Module – 4

9 Hours

Non-seasonal Box-Jenkins Modeling and Their Tentative Identification: Stationary and Non-stationary Time Series. The Sample Autocorrelation and Partial Autocorrelation Functions: The SAC and SPAC. An Introduction to Non seasonal Modeling and Forecasting. Tentative Identification of Non-Seasonal Box-Jenkins Models. Estimation, Diagnostic Checking, and Forecasting for Non-Seasonal Box-Jenkins Models: Estimation. Diagnostic Checking. Forecasting. A Case Study. Box-Jenkins Implementation of Exponential Smoothing.

Textbook 1: Chapter 9 & 10 (Part- IV)

Module – 5

9 Hours

Box-Jenkins Seasonal Modeling: Transforming a Seasonal Time Series into a Stationary Time Series. Examples of Seasonal Modeling and Forecasting. Box-Jenkins Error Term Models in Time Series Regression.

Advanced BoxJenkins Modeling: The General Seasonal Model and Guidelines for Tentative Identification. Intervention Models. A Procedure for Building a Transfer Function Model Causality in time series: Granger causality. Hypothesis testing on rational expectations. Hypothesis testing on market efficiency.

Textbook 1: Chapter 11 & 12 (Part- IV)

COURSE OUTCOMES:

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

CO1	Describe the fundamental advantages and necessity of forecasting in diverse business and engineering environments, demonstrating an understanding of its role in decision-
CO2	Identify and select an appropriate forecasting method for a given organizational or operational context by analyzing environmental factors and data characteristics.
CO3	Apply various quantitative and qualitative forecasting techniques, including data collection and computational procedures, using suitable statistical tools or software.
CO4	Analyze and interpret forecasting results to evaluate model performance, accuracy, and reliability based on statistical measures.
CO5	Improve and refine forecasts by <i>developing and validating</i> enhanced statistical models grounded in empirical data analysis and model diagnostics.

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. 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

- Forecasting, Time Series, and Regression, Bruce L. Bowerman, Richard O'Connell, Anne Koehler, Cengage Learning, 2004

Reference Book:

- The Econometric Modelling of Financial Time Series, Terence C. Mills, Raphael N. Markellos, Cambridge University Press, 2008

Self-Study Topics:

- Deep Learning for Time Series:
- RNN, LSTM, GRU
- Transformer-based forecasting
- Hybrid models (ARIMA + ML)
- Anomaly detection in time series



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RNS INSTITUTE OF TECHNOLOGY

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

Department of CSE (Data Science)

Autonomous Scheme
(Effective from Academic Year 2024 – 25)



- Multivariate time series forecasting
- Applications in:
 - Healthcare (useful for your ovarian cancer research)
 - Finance
 - IoT

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Theory of Computation		
Course Code:	BCD515C	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 core concepts in Automata and Theory of Computation. 2. Identify different Formal Language Classes and their Relationships. 3. Learn concepts of Grammars and Recognizers for different formal languages. 4. Prove or disprove theorems in automata theory using their properties. 5. Determine the decidability and intractability of Computational problems.			
Module – 1			9 Hours
Introduction to Finite Automata, Structural Representations, Automata and Complexity. The Central Concepts of Automata Theory. Deterministic Finite Automata, Nondeterministic Finite Automata, An Application: Text Search, Finite Automata with Epsilon-Transitions. Textbook 1: Chapter -1 (1.1, 1.5), Chapter-2 (2.2, 2.3, 2.4, 2.5)			
Module – 2			9 Hours
Regular Expressions, Finite Automata and Regular Expressions, Proving Languages not to be Regular. Closure Properties of Regular Languages, Equivalence and Minimization of Automata, Applications of Regular Expressions. Textbook 1: Chapter -3 (3.1, 3.2 (Except 3.2.1), 3.3), Chapter - 4 (4.1, 4.2, 4.4)			
Module – 3			9 Hours
Context-Free Grammars, Parse Trees, Ambiguity in Grammars and Languages, Ambiguity in Grammars and Languages, Definition of the Pushdown Automaton, The Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata. Textbook 1: Chapter -5 (5.1, 5.2, 5.4), Chapter -6 (6.1, 6.2, 6.3.1, 6.4)			
Module – 4			9 Hours
Normal Forms for Context-Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages. Textbook 1: Chapter -7 (7.1, 7.2, 7.3)			
Module – 5			9 Hours
Introduction to Turing Machines: Problems That Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Undecidability: A Language That Is Not Recursively Enumerable. Textbook 1: Chapter -8 (8.1, 8.2, 8.3, 8.4), Chapter-9 (9.1, 9.2)			

COURSE OUTCOMES:

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

CO1	Apply the fundamentals of automata theory to write DFA, NFA, Epsilon-NFA and conversion between them.
CO2	Prove the properties of regular languages using regular expressions.
CO3	Design context-free grammars (CFGs) and pushdown automata (PDAs) for formal languages.
CO4	Design Turing machines to solve the computational problems.
CO5	Describe the concepts of decidability and undecidability.

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.			

Textbook

1. **John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman**, “Introduction to Automata Theory, Languages and Computation”, Second Edition, Pearson.

Reference Books

1. **Elain Rich**, “Automata, Computability and complexity”, 1st Edition, Pearson Education, 2018.
2. **K.L.P Mishra, N Chandrashekar**, 3rd Edition, “Theory of Computer Science”, PHI, 2012.
3. **Peter Linz**, “An introduction to Formal Languages and Automata”, 3rd Edition, Narosa, Publishers, 1998.
4. **Michael Sipser**: “Introduction to the Theory of Computation”, 3rd edition, Cengage learning, 2013.
5. **John C Martin**, “Introduction to Languages and The Theory of Computation”, 3rd Edition, Tata McGraw –Hill Publishing Company Limited, 2013.

Web links and Video Lectures (e-Resources):

- <https://archive.nptel.ac.in/courses/106/105/106105196/>
- <https://archive.nptel.ac.in/courses/106/106/106106049/>
- <https://nptelvideos.com/course.php?id=717>

Self-study topics:

- Applications of Finite Automata in real-world systems (e.g., text search, lexical analysis)
- Advanced problems on DFA/NFA design and state minimization
- Proof techniques for non-regular and non-context-free languages (Pumping Lemma)
- Ambiguity in Context-Free Grammars and methods to remove ambiguity
- Practical relevance of Pushdown Automata in parsing
- Introduction to undecidability and real-world implications of Turing Machines
- Case studies on problems that are not recursively enumerable

Activity-Based Learning:

1. JFLAP (Java Formal Languages and Automata Package) – Design and simulate DFA/NFA to visualize state transitions.
2. Use JFLAP to construct Regular Grammars, CFGs, PDA, and Turing Machines, and validate their behavior through step-by-step execution.
3. Analyze language acceptance, ambiguity, and computation traces using simulation tools. Perform automata minimization, NFA to DFA conversion, and CFG to PDA transformations using JFLAP.

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Data Security and Privacy		
Course Code:	BCD515D	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 basics of, Security, its principle and Cryptography 2. To study various symmetric and asymmetric cryptographic Algorithm 3. Apply the knowledge of Cryptography to various fields 4. Study the key management system 5. Understand the necessity of data security.			
Module – 1			9 Hours
Computer and Network Security Concepts: Information Security and Network Security, Security Attacks, Security Services, A model for Network Security. Classical encryption techniques: Symmetric cipher model, Substitution Techniques: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Polyalphabetic Ciphers. Transposition Techniques Block Ciphers and Data Encryption Standards: Traditional Block Cipher structures, data Encryption Standard (DES), A DES Example, The strength of DES, Block cipher design principles. Textbook 1: Chapter-1(1.1,1.3,1.4,1.8), Chapter-3 (3.1,3.2,3.3), Chapter-4 (4.1,4.2,4.3,4.4,4.5)			
Module – 2			9 Hours
Public key cryptography and RSA: Principles of public key cryptosystems -Public key cryptosystems, Applications for public key cryptosystems, Requirements for public key cryptography, public key Cryptanalysis The RSA algorithm: Description of the Algorithm, Computational aspects, The Security of RSA Other Public Key Cryptosystems: Diffie-Hellman key exchange, Elliptic Curve Cryptography Textbook 1: Chapter-9 (9.1, 9.2), Chapter-10 (10.1, 10.4)			
Module – 3			9 Hours
Digital Signature: Digital Signatures, NIST Digital signature algorithm Cryptographic Key management and distribution: Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, X.509 Certificates, Public Key Infrastructures Textbook 1: Chapter-13 (13.1,13.4), Chapter-15 (15.1,15.2,15.3,15.4,15.5)			

Module – 4	9 Hours
Transport-Level Security: Web security consideration, Transport layer security. IP Security: IP Security overview, IP Security Policy, Encapsulating Security Payload, Combining security associations, Internet key exchange. Textbook 1: Chapter- 17 (17.1, 17.2), Chapter-20 (20.1, 20.2, 20.3 20.4, 20.5)	
Module – 5	9 Hours
Data Security: Data Security: Data hiding in Text-Basic features, Applications of data hiding, Watermarking, Intuitive Methods, Simple Digital methods, Data hiding in Text, Innocuous Text, Mimic Functions. Data hiding in Images: LSB encoding, BPCS Steganography, Lossless data hiding Textbook 2: Chapter-10 (10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8) , Chapter-11(11.1, 11.2, 11.3)	

COURSE OUTCOMES:

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

CO1	Illustrate the basic concepts of Cryptography and Security aspects
CO2	Analyse various Cryptographic Algorithm.
CO3	Describe various key management scenarios.
CO4	Analyse IP security and Web security.
CO5	Apply the Data security concepts for Text and images.

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.			

Textbooks:

1. Cryptography and Network Security”, William Stallings, Pearson Publication, eighth Edition.
2. Data Privacy and Security, Salomon, David, Springer, 2003.

Reference Books:

1. Cryptography and Network Security, Behrouz A Forouzan, Dedeep Mukhopadhyay, TMH, 6th edition, 2021.
2. Information Security: Principles and practice, Mark Stamp, Wiley Inter Science, 2011

Web links:

1. <https://www.geeksforgeeks.org/cryptography-and-network-security/>
2. <https://www.khanacademy.org/computing/computer-science/cryptography>
3. [Open NPTEL Cryptography and Network Security Course](#)
4. https://www.tutorialspoint.com/cryptography/cryptography_steganography.htm

Self – Study topics:

1. Difference between **active vs passive attacks**.
2. Real-world applications (HTTPS, banking systems).
3. Certificate Authorities (CA).
4. VPN working using IPsec.
5. Tools used for data hiding.

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Computer Vision		
Course Code:	BCD515E	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 of computer vision and digital image processing. 2. Explain the processes involved in image enhancement and image restoration. 3. Demonstrate knowledge of color image processing techniques and morphological operations. 4. Apply appropriate techniques for image segmentation in various applications. 5. Utilize object detection and recognition methods to analyse and interpret visual data.			
Module – 1			9 Hours
Introduction: What is computer vision? A brief history. Image Formation: Photometric image formation, The digital camera. Image processing: Point operators, Linear filtering. Textbook 1: Chapter - 1 (1.1, 1.2), Chapter-2 (2.2, 2.3), Chapter-3 (3.1, 3.2)			
Module – 2			9 Hours
Image processing: More neighbourhood operators, Fourier transforms, Pyramids and wavelets, and Geometric transformations. Textbook 1: Chapter - 3 (3.3 - 3.6)			
Module – 3			9 Hours
Image Restoration and Reconstruction: A model of Image degradation/restoration process, restoration in the presence of noise only, periodic noise reduction by frequency domain filtering. Image Segmentation: Fundamentals, Point, Line and edge detection, thresholding (Foundation & Basic global thresholding only), Segmentation by region growing & region splitting & merging. Textbook 2: Chapter - 5 (5.1 to 5.4), Chapter -10 (10.1 to 10.3.2, 10.4)			
Module – 4			9 Hours
Color Image Processing: Color fundamentals, color models, Pseudocolor image processing, full color image processing, color transformations, color image smoothing and sharpening, Using color in image segmentation, Noise in color images. Textbook 2: Chapter - 6 (6.1-6.8)			

Module – 5	9 Hours
Morphological Image Processing: Preliminaries, Erosion and Dilation, opening and closing, Hit-or-miss transform, some basic morphological algorithms. Feature Extraction: Background, Boundary preprocessing (Boundary following & Chain codes only). Image pattern Classification: Background, Patterns and classes, Pattern classification by prototype matching (Minimum distance classifier only).	
Textbook 2: Chapter - 9 (9.1-9.5), Chapter – 11 (11.1-11.2.2), Chapter - 12 (12.1-12.3.1)	

COURSE OUTCOMES:

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

CO1	Describe the fundamentals of computer vision and its applications.
CO2	Apply the image enhancement techniques for smoothing and sharpening of images.
CO3	Compare the different image restoration and segmentation techniques.
CO4	Demonstrate the smoothing and sharpening techniques for color images.
CO5	Analyse morphological, feature extraction, and pattern classification techniques for object recognition.

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.**

Textbooks:

1. Richard Szeliski, *Computer Vision: Algorithms and Applications* (Texts in Computer Science), 2nd Edition, 2022, Springer.
2. Rafael C. Gonzalez, Woods R. E., and Eddins S. L., *Digital Image Processing*, Pearson, 4th Edition, 2019.

Reference Books:

1. **David Forsyth and Jean Ponce**, *Computer Vision: A Modern Approach*, 2nd Edition, Pearson, 2015.
2. **Reinhard Klette**, *Concise Computer Vision – An Introduction into Theory and Algorithms*, Springer, 2014.

Web links:

1. Virtual Labs: <https://cse19-iiith.vlabs.ac.in/>
2. https://onlinecourses.nptel.ac.in/noc21_ee78/preview
3. Introduction to Machine Vision (YouTube): <https://www.youtube.com/watch?v=tY2gczObpfU>
4. https://coral.ise.lehigh.edu/optml/files/2019/10/OptML_CV_tutorial_1_compressed.pdf

Self – Study topics:

1. Implementation of important concepts of Image enhancement (point & filters) and restoration techniques with C++/Java/Python
2. Implementation of segmentation, Morphological and color image processing techniques with C++/Java/Python

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Ethics in AI		
Course Code:	BCD515F	CIE MARKS	50
(L :T : P) + SL	(3:0:0) + (45 hours)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to 1. Study the morality and ethics in AI. 2. Learn about the Ethical initiatives in the field of Artificial Intelligence. 3. Study about AI standards and Regulations. 4. Study about social and ethical issues of Robot Ethics 5. Study about AI and Ethics challenges and opportunities			
Module-1			9 Hours
Introduction: Definition of morality and ethics in AI-Impact on society- Impact on human psychology-Impact on the legal system –Impact on the environmental and the planet-Impact on trust.			
Textbook 1: Chapter 1 (1.1 - 1.3), Chapter 2 (2.1 - 2.3), Chapter 7 (7.1 – 7.3), Chapter (8.3)			
Module-2			9 Hours
Ethical Initiatives In AI: International ethical initiatives-ethical harms and concerns-case study: healthcare and robots, Autonomous Vehicles, Warfare and weaponization.			
Textbook 1: Chapter 10 (10.1-10.4), Chapter 11 (11.1 -11.4), Chapter 12 (12.1 - 12.2)			
Module-3			9 Hours
AI Standards and Regulations: Model process for Addressing Ethical Concerns During system Design, Transparency of Autonomous System –Data Privacy Process, Algorithmic Bias Considerations, Ontological Standard of Ethically Driven Robotics and Automation System.			
Textbook 1: Chapter 18 (18.1, 18.2, 18.4), Chapter 22 (22.2), Chapter 20 (20.1-20.3), Chapter 21 (21.3.2)			
Module-4			9 Hours
Rob ethics Social and Ethical Implication of Robotics: Robot-Rob ethics, Ethics and Morality, Moral Theories-Ethics in Science and Technology, Ethical Issues in an ICT society, Harmonization of Principles, Ethics and Professional Responsibility Rob ethics Taxonomy.			
Textbook 1: Chapter 23 (23.1- 23.2), Chapter 24 (24.1-24.3.4, 24.3.6-24.3.9)			

Module-5	9 Hours
Ethical Issues in artificial intelligence, Societal issues concerning the application of Artificial Intelligence in Medicine, Decision making roles in industries, National and International strategies in AI. Textbook 1: Chapter 25 (25.1-25.2), Chapter 26 (26.1-26.6)	

COURSE OUTCOMES:

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

CO1	Learn about morality and ethics in AI.
CO2	Acquire the knowledge of real time applications ethics, issues and challenges
CO3	Understand the ethical harms and ethical initiatives in AI
CO4	Learn about AI standards and Regulations like AI Agent, Safe Design of Autonomous and Semi – Autonomous Systems
CO5	Understand the concepts of Rob ethics and Morality with professional Responsibilities

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.			



Textbook:

1. Eleanor **Bird**, **Jasmin Fox-Skelly**, **Nicola Jenner**, **Ruth Larbey**, **Emma Weitkamp**, and **Alan Winfield**. The Ethics of Artificial Intelligence: Issues and Initiatives. EPRS| European Parliamentary Research Service, Scientific Foresight Unit(STOA), PE 634.452-March 2020.

Reference Books:

1. **Paula Boddingtons**. Towards a code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory and Algorithms) November 2017.
2. **Mark Coeckelbergh** AI Ethics The MIT Press-Essential Knowledge Series, April 2020.

Web links:

- https://arxiv.org/abs/1907.07892?utm_source=chatgpt.com
- <https://arxiv.org/abs>
- <https://arxiv.org/abs/1801.08572>

Self-Study Topics:

1. Basics of Data Analysis
2. Python for EDA
3. Data Cleaning
4. Data Visualization
5. Exploratory Techniques
6. Working with Real Datasets

B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – IV			
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. 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 environmental protection.

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 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.

B.E. (Common to all branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – IV / 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: <i>The purpose of the course is to facilitate the learner to:</i> 1. Familiarize the students with the basic biological concepts and their engineering applications. 2. Enable the students with an understanding of bio design principles to create novel devices and structures. 3. Provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems. 4. Motivate the students to develop 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
Introduction to 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, food processing, enzymes in biobleaching, Lipids in biodiesel and detergents production.			
Module-3			6 Hours
Introduction to adaptations of anatomical principles for bioengineering design, Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as purification system. Kidney as a filtration system.			
Module-4			6 Hours
Introduction to nature inspired biomaterials and mechanisms, Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Artificial blood - haemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).			
Module-5			6 Hours
Introduction to 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 the basic biological concepts for relevant industrial applications. adaptation.
CO3	Evaluate the principles of design and development, for exploring engineering knowledge in biological
CO4	Think critically towards exploring innovative biobased solutions for socially relevant problems.

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 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. Basuchandra's Biology for Engineers, Chandra shekara. 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.
3. Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
5. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
6. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
7. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.

8. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
9. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha, A C Udayashankar, Lambert Academic Publishing, 2019.

B.E. (CSE and Allied Branches)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
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 hrs
COURSE LEARNING OBJECTIVES:			
1. Understand the fundamental concepts of research and its various types. 2. Apply the principles of literature review, technical reading, attribution, and citation in academic 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 Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.			
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 research 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 Development 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			
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
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 Nejakar, Dr. Harish Bendigeri “Research Methodology and Intellectual Property Rights”, ISBN 978-93-5987-928-4, Edition: 2023-24.

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-

Weblinks and Video Lectures (e-Resources):

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

- Quizzes • Assignments • Seminars

B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) 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.

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/>

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title	PHYSICAL EDUCATION		
Course Code	BPEK559	CIE MARKS	100
(L : T : P)	(0:0:2)	SEE MARKS	—
Credits	—	EXAM HOURS	—

Course Learning Objectives

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 developing and maintaining a healthy lifestyle.

Module-1

3 Hours

110 Mtrs and 400Mtrs:

1. Hurdling Technique: Lead leg Technique, Trail leg Technique
2. Crouch start (its variations) use of Starting Block.

Module-2

3 Hours

High Jump

- a) Approach Run
- b) Take-off
- c) Bar Clearance (Straddle)
- d) Landing

Module-3

3

Hours

Discus Throw

- a) Holding the Discus
- b) Initial Stance Primary Swing
- c) Rotation
- d) Release and Recovery (Rotation in the circle)

Module-4	3 Hours
I. Fundamental skills a) 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. b) Trapping: Trapping the Rolling ball and the Bouncing ball with sole of the foot. c) Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot. d) Heading: In standing, running and jumping condition. e) Throw-in: Standing throw-in and Running throw-in. f) Tackling: Simple Tackling, Slide Tackling. g) Goal Keeping: Collection of Ball, Ball clearance- kicking, throwing and deflecting. h) Game practice with application of Rules and Regulations II. Rules and their interpretation and duties of the officials	
Module-5	3 Hours
I. Fundamental skills a) Passing: Short pass, Long pass, push pass, hit b) Trapping. c) Dribbling and Dozing. d) Penalty stroke practice. e) Penalty corner practice. f) Tackling: Simple Tackling, Slide Tackling. g) Goal Keeping, Ball clearance- kicking and deflecting. h) Game practice with application of Rules and Regulations II. 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.

CO4	Demonstrate fundamental skills of football such as kicking, trapping, dribbling, heading, throw-in, tackling and goalkeeping along with understanding rules and officiating.
CO5	Exhibit basic skills and techniques in hockey, including passing, trapping, dribbling, tackling, penalty strokes/corners and understand rules and duties of officials.

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,
4. Rules of Play, Teaching Hints and Fundamentals by Louis E. Mean

Reference Books:

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

B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	YOGA		
Course Code:	BYOK559	CIE MARKS	100
L : T : P:	(0:0:2)	SEE MARKS	0
Credits:	0	EXAM HOURS	-
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Physical, Mental and Spiritual objectives of Yoga 2. Explain the meaning of Yoga 3. Discuss the importance of Yoga and its scope 4. Describe the aims and objectives of Yoga 5. Clarify the misconceptions on Yoga			
Module-1			
Suryanamaskar 12 count 6 rounds 1. Suryanamaskar prayer. 2. Meaning, need & Importance 3. Benefits of Suryanamaskara			
Module-2			
1. Meaning and definition. 2. Brief introduction of yogic practices for the common man 3. Rules and regulations 4. Misconceptions of Yoga			
Module-3			
Need and importance of different Asanas, 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			
Need and importance of different Asanas, meaning by name, technique, precautionary measures and benefits of each asana. Supine line 1. Sarvangasana 2. Chakraasana			
Module-5			

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

Pranayama:

1. Ujjayi
2. Sheetali
3. 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, Sheetali) to improve breathing control, concentration and overall health.

ASSESSMENT AND EVALUATION REGULATIONS OF MC

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 by Sri Swami Satchidananda.
2. Light on Yoga by B.K.S. Iyengar.

Reference Books:

1. The Heart of Yoga by T.K.V. Desikachar.
2. Asana Pranayama Mudra Bandha by Swami Satyananda Saraswati <https://pledge.mygov.in>



VI Semester

B.E. CSE (DATA SCIENCE)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	Big Data Analytics		
Course Code:	BCD601	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 purpose of the course is to facilitate the learner to:			
1. To implement MapReduce programs for processing big data.			
2. To realize storage and processing of big data using MongoDB, Pig, Hive and Spark.			
3. To analyse big data using machine learning techniques.			
Module-1		9 Hours	
Introduction to Big Data: Classification of digital data, Characteristics, Evolution, definition and challenges of big data, what is big data, Why Big data, Typical data warehouse and Hadoop environment, Traditional Business Intelligence Vs Big Data, Typical data warehouse and Hadoop environment.			
Introduction to Big Data Analytics: What Big Data Analytics, Classification of Big Data, Classification of Analytics, why big Data Analytics is important, Data Science, Data Scientist, Terminologies Used In Big Data Environments, Top Analytics Tools			
Textbook 1: Chapter - 1, Chapter - 2:(2.1 to 2.11) Chapter - 3: (3.2, 3.5, 3.8, 3.10-3.12, 3.14)			
Module-2		9 Hours	
Hadoop: Introducing Hadoop, Why Hadoop, why not RDBMS, RDBMS versus Hadoop, Distributed Computing Challenges, History of Hadoop. Hadoop Overview, Use cases of Hadoop. Hadoop Distributors, HDFS.			
Introduction to MapReduce: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression.			
Textbook 1: Chapter - 5:(5.1 to 5.10) Chapter - 8: (8.1 to 8.8)			
Module-3		9 Hours	
Introduction to MongoDB: What is MongoDB, Why MongoDB, Terms used in RDBMs and MongoDB, Data Types in MongoDB, MongoDB Query Language.			
Introduction to Cassandra: Apache Cassandra- An Introduction, Features of Cassandra, CQL Data Types, CQLSH, Keyspaces, CRUD Operations			
Textbook 1: Chapter - 6: (6.1 to 6.5) Chapter -7: (7.1 to 7.6)			
Module-4		9 Hours	
Introduction to Hive: What is Hive, Hive Architecture, Hive Data Types, Hive File Format, HQL, RC File Implementation, User Defined Functions.			
Introduction to Pig: What is Pig, the Anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use Cases for Pig, Pig Latin Overview, Pig Data Types, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operators, Eval Functions, Complex Data Types, Pig vs Hive.			
Textbook 1: Chapter - 9: (9.1 to 9.6, 9.8) Chapter - 10: (10.1 to 10.13, 10.22)			

Module-5	9 Hours
Spark: Introduction, Spark, Introduction to Data Analytics with Spark. Text, Web Content and Link Analytics: Introduction, Text Mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of web and Analysing a Web Graph. Textbook 2: Chapter- 5: (5.1 to 5.3) and Chapter - 9: (9.1 to 9.4)	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
Experiments (java/Python/R)	
1	Install Hadoop and implement the following file management tasks in Hadoop Adding Files and Directories Retrieving Files Delete files and directories Hint: A typical Hadoop workflow creates a datafiles (such as log files) elsewhere copies them into HDFS using one of the above command line utilities.
2	Develop a Map Reduce program for Matrix Multiplication.
3	Develop a Map Reduce program for mines the weather data and display appropriate messages indicating the weather condition of the day.
4	Develop a Map Reduce program to find the tags associated with each movie by analysing movie lens data.
5	Implement functions: Count-Sort-Limit-Skip- Aggregate using mango DB.
6	Implement CRUD operations using Cassandra
7	Use HIVE to create, alter, and drop databases, tables, views, functions and indexes
8	Implement word count program in Hadoop and spark

COURSE OUTCOMES:

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

CO1	Identify and list various Big Data concepts, tools and applications
CO2	Develop programs using HADOOP framework.
CO3	Make use of Hadoop Cluster to deploy Map Reduce jobs, PIG, HIVE, Cassandra and Spark programs.
CO4	Analyze the given data set and identify deep insights from the data set.
CO5	Demonstrate Text, Web Content and Link Analytics

ASSESSMENT DETAILS (Both CIE and SEE)

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. **Seema Acharya and Subhashini Chellapan**, “Big Data Analytics”, 2nd Edition, Wiley India Publisher, 2019.
2. **Rajkamal and Preeti Saxena**, “Big Data Analytics, Introduction to Hadoop, Spark and Machine Learning”, Computer Organization”, 5th Edition, 2nd Edition, McGraw-Hill, 2019.

Reference Books

1. **Arshdeep Bahga, Vijay Madisetti**, "Big Data Analytics: A Hands-On Approach", 1st Edition, VPT Publications, 2018.
2. **Douglas Eadline**, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1st Edition, Pearson Education, 2016.
3. **Anil Maheshwari**, "Data Analytics", 2nd Edition, McGraw Hill Education, 2023.

Weblinks:

1. Introduction to MapReduce and Hadoop HDFS
https://www.youtube.com/watch?v=6qboPC1rWEY&list=PLm_MSClsnwm8vZF0pyRth3wgVMxE6jvY&index=4
2. Big Data Analytics and Hadoop from Greate Learning
<https://www.bing.com/videos/riverview/relatedvideo?q=Big+Data+Analytics+Training+Online&&mid=164A79137B0CEF24471C164A79137B0CEF24471C&&FORM=VRDGAR>
3. Data Analytics for Beginners
<https://www.bing.com/videos/riverview/relatedvideo?q=Big%20Data%20Analytics%20Training%20Online&mid=21F2F8B8BBF30AAB37A921F2F8B8BBF30AAB37A9&ajaxhist=0>
4. Statistical Foundation for Big Data Analysis NPTEL Course :
https://onlinecourses.nptel.ac.in/noc26_cs09

Self – Study topics:

1. Cassandra: Collections, Counters, Time to Leave, Alter Command
2. Pig: Piggy Bank, User Defined Functions, Parameter Substitution, Diagnostic Operator, Word Count Example
3. Hadoop: Data ETL (Extract, Transform & Load) Process, Introduction to Analytics & Reporting, Social Network as graph and Social network Analytics



Activity Based Learning

1. Flipped Classroom
2. Group Discussion (GD)
3. Student Seminars
4. Project Based Learning
5. Mini Project using MongoDB/ Cassandra
6. NPTEL/ Infosys Springboard Courses on DBMS
7. **Peer Teaching** - Make Groups and give crosswords related to the subject by using <https://www.ohmydots.com/creator-crossword.html>

B.E. CSE (DATA SCIENCE) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Artificial Intelligence and Machine Learning		
Course Code:	BCD602	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> - Understands the basics of AI, history of AI and its foundations, basic principles of AI for problem solving - Explore the basics of Machine Learning & Machine Learning process, understanding data, - Understand the Working of Artificial Neural Networks			
Module-1			9 Hours
Introduction: What is AI, The foundation of Artificial Intelligence Intelligent Agents: Agents and Environments, Good Behaviour: The concept of rationality, The nature of Environments, the structure of Agents. Solving Problems by searching: Problem solving agents, Example problems (Toy Problems, 8-Puzzle, 8-Queens) Textbook 1: Chapter - 1: (1.1 - 1.2) Chapter - 2: (2.1 - 2.4) Chapter - 3: (3.1 - 3.2)			
Module-2			9 Hours
Problem solving by searching: Searching for solutions, Uniformed search strategies (Breadth First Search, Uniform Cost Search, Depth First Search, Depth Limited Search), Informed search strategies (Greedy best-first Search, A* Search), Heuristic functions. Textbook 1: Chapter - 3: (3.3 - 3.6).			
Module-3			9 Hours
Introduction to machine learning: Need for Machine Learning, Machine Learning Explained, and 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, types of data, Big data analytics framework, Descriptive statistics, univariate data analysis and visualization Textbook 2: Chapter - 1: (1.1 - 1.7) Chapter - 2: (2.1, 2.3 - 2.5)			
Module-4			9 Hours
Understanding Data: Bivariate and Multivariate data, Multivariate statistics, Essential mathematics for Multivariate data – Linear systems and Gaussian Elimination for Multivariate Data, Matrix Decompositions, ML and importance of Probability and statistics (probability distributions, Discrete,			

Density Estimation, Parametric Estimation, Maximum likelihood Estimation), Overview hypothesis, Feature engineering and dimensionality reduction techniques. Basics of Learning Theory: Introduction to learning and its types, Design of learning system, Introduction to concept learning, Representation of a Hypothesis, Hypothesis Space, Heuristics space search, Generalization and Specialization, Find-S algorithm, Modelling in Machine Learning: Model Selection and Model Evaluation Textbook 2: Chapter - 2: (2.6 - 2.10) Chapter - 3: (3.1,3.3,3.4(3.4.1,3.4.2, 3.4.3, 3.4.4,3.4.5),3.6 (3.6.1))	
Module-5	9 Hours
Similarity-based learning: Introduction to Similarity or instance-based learning, nearest Neighbour learning, weighted k- Nearest - Neighbour algorithm. Regression Analysis: Introduction to Linear Regression, Validation of Regression Methods. Artificial Neural Network: Introduction, Biological neurons, Artificial neurons, Perceptron and learning theory, types of Artificial neural Network, learning in multilayer Perceptron, Radial basis function neural network. Textbook 2: Chapter - 4: (4.1 - 4.3) Chapter - 5: (5.3, 5.4) Chapter - 10: (10.1to 10.7)	

COURSE OUTCOMES:

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

CO1	Explain Basics of Artificial Intelligence.
CO2	Apply the suitable search strategy to solve problems.
CO3	Develop similarity-based learning models and regression models for solving classification and prediction tasks.
CO4	Utilize probabilistic learning models & clustering algorithms to identify patterns in data and implement reinforcement learning techniques.
CO5	Build neural network models using perceptrons and multilayer architectures

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.			

Textbooks:

- Stuart Russel, Peter Norvig:** “Artificial Intelligence A Modern Approach”, 3rd Edition, Pearson Education, 2015.
- S. Sridhar, M Vijayalakshmi** “Machine Learning”. Oxford University Press, 2021.

Reference Books:

- Elaine Rich, Kevin Knight:** “Artificial Intelligence”, 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709
- Nils J. Nilsson:** “Principles of Artificial Intelligence”, Elsevier, 1980, ISBN: 978-3-540-11340-9
- Murty, M. N., and V. S. Ananthanarayana,** “Machine Learning: Theory and Practice”, Universities Press, 2024.

Weblinks:

- Artificial Intelligence – AIMA Companion Resources. <https://aima.cs.berkeley.edu/>
- AI Search Algorithms Visualization.
<https://www.cs.usfca.edu/~galles/visualization/Search.html>
- Problem solving agent: <https://www.youtube.com/watch?v=KTPmo-KsOis>
- <https://www.javatpoint.com/history-of-artificial-intelligence>
- <https://www.tutorialandexample.com/problem-solving-in-artificial-intelligence>
- <https://techvidvan.com/tutorials/ai-heuristic-search/>
- <https://www.analyticsvidhya.com/machine-learning/>
- <https://www.hackerearth.com/practice/machine-learning/machine-learning-algorithms/mldecision-tree/tutorial/>
- <https://www.javatpoint.com/unsupervised-artificial-neural-networks>



Self-Study Topics:

1. Google Machine Learning Crash Course <https://developers.google.com/machine-learning/crash-course>
2. Statistics and Probability – Khan Academy <https://www.khanacademy.org/math/statistics-probability>
3. AI Applications in Real World
4. Introduction to Deep Learning
5. Model Evaluation Techniques
6. AI/ML Tools and Practical Implementation

Activity / Mini-Project Based Learning:

1. Scikit-Learn Tutorials and Examples <https://scikit-learn.org/stable/tutorial/index.html>
2. Kaggle – Machine Learning Datasets and Notebooks <https://www.kaggle.com/>

B.E. CSE (DATA SCIENCE) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Large Language Models		
Course Code:	BCD613A	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 NLP pre-training methods including supervised, unsupervised, self-supervised learning and transformer architectures used in Large Language Models. 2. Explain the architecture, training process, scaling techniques, long-sequence modeling, and prompt design strategies such as in-context learning, chain-of-thought reasoning, RAG, and tool usage. 3. Understand prompt optimization and alignment techniques including fine-tuning, soft prompts, RLHF, reward modeling, and preference optimization for improving LLM performance.			
Module-1			9 Hours
Pre-training: Pre-training NLP Models: Unsupervised, Supervised and Self-supervised Pre-training, Adapting Pre-trained Models Self-supervised Pre-training Tasks: Decoder-only Pre-training, Encoder-only Pre-training, Encoder-Decoder Pre-training, Comparison of Pre-training Tasks. Example: BERT: The Standard Model, More Training and Larger Models, Applying BERT Models. Textbook 1: Chapter – 1 (1.1 - 1.2), 1.3 (1.3.1–1.3.2), 1.4			
Module-2			9 Hours
Generative Models: A Brief Introduction to LLMs, Decoder-only Transformers, Training LLMs, Fine-tuning LLMs, Aligning LLMs with the World, Prompting LLMs. Training at Scale: Data Preparation, Model Modifications, Distributed Training, Scaling Laws. Long Sequence Modeling: Optimization from HPC Perspectives, Efficient Architectures, Cache and Memory, Sharing across Heads and Layers, Position Extrapolation and Interpolation. Textbook 1: Chapter – 2 (2.1–2.3)			

Module-3	9 Hours
Prompting: General Prompt Design, Basics, In-context Learning, Prompt Engineering Strategies, More Examples. Advanced Prompting Methods: Chain of Thought, Problem Decomposition, Self-refinement, Ensembling, RAG and Tool Use. Textbook 1: Chapter – 3 (3.1, 3.2)	
Module-4	9 Hours
Learning to Prompt: Prompt Optimization, Soft Prompts, Prompt Length Reduction. Alignment: An Overview of LLM Alignment. Instruction Alignment: Supervised Fine-tuning, Fine-tuning Data Acquisition, Fine-tuning with Less Data, Instruction Generalization, Using Weak Models to Improve Strong Models. Textbook 1: Chapter – 3 (3.3) Chapter – 4 (4.1, 4.2)	
Module-5	9 Hours
Human Preference Alignment (RLHF): Basics of Reinforcement Learning, Training Reward Models, Training LLMs. Improved Human Preference Alignment: Better Reward Modeling, Direct Preference Optimization, Automatic Preference Data Generation, Step-by-step Alignment, Inference-time Alignment. Textbook 1: Chapter – 4 (4.3, 4.4)	

COURSE OUTCOMES:

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

CO1	Understand the fundamentals of pre-training in large language models, including different pre-training methods and model architectures.
CO2	Explain the working of generative models and the process of building large language models, including training and scaling techniques.
CO3	Analyse techniques for handling long sequences and improving efficiency in large language models.
CO4	Apply prompting strategies, including basic and advanced methods such as chain-of-thought reasoning and automatic prompt design.
CO5	Understand and evaluate alignment techniques, including instruction fine-tuning and human feedback-based alignment (RLHF).

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.			

Textbooks:

- Tong Xiao, Jingbo Zhu:** “Foundations of Large Language Models”, NLP Lab, Northeastern University & NiuTrans Research, 2021–2025.

Reference Books:

- Keras, Rafael Valle,** “Hands-On Generative Adversarial Networks with”, 1st Edition, Packt Publishing, 2019.
- Probabilistic Machine Learning: Advanced Topics,** Kevin P. Murphy, 1st Edition, MIT Press, 2023.
- Phil Wang,** “The GAN Handbook”, 1st Edition, Independently Published, 2022.
- Denis Rothman,** “Transformers for Natural Language Processing”, 2021.

Weblinks:

1. [Allal et al., 2024] Loubna Ben Allal, Anton Lozhkov, and Daniel van Strien. cosmopedia: how to create large-scale synthetic data for pre-training. <https://huggingface.co/blog/cosmopedia>, 2024.
2. [Burns et al., 2023] Collin Burns, Jan Leike, Leopold Aschenbrenner, Jeffrey Wu, Pavel Izmailov, Leo Gao, Bowen Baker, and Jan Hendrik Kirchner. Weak-to-strong generalization, 2023b. URL <https://openai.com/index/weak-to-strong-generalization>.
3. [Ruan et al., 2024] Junhao Ruan, Long Meng, Weiqiao Shan, Tong Xiao, and Jingbo Zhu. A survey of llm surveys. <https://github.com/NiuTrans/ABigSurveyOfLLMs>, 2024.
4. <https://github.com/Hannibal046/Awesome-LLM>

Self-Study Topics:

1. https://www.youtube.com/watch?v=zjkBMFhNj_g
2. <https://www.deeplearning.ai/courses/generative-ai-with-llms/>
3. <https://cohere.com/llmu>
4. https://www.youtube.com/playlist?list=PLZoTAELRMXVNNrHSKv36Lr3_156yCo6Nn
5. <https://huggingface.co/papers/trending>

Activity / Mini-Project Based Learning:

1. DeepLearning.AI: “Building Systems with the ChatGPT API” <https://www.deeplearning.ai/short-courses/building-systems-with-chatgpt/>
2. Hugging Face: “Build and Deploy LLM Apps (Transformers + Spaces)” <https://huggingface.co/learn>
3. LangChain: “LLM Application Development (RAG, Agents)” <https://python.langchain.com/docs/tutorials/>
4. Microsoft: “Azure OpenAI & LLM App Development Labs” <https://learn.microsoft.com/en-us/training/>
5. Google: “Generative AI Learning Path (Gemini & LLMs)” <https://cloud.google.com/learn>

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Pattern Recognition		
Course Code:	BCD613B	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. Explain various Image processing and Pattern recognition techniques. 2. Illustrate mathematical morphology necessary for Pattern recognition. 3. Demonstrate Image Representation and description and feature extraction. 4. Explain principles of Decision Trees and Clustering in pattern recognition.			
Module-1			9 Hours
Introduction: Definition of PR, Applications, Datasets for PR, Different paradigms for PR, Introduction to probability, events, random variables, Joint distributions and densities, Moments of Random variables, Estimation of parameters from samples, Minimum risk estimators, problems. Textbook 1: Chapter -1(1.1-1.3), Textbook 2: Chapter -2(2.1-2.8)			
Module-2			9 Hours
Representation: Data structures for PR, Representation of clusters, proximity measures, size of patterns, Abstraction of Data set, Feature extraction, Feature selection, Evaluation of Classifiers, Evaluation of Clustering Textbook 1: Chapter -2(2.1-2.9)			
Module-3			9 Hours
Nearest Neighbor Based classifiers: Nearest Neighbor algorithm, Variants of NN algorithms, use of NN for transaction databases, efficient algorithms, Data reduction, prototype selection. Bayes Classifier: Bayes theorem, minimum error rate classifier, estimation of probabilities, comparison with NNC, Naive Bayes classifier, Bayesian belief network Textbook 1: Chapter -3(3.1-3.6), Chapter -4(4.1-4.6)			
Module-4			9 Hours
Decision Trees: Introduction, DT for PR, Construction of DT, Splitting at the nodes, Over fitting & Pruning, Example of Decision tree Induction. Hidden Markov models: Markov models for classification, Hidden Markov models and classification using HMM Textbook 1: Chapter -6(6.1-6.6), Chapter -5(5.1-5.3)			
Module-5			9 Hours
Clustering: Why is Clustering Important? Hierarchical Algorithms, Partitional Clustering, Clustering Large Data Sets. An application: Handwritten Digit Recognition			

Textbook 1: Chapter -9(9.1-9.4), Chapter -11(11.1-11.5)

COURSE OUTCOMES:

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

CO1	Explain the basics of pattern recognition, its uses, key probability concepts, and minimum-risk estimation.
CO2	Apply appropriate data representations, feature extraction/selection methods, and evaluation techniques for pattern recognition tasks.
CO3	Analyse and implement Nearest Neighbor and Bayesian classifiers for various pattern recognition problems.
CO4	Construct and evaluate Decision Trees and Hidden Markov Models for classification applications.
CO5	Apply clustering methods and demonstrate their use in tasks like handwritten digit recognition.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	12	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Alternate Assessment (CIE) (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.

Suggested Learning Resources:

Textbooks:

1. **V Susheela Devi, M Narsimha Murthy**, “Pattern Recognition (An Introduction)” , 2011 Universities Press, ISBN 978-81-7371-725-3
2. **Earl Gose, Richard Johnsonbaugh, Steve Jost**, “Pattern Recognition & Image Analysis”, PH ISBN81-203-1484-0, 1996.

Reference Book:

1. **Duda R. O., P.E. Hart, D.G. Stork**, “Pattern Classification”, John Wiley and sons, 2000

Weblinks:

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

Self-Study Topics:

1. Google Machine Learning Crash Course: <https://developers.google.com/machine-learning/crash-course>
2. Statistics & Probability: <https://www.coursera.org/learn/machine-learning-probability-and-statistics>

Activity / Mini-Project Based Learning:

- <https://github.com/topics/human-activity-recognition>

B.E. CSE (DATA SCIENCE) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Social Network Analysis		
Course Code:	BCD613C	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours / Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES: 1. To introduce the fundamentals of Social Network Analysis and its significance in understanding societal connections and behaviours. 2. To analyse various models of network growth and understand the properties of real-world networks. 3. To explore link analysis algorithms and their applications in understanding relationships within a network. 4. To study community detection methods and their relevance in identifying meaningful clusters within networks. 5. To understand link prediction techniques and their application in forecasting future connections within a network.			
Module-1			9 Hours
Networks and Society - What is Social Network Analysis, why do We Study Social Networks, Applications of Social Network Analysis, Preliminaries, Three Levels of Social Network Analysis. Network Measures - Network Basics, Node Centrality, Assortativity, Transitivity and Reciprocity, Similarity, Degeneracy. Textbook 1 – Chapter 1 (1.1. – 1.5), Chapter 2 (2.1 – 2.6)			
Module-2			9 Hours
Network Growth Models - Properties of Real-World Networks, Random Network Model, Ring Lattice Network Model, Watts–Strogatz Model, Preferential Attachment Model, Price’s Model, Local-world Network Growth Model, Network Model with Accelerating Growth, Aging in Preferential Attachment. Textbook 1 – Chapter 3 (3.1 – 3.9)			
Module-3			9 Hours
Link Analysis - Applications of Link Analysis, Signed Networks, Strong and Weak Ties, Link Analysis Algorithms, PageRank, Personalised PageRank, DivRank, SimRank, PathSIM. Textbook 1 – Chapter 4 (4.1 – 4.8)			
Module-4			9 Hours
Community Structure in Networks - Applications of Community Detection, Types of Communities, Community Detection Methods, Disjoint Community Detection, Overlapping Community Detection, Local Community Detection, Community Detection vs Community Search, Evaluation of Community Detection Methods. Textbook 1 – Chapter 5 (5.1 – 5.8)			

Module-5

9 Hours

Link Prediction - Applications of Link Prediction, Temporal Changes in a Network, Problem Definition Evaluating Link Prediction Methods, Heuristic Models, Probabilistic Models, Supervised Random Walk, Information-theoretic Model, Latest Trends in Link Prediction.

Textbook 1 – Chapter 6 (6.1 – 6.9)

COURSE OUTCOMES:

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

CO1	Illustrate the core concepts of Social Network Analysis and its levels of study.
CO2	Demonstrate the different network growth models for real-world networks.
CO3	Apply algorithms of PageRank and SimRank to analyse and interpret link relationships.
CO4	Apply community detection methods and evaluating their effectiveness in real-world scenarios.
CO5	Analyse heuristic, probabilistic, and supervised models to predict network link formations and changes.

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.			

Textbooks:

1. **Tanmoy Chakraborty**, “Social Network Analysis”, Wiley India Pvt. Ltd., 2021

Reference Books:

1. **Albert-Laszlo Barabasi**, “Network Science”, Cambridge University Press, 2016
2. **Stanley Wasserman, Katherine Faust**, “Social Network Analysis: Methods and Applications”, Cambridge University Press, 1994

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc22_cs117/preview
2. <https://social-network-analysis.in/>
3. <https://www.coursera.org/learn/social-network-analysis>

Activity / Mini-Project Based Learning:

Activity 1: Network Visualization and Analysis. Understand network basics, measures, and visualization techniques using a real-world dataset.

Activity 2: Community Detection and Link Prediction Project. Apply community detection techniques and predict future connections within a network.

B.E. CSE (DATA SCIENCE)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	Quantum Machine Learning		
Course Code:	BCD613D	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. To understand the fundamentals of quantum computation, quantum information, and their historical evolution. 2. To learn the concepts of qubits, quantum gates, and quantum circuits for building quantum systems. 3. To explore quantum algorithms and their advantages over classical computation. 4. To gain practical knowledge of quantum computing tools such as Qiskit and PennyLane for implementing QML models. 5. To study quantum machine learning techniques, including quantum SVMs, hybrid models, and quantum-inspired algorithms, along with their practical challenges.			
Module-1		9 Hours	
Introduction: Global perspective: History of quantum computation and quantum information, Future directions. Quantum bits Quantum computation: Single qubit gates Multiple qubit gates. Quantum circuits. Qubit copying circuit. Example: Bell states Quantum algorithms Classical computations on a quantum computer Quantum parallelism Deutsch’s algorithm The Deutsch–Jozsa algorithm Quantum algorithms summarized			
Textbook 1: Chapter 1:(1.1 - 1.5) Reference Book: Chapter 1			
Module-2		9 Hours	
The Tool of the Trade in Quantum Computing. Tools for quantum computing: a non-exhaustive overview. Working with Qiskit. Working with Penny Lane What Is Quantum Machine Learning? The basics of machine learning. Do you want to train a model? Quantum-classical models			
Textbook 1: Chapter 2: (2.1 - 2.3) Chapter 8: (8.1 - 8.3)			
Module-3		9 Hours	
Quantum Support Vector Machines Support vector machines, Going quantum, Quantum support vector machines in Penny Lane, Quantum support vector machines in Qiskit			

Hybrid Architectures: The what and why of hybrid architectures, Hybrid architectures in Penny Lane. Hybrid architectures in Qiskit Textbook 1: Chapter 9: (9.1 - 9.3) Chapter 11:(11.1 -11.3)	
Module-4	9 Hours
Quantum Inspired Machine Learning: Tang's Quantum Inspired Algorithm for Recommendation Systems Quantum Inspired Data Clustering Quantum Inspired Gravitational Search Quantum Enhanced Machine Learning Quantum Algorithms for Linear Algebra, Quantum Algorithms for Regression, Quantum Algorithms for Clustering, Quantum Algorithms for Nearest Neighbor Search Quantum Algorithms for Classification Quantum Boosting Textbook 2: Chapter 4: (4.1, 4.3)	
Module-5	9 Hours
Characteristics of QML Methods Hardware Requirements, Quantum Memory, Qubit Connectivity, Qubit Count, Quantum Circuit Depth Algorithmic Requirements Data Pre-and Post-Processing, Statistical Error, Noise Robustness Textbook 2: Chapter 5: (5.1, 5.2)	

COURSE OUTCOMES:

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

CO1	Explain the principles of quantum computing, quantum circuits, and fundamental quantum algorithms.
CO2	Apply quantum computing frameworks such as Qiskit and PennyLane to implement basic quantum machine learning models.
CO3	Analyse and evaluate quantum machine learning models including quantum SVMs, hybrid architectures, and quantum-inspired algorithms.
CO4	Assess the performance and limitations of QML systems considering hardware constraints, noise, and scalability.

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.			

Textbooks:

- F. Combarro Samuel González Castillo**, “A Practical Guide to Quantum Machine Learning and Quantum Optimization”, by Elías 1st Edition Packt Publishing Ltd. 2023.
- Christian Bauckhage, Fraunhofer IAIS**, “Quantum Machine Learning State of the Art and Future Directions” by 1st Edition Federal Office for Information Security 2022.

Reference Book:

- Michael A. Nielsen & Isaac L. Chuang**, “Quantum Computation and Quantum Information”, 10th Anniversary Edition Self-Study Resources.

Self Study Topics:

- <https://www.youtube.com/watch?v=RDdYapLntbE>
- https://www.youtube.com/watch?v=uCm027_jvZ0
- [Quantum Machine Learning | PennyLane](#)
- [Quantum Machine learning | Quantum Machine Learning: From Fundamentals to Applications](#)
- [Quantum Algorithms part 2 | Fundamentals to Shor's and Grover's Algorithms, Oracles, Entanglement](#)
- [Top Applications Of Quantum Computing for Machine Learning](#)
- [Quantum Machine Learning: What It Is, How It Works, and More | Coursera](#)



Weblinks:

1. **Hands On Quantum Machine Learning With Python Dr. Frank Zickert PYQML 2021** https://stel.asu.cas.cz/~skoda/QML/Dr.%20Frank%20Zickert%20%20Hands%20On%20Quantum%20Machine%20Learning%20With%20Python%20Volume%201_%20Get%20Started%20PYQML%20%282021%29.pdf?utm
2. [GitHub - krishnakumarsekar/awesome-quantum-machine-learning: Here you can get all the Quantum Machine learning Basics, Algorithms ,Study Materials ,Projects and the descriptions of the projects around the web · GitHub](#)

Activity based learning/Mini Project:

1. [Quantum Learning Resources – Learn Quantum Computing | Microsoft Azure](#)
2. [Quantum Machine Learning: What It Is, How It Works, and More | Coursera](#)

B.E. CSE (Data Science)			
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/ Sem)	SEE MARKS	50
Credits:	3	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
The purpose of the course is to facilitate the learner to:			
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://ds1-iiith.vlabs.ac.in/exp/tree-traversal/depth-first-traversal/dft-practice.html>
8. 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 CSE (Data Science)			
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.

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. 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. 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.

Weblinks

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

ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science) 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)			

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 8 (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. Analyse 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.
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. 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

B.E. CSE (DATA SCIENCE)			
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>			
1. Understand the fundamental concepts of data science. 2. Explain statistical and probabilistic concepts for data-driven decision making. 3. Apply the data science methodology and analytics life cycle to solve real-world problems. 4. Analyse and implement core machine learning techniques. 5. 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)			

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.
- 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. **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>
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. CSE (DATA SCIENCE)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

SEMESTER – VI

Course Title:	Artificial Intelligence and Machine Learning Laboratory		
Course Code:	BCDL606	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. To become familiar with data and visualize univariate, bivariate, and multivariate data using statistical techniques and dimensionality reduction. 2. To understand various machine learning algorithms such as similarity-based learning, regression, decision trees, and clustering. 3. To familiarize with learning theories, probability-based models and developing the skills required for decision-making in dynamic environments.			
Program 1. Depth First Search Algorithm			
Implement and Demonstrate Depth First Search Algorithm on Water Jug Problem			
Program 2. Best First Search Algorithm			
Implement and Demonstrate Best First Search Algorithm on Missionaries-Cannibals Problems			
Program 3. Histogram and Box Plot Analysis of California Housing Dataset			
Develop a program to create histograms for all numerical features and analyze the distribution of each feature. Generate box plots for all numerical features and identify any outliers. Use California Housing dataset.			
Program 4. Correlation Analysis - California Housing Dataset			
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.			
Program 5. PCA Dimensionality Reduction			
Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of the Iris dataset from 4 features to 2.			
Program 6. Find-S Algorithm for Hypothesis Learning			
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.			
Program 7. k-NN Classification on Randomly Generated Data			
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			
Program 8. Locally Weighted Regression algorithm			

Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graph.

Program 9. Linear Regression and Polynomial Regression

Develop a program to demonstrate the working of Linear Regression and Polynomial Regression. Use Boston Housing Dataset for Linear Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression.

Program 10. Decision Tree Classification - Breast Cancer Dataset

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.

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	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.			

COURSE OUTCOMES:

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

CO1	Illustrate the principles of multivariate data and apply dimensionality reduction techniques.
CO2	Demonstrate similarity-based learning methods and perform regression analysis.
CO3	Develop decision trees for classification and regression problems, and Bayesian models for probabilistic
CO4	Implement the clustering algorithms to share computing resources.



Weblinks:

1. Scikit-Learn Documentation (Hands-on ML)
<https://scikit-learn.org/stable/>
2. UCI Machine Learning Repository
<https://archive.ics.uci.edu/ml/>



ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	DevOps		
Course Code:	BCDL657A	CIE MARKS	50
(L: T: P) + SL	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> CO1: To introduce DevOps terminology, definition & concepts CO2: To understand the different Version control tools like Git, Mercurial CO3: To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment) CO4: To understand Configuration management using Ansible CO5: Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems			
Experiment 1. Version Control using Git and GitHub			
Introduction to Version Control Systems and GitHub workflow. i) Install and configure Git. ii) Create a local repository. iii) Create a remote repository on GitHub. iv) Perform basic Git commands – clone, add, commit, push, pull. v) Understand collaboration using GitHub.			
Experiment 2. Branching and Merging using Git			
Working with Git branches. i) Create and switch branches. ii) Modify project files in branches. iii) Merge branches. iv) Resolve basic merge conflicts.			
Experiment 3. Introduction to Maven and Gradle			
Overview of Build Automation Tools. i) Understand build automation concepts. ii) Compare Maven and Gradle features. iii) Install Maven and Gradle. iv) Explore project structure and basic commands.			
Experiment 4. Working with Maven			
Building applications using Maven.			

i) Create a Maven project. ii) Understand POM.xml file structure. iii) Add dependencies. iv) Use plugins and build the project.
Experiment 5. Working with Gradle
Gradle project setup and execution. i) Create a Gradle project. ii) Understand build scripts (Groovy/Kotlin DSL). iii) Manage dependencies. iv) Execute build tasks.
Experiment 6. Maven to Gradle Migration
Practical build automation exercise. i) Build a Java application using Maven. ii) Convert the same project to Gradle. iii) Configure dependencies. iv) Execute and verify application output.
Experiment 7. Introduction to Jenkins
Continuous Integration basics. i) Install Jenkins locally or on cloud. ii) Perform initial configuration. iii) Install required plugins. iv) Create and execute a sample Jenkins job.
Experiment 8. Continuous Integration using Jenkins
Automated build process. i) Set up Jenkins pipeline. ii) Integrate Jenkins with Maven/Gradle project. iii) Run automated builds and tests. iv) Monitor build execution.
Experiment 9. Introduction to Docker and Containerization
Containerization fundamentals. i) Install Docker. ii) Create Dockerfile for a simple Java application. iii) Build Docker image. iv) Run container from image. v) Push image to Docker Hub.
Experiment 10. Configuration Management using Ansible
Automation using Ansible playbooks. i) Understand Ansible inventory and modules. ii) Create inventory file.

iii) Write simple playbook.
iv) Automate server configuration using playbook.
Experiment 11. Jenkins Pipeline with Deployment using Ansible
CI/CD workflow implementation.
i) Create Jenkins CI pipeline for Maven project.
ii) Integrate Jenkins with Ansible.
iii) Automate build and deployment process.
iv) Verify deployment execution.
Experiment 12. Azure DevOps Build and Release Pipelines
Complete DevOps workflow.
i) Create Azure DevOps project.
ii) Integrate repository and create build pipeline.
iii) Run builds and unit tests.
iv) Create release pipeline.
v) Deploy application using Azure Pipelines.

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	Demonstrate different actions performed through Version control tools like Git.

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	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.			

Reference Books:

1. **Gene Kim, Jez Humble, Patrick Debois & John Willis**, “The DevOps Handbook: How to Create World-Class Agility, Reliability & Security in Technology Organizations”, IT Revolution Press.
2. **Jez Humble & David Farley**, “Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation”, Addison-Wesley Professional.

Suggested Learning Resources:

1. <https://www.geeksforgeeks.org/devops-tutorial/>
2. <https://www.javatpoint.com/devops>
3. <https://www.youtube.com/watch?v=2N-59wUIPVI>
4. <https://www.youtube.com/watch?v=87ZqwoFeO88>

CSE (DATA SCIENCE) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Generative AI		
Course Code:	BCDL657B	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. 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.			
Experiment 1. Pre-trained Word Vectors & Vector Arithmetic			
Explore pre-trained word vectors. Explore word relationships using vector arithmetic. Perform arithmetic operations and analyze results i) Load pre-trained word vectors (e.g., Word2Vec or GloVe). ii) Select a set of words and retrieve their vector representations. iii) Perform vector arithmetic operations (e.g., king – man + woman). iv) Analyze the results to observe semantic relationships between words. v) Compute similarity between words using cosine similarity. vi) Visualize relationships or compare nearest words. vii) Interpret and report the findings based on vector operations.			
Experiment 2. Visualization of Word Embeddings (PCA / t-SNE)			
Use dimensionality reduction (e.g., PCA or t-SNE) to visualize word embeddings for Q 1. 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. i) Load pre-trained word embeddings (e.g., Word2Vec or GloVe). ii) Select 10 words from a specific domain (e.g., sports or technology). iii) Extract vector representations of the selected words. iv) Apply dimensionality reduction techniques such as PCA or t-SNE. v) Visualize the word embeddings in 2D space. vi) Analyze clusters and relationships among the words. vii) Generate 5 semantically similar words for a given input and interpret the results.			
Experiment 3. Custom Word2Vec Model Training			
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.			

- i) Collect a small domain-specific dataset (e.g., legal or medical text).
- ii) Preprocess the text data (tokenization, removing stopwords, cleaning).
- iii) Train a Word2Vec model on the prepared dataset.
- iv) Generate word embeddings for the vocabulary.
- v) Retrieve similar words for selected domain-specific terms.
- vi) Analyze how embeddings capture domain-specific semantics.
- vii) Interpret and report the observations based on similarity results.

Experiment 4. Prompt Enhancement using Word Embeddings

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.

- i) Load pre-trained word embeddings (e.g., Word2Vec or GloVe).
- ii) Take an initial prompt as input.
- iii) Retrieve semantically similar words using embeddings.
- iv) Enrich the original prompt using the similar words.
- v) Generate responses for both original and enriched prompts using a Generative AI model.
- vi) Compare the outputs in terms of detail, relevance, and quality.
- vii) Analyze and report the improvement achieved through prompt enhancement.

Experiment 5. Creative Text Generation using Embeddings

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.

- i) Load pre-trained word embeddings (e.g., Word2Vec or GloVe).
- ii) Take a seed word as input from the user.
- iii) Retrieve semantically similar words using embeddings.
- iv) Select relevant similar words for creative use.
- v) Construct a meaningful sentence or short paragraph using these words.
- vi) Ensure coherence and contextual relevance in the generated text.
- vii) Analyze and present the generated creative output.

Experiment 6. Sentiment Analysis using Hugging Face

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.

- i) Import the required libraries from the transformers package.
- ii) Load the pre-trained sentiment analysis pipeline.
- iii) Provide input sentences based on a real-world application (e.g., reviews, feedback).
- iv) Process the input text using the model.

- v) Analyze the sentiment (positive, negative, or neutral).
- vi) Display the predicted sentiment along with confidence scores.
- vii) Interpret and report the results for different input sentences.

Experiment 7. Text Summarization using Hugging Face

Write a program to perform **text classification (topic detection)** using the pre-trained model **facebook/bart-large-mnli**. The program should take an input sentence and classify it into one of the given categories such as technology, sports, politics, or education.

- i) Import the required libraries from the transformers package.
- ii) Load the pre-trained model *facebook/bart-large-mnli* using the zero-shot classification pipeline.
- iii) Take an input sentence from the user.
- iv) Define the candidate categories (technology, sports, politics, education).
- v) Perform text classification using the model.
- vi) Display the predicted category along with the confidence score.
- vii) Analyze and interpret the classification result.

Experiment 8 Document Processing with LangChain and Cohere

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.

- i) Install required libraries: langchain, cohere, and langchain-community.
- ii) Obtain the Cohere API key by logging into Cohere.
- iii) Set up the API key in the environment.
- iv) Load a text document from Google Drive.
- v) Create a prompt template to structure the output.
- vi) Use LangChain to process the document with the prompt template.
- vii) Generate and display the formatted output

Experiment 9. Institution Information Extraction using Pydantic & LangChain

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.

- i) Take the institution name as input from the user.
- ii) Define a structured schema using Pydantic for the required output fields.
- iii) Create a custom output parser based on the defined schema.
- iv) Use LangChain to build a chain for processing the query.
- v) Retrieve relevant information from Wikipedia.
- vi) Extract details such as founder, year of establishment, branches, number of employees, and summary.
- vii) Display the structured output in the specified format

Experiment 10. Chatbot for Indian Penal Code

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

- i) Download the official document of the Indian Penal Code.
- ii) Load and preprocess the document (text cleaning and splitting into chunks).
- iii) Convert the text into embeddings for efficient retrieval.
- iv) Store embeddings in a vector database.
- v) Build a retrieval-based chatbot using a Generative AI model.
- vi) Accept user queries related to IPC and retrieve relevant information.
- vii) Generate accurate responses and enable interactive conversation with the chatbot

COURSE OUTCOMES:

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

CO1	Develop the ability to explore and analyse word embeddings, perform vector arithmetic to investigate word relationships, visualize embeddings using dimensionality reduction techniques
CO2	Apply prompt engineering skills to real-world scenarios, such as information retrieval, text generation.
CO3	Utilize pre-trained Hugging Face models for real-world applications, including sentiment analysis and text summarization.
CO4	Apply different architectures used in large language models, such as transformers, and understand their advantages and limitations

ASSESSMENT AND EVALUATION REGULATIONS OF IPCC

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

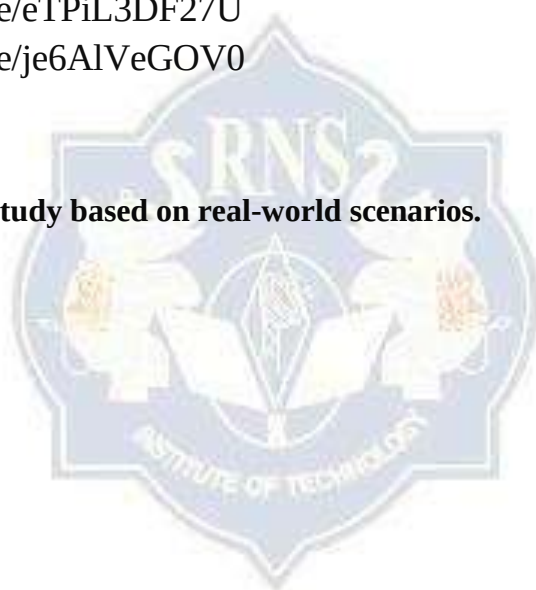
			for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Weblinks:

1. https://www.w3schools.com/gen_ai/index.php
2. <https://youtu.be/eTPiL3DF27U>
3. <https://youtu.be/je6AlVeGOV0>

Self-Study Topics:

- **Activity: Case Study based on real-world scenarios.**



ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Healthcare Analytics		
Course Code:	BCDL657C	CIE MARKS	50
(L: T: P) +SL	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. Introduce students to the fundamentals and structure of healthcare data, including clinical and time-series datasets. 2. Enable students to preprocess and analyze medical datasets by handling missing values, noise, and class imbalance. 3. Guide students in implementing machine learning techniques for healthcare applications such as disease prediction, risk stratification, and survival analysis. 4. Facilitate the evaluation and interpretation of models using appropriate metrics and explainable AI techniques. 5. Encourage the development of data-driven solutions for real-world healthcare problems with a focus on reliability and ethics.			
Program 1- Patient Risk Stratification – Predicting High-Risk Patients Design and implement a Python program to classify patients into low, medium, and high-risk categories using machine learning classification algorithms. Objective: Record and compare model performance (accuracy, precision, recall) for different classifiers on clinical datasets. Application: Helps in early identification of high-risk patients for preventive healthcare and resource allocation.			
Program 2 Disease Progression Modeling – Predicting Disease Trends Design and implement a Python program to analyze patient historical data and predict disease progression using regression/time-series techniques. Objective: Evaluate prediction accuracy and analyze trends over time. Application: Helps doctors monitor chronic diseases like diabetes and cancer progression.			
Program 3 Imbalanced Data Handling – Rare Disease Detection Design and implement a Python program to handle imbalanced medical datasets using SMOTE and compare results with original data. Objective: Analyze improvement in classification performance after balancing the dataset. Application: Improves detection of rare diseases and critical conditions.			
Program 4 Explainable AI – Interpretable Medical Diagnosis Design and implement a Python program to explain predictions of a trained ML model using SHAP or LIME techniques. Objective: Interpret model outputs and identify key contributing features. Application: Enhances transparency and trust in AI-based healthcare decisions.			

Program 5	Hospital Readmission Prediction – Risk Analysis
Design and implement a Python program to predict patient readmission probability using ensemble learning techniques. Objective: Compare performance of multiple ensemble models. Application: Helps hospitals reduce readmission rates and improve care quality.	
Program 6	Drug Response Prediction – Personalized Treatment
Design and implement a Python program to predict patient response to specific drugs using classification techniques. Objective: Analyze feature importance influencing drug effectiveness. Application: Supports personalized medicine and optimized treatment planning	
Program 7	Medical Image Classification – Automated Diagnosis
Design and implement a Python program to classify medical images using feature extraction and ML models. Objective: Evaluate classification accuracy on image datasets. Application: Assists in automated diagnosis using X-ray or MRI data.	
Program 8-	Anomaly Detection in Health Data – Abnormal Pattern Detection
Design and implement a Python program to detect anomalies in patient vital data using Isolation Forest or similar algorithms. Objective: Identify unusual patterns and evaluate detection efficiency. Application: Enables early warning systems for critical health conditions.	
Program 9-	Survival Analysis – Patient Outcome Prediction
Design and implement a Python program to estimate survival probability using statistical and ML techniques. Objective: Analyze survival trends and model performance. Application: Useful in prognosis prediction for critical illnesses.	
Program 10	Healthcare Recommendation System – Personalized Care
Design and implement a Python program to recommend treatments or preventive measures using ML-based recommendation systems. Objective: Evaluate recommendation accuracy and relevance. Application: Supports clinical decision-making and personalized healthcare.	

COURSE OUTCOMES:

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

CO1	Understand and preprocess healthcare datasets including handling missing values, noise, and imbalanced data
CO2	Apply machine learning algorithms to analyze patient data for prediction and classification tasks
CO3	Design and implement advanced models for healthcare applications such as disease prediction, readmission analysis, and survival modeling
CO4	Evaluate and interpret healthcare models using performance metrics and explainable AI techniques

CO5	Develop data-driven solutions for real-world healthcare problems ensuring accuracy, reliability, and ethical considerations
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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	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.			

Text books

- Hands-On Machine Learning with Scikit-Learn & TensorFlow – *Aurélien Géron*
- Python for Data Analysis – *Wes McKinney*
- Introduction to Statistical Learning – *Gareth James*
- Healthcare Analytics Made Simple – *Vikas Kumar*

Reference Links

- <https://www.kaggle.com/datasets>
(Search: diabetes, cancer, heart disease)
- <https://archive.ics.uci.edu/ml/index.php>
- <https://www.kaggle.com/datasets/uciml/pima-indians-diabetes-database>
- https://scikit-learn.org/stable/supervised_learning.html
- <https://www.statsmodels.org/stable/index.html>
- <https://machinelearningmastery.com/time-series-forecasting/>
- <https://imbalanced-learn.org/stable/>
- <https://shap.readthedocs.io/en/latest/>
- <https://www.kaggle.com/datasets/csafriz2/drug-response>
- <https://www.tensorflow.org/tutorials/images/classification>
- <https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia>
- https://scikit-learn.org/stable/modules/outlier_detection.html
- <https://lifelines.readthedocs.io/en/latest/>
- <https://towardsdatascience.com/recommender-systems-in-healthcare>

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Financial & Marketing Analytics		
Course Code:	BCDL657D	CIE MARKS	50
(L: T: P) +SL	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. Introduce students to financial and marketing datasets including transactional and customer behavior data. 2. Enable students to perform data preprocessing and feature engineering for analytical tasks. 3. Guide students in applying machine learning techniques for problems such as fraud detection, churn prediction, and customer segmentation. 4. Facilitate the analysis and evaluation of models to support effective business decision-making. 5. Encourage students to develop intelligent, data-driven strategies for financial optimization and marketing effectiveness.			
Program 1 -Credit Risk Modeling – Loan Default Prediction			
Design and implement a Python program to predict loan default probability using classification algorithms. Objective: Compare model performance for different classifiers. Application: Helps financial institutions in loan approval decisions.			
Program 2 Fraud Detection – Transaction Analysis			
Design and implement a Python program to detect fraudulent financial transactions using anomaly detection techniques. Objective: Evaluate detection accuracy and false positives. Application: Prevents financial fraud and enhances security.			
Program 3 Customer Lifetime Value Prediction – Revenue Estimation			
Design and implement a Python program to estimate customer lifetime value using regression models. Objective: Analyze prediction accuracy and influencing factors. Application: Helps businesses optimize customer retention strategies.			
Program 4 Market Basket Analysis – Product Association			
Design and implement a Python program to discover product associations using Apriori or FP-Growth algorithms. Objective: Identify frequent itemsets and association rules. Application: Improves product placement and cross-selling strategies.			
Program 5 Customer Segmentation – Behavioral Clustering			
Design and implement a Python program to segment customers using clustering algorithms and PCA.			

Objective: Evaluate clustering performance using metrics like silhouette score. Application: Enables targeted marketing and personalization.
Program 6 Price Optimization – Revenue Maximization Design and implement a Python program to determine optimal pricing using regression and optimization techniques. Objective: Analyze price-demand relationship. Application: Helps businesses maximize profit.
Program 7 Sentiment Analysis – Customer Feedback Mining Design and implement a Python program to analyze customer reviews using NLP techniques. Objective: Classify sentiment and evaluate model performance. Application: Supports brand monitoring and customer satisfaction analysis.
Program 8- Churn Prediction – Customer Retention Design and implement a Python program to predict customer churn and explain results using SHAP. Objective: Identify key factors influencing churn. Application: Helps companies reduce customer attrition.
Program 9- Campaign Effectiveness – Marketing Analysis Design and implement a Python program to evaluate marketing campaigns using A/B testing and ML models. Objective: Compare campaign performance metrics. Application: Improves marketing ROI.
Program 10 Recommendation System – Product Suggestions Design and implement a Python program to build a recommendation engine using collaborative filtering. Objective: Evaluate recommendation accuracy. Application: Used in e-commerce platforms like Amazon/Netflix.

COURSE OUTCOMES:

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

CO1	Understand and preprocess financial and marketing datasets for analysis
CO2	Apply machine learning techniques for prediction tasks such as credit risk, churn, and customer behaviour
CO3	Design and implement advanced analytics solutions such as recommendation systems and fraud detection models
CO4	Analyze and evaluate model performance using appropriate metrics and interpret results for decision-making
CO5	Develop intelligent data-driven strategies for business optimization and marketing effectiveness

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

Reference Links:

- <https://scikit-learn.org/stable/tutorial/index.html>
- <https://pandas.pydata.org/docs/>
- <https://numpy.org/doc/>
- <https://matplotlib.org/stable/tutorials/index.html>
- <https://www.kaggle.com/datasets/uciml/german-credit>
- <https://towardsdatascience.com/credit-risk-modelling>
- <https://www.kaggle.com/datasets/mlg-ulb/creditcardfraud>
- https://scikit-learn.org/stable/modules/outlier_detection.html
- <https://towardsdatascience.com/price-optimization-machine-learning>
- <https://www.kaggle.com/code> (search: price optimization)
- <https://www.kaggle.com/datasets/blastchar/telco-customer-churn>
- <https://lifetimes.readthedocs.io/en/latest/>
- https://rasbt.github.io/mlxtend/user_guide/frequent_patterns/apriori/
- <https://www.kaggle.com/datasets/heeraldedhia/groceries-dataset>
- <https://scikit-learn.org/stable/modules/clustering.html>
- <https://www.kaggle.com/datasets/vjchoudhary7/customer-segmentation>
- <https://www.kaggle.com/blastchar/telco-customer-churn>
- <https://towardsdatascience.com/customer-churn-analysis>
- <https://surprise.readthedocs.io/en/stable/>
- <https://www.kaggle.com/datasets/rounakbanik/the-movies-dataset>
- <https://www.nltk.org/book/>
- <https://textblob.readthedocs.io/en/dev/>

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Indian Knowledge Systems		
Course Code:	BIKS608	CIE MARKS	100
(L :T : P) + SL	(1:0:0) + (15 hrs/semester)	SEE MARKS	-
Credits:	0	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is</i> - To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system. - To make the students understand the traditional knowledge and analyze it and apply it to their day-to-day life.			
Module-1			5 hrs
Introduction to Indian Knowledge Systems (IKS): Overview, Importance of ancient knowledge, The IKS corpus, Vedic Corpus, Philosophical systems, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.			
Module-2			5 hrs
Fundamental concepts for science and technology: Linguistics, Numbers and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.			
Module-3			5 hrs
Traditional Knowledge in Professional Domain: Town planning and architecture, Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and Public administration.			

COURSE OUTCOMES:

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

- | | |
|------------|---|
| CO1 | Provide an overview of the concept of the Indian Knowledge System and its importance. |
| CO2 | Appreciate the need for and importance of protecting traditional knowledge. |
| CO3 | Recognize the relevance of Traditional knowledge in different domains. |
| CO4 | Establish the significance of Indian Knowledge systems in the contemporary world. |

ASSESSMENT DETAILS (CIE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	40	--	Each test will be conducted for 25 Marks adding upto 50 marks. Final test marks will be reduced to 40 Marks
Experimental Learning (B)	40	---	Case Study-based Teaching-Learning. Video-based Seminar (4-5 minutes per student on a relevant IKS topic)
Quiz(C)	20	---	Each quiz is evaluated for 10 marks adding up to 20 Marks.
Total CIE (A+B+C)	100	40	CIE Evaluation is done for a maximum of 100 marks

Suggested Learning Resources:

Textbook:

1. Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93- 91818-21-0M. M. Mano, Digital Logic and Computer Design. PHI Learning, 2008. ISBN: 978-81-203-0417-84.

Reference Books:

1. Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230
2. Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334

Suggested Web Links:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>
3. <http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63> (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5. https://unctad.org/system/files/official-document/ditcted10_en.pdf
6. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7. https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAAYASAAEgIm1vD_BwE

B.E. CSE (Data Science)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VII			
Course Title:	Deep Learning and Reinforcement Learning		
Course Code:	BCD701	CIE MARKS	50
(L: T: P) + SL	(3:0:2) + (45 Hours / Sem)	SEE MARKS	50
Credits:	04	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to 8. Understand the fundamentals of deep learning. 9. Know the theory behind Convolutional Neural Networks, RNN. 10. Illustrate the strength and weaknesses of many popular deep learning approaches. 11. Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.			
Module-1			9 Hours
Introduction to Deep Learning: Introduction, Shallow Learning, Deep Learning, why to use Deep Learning, How Deep Learning Works, How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization. Textbook 1: Chapter-1 (1.1–1.5), Textbook 2: Chapter-8 (8.1–8.2)			
Module-2			9 Hours
Basics of Supervised Deep Learning: Introduction, Convolution Neural Network, Evolution of Convolution Neural Network, Convolution Operation, Architecture of CNN. Textbook 1: Chapter-2 (2.1–2.5)			
Module-3			9 Hours
Training Supervised Deep Learning Networks: Training Convolution Neural Networks, Gradient Descent-Based Optimization Techniques, Challenges in Training Deep Networks, Weight Initialization Techniques Supervised Deep Learning Architectures: LeNet-5, AlexNet Textbook 1: Chapter-3 (3.2, 3.4-3.6), Chapter-4 (4.2, 4.3)			
Module-4			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 and Other Gated RNNs. Textbook 2: Chapter-10 (10.1–10.3, 10.5, 10.6, 10.10)			

Module-5	9 Hours
Deep Reinforcement Learning: Introduction, Stateless Algorithms: Multi-Armed Bandits, The Basic Framework of Reinforcement Learning, Case Studies (AlphaGo: Championship Level Play at Go, Self-Learning Robots, Building Conversational Systems: Deep Learning for Chatbots, Self-Driving Cars)	
Textbook 3: Chapter-9 (9.1–9.3, 9.7(9.7.1- 9.7.4))	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
1	Design and implement a neural-based network for generating word embeddings for words in a document corpus.
2	Write a program to demonstrate the working of a deep neural network for a classification task.
3	Design and implement a Convolutional Neural Network (CNN) for classification of image dataset.
4	Build and demonstrate an autoencoder network using neural layers for data compression on image dataset.
5	Design and implement a deep learning network for classification of textual documents.
6	Design and implement a deep learning network for forecasting time series data.
7	Write a program to enable pre-trained models to classify a given image dataset.
8	Simple Grid World Problem: Design a custom 2D grid world where the agent navigates from a start position to a goal, avoiding obstacles. Environment: Custom grid.

COURSE OUTCOMES:

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

- CO1** Understand core deep learning concepts and the optimization challenges in neural networks.
- CO2** Design supervised deep learning models with emphasis on convolution operations and CNN architectures.
- CO3** Train and optimize deep neural networks using gradient methods, initialization strategies, and standard CNN models.
- CO4** Develop and analyse recurrent and recursive architectures including RNNs, LSTMs, and gated networks.
- CO5** Apply stateless reinforcement learning algorithms and basic RL frameworks to practical tasks.

ASSESSMENT DETAILS (Both CIE and SEE)

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:

2. **M. Arif Wani Farooq Ahmad Bhat Saduf Afzal Asif Iqbal Khan**: “Advances in Deep Learning”, Springer, 2020.
3. **Ian Goodfellow, Yoshua Bengio, Aaron Courville**: “Deep Learning”, MIT Press, 2016.
4. **Charu C. Aggarwal**: “Neural Networks and Deep Learning”, Springer, 2018.

Reference Books:

6. **Bengio, Yoshua**: "Learning deep architectures for AI." Foundations and trends in Machine Learning, 2009.

7. **N.D. Lewis:** “Deep Learning Made Easy with R: A Gentle Introduction for Data Science”, January 2016.
8. **Nikhil Buduma:** “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms”, O’Reilly publications.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=aPfkYu_qiF4
2. <https://www.youtube.com/watch?v=ctg14QIspRo>
3. <https://www.youtube.com/watch?v=cFgASecJGo8>
4. <https://www.youtube.com/watch?v=PmZp5VtMwLE>
5. <https://www.coursera.org/learn/neural-networks-deep-learning>
6. https://onlinecourses.nptel.ac.in/noc20_cs62/preview

Activity-Based Learning:

1. Mini projects (2 to 4 students) using Deep Learning concepts
2. Review Paper on Deep Learning Applications.

Self – Study topics:

1. NPTEL Course on Deep Learning – Part 1 (IIT Ropar) – 12 Weeks
2. Introduction to Deep Learning – Infosys Springboard Course – 5 hours
3. Transformers in Deep Learning
4. Regularisation Techniques for Deep Learning
5. Autoencoders and Their Applications
6. Densely Connected Convolutional Network (DenseNet)

An Institute with a Difference

B.E. CSE (DATA SCIENCE) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Block Chain Technology		
Course Code:	BCD702	CIE MARKS	50
(L: T: P) + SL	(3:0:2) (45 Hours / Sem)	SEE MARKS	50
Credits:	04	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the fundamentals of blockchain, distributed systems, and decentralization, including types and evolution of blockchains. 2. Apply cryptographic techniques such as symmetric/asymmetric encryption, RSA, ECC, and digital signatures for secure blockchain systems. 3. Analyze consensus algorithms and explain the architecture and transaction mechanisms of Bitcoin. 4. Demonstrate blockchain applications including Bitcoin usage and smart contract design and deployment. 5. Examine the architecture of platforms like Ethereum and Hyperledger Fabric for real-world applications.			
Module – 1			9 Hours
Blockchain 101: The growth of blockchain technology, Distributed systems, The history of blockchain, Introducing Blockchain, Types of blockchain. Decentralization Introducing Decentralization, Full ecosystem Decentralization, Decentralization in practice, Innovative trends. Textbook: Chapter-1 (pg:01-26), Chapter-2 (pg:29-49)			
Module – 2			9 Hours
Symmetric Cryptography: Introducing Cryptography, Cryptographic primitives, Advanced Encryption Standard. Asymmetric Cryptography: Asymmetric cryptography, Introducing RSA, Introducing ECC, Digital Signatures. Textbook: Chapter-3 (pg:52-76), Chapter-4 (pg:79-108)			
Module – 3			9 Hours
Consensus Algorithms: Introducing consensus, Analysis and design, Classification, Algorithms, Choosing an Algorithm. Bitcoin Architecture: Cryptographic keys, Addresses, Transactions.			

Textbook: Chapter-5 (pg:119-155), Chapter-6 (pg:157-175)	
Module – 4	9 Hours
Bitcoins in Practice: Bitcoins in real world, Bitcoin payments, Innovation in bitcoins, Bitcoins client installation, Experimenting further with bitcoin-cli. Smart contracts: Introducing smart contracts, Ricardian contracts, smart contract templates, oracles, Deploying smart contracts, The DAO, Advances in smart contracts.	
Textbook: Chapter-7 (pg:197-218), Chapter-8 (pg:221-243)	
Module – 5	9 Hours
Ethereum Architecture: Introducing Ethereum, cryptocurrency, Keys and addresses, Accounts, Transactions and Messages. Hyperledger: Projects under Hyperledger, Hyperledger reference architecture, Hyperledger Fabric, Fabric 2.0.	
Textbook: Chapter-9 (pg:247-269), Chapter-14 (pg:444-466)	

PRACTICAL COMPONENT OF IPCC

Sl. No.	EXPERIMENTS
1	Simulate a distributed system with network partitions to observe behavior under different CAP conditions.
2	Implement a Byzantine fault-tolerant system with malicious nodes to analyze consensus success and failure.
3	Generate hashes using SHA-256 and analyze the impact of small input changes.
4	Generate public/private keys and perform signing and verification using ECDSA.
5	Build a Merkle Tree and verify data integrity using the root hash.
6	Create, sign, and broadcast a transaction using Bitcoin test network.
7	Install and configure Geth to create wallets, run a private Ethereum network, and perform transactions
8	Set up a blockchain network using Hyperledger Fabric and deploy chaincode to execute transactions.
Open Ended Experiments	
1	Implement and analyze a basic blockchain in Python by varying parameters such as block size, mining difficulty, and transaction volume.
2	Develop and test smart contracts using Solidity and evaluate gas usage and security vulnerabilities.
3	Design and deploy a permissioned blockchain network using Hyperledger Fabric with customized access control

COURSE OUTCOMES:

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

CO1	Explain the core concepts of blockchain, distributed systems, and decentralization, including types and evolution of blockchain technology.
CO2	Apply cryptographic techniques such as AES, RSA, ECC, and digital signatures to secure blockchain transactions.
CO3	Analyze and evaluate consensus algorithms and describe the architecture and working of Bitcoin.
CO4	Develop and deploy basic smart contracts and demonstrate blockchain applications in real-world scenarios.
CO5	Examine and compare blockchain platforms such as Ethereum and Hyperledger Fabric for enterprise and decentralized solutions.

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 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.

Textbooks:

1. **Imran Bashir**. “Mastering Blockchain”, Fourth Edition, Packt – 2023.

Reference Books:

1. **Andreas M.**, “Mastering Bitcoin: Programming the Open Blockchain”, O’rielly – 2017.

Web links and Video Lectures:

1. <https://nptel.ac.in/courses/106104220>
2. <https://www.geeksforgeeks.org/blockchain/>
3. <https://www.tutorialspoint.com/blockchain/index.htm>

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

- Course Project: Covers the implementation of the major concepts outlined in the syllabus

Self-Study Topics:

1. Study the architecture and working of decentralized applications (DApps) on Ethereum with real-world examples.
2. Compare consensus mechanisms such as Proof of Work, Proof of Stake, and PBFT in terms of performance, security, and scalability.
3. Explore enterprise blockchain solutions using Hyperledger Fabric and analyze their use cases in industry.

B.E. CSE (DATA SCIENCE)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VII			
Course Title:	Cloud Computing		
Course Code:	BCD703	CIE MARKS	50
(L: T: P) + SL	(3:2:0) + (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. Introduce the rationale behind the cloud computing revolution and the business drivers 2. Introduce various models of cloud computing 3. Introduction on how to design cloud native applications, the necessary tools and the design trade-offs. 4. Realize the importance of Cloud Virtualization, Abstraction`s and 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, OS security, VM Security, Security Risks Posed by Shared Images and Management OS, XOAR, A Trusted Hypervisor.

Cloud Security and Trust Management: Cloud Security Defense Strategies, Distributed Intrusion/Anomaly Detection, Data and Software Protection Techniques, Reputation-Guided Protection of Data Centers.

Textbook 1: Chapter-4 (4.6)

Textbook 2: Chapter-9 (9.1-9.3, 9.5-9.6, 9.8-9.11)

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 (6.1-6.5)

COURSE OUTCOMES:

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

CO1	Understand and analyze various cloud computing platforms and service provider.
CO2	Illustrate various virtualization concepts
CO3	Identify the architecture, infrastructure and delivery models of cloud computing.
CO4	Understand the Security aspects of Cloud.
CO5	Define platforms for development of cloud 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.
- 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. 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:

- Kai Hwang, Geoffrey C Fox, and Jack J Dongarra**, Distributed and Cloud Computing, Morgan Kaufmann, Elsevier 2012.
- Dan C. Marinescu**, Cloud Computing Theory and Practice, Morgan Kaufmann, 2nd Edition, Elsevier 2018.

Reference Books:

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

Web links and Video Lectures (e-Resources):

- <https://freevideolectures.com/course/4639/nptel-cloud-computing/1>.
- <https://www.youtube.com/playlist?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J>
- https://www.youtube.com/watch?v=EN4fEbcFZ_E
- <https://www.youtube.com/watch?v=RWgW-CgdIk0>

Self -Study Topics:

- Serverless computing, focusing on execution of code without the need to manage servers.
- Containers as a lightweight virtualization technique for application deployment.
- Understanding microservices architecture by dividing applications into small, independent services.
- Introduction to cloud monitoring for tracking system performance, availability, and usage.
- Service level agreements (SLA) and their role in defining expected performance and availability of services.

6. Understanding big data in cloud computing for handling and analyzing large-scale datasets.
7. Introduction to disaster recovery and backup techniques used to restore data after system failures.
8. Multi-cloud and hybrid cloud strategies for utilizing multiple cloud environments effectively.



ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Natural Language Processing		
Course Code:	BCD714A	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to 1. Learn the importance of natural language modelling. 2. Understand the applications of natural language processing. 3. Study spelling, error detection, and correction methods and parsing techniques in NLP. 4. Illustrate the information retrieval models in natural language processing.			
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: Paninian Framework, Karaka theory, Statistical Language Model - N-gram model (unigram, bigram). Textbook 1: Chapter -1 (1.1-1.7), Chapter -2 (2.2.5, 2.3)			
Module-2			9 Hours
Word Level Analysis: Regular Expressions, Finite-State Automata, Morphological Parsing, Words and Word Classes, Part-of-Speech Tagging. Syntactic Analysis: Context-Free Grammar, Constituency, Phrase Level Constructions, Top-down, and Bottom-up Parsing, CYK Parsing. Textbook 1: Chapter-3 (3.2-3.4, 3.6, 3.7), Chapter-4 (4.2, 4.3, 4.3.1, 4.4.1, 4.4.2, 4.4.5)			
Module-3			9 Hours
Naive Bayes, Text Classification and Sentiment: Naive Bayes Classifiers, Training the Naive Bayes Classifier, Worked Example, Optimizing for Sentiment Analysis, Naive Bayes for Other Text Classification Tasks, Naive Bayes as a Language Model, Evaluation: Precision, Recall, F-measure, Avoiding Harms in Classification. Textbook 2: Chapter- 4 (4.1-4.7, 4.10)			
Module-4			9 Hours
Information Retrieval: Design Features of Information Retrieval Systems, Information Retrieval Models - Classical, Non-classical, Alternative Models of Information Retrieval-Cluster model, Fuzzy model, LSIM model.			

Lexical Resources: Introduction, WordNet, FrameNet, Stemmers.

Textbook 1: Chapter- 9 (9.2-9.6), Chapter- 12 (12.1-12.4)

Module-5

9 Hours

Machine Translation: Language Divergences and Typology, Machine Translation using Encoder-Decoder, Details of the Encoder-Decoder Model, Translating in Low-Resource Situations, MT Evaluation, Bias and Ethical Issues.

Textbook 2: Chapter-13 (13.1-13.7)

COURSE OUTCOMES:

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

CO1	Describe and interpret fundamental concepts of NLP, including grammar-based and statistical language models.
CO2	Apply morphological analysis and syntactic parsing techniques in NLP.
CO3	Develop and apply Naïve Bayes classifiers for sentiment analysis and text classification.
CO4	Analyze information retrieval models and utilize lexical semantics and lexical resources in NLP applications.
CO5	Apply and evaluate encoder-decoder models for machine translation in NLP.

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

- Tanveer Siddiqui, U.S. Tiwary**, “Natural Language Processing and Information Retrieval”, Oxford University Press.
- Daniel Jurafsky, James H. Martin**, “Speech and Language Processing, An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2023.

Reference Books:

- Akshay Kulkarni, Adarsha Shivananda**, “Natural Language Processing Recipes Unlocking Text Data with Machine Learning and Deep Learning using Python”, Apress, 2019.
- T V Geetha**, “Understanding Natural Language Processing Machine Learning and Deep Learning Perspectives”, Pearson, 2024.
- Gerald J. Kowalski and Mark.T. Maybury**, “Information Storage and Retrieval systems”, Kluwer Academic Publishers.

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:

Text Classification Game

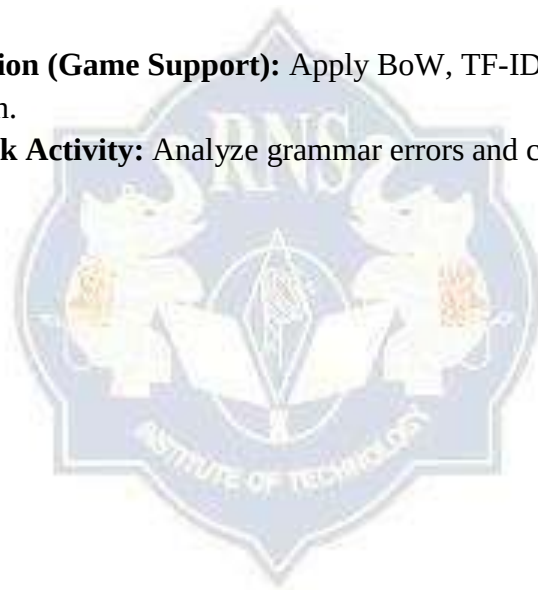
- Objective: Learn supervised learning and text classification.
- Activity: Provide students with a set of documents (e.g., movie reviews) labelled as positive or negative. Divide them into groups and have them create a simple classification model using keywords or phrases. They can then test their model on new reviews.

Grammar Check and Correction

- Objective: Learn about language structure and NLP tools.
- Activity: Provide sentences with grammatical errors. Students can use grammar checking tools (like Grammarly or LanguageTool) to identify errors and suggest corrections, discussing why each suggestion is made.

Self-Study topics:

1. **Neural Networks & Deep Learning:** Implement NN, CNN, and RNN/LSTM models with transfer learning.
2. **Model Evaluation & Visualization:** Visualize training metrics using TensorBoard or Matplotlib.
3. **Text Classification (Game Support):** Apply BoW, TF-IDF, and Naive Bayes for text classification.
4. **Grammar Check Activity:** Analyze grammar errors and compare rule-based vs ML approaches.



ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VII			
Course Title:	Cognitive Computing		
Course Code:	BCD714B	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES:			
The purpose of the course is to facilitate the learner to:			
1. Understand various concepts of cognitive computing.			
2. Understand the evolution of Watson services from the original DeepQA architecture.			
3. Describe various case studies related to cognitive computing.			
4. Develop cognitive computing related applications.			
Module-1			9 Hours
Foundations of Cognitive Computing: Cognitive computing as new generation, Uses of cognitive systems, what makes system cognitive, Gaining insights from data, Artificial intelligence-the foundation, Understanding cognition, Understanding complex relationships, Elements of cognitive systems			
Design Principles for Cognitive Systems: Components of cognitive systems, Building the Corpus, Bringing data into the cognitive system, Machine learning, Hypothesis generation and scoring, Presentation and visualization services.			
Textbook: Chapter-1 (1.1-1.9), Chapter -2 (2.1-2.6)			
Module-2			9 Hours
Natural Language Processing-Support of Cognitive System: The role of NLP in a cognitive system, Semantic Web, Applying natural language technologies to business problems			
The Relationship Between Big Data and Cognitive Computing: Dealing with Human-Generated Data, Defining Big Data, The Architectural Foundation for Big Data, Analytical Data Warehouses, Hadoop, Data in Motion and Streaming Data, Integration of Big Data with Traditional Data.			
Textbook: Chapter-3 (3.1-3.3), Chapter -4 (4.1-4.6)			
Module-3			9 Hours
Representing Knowledge in Taxonomies and Ontologies: Representing Knowledge, Defining Taxonomies and Ontologies, Explaining How to Represent Knowledge, Models for Knowledge Representation, Implementation Considerations.			
Applying Advanced Analytics to Cognitive Computing: Advanced Analytics Is on a Path to Cognitive Computing, Advanced Analytics Is on a Path to Cognitive Computing, Using Advanced Analytics to Create Value, Impact of Open-Source Tools on Advanced			

Analytics.

Textbook: Chapter-5 (5.1-5.5), Chapter -6 (6.1-6.4)

Module-4

9 Hours

The Role of Cloud and Distributed Computing in Cognitive Computing: Leveraging Distributed Computing for Shared Resources, Why Cloud Services Are Fundamental to Cognitive Computing Systems, Characteristics of Cloud Computing, Cloud Computing Models, Delivery Models of the Cloud, Managing Workloads, Security and Governance, Data Integration and Management in the Cloud.

IBM's Watson as a Cognitive System: Watson Defined, Advancing Research with a "Grand Challenge", Preparing Watson for Jeopardy, Preparing Watson for Commercial Applications, The Components of DeepQA Architecture.

Textbook: Chapter-7 (7.1-7.8), Chapter-9 (9.1-9.5)

Module-5

9 Hours

The Process of Building a Cognitive Application: The Emerging Cognitive Platform, Defining the Objective, Defining the Domain, Understanding the Intended Users and Defining their Attributes, Defining Questions and Exploring Insights, Creating and Refining the Corpora, Training and Testing.

Building a Cognitive Healthcare Application: Foundations of Cognitive Computing for Healthcare, Constituents in the Healthcare Ecosystem, Learning from Patterns in Healthcare Data, Building on a Foundation of Big Data Analytics, Cognitive Applications across the Healthcare Ecosystem, Starting with a Cognitive Application for Healthcare, Using Cognitive Applications to Improve Health and Wellness, Using a Cognitive Application to Enhance the Electronic Medical Record, Using a Cognitive Application to Improve Clinical Teaching.

Textbook: Chapter-10 (10.1-10.7), Chapter-11 (11.1-11.9)

COURSE OUTCOMES:

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

CO1	Explain the key concepts, evolution, and characteristics of cognitive computing systems.
CO2	Analyze the architectural design principles and workflow components of cognitive systems.
CO3	Apply NLP and big data processing techniques in cognitive computing applications.
CO4	Evaluate knowledge representation models and advanced analytics methods for insight generation.
CO5	Design cloud-enabled cognitive solutions and illustrate real-world implementations like IBM Watson.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	12	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Alternate Assessment (CIE) (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 (40%) out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			
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. **Judith Hurwitz, Marcia Kaufman, Adrian Bowles**, Cognitive Computing and Big Data Analytics, 1st Edition, Wiley Publisher, 2015, ISBN: 978-1-118-89662-4.

Reference Books:

1. **Jerome R. Busemeyer, Peter D. Bruza**, “Quantum Models of Cognition and Decision”, Cambridge University Press, 2014. Gilberg & Forouzan, “Data Structures: A Pseudo-code approach with C”, 2nd Edition, Cengage Learning, 2014.
2. **Peter Finger**, Cognitive Computing: A Brief Guide for Game Changers, Meghan Kiffler Press, 1st Edition, 2015.
3. **Kai Hwang**, Cloud Computing for Machine Learning and Cognitive Applications, MIT Press Publishers, June 2017.

Web links and Video Lectures (e-resources):

1. https://youtu.be/S47aSEqm_0I?si=34alu47wCWGdsxwN

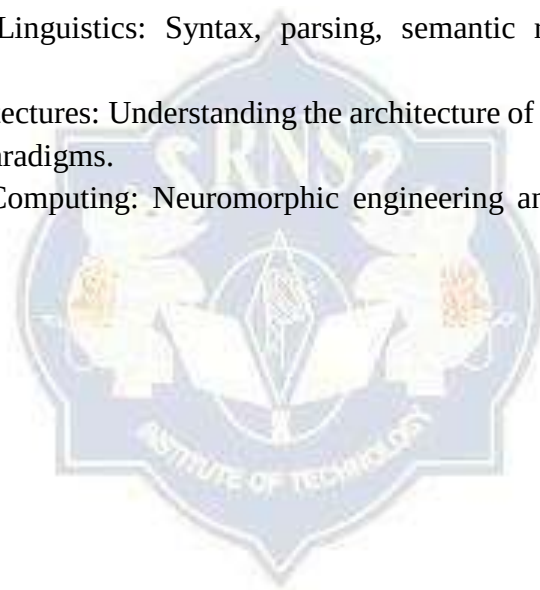
2. <https://www.youtube.com/watch?v=8zYp4yH4PoQ&pp=ygUTY29nbml0aXZlIGNvbXB1dGluZw%3D%3D>
3. <https://www.ibm.com/think/topics/cognitive-computing>
4. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>
5. <https://www.ibm.com/products/watsonx-ai>

Activity Based Learning: The following is shown as examples only but not limited to:

1. LeetCode - The World's Leading Online Programming Learning Platform.
2. HackerRank - Online Coding Tests and Technical Interviews.

Self-Study Topics:

1. Computational Linguistics: Syntax, parsing, semantic representation, and language generation.
2. Cognitive Architectures: Understanding the architecture of the mind, cognitive psychology, and Modeling paradigms.
3. Brain-Inspired Computing: Neuromorphic engineering and computational modeling of neural systems



ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Applied AI for Data Science		
Course Code:	BCD714C	CIE MARKS	50
(L: T: P) + SL	(3:0:0) + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
COURSE LEARNING OBJECTIVES: The objectives of the course are to facilitate the learners to 6. Explain AI fundamentals and industrial applications 7. Apply data preprocessing & feature engineering for industrial datasets. 8. Build & evaluate ML models for industrial problems. 4. Deploy AI models using frameworks & MLOps 5. Evaluate ethical & responsible AI practices			
Module-1			9 Hours
Introduction to AI & Industrial Applications: Evolution of Artificial Intelligence, Industry 4.0 and the role of AI, AI in manufacturing, healthcare, finance, logistics Data science workflow for industry Intelligent automation, RPA and AI-driven decision systems.			
Textbook 1: Chapter-1 (1.1 - 1.3), Chapter-2 (2.1 - 2.3), Chapter-9 (9.4, 9.5)			
Module-2			9 Hours
Data Engineering & Pre-processing for Industry: Types of industrial data (sensor data, text, images, logs, transactional data), Data acquisition, data lakes, data warehouses, Data cleaning, transformation, feature engineering, Handling missing data, outliers, imbalance, Exploratory Data Analysis (EDA) for industrial datasets			
Textbook 1: Chapter-3 (3.1-3.4), Chapter-4 (4.1, 4.4), Chapter-5 (5.1, 5.2)			
Module-3			9 Hours
Machine Learning for Industrial Applications: Supervised learning: Regression, Classification, Unsupervised learning: Clustering, Anomaly detection, Time-series forecasting for predictive maintenance, Model evaluation: Accuracy, Precision, Recall, ROC, AUC, Ensemble models: Random Forest, XGBoost.			
Textbook 1: Chapter-7 (7.1, 7.2), Chapter-8 (8.4), Chapter-9 (9.1, 9.2, 9.3, 9.3.2)			
Module-4			9 Hours
Artificial Intelligence Frameworks & Deployment: Deep Learning basics: ANN, CNN, RNN fundamentals, Industrial applications of DL (vision, NLP, automation), AI deployment pipeline, MLOps: Model versioning, CI/CD, monitoring, Cloud AI services: Azure AI, AWS Sage maker, Google AI Platform			
Textbook 1: Chapter-10 (10.1, 10.2), Chapter-12 (12.1, 12.3.4), Chapter-14 (14.3.6, 14.3.9)			
Module-5			9 Hours

AI Ethics, Governance & Case Studies in Industry: Responsible AI principles, Fairness, transparency, accountability, Ethical issues in industrial automation, AI governance models and standards, Socio-economic impact of AI in industry, Successful and failed AI project case studies

Textbook 1: Chapter-18 (18.1,18.2), Chapter-20 (20.1, 20.6, 20.8), Chapter-21 (21.4)

COURSE OUTCOMES:

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

CO1	Understand fundamentals of AI and its applications in modern industries.
CO2	Apply data pre-processing, data engineering, and ML techniques for industrial datasets.
CO3	Develop supervised and unsupervised ML models for real-world industrial problems.
CO4	Apply AI frameworks, model deployment, and MLOps workflows in industrial environments.
CO5	Analyze industrial case studies and ethical issues in deploying AI systems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	12	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Alternate Assessment (CIE) (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 (40%) out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

- 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. **Stuart Russell & Peter Norvig**, Artificial Intelligence: A Modern Approach, 4th Edition. PDF available online (AIMA 4e PDF)

Reference Books:

1. **Ian Good fellow, Yoshua Bengio, Aaron Courville**, Deep Learning, MIT Press. Official free PDF available (MIT Press).
2. **Trevor Hastie, Robert Tibshirani, Jerome Friedman**, The Elements of Statistical Learning, Springer. Official free PDF available.
3. **Christopher Bishop**, Pattern Recognition and Machine Learning, Springer. PDF commonly available

Web links:

1. MIT Introduction to Deep Learning (<https://introtodeeplearning.mit.edu>)
2. Stanford CS221: AI Principles & Techniques (<https://stanford-cs221.github.io>)
3. Google AI Education (<https://ai.google/education>)
4. Kaggle Learn - Industrial Data Tutorials (<https://www.kaggle.com/learn>)
5. Data camp "Data Science for Industry 4.0" (<https://www.datacamp.com>)
6. PyTorch Tutorials with Industry Case Studies (<https://pytorch.org/tutorials>)
7. Tensor Flow Industrial Examples (<https://www.tensorflow.org/resources/learn-ml>)
8. Google MLOps Guide (<https://cloud.google.com/architecture/mlops>)
9. AWS Machine Learning Engineering Path (<https://aws.amazon.com/machine-learning/learn>)

Self-Study Topics:

1. Big Data & Tools
2. SQL & Databases
3. Data Visualization & BI Tools
4. Advanced ML

B.E. CSE (Data Science) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	Data Driven Decision Making and Business Intelligence		
Course Code:	BCD714D	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 nature of data, statistical Modelling and visualization. 2. Learn concepts of Business Intelligence and Data Warehousing. 3. Gain knowledge on Data mining process and SNA, text & Web analytics			
Module-1			9 Hours
An Overview of Business Intelligence, Analytics, Data Science, and AI: Changing Business Environments and Evolving Needs for Decision Support and Analytics, Decision-Making Processes and Computerized Decision Support Framework, Evolution of Computerized Decision Support to Analytics/Data Science, A Framework for Business Intelligence, Analytics Overview. Artificial Intelligence - Concepts, Drivers, Major Technologies, and Business Applications: Major AI Technologies and Some Derivatives, AI Support for Decision Making, Conversational AI—Chatbots. [Note: Analytics in action – Excluded]			
Textbook 1: Chapter-1 (1.2-1.6), Chapter-2 (2.4-2.6, 2.9)			
Module-2			9 Hours
Descriptive Analytics I -Nature of Data, Big Data, and Statistical Modelling: The Nature of Data in Analytics, A Simple Taxonomy of Data, The Art and Science of Data Preprocessing, Definition of Big Data, Fundamentals of Big Data Analytics, Big Data Technologies, Big Data and Stream Analytics, Statistical Modelling for Business Analytics, Regression Modelling for Inferential Statistics. [Note: Analytics in action – Excluded]			
Textbook 1: Chapter-3 (3.2-3.10)			
Module-3			9 Hours
Descriptive Analytics II: Business Intelligence Data Warehousing, and Visualization: Business Intelligence and Data Warehousing, Data Warehousing Process, Data Warehousing Architectures, Data Management and Warehouse Development, Data Warehouse Administration, Security Issues, and Future Trends, Business Reporting, Data Visualization, Information Dashboards, Recurrent Networks and Long Short-Term Memory Networks (LSTM), Legal, Privacy and Ethical Issues. [Note: Analytics in action – Excluded]			

Textbook 1: Chapter-4 (4.2-4.8,4.11), Chapter-7 (7.8), Chapter-11 (11.5)

Module-4

9 Hours

Predictive Analytics I - Data mining process, methods, and Algorithms: Data Mining Concepts and Applications, Data Mining Applications, Data Mining Process, Data Mining Methods. Prescriptive Analytics - Optimization and Simulation: Model-Based Decision-Making, Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Decision Modelling with Spreadsheets.

[Note: Analytics in action – Excluded]

Textbook 1: Chapter-5 (5.2-5.5), Chapter-8 (8.2-8.5)

Module-5

9 Hours

Predictive Analytics II - Text, Web, and Social Media Analytics: Text Analytics and Text Mining Overview, Natural Language Processing (NLP), Text Mining Applications, Text Mining Process, Sentiment Analysis and Topic Modelling, Web Mining Overview, Search Engines, Web Usage Mining (Web Analytics), Social Analytics.

[Note: Analytics in action – Excluded]

Textbook 1: Chapter-6 (6.2-6.10)

COURSE OUTCOMES:

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

CO1	Explain the role of business analytics in a dynamic business environment.
CO2	Demonstrate modern tools for Statistical Modelling and Visualization.
CO3	Illustrate analytics for Business Analytics and Data Warehousing.
CO4	Implement algorithms for data mining techniques and processes.
CO5	Develop scripts for Text & Web mining and social network analysis.

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.			

Textbook:

- Ramesh Sharda, Dursun Delen and Efraim Turban**, “Business Intelligence, Analytics, Data Science and AI – A Managerial Perspective”, 5th edition, Global Edition, Pearson Education Limited, 2024.

Reference Books:

- Steve Williams**, Business Intelligence Strategy and Big Data Analytics - A General Management Perspective, Morgan Kaufmann (Elsevier), 2016.
- Vincent Charles, Pratibha Garg, Neha Gupta and Mohini Agarwal**, Data Analytics and Business Intelligence - Computational Frameworks, Practices, and Applications, CRC Press, 2023.
- Ira J. Haimowitz**, DATA ANALYTICS FOR BUSINESS - Lessons for Sales, Marketing, and Strategy, Routledge (Taylor & Francis), 2023.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc24_cs65/preview
- https://onlinecourses.nptel.ac.in/noc21_cs45/preview
- <https://www.geeksforgeeks.org/what-is-data-analytics/>
- https://onlinecourses.nptel.ac.in/noc20_mg11/preview
- https://onlinecourses.nptel.ac.in/noc23_mg104/preview
- https://onlinecourses.nptel.ac.in/noc20_mg24/preview

Activity Based Learning/ Practical Based learning

- Discussion of business analytics and decision-making case studies.
- Basic data analysis and visualization using suitable datasets.
- Practice of data mining techniques such as clustering and association analysis.
- Simple text, web, and sentiment analysis activities using real data.

5. Study and interpretation of social network data and analytical results.

Self – Study Topics:

1. Study of “**Analytics in Action**” cases (excluded) from the prescribed textbook for additional understanding of real-world applications.
2. Case study on Data-Driven Decision Making in different industries.
3. Conceptual study of interactive business dashboards using real-world datasets.
4. Study of AI-based chatbots in customer relationship management and business automation.
5. Analysis of social media data for product or brand performance evaluation.
6. Study of predictive analytics applications in business forecasting.



ESTD : 2001

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B.E. CSE (Data Science) 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. Analyze problems using algorithm design methods such as the brute force method, greedy method, 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: 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 Approaches: Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching. Textbook: Chapter-2 (2.3,2.4), Chapter-3 (3.1,3.2)			
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: 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: 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: 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.

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.			

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.

Web links and Video Lectures (e-Resources):

1. <https://youtu.be/xGYsEge9Vl0?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 Topics:

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.

B.E. CSE (Data Science) 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. To introduce fundamental principles of information security and its importance in modern systems. 2. To provide knowledge on identification and authentication mechanisms used for user verification. 3. To familiarize access control concepts and models for regulating resource access. 4. To introduce auditing and accountability mechanisms for ensuring system security and traceability. 5. To present the fundamentals of cryptography and its role in securing data across different states.			
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: Chapter-1 (pg:24-51)			
Module-2			9 Hours
Identification and Authentication: Identification, Authentication, Common Identification and Authentication methods. Textbook: Chapter-2 (pg:54-70)			
Module-3			9 Hours
Authorization and Access Controls: What are Access Controls? Implementing Access Controls, Access Control Models, Physical Access Controls. Textbook: Chapter-3 (pg:72-94)			
Module-4			9 Hours
Auditing and Accountability: Accountability, Security Benefits of Accountability, Auditing. Textbook: Chapter-4 (pg:96-107)			
Module-5			9 Hours
Cryptography: The History of Cryptography, Modern Cryptographic Tools, Protecting Data at Rest, in Motion and in Use. Textbook: Chapter-5 (pg:109-133)			

COURSE OUTCOMES:

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

CO1	Apply information security concepts, attacks, and defense-in-depth.
CO2	Demonstrate authentication methods for user verification.
CO3	Analyze access control models and mechanisms for regulating resource access.
CO4	Examine auditing and accountability for ensuring security and traceability.
CO5	Implement cryptographic techniques for protecting data at rest, in transit, and in use.

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

Text Book:

- Jason. Andress**, Foundations of Information Security: A Straightforward Introduction. San Francisco, CA, USA: No Starch Press, 2019, ISBN: 9781718500044.

Reference Books:

- 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. nptel.ac.in/courses/106105162
2. [Cyber Security Full Course for Beginner - YouTube](#)
3. [Introduction to Cryptography and Network Security – Neso academy](#)
4. <https://iamsridhariyer.com/infosec/>

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 in modern networks
2. Cybersecurity frameworks (NIST, ISO 27001 overview)
3. Security in cloud computing environments
4. Blockchain applications in information security
5. Ethical hacking and penetration testing basics

ESTD : 2001

An Institute with a Difference

B.E. CSE (Data Science) 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. To understand the essential javascript concepts for web development. 2. To style Web applications using bootstrap. 3. To utilize React JS to build front end User Interface. 4. To understand the usage of API's to create web applications using Express JS. 5. To 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 (pg:53-82), Chapter-3 (pg:83-143), Chapter-4 (pg:145-181)			
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 (pg:184-241), Chapter-6 (pg:243-291)			
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 (pg:567-611) Textbook 2: Chapter-1 (pg:01-15), Chapter-2 (pg:17-36), Chapter-3 (pg:41-55)			
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 (pg:61-82), Chapter-5 (pg:85-92)

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 (pg:137-165), Chapter-8 (pg:203-217)

COURSE OUTCOMES

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

- CO1** Apply 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, 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)

B.E. CSE (Data Science)
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)

Module-3

9 Hours

Similarity-based Learning: Nearest-Neighbour Learning, Weighted K-NearestNeighbor 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, NaiveBayes 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.

Textbook1: Chapter8 (8.1-8.4), Chapter10 (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.
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
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ASSESSMENT AND EVALUATION REGULATIONS OF OEC

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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. S. Sridhar and M. Vijayalakshmi, Machine Learning, 1st Edition, Oxford University Press, 2021.

Reference Books:

1. M. Narasimha Murty and V. S. Ananthanarayana, Machine Learning: Theory and Practice, 1st Edition, Universities Press, 2024.
2. Tom M. Mitchell, Machine Learning, 1st Edition, McGraw-Hill Education, 1997.
3. Andriy Burkov, The Hundred-Page Machine Learning Book, 1st Edition, Andriy Burkov, 2019.

Web Links:

1. <https://www.universitiespress.com/resources?id=9789393330697>
2. https://www.drssridhar.com/?page_id=1053

3. <https://www.geeksforgeeks.org/machine-learning/>
4. https://www.tutorialspoint.com/machine_learning/index.htm
5. https://onlinecourses.nptel.ac.in/noc22_cs29/preview



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