

NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai & Accredited by NAAC)

K.R. NAGAR, KOVILPATTI – 628 503

www.nec.edu.in

REGULATIONS – 2019

CURRICULUM & SYLLABUS

B.Tech. - ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

B.Tech. – ARTIFICIAL INTELLIGENCE AND DATA SCIENCE
CURRICULUM AND SYLLABUS

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

VISION

To Produce globally competent, innovative, Computing professionals to meet current challenges in the field of Artificial intelligence and Data Science with social responsibilities

MISSION

- Offering well-balanced curriculum with state of the art technologies to impart professional competencies and transferable skills.
- Bringing innovations in Teaching-Learning process through experienced learning and project/product based learning.
- Collaborating National and International Industries and Academia to develop foresight technologies in Artificial intelligence and Data Science.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Within few years(3 to 5 years) of graduation, our graduates are expected to:

1. be successful in their professional career as data scientist, data modeller, data architect, business intelligence developer and software developer with technical and managerial skills in the field of artificial intelligence and data science
2. pursue higher studies at the institute of repute in India and abroad and work in educational institutions, research organisations and reputed software industries and be successful entrepreneurs.
3. collaborate in multi disciplinary teams and be the leaders in their organisations, their profession and in society.

PROGRAMME OUTCOMES (POs)

By the time of graduation graduates will attain the following programme outcomes:

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

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

PREAMBLE OF THE CURRICULUM & SYLLABI

The Curriculum and Syllabi under Regulations 2019 are implemented based on the recommendations of AICTE, New Delhi and UGC, New Delhi. The course content of each course

shall be fixed in accordance with the Programme Educational Objectives (PEOs), Programme Outcomes (POs) and Course Outcomes (COs).

Further, The CBCS enables the students to earn credits across programmes and provides flexibility for slow and fast learners in registering the required number of credits in a semester. The CBCS facilitates the transfer of credits earned in different departments / Centers of other recognized / accredited universities or institutions of higher education in India and abroad either by studying directly or by online method.

The curriculum of **AI & DS programme** is designed with total number of credits **164 (124)** for Lateral entry). The curriculum shall have the following category of courses with credits as given in Table-1.

TABLE – 1 CATEGORY OF COURSES

Sl. No	Coursework – Subject Area	The range of Total credits
1.	Humanities and Social Sciences including Management courses	15
2.	Basic Science courses	23.5
3.	Engineering Science courses	19.5
4.	Employability Enhancement Course	2
5.	Professional Core courses	61
6.	Professional Elective courses relevant to chosen specialization / branch	24
7.	Open Elective courses from other technical and /or emerging subject areas	6
8.	Skill Development Courses	13
9.	Mandatory courses	(non – credit)
	TOTAL	164

- i. **Humanities and Social Sciences (HSMC)** include English, Communication Skill laboratory and Management courses
- ii. **Basic Science Courses (BSC)** include Chemistry, Physics, Biology and Mathematics
- iii. **Engineering Science Courses (ESC)** include Workshop, Drawing, Basics of Electrical / Electronics / Mechanical / Civil / Computer / Instrumentation Engineering
- iv. **Employability Enhancement Course (ESC)** include Innovation through Design Thinking
- v. **Professional Core Courses (PCC)** include the core courses relevant to the chosen programme of study.
- vi. **Professional Elective Courses (PEC)** include the elective courses relevant to the chosen programme of study.
- vii. **Open Elective Courses (OEC)** include inter-disciplinary courses which are offered in other Engineering/Technology Programme of study.
- viii. **Skill Development Courses (SDC)** include the courses such as Project, Seminar and Inplant training / Internship for improving Employability Skills.

ix. **Mandatory courses (MAC)** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc.

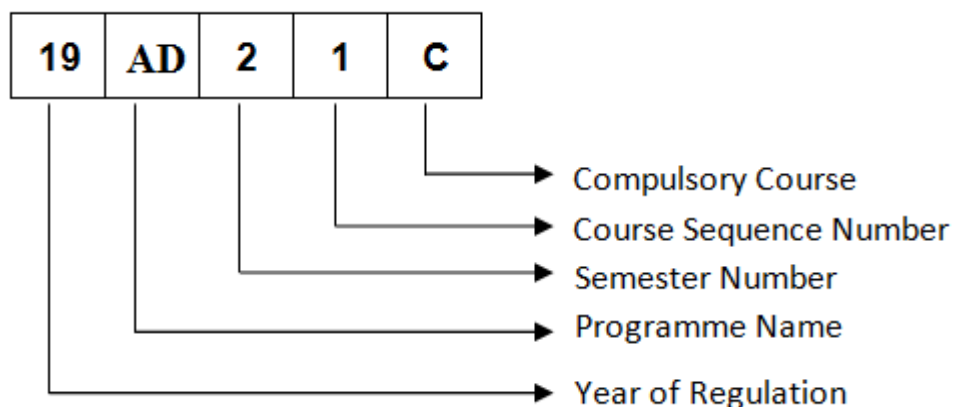
Performance in each course of study shall be evaluated based on Continuous Assessment throughout the semester and end semester examination at the end of the programme. Keeping in mind the content of the courses and delivery methods, different question paper patterns are suggested, as given in Table-2.

TABLE – 2 QP - QUESTION PATTERN

R-2019 REVISED Question Pattern Format

Subject Type	Question pattern	2 marks	4 marks	10 marks	11 marks	12 marks	16 marks	20 marks	Total
Theory (3 / 4 credit)	A	10	5	-	--	5 Qns (either or type)	--	--	100
Theory (2 credit)	B	10	-	-	5 Qns (either or type)	--	--	--	75
Theory (1 credit)	C	5	--	2 Qns (either or type)	--	--	--	--	30
Theory (Trans Disciplinary)	D	-	-	-	-	-	--	5 out of 8	100
Design Oriented / Theory	E	--	-	--	-	-	--	5 Qns (either or type)	100
Theory (3 / 4 credit)	F	10	--	--	--	--	5 Qns (either or type)	--	100

FORMAT FOR COURSE CODE



REGULATIONS – 2019 CURRICULUM AND SYLLABUS

B.Tech. - ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

SEMESTER I

S. No	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	HSMC	19AD11C	English – I	2	0	0	0	2	B
2.	BSC	19AD12C	Mathematical Foundations for Data Science	3	1	0	0	4	A
3.	BSC	19AD13C	Semiconductor Physics and Optoelectronics	2	0	0	0	2	B
4.	BSC	19AD14C	Chemistry for Artificial Intelligence and Data Science	2	0	0	0	2	B
5.	ESC	19AD15C	Engineering Graphics	2	0	4	0	4	E
6.	ESC	19AD16C	C Programming	3	0	0	0	3	A
PRACTICAL COURSES									
7.	BSC	19AD17C	Semiconductor Physics and Chemistry Laboratory	0	0	3	0	1.5	-
8.	ESC	19AD18C	C Programming Laboratory	0	0	3	0	1.5	-
TOTAL				14	1	10	0	20	

SEMESTER II

S. No	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	HSMC	19AD21C	English II	2	0	0	0	2	B
2.	BSC	19AD22C	Probability and Statistics	3	1	0	0	4	A
3.	BSC	19AD23C	Principles of Digital Electronics	3	1	0	0	4	A
4.	BSC	19AD24C	Environmental Science	2	0	0	0	2	B
5.	HSMC	19GN02C	Heritage of Tamils (தமிழர் மரபு)	1	0	0	0	1	C
INTEGRATED COURSE (Theory + Lab + Experiential Learning Practices)									
6.	EEC	19AD25C	Innovation through Design Thinking	1	0	2	0	2	-
7.	ESC	19AD26C	Python Programming	2	0	2	2	4	A
PRACTICAL COURSES									
8.	HSMC	19AD27C	Communication and Soft Skills Laboratory	0	0	2	0	1	-
TOTAL				14	2	6	2	20	

SEMESTER III

S. No.	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	BSC	19AD31C	Discrete Mathematics	3	1	0	0	4	A
2.	PCC	19AD32C	Fundamentals of Data Science	3	1	0	0	4	A
3.	PCC	19AD33C	Operating Systems	3	0	0	0	3	A
4.	PCC	19AD34C	Data Structures	3	0	0	0	3	A
5.	PCC	19AD35C	Computer Networks	3	0	0	0	3	A
6.	PCC	19AD36C	Object Oriented Programming with Java	3	0	0	0	3	A
7.	HSMC	19GN03C	Tamils and Technology (தமிழரும் தொழில் நுட்பமும்)	1	0	0	0	1	C
PRACTICAL COURSES									
8.	PCC	19AD37C	Data Science Laboratory	0	0	3	0	1.5	-
9.	PCC	19AD38C	Data Structures Laboratory	0	0	3	0	1.5	-
10.	PCC	19AD39C	Object Oriented Programming Laboratory	0	0	3	0	1.5	-
TOTAL				19	2	9	0	25.5	

SEMESTER IV

S. No.	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	ESC	19AD41C	Calculus and Numerical Methods	3	1	0	0	4	A
2.	PCC	19AD42C	Machine Learning	3	1	0	0	4	A
3.	PCC	19AD43C	Database Management Systems	3	0	0	0	3	A
4.	PCC	19AD44C	Design and Analysis of Algorithms	3	1	0	0	4	A
5.	PEC	--	Elective – I	3	0	0	0	3	A
PRACTICAL COURSES									
6.	PCC	19AD45C	Machine Learning Laboratory	0	0	3	0	1.5	-
7.	PCC	19AD46C	Database Management Systems Laboratory	0	0	3	0	1.5	-
INTEGRATED COURSE (Theory + Lab +Experiential Learning Practices)									
8.	PCC	19AD47C	Artificial Intelligence	2	0	2	2	4	A
TOTAL				17	3	8	2	25	

SEMESTER V

S. No.	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	HSMC	19AD51C	Professional Ethics and Human Values	3	0	0	0	3	A
2.	PCC	19AD52C	Deep Learning	3	0	0	0	3	A
3.	PCC	19AD53C	Data Visualization	3	0	0	0	3	A
4.	ESC	19AD54C	Embedded Systems and IOT	3	0	0	0	3	A
5.	OEC	-	Open Elective – I	3	0	0	0	3	A
6.	PEC	-	Elective – II	3	0	0	0	3	A
PRACTICAL COURSES									
7.	PCC	19AD55C	Deep Learning Laboratory	0	0	3	0	1.5	-
8.	PCC	19AD56C	Embedded Systems and IOT Laboratory	0	0	3	0	1.5	-
INTEGRATED COURSE (Theory + Lab)									
9.	PCC	19AD57C	Computer Vision	3	0	2	0	4	A
TOTAL				21	0	8	0	25	

SEMESTER VI

S. No.	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	HSMC	19AD61C	Finance and Accounting	3	0	0	-	3	A
2.	PCC	19AD62C	Big Data Analytics	3	0	0	-	3	A
3.	PCC	19AD63C	Data Mining	3	0	0	-	3	A
4.	PEC	-	Professional readiness for Innovation, Employability, Entrepreneurship (Elective – III)	3	0	0	-	3	A
5.	PEC	-	Elective – IV	3	0	0	-	3	A
6.	OEC	-	Open Elective – II	3	0	0	-	3	A
7.	MAC	19MC01C	Constitution of India	3	0	0	-	0	-
PRACTICAL COURSES									
8.	PCC	19AD64C	Product Development Laboratory	0	0	4	-	2	-
9.	PCC	19AD65C	Big Data Analytics Laboratory	0	0	3	-	1.5	-
10.	SDC	19AD66C	Comprehension	0	0	2	-	1	-
TOTAL				21	0	9	-	22.5	

SEMESTER VII

S. No	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSES									
1.	HSMC	19AD71C	Business Process Management	2	0	0	-	2	B
2.	PEC		Elective – V	3	0	0	-	3	
3.	PEC		Elective – VI	3	0	0	-	3	
4.	PEC		Elective – VII	3	0	0	-	3	
PRACTICAL COURSES									
5.	SDC	19AD72C	Project Work – I	0	0	6	-	3	-
6.	SDC	19AD73C	Research Paper and Patent Review – Seminar	0	0	2	-	1	-
TOTAL				11	0	8	-	15	

SEMESTER VIII

S. No	Course Category	Course Code	Course Title	L	T	P	E	C	QP
THEORY COURSE									
1.	PEC	---	Elective – VIII	3	0	0	-	3	-
PRACTICAL COURSES									
2.	SDC	19AD81C	Project Work – II/Industry Practice	0	0	12	-	6	-
3.	SDC	19AD82C	Internship / Inplant Training	0	0	4	-	2	-
TOTAL				3	0	16	-	11	

Total Number of Credits: 164

LIST OF ELECTIVES

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
DATA SCIENCE								
1.	PEC	19AD01E	Data Engineering	3	0	0	3	A
2.	PEC	19AD02E	Business Analytics	3	0	0	3	A
3.	PEC	19AD03E	Social Network Analysis	3	0	0	3	A
4.	PEC	19AD04E	Health care Analytics	3	0	0	3	A
5.	PEC	19AD05E	Web Analytics	3	0	0	3	A
6.	PEC	19AD06E	Bio Informatics	3	0	0	3	A
7.	PEC	19AD07E	Exploratory Data Analytics	3	0	0	3	A
8.	PEC	19AD08E	Text andSpeech Analytics	3	0	0	3	A
9.	PEC	19AD09E	Image Analytics	3	0	0	3	A
AI and ROBOTICS								
10.	PEC	19AD10E	Cognitive Science	3	0	0	3	A
11.	PEC	19AD11E	Reinforcement Learning	3	0	0	3	A
12.	PEC	19AD12E	Natural Language Processing	3	0	0	3	A
13.	PEC	19AD13E	Knowledge Engineering	3	0	0	3	A
14.	PEC	19AD14E	Industrial AI	3	0	0	3	A
15.	PEC	19AD15E	Optimization Techniques	3	0	0	3	A
16.	PEC	19AD16E	Mobile Robots	3	0	0	3	A
17.	PEC	19AD17E	Internet of Things	3	0	0	3	A
18.	PEC	19AD18E	Robotics Process Automation	3	0	0	3	A
19.	PEC	19AD19E	AI tools for Engineers	3	0	0	3	A
DESIGNING / PROGRAMMING								
20.	PEC	19AD20E	Internet and Web Technology	3	0	0	3	A
21.	PEC	19AD21E	App Development	3	0	0	3	A
22.	PEC	19AD22E	Programming Paradigms	3	0	0	3	A
23.	PEC	19AD23E	Augmented Reality and Virtual Reality	3	0	0	3	A
24.	PEC	19AD24E	UI and UX Design	3	0	0	3	A
COMPUTING								
25.	PEC	19AD25E	Cloud Computing	3	0	0	3	A
26.	PEC	19AD26E	Soft computing	3	0	0	3	A
27.	PEC	19AD27E	Distributed Systems	3	0	0	3	A
28.	PEC	19AD28E	Nature and Bio inspired computing	3	0	0	3	A
29.	PEC	19AD29E	Neural Computing	3	0	0	3	A
SECURITY								
30.	PEC	19AD30E	Cloud Security	3	0	0	3	A
31.	PEC	19AD31E	Cyber Security	3	0	0	3	A
32.	PEC	19AD32E	Information Security	3	0	0	3	A
33.	PEC	19AD33E	Ethical Hacking	3	0	0	3	A
34.	PEC	19AD34E	Ethics for AI	3	0	0	3	A
SOFTWARE								
35.	PEC	19AD35E	Software Testing and Quality Assurance	3	0	0	3	A
36.	PEC	19AD36E	Agile Methodologies	3	0	0	3	A

37.	PEC	19AD37E	Software Engineering	3	0	0	3	A
BLOCKCHAIN TECHNOLOGY								
38.	PEC	19AD38E	Block Chain Technology	3	0	0	3	A
39.	PEC	19AD39E	Digital Currencies And Crypto Assets	3	0	0	3	A
40.	PEC	19AD40E	Smart Contract and Solidity	3	0	0	3	A
41.	PEC	19AD41E	Blockchain Frameworks Laboratory	0	0	4	2	-
SKILL DEVELOPMENT COURSE								
42.	SDC	19AD42E	Professional readiness for Innovation, Employability, Entrepreneurship	0	0	6	3	A

ONE CREDIT ELECTIVE COURSES

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP®
DATA SCIENCE								
1.	PEC	19AD01L	Statistical foundations for data science	1	0	0	1	C
2.	PEC	19 AD02L	R programming	0	0	2	1	-
3.	PEC	19 AD03L	Time Series Data Analytics	0	0	2	1	-
4.	PEC	19 AD04L	Scala for Data Science	0	0	2	1	-
5.	PEC	19 AD05L	Data visualization using Power BI	0	0	2	1	-
AI & DEEP LEARNING								
6.	PEC	19 AD06L	Applied Machine Learning	1	0	0	1	C
7.	PEC	19 AD07L	Machine learning with Tensorflow	0	0	2	1	-
8.	PEC	19 AD08L	Multivariate Calculus for AI	1	0	0	1	C
9.	PEC	19 AD09L	Digital Twin and Simulation	1	0	0	1	C
10.	PEC	19 AD10L	AI Services	1	0	0	1	C
NETWORKING								
11.	PEC	19 AD11L	Cyber security tools and techniques	0	0	2	1	-
12.	PEC	19 AD12L	Vehicular Cloud Networking	1	0	0	1	C
13.	PEC	19 AD13L	Speckled computing	1	0	0	1	C
14.	PEC	19 AD14L	Introduction to Networks	1	0	0	1	C
APPLICATION DEVELOPMENT								
15.	PEC	19 AD15L	Server-side Development using Node.js	0	0	2	1	-
16.	PEC	19 AD16L	Web Application Development using AngularJS	0	0	2	1	-
17.	PEC	19 AD17L	NoSQL on MongoDB	0	0	2	1	-
18.	PEC	19 AD18L	Application development using Flutter	0	0	2	1	-
19.	PEC	19 AD19L	Application development using Firebase	0	0	2	1	-
20.	PEC	19 AD20L	Linux Administration	0	0	2	1	-
21.	PEC	19 AD21L	Software testing using Selenium	0	0	2	1	-

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: enhance their basic language skills to understand various aspects of communication skills (K3)

CO2: express their thoughts with correct usage of language in formal writings (K3)

CO3: understand various language components and develop pronunciation skills. (K2)

CO4: prepare effective technical documents and interpret any pictorial representation. (K3)

CO5: frame sentences and write effective reports. (K3)

UNIT I**6**

Parts of Speech – Newspaper article presentation – Greetings and self-Introduction– Instruction writing–Technical vocabulary– Purpose of listening– Listening for general information.

UNIT II**6**

Transformation of words into different grammatical forms – Letter to friends/ parents/ siblings – Process description – Letter writing (for Industrial visits and training) – Talks on technology– Listening to scientific talks.

UNIT III**6**

Personality adjectives – Phonetics - (Vowels - Consonants – Diphthongs – Transcriptions) – Kinds of sentences (Statement, Interrogative, Imperative & Exclamatory) – Situational conversation

UNIT IV**6**

Technical terms and extended definitions – Active and Passive Voices – Note-making – E-mail writing – Picture description – Checklists.

UNIT V**6**

Homophones – Concord – Foreign words and phrases – Verbal analogies – Report writing (Types–Structure – Stages in report writing – Model report).

L:30; TOTAL:30 PERIODS**TEXT BOOKS**

1. Anderson and Paul. V, "Technical Communication: A Reader Centered Approach," 9th Edition, New Delhi: Cengage, 2018.
2. Murphy. R, "Basic Grammar Practice on Tense," New Delhi: Cambridge University Press, 2018.

REFERENCES

1. Lucantoni and Peter, "English as a Second Language," Cambridge University Press, 2022.
2. McCarthy. M, "English Grammar, The Basics," 1st Edition, New York: Routledge, 2021.
3. Raman. M, and Sharma. S, "Technical Communication: Principles and Practice", 3rd Edition New Delhi: Oxford University Press, 2015.

19AD12C	MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE	L	T	P	C
		3	1	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1: make use of orthogonal transformation (K3)
- CO2: interpret the ideas of orthonormal basis and perform matrix decomposition (K2)
- CO3: solve ordinary differential equations (K2)
- CO4: solve partial differential equations (K2)
- CO5: evaluate area and volume using double and triple integrals (K3)

UNIT I MATRICES 12

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors – Diagonalisation of a matrix by orthogonal transformation- Quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation - Cayley – Hamilton theorem.

UNIT II INNER PRODUCT SPACES AND MATRIX DECOMPOSITION 12

Inner Product and Norms – Orthonormal Vectors – Gram Schmidt Orthogonalization process - QR decomposition – Generalised Inverse - Singular Value Decomposition.

UNIT III ORDINARY DIFFERENTIAL EQUATIONS 12

Solutions of first order Ordinary Differential Equations - Equations solvable for 'p', equations solvable for 'y', equations solvable for 'x' - Solutions of higher order linear differential equations with constant coefficients – Cauchy's and Legendre's linear equations.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - Lagrange's linear equations - Solutions of homogeneous and Non-homogeneous linear partial differential equations of second and higher order with constant coefficients.

UNIT V MULTIPLE INTEGRALS 12

Double integration – Cartesian and polar coordinates - Change of order of integration - Area as double Integral -Triple integration in cartesian coordinates – Volume as triple integration.

L:45;T:15; TOTAL:60 PERIODS

TEXTBOOKS

1. Grewal. B.S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, Delhi, 2018.
2. James E. Gentle, "Matrix Algebra", 2nd Edition, Springer International Publishing, 2017.
3. Kenneth B. Howell, "Ordinary Differential Equations", 2nd Edition, CRC Press Taylor and Francis, 2020
4. Shankar Rao. G, "Linear Algebra", 1st Edition, Wiley, India, 2017

REFERENCES

1. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Private Limited, 2016.

2. Dennis G. Zill, "Advanced Engineering Mathematics", 6th Edition, Jones & Bartlett Learning, 2018
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2017
4. Richard Bronson, "Theory and Problems of Matrix Operations", 2nd Edition, McGraw Hill, New York, 2011

19AD13C	SEMICONDUCTOR PHYSICS AND OPTOELECTRONICS	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1: recognize the different types of semiconductors and their properties (K2)
- CO2: select the suitable semiconductor diode for a simple electronic circuit application (K2)
- CO3: explain the constructional features and working of different types of transistors (K2)
- CO4: discuss the basic principle, types, and applications of laser and display devices (K2)
- CO5: describe the types, fabrication, losses, and applications of optical fibers (K2)

UNIT I SEMICONDUCTING MATERIALS 6

Energy band formation – Direct and indirect bandgap semiconductors - Intrinsic semiconductors; carrier concentration in intrinsic semiconductors, variation of Fermi level with temperature — Extrinsic semiconductors; carrier concentration in n-type & p-type semiconductors, variation of Fermi level with temperature and impurity concentration — Hall effect

UNIT II DIODES 6

Theory of PN junction diode - Energy Band Structure - Biasing of PN Junction – Forward bias and Reverse bias - Current equation – Zener diode; characteristics, voltage regulator – Half wave and full wave rectifiers

UNIT III TRANSISTORS 6

BJT: Construction and Operation of NPN and PNP Transistors - Study of CE, CB, and CC configurations and comparison of their characteristics
 FET: Construction and Operation of N-Channel JFET – Expression for Drain Current, Comparison of JFET and BJT- MOSFET; enhancement and depletion mode, comparison with JFET

UNIT IV OPTICAL DEVICES 6

Principle of spontaneous emission and stimulated emission - Population inversion – Pumping - Einstein's A and B coefficients – Different types of lasers: gas lasers (CO₂), solid-state lasers (Nd-YAG), semiconductor laser - Applications of lasers in science, engineering, and medicine - LED-OLED.

UNIT V FIBRE OPTICS 6

Principle – Total internal reflection - Acceptance angle and Numerical aperture - Types of optical fibers - Double crucible technique – Splicing - Losses in optical fibers - Fiber optic communication system - Applications – Fiber optic sensors – Medical Endoscope

L:30; TOTAL:30 PERIODS

TEXT BOOKS

1. David A. Bell, "Fundamentals of Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2009.
2. John Wilson, John Hawkes, "Optoelectronics", 3rd Edition, Pearson Education, 2018.

REFERENCES

1. Mathur. K.S, "Fiber Optic fundamentals and Advances in communications", 1st Edition, Zorbabooks, 2021.
2. Renk, Karl. F "Basics of laser physics", 2nd Edition, Springer international publishing, 2018.
3. Salivahanan. S, Suresh Kumar. N and Vallavaraj. A, "Electronic Devices and Circuits", 2nd Edition, Tata McGraw Hill, 2018.

19AD14C	CHEMISTRY FOR ARTIFICIAL INTELLIGENCE AND DATA	L	T	P	C
	SCIENCE	2	0	0	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: express the mechanism of chemical bond formation in different molecules (K2)

CO2: identify the suitable novel organic materials used in various electronics industries (K2)

CO3: familiar with the structure of nucleic acids and proteins (K2)

CO4: interpret the results of various analytical methods to evaluate biomolecules in the biological systems (K2)

CO5: design and predict the molecular structure using artificial intelligence (K2)

UNIT I CHEMICAL BONDING 6

Introduction – Types of chemical bonds – Molecular interactions: van der waals forces and hydrogen bonding – Chemical bonding – Molecular orbitals as a linear combination of atomic orbitals - molecular orbital energy level diagram of homo and heteronuclear diatomic molecules - hybridization (sp, sp² and sp³)

UNIT II ELECTRONIC MATERIALS 6

Organic semiconducting materials – Advantages - p-type and n-type semiconducting materials; pentacene and fullerenes - C-60 - Organic light emitting polymers; polythiophene and polyphenylene vinylene - Sensors – Fundamentals – Types; biosensors, chemical sensors - Microsensors – Nanosensors.

UNIT III DNA AND PROTEINS 6

Basic chemistry of nucleic acids, Structure of DNA, Structure of RNA, DNA Replication, - Transcription, -Translation, Genes- the functional elements in DNA, Analysing DNA, DNA sequencing. Proteins: amino acids, protein structure, secondary, tertiary, and quaternary structure, protein folding and function - Nucleic acid and protein interaction.

UNIT IV ANALYTICAL TECHNIQUES FOR BIOLOGICAL SYSTEMS 6

UV-Visible and Circular dichroism (Principle, instrumentation, and applications) - Microscopy: fluorescence microscopy; confocal microscopy; (Principle, instrumentation, and applications) - Bioassay methods PCR and ELISA.

UNIT V CHEM INTELLIGENCE 6

Introduction – Molecular properties prediction: QSAR – retro synthesis – Databases; primary and secondary databases - PDB, Genbank, CATH, SCOP, NCBI - Sequence analyze methods – Molecular docking.

L: 30; TOTAL: 30 PERIODS

TEXTBOOKS

1. Bahl. B.S and Bahl. A, "A Textbook of Organic Chemistry", 22nd Edition, S.Chand publications, 2021.
2. Nelson, D.L, and Cox. M.M, "Lehninger Principles of Biochemistry", 7th Edition, W.H.Freeman, Macmillan Learning, 2017.

REFERENCE BOOKS

1. Clayden. J, Greeves. N and Warren. S, "Organic Chemistry", 2nd Edition, Oxford University Press, 2014.
2. Engel. T and Gasteiger. J, "Chemoinformatics: Basic Concepts and Methods", 1st Edition, Wiley-VCH, 2018.
3. Skoog. D, Holler. F and Crouch. S, "Principles of Instrumental Analysis" 7th Edition, Brooks / Cole, 2017.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: familiarize with the fundamentals of Engineering graphics and construct the engineering curves. (K2)

CO2: construct the orthographic projections of points, straight lines and lamina (K2)

CO3: draw the projections of simple solids in different positions. (K3)

CO4: visualize the sectional views and surface areas of various solids. (K3)

CO5: perform freehand sketching and prepare elementary 2-D& 3D sketches of simple solids.(K3)

INTRODUCTION**5**

Principles of Engineering Graphics – significance. Usage of Drawing Instruments. Lettering and dimensioning exercise. First angle projection should be followed for all the topics except projection of points.

UNIT I ENGINEERING CURVES**17**

Construction of ellipse, parabola and hyperbola using eccentricity method– Construction of cycloids, Epi and Hypo-cycloids - construction of involutes for square and circle –Tangent and Normal to the above curves.

UNIT II ORTHOGRAPHIC PROJECTIONS**17**

Principle of orthographic projections – Conventions - First angle and third angle projections. Projections of points placed in all quadrants – projections of straight lines – inclined to both reference planes - determination of true length and inclinations. Projections of regular polygonal surfaces and circular lamina inclined to both reference planes.

UNIT III PROJECTIONS OF SOLIDS**17**

Projections of simple solids like prisms, pyramids, cylinder and cone - axis inclined to one reference plane - change of position method.

UNIT IV SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES**17**

Sectioning of simple solids – Axis perpendicular to horizontal plane- Drawing sectional views with true shape of the section. Development of lateral surfaces of truncated solids – Prisms, pyramids, cylinder and cone.

UNIT V ISOMETRIC PROJECTIONS AND FREE HAND SKETCHING**17**

Principles of isometric projection – isometric scale – isometric projections of simple solids like prism, pyramid, cone and cylinder – Combination of solids. Orthographic views of simple components by Free hand drawing - Transferring measurement from the given object to the free hand sketches.

L: 30; P: 60; TOTAL: 90 PERIODS

TEXT BOOKS

1. Bhatt N.D, “Engineering Drawing”, 53rd Edition, Charotar Publishing House, 2014.
2. Shah M.B and Rana B.C, “Engineering Drawing”, Pearson Education, 2nd Edition, 2009.

REFERENCES

1. Agrawal B. & Agrawal C.M., Engineering Graphics, TMH Publication, 2nd Edition, 2013
2. Narayana K.L. & Kannaiah P, Text book on Engineering Drawing, Scitech Publishers, 2010.
3. Gopalakrishna K.R, “Engineering Drawing”, Subhas Publications, 32nd Edition, 2017.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: practice the fundamental programming concepts and terminologies. (K3)

CO 2: use different control structures and understand how function calls are carried out. (K3)

CO 3: solve problems using arrays and strings. (K3)

CO 4: develop applications in C using structures and file handling. (K3)

CO 5: structure how to store and manage the addresses of dynamically allocated blocks of memory (K3)

UNIT I FUNDAMENTALS OF C PROGRAMMING 9

Introduction to programming paradigms - Features of C language - Structure of C program - Compilation process - I/O statements - Tokens: Variables, Data Types, Identifiers, Keywords, Constants, Operators - Type Casting - Storage classes - Pre-processor directives.

UNIT II CONTROL STATEMENTS AND FUNCTIONS 9

Decision making statements: if, if-else, if-elseif-else, switch. Looping statements: while, for, do-while, Nested loops, Infinite Loops, break, continue, goto Functions: Introduction - Function prototype, Function definition, Function call, Built-in functions - Recursion - Math function - Example Programs in functions

UNIT III ARRAYS AND STRINGS 9

Array: Introduction, Declaration, Initialization - Types of array: One dimensional, Two Dimensional, Multi-Dimensional – Sorting and Searching in Array. String: Introduction, Ways to declare a string in C - String Functions

UNIT IV STRUCTURES AND FILE HANDLING 9

Structure: Introduction - typedef in C - Array of Structures - Nested Structure - Structure Padding – Union – Files: Introduction, Types of file processing: Sequential access, Random access - File Handling – Programs using File

UNIT IV POINTERS AND MEMORY ALLOCATION 9

Pointers: Introduction, Declaration - Pointer to array, Pointer to a function, Pointer to structure - Pointer operators and Pointer arithmetic - Arrays and pointers - Array of pointers - Structure pointer - Memory Allocation in C - Command line arguments

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Harsha Priya, R. Ranjeet, "Programming and Problem Solving Through C Language", Firewall/Laxmi Publications (P) Ltd., New Delhi, 2015.

REFERENCES

1. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", Second Edition, Oxford University Press, 2013.
2. M.G.Venkateshmurthy, "Programming Techniques through C": A Beginner's Companion, Pearson Education, Canada, 2009.
3. Ashok.N.Kamthane, "Computer Programming", Pearson Education, India, 2011.

PART A – SEMICONDUCTOR PHYSICS LABORATORY**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: interpret the properties of the laser and verify the parameters of optical fiber (K3)

CO2: demonstrate the voltage-current characteristics of different diodes (K3)

CO3: analyze the characteristics of transistors (K3)

LIST OF EXPERIMENTS

1. Determination of angle of divergence of the laser beam and acceptance angle, the numerical aperture of optical fiber
2. Determination of wavelength of laser using grating and particle size of lycopodium powder
3. Determination of V-I characteristics of PN junction diode
4. Determination of V-I characteristics of Zener junction diode
5. Determination of V-I characteristics of light emitting diode
6. Determination of characteristics of BJT
7. Determination of characteristics of FET
8. Study of logic gates using transistors

- A minimum of FIVE experiments shall be offered.

TEXTBOOK

1. Sessa Sai Kumar Vemula, "Engineering Physics lab manual" 1st Edition, LAP LAMBERT Academic Publishing, 2017

REFERENCE BOOK

1. David Loyd, " Physics laboratory" 4th Edition, Cengage Learning, 2013

PART-B CHEMISTRY LABORATORY**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: determine the chemical parameters of the water sample (K3)

CO2: quantify the amount of acid by pH metric methods (K3)

CO3: identify the biomolecules (K3)

CO4: estimate the amount of biomolecules present in the given samples (K3)

LIST OF EXPERIMENTS

1. Estimation of Total hardness of water sample
2. Estimation of Alkalinity of water sample
3. Estimation of HCl by pH method
4. Qualitative analysis of biomolecules
5. Estimation of glycine
6. Estimation of Vitamin – C
7. Separation of amino acids by TLC method
8. Determination of DNA binding constant by UV-Visible spectroscopy (Demo)

P: 45; TOTAL: 45 PERIODS

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Biology

TEXTBOOKS

1. Bhujbal. N, Kolat. S and Kand. R, "Practical Organic Chemistry: A Laboratory experiments for Graduates and Post Graduates", 1st Edition, Prashant Publications, 2020
2. Svehla and Sivasankar, "Vogel's Qualitative Inorganic Analysis", 8th Edition, Pearson Education Limited, 2015.

19AD18C

C PROGRAMMING LABORATORY

L	T	P	E	C
0	0	3	0	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: solve simple syntactical structures of C Language (K3)

CO 2: enhance the programming skills in C using arrays and functions (K3)

CO 3: develop programs using pointers, structures and file concepts (K3)

List of Experiments:

1. I/O statements, operators, expressions
2. Decision-making constructs: if-else, goto, switch-case, break-continue
3. Loops: for, while, do-while
4. Arrays: 1D and 2D, Multi-dimensional arrays, traversal
5. Strings: operations
6. Functions: call, return, passing parameters by (value, reference), passing arrays to function.
7. Recursion
8. Pointers: Pointers to functions, Arrays, Strings, Pointers to Pointers, Array of Pointers
9. Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions.
10. Files: reading and writing, File pointers, file operations, random access, processor directives.

P: 45; TOTAL: 45 PERIODS

Software Requirement: Turbo C

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: frame effective conditional and interrogative sentences. (K3)

CO 2: write effective letters and reports in any professional context. (K3)

CO 3: enhance the vital sub-functions of communication in any formal situation. (K3)

CO 4: participate actively in both informal and formal discussions. (K3)

CO 5: recall the acquired skills and apply them in the workplace. (K2)

UNIT I

6

Standard abbreviations – Tenses (Present, Past, and Future) – Question framing – Asking and answering Yes/No and Wh questions - If conditionals.

UNIT II

6

Single-Word substitution – Business letters for quotations and clarification – Chart description – Review of recent technologies – Listening to TED talks.

UNIT III

6

Idioms and Phrases – Direct & Indirect Speech– Business letters for placing orders and making complaints – Product description.

UNIT IV

6

Error spotting (Based on Concord, Pronouns, Articles & Adverb Placement) – Group Discussion (Uses – Structure – Strategies – Team Work – Positive & Negative Body Languages – Samples – Demo) – Proposal writing.

UNIT V

6

Job application letter & Résumé preparation –Circular and minutes of the meeting – Reading (Skimming, Scanning, and Inferring) – Reading comprehension.

L:30; TOTAL:30 PERIODS

TEXTBOOKS

1. Bovee. C.L, and Thill. J.V, "Business Communication Today," 15th Edition, New Delhi: Pearson Education, 2021.
2. Digiacomo. M, "The English Grammar Workbook for Adults," Emeryville, CA: Rockridge Press, 2020.

REFERENCE BOOKS

1. Lester. M and Larry. B, "Handbook of English Grammar and Usage", 3rd Edition, McGraw Hill Education, 2018.
2. Meenakshi. R, Sangeeta. S, "Professional English", Oxford university press, 2019.
3. Ravindra Nath. T, "Technical English-II", Shaswat publication, 2020.
4. Sudharshana. N. P, "English for Engineers", Cambridge University Press, 2018.
5. Walter. S, "Oxford English Grammar Course", 2019.

19AD22C

PROBABILITY AND STATISTICS

L	T	P	C
3	1	0	4

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

CO1: recognize the concepts of random variables and standard distributions (K2)

CO2: perform the ideas of two-dimensional random variables (K2)

CO3: calculate the various measures of dispersion (K3)

CO4: apply the concepts of testing of hypothesis for small and large samples (K3)

CO5: grasp the principles of design of experiments and perform analysis of variance (K3)

UNIT I RANDOM VARIABLES 12

Discrete and continuous random variables - Moments - Moment generating functions and their properties. Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 12

Joint distributions - Marginal and conditional distributions – Covariance - Correlation and regression - Transformation of random variables - Central limit theorem.

UNIT III STATISTICS 12

Mean – Median – Mode - Moments - Skewness- Kurtosis- Correlation - Single and bivariate frequency distributions - Regression lines.

UNIT IV TESTING OF HYPOTHESIS 12

Large samples - Tests on means and proportions for large samples - Tests for single variance and equality of variances - Small samples – t-test - F- test – Chi-square test – Applications: Case study – Sampling.

UNIT V DESIGN OF EXPERIMENTS 12

One-way and two-way classifications - Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design.

L:45; T: 15; TOTAL:60 PERIODS

TEXTBOOKS

1. Dharmaraja Selvamuthu and Dipayan Das, “Introduction to Statistical Methods, Design of Experiments and Statistical Quality Control”, Springer Nature Singapore Pvt. Ltd, 2018.
2. Gupta. S.C. and Kapoor. V.K., “Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons, Delhi, 2020
3. Peyton. Z. Peebles. J.R, “Probability, Random Variables, and Random Signal Principles”, McGraw Hill, 4th Edition, 2017

REFERENCE BOOKS

1. John E. Freund’s, “Mathematical Statistics with applications”, 8th Edition, Pearson Education Ltd, 2014
2. Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes”, 2nd Edition, Elsevier, 2014
3. Richard A. Johnson, “Miller and Freund’s Probability and Statistics for Engineers”, 9th Edition, Pearson Education Private Ltd., 2020.

19AD23C	PRINCIPLES OF DIGITAL ELECTRONICS	L	T	P	C
		3	1	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO 1: summarize the basics of Boolean algebra and illustrate the Boolean functions by logic gates. (K2)
- CO 2: explain and design different types of adder and subtractor in combinational circuits. (K2)
- CO 3: explain and design multiplexers and encoders in combinational circuits. (K2)
- CO 4: illustrate the basics of synchronous sequential logic and Registers. (K2)
- CO 5: classify and explain different types of memories. (K2)

UNIT I BOOLEAN ALGEBRA AND LOGIC GATES 12

Review of binary number systems - Binary arithmetic - Computer codes – BCD, Gray code, Excess 3 code - Boolean algebra and theorems - Boolean functions - Simplifications of Boolean functions using Karnaugh map – Logic gates.

UNIT II COMBINATIONAL LOGIC-I 12

Design procedure - Half adder - Full Adder - Half subtractor - Full subtractor - Parallel binary adder - Parallel binary subtractor - Fast Adder - Carry Look - Ahead adder - Serial Adder / Subtracter - BCD adder- BCD subtractor -Binary Multiplier - Binary Divider.

UNIT III COMBINATIONAL LOGIC-II 12

Parity Checker/Generator – Multiplexer – Demultiplexer – Encoder - Priority Encoder – Decoder -BCD to Seven segment Display Decoder/Driver - LCD Display and Comparators.

UNIT IV SYNCHRONOUS SEQUENTIAL LOGIC 12

Sequential circuits - Latches – Flip-Flops - Analysis of clocked sequential circuits – State reduction and assignment – Design procedure - Registers – Shift Registers – Ripple counters – Synchronous Counters.

UNIT V MEMORY AND PROGRAMMABLE LOGIC 12

Memory – Introduction – Random-Access Memory – Memory Decoding – Read-only memory - Programmable Logic Array – Programmable Array Logic – Sequential Programmable Devices.

L:45; T:15; TOTAL:60 PERIODS

TEXTBOOKS

1. Morris Mano. M and Michael D. Ciletti., “Digital Design”, Pearson Education, 6th Edition, 2018.
2. Salivahanan S. and Arivazhagan S., “Digital Circuits and Design”, 5th Edition, Oxford University Press, 2018.

REFERENCE BOOKS

1. Charles H. Roth and Larry L Kinney, “Fundamentals of Logic Design” (with Companion CD-ROM), 7th Edition, Thomson Learning, 2013
2. Donald P Leach, Albert Paul Malvino and Goutam Saha, “Digital Principles and Applications”, 6th Edition, Tata McGraw Hill, 2008

- Godse. D.A. and Godse. A.P, "Digital Electronics", Technical Publications, 4th Edition, 2017
- Rishabh Anand, "Digital Electronics", Chand Publications, 2nd edition, 2021
- Thomas L. Floyd, "Digital Fundamentals", 11th Edition, Pearson Education, 2017

19AD24C	ENVIRONMENTAL SCIENCE	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: express the structure and functions of different ecosystems (K2)

CO2: identify the causes, impacts, and management of e-waste, municipal waste, and hazardous waste (K2)

CO3: recognize the causes, impacts, and preventive measures of various global issues (K2)

UNIT I ENVIRONMENT AND ECOSYSTEMS 6

Scope and importance of the environment – Need for public awareness – Ecosystem – Structure and function of an ecosystem – Energy flow in the ecosystem – Forest and aquatic ecosystems – A field study of simple ecosystems – Pond and forest.

UNIT II INTEGRATED WASTE MANAGEMENT IN SMART CITIES 6

Introduction – Generation and types of solid waste - Swachh Bharat Mission - Solid waste: collection, transportation, segregation and processing – Disposal: landfill, biochemical processes, and energy recovery - Municipal solid waste management rules 2016.

UNIT III E-WASTE MANAGEMENT 6

Introduction – Composition - Types – Generation – Environmental and health hazards of e-waste – Recycling - Recovery of metals: pyrometallurgical, hydrometallurgical, and biometallurgical process – e-waste management and handling rules 2016 – e-waste management companies in India.

UNIT IV HAZARDOUS WASTE MANAGEMENT 6

Sources – Hazard identification – Dose - Response assessment – Risk characterization: Impact on plants, animals, and human beings – Hazardous waste management act 1986 - Physical treatment methods: sedimentation, adsorption, aeration - Chemical treatments: neutralization, precipitation, and redox method – Biological method.

UNIT V GLOBAL AND REGIONAL ENVIRONMENTAL ISSUES 6

Global effects of air pollution: Global warming and climate change - Acid rain - Ozone hole- Biodiversity: types, threats, and conservation - Population - Energy consumption and environmental degradation.

L: 30; TOTAL: 30 PERIODS

TEXTBOOKS

- Miller. G.T and Spoolman. S, "Environmental Science", 16th Edition, Brooks/Cole Publishing Co., 2018.
- Peavy. H.S, Rowe. D.R and Tchobanoglous. G, "Environmental Engineering", 2nd Edition, McGraw Hill Education, 2020.

REFERENCE BOOKS

1. Kaushik. A and Kaushik. C.P, "Environmental Science and Engineering", 6th Edition, New Age International Publishers, 2018.
2. Weller. K, "Environmental Science and Biological Engineering", 1st Edition, WIT Press, 2015.

19GN02C

HERITAGE OF TAMILS (தமிழர் மரபு)

L T P C
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART-SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

L: 15; TOTAL: 15 PERIODS

REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல.சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை – ஆற்றங்கரை நாகரீகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu)

- (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
 9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
 10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
 11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
 12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

19GN02C

HERITAGE OF TAMILS (தமிழர் மரபு)

L T P C

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அலகு I

மொழி மற்றும் இலக்கியம்

3

இந்திய மொழிக்குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II

மரபு பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக்கலை

3

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளூர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III

நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்

3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV

தமிழர்களின் திணைக் கோட்பாடுகள்

3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு

3

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப் படிகள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

L: 15; TOTAL: 15 PERIODS

REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல.சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை - ஆற்றங்கரை நாகரீகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

19AD25C

INNOVATION THROUGH DESIGN THINKING

L T P C

1 0 2 2

COURSE OUTCOMES

Upon Successful completion of this course, the students will be able to

CO1: To discuss the design thinking process and innovation. (K2)

CO2: Practice design thinking process through a multidisciplinary task. (K3)

UNIT I BASICS OF DESIGN THINKING PROCESS

15

Design thinking process basics - Ideation tools - case studies.

UNIT II PRACTICING DESIGN THINKING PROCESS

30

Real world problem selection-Practicing the preliminary stages of Design Thinking Process - work presentation.

L: 15; P: 30; TOTAL: 45 PERIODS

REFERENCES

1. Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef, "Design Thinking: The Handbook", WS Professional, 2020
2. Pavan Soni, "Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem solving", Penguin Random House, 2020
3. D.M. Arvind Mallik, "Design Thinking for Educators", Notion Press, 2019
4. Michael Lewrick, "The Design Thinking Playbook", Wiley, 2019
5. Kathryn Christopher, "Design Thinking in Engineering", Kendall Hunt Publishing Company, 2019
6. Robert Curedale, "Design Thinking Process & Methods" 5th Edition, Design Community College Inc, 2019
7. David Lee, "Design Thinking in the Classroom", Ulysses Press, 2018
8. Jimmy Jain, "Design Thinking for Startups", Notion Press, 2018
9. Monika Hestad Silvia Rigoni Anders Grnli, "The Little Booklet on Design Thinking: An Introduction", 2nd Edition, Zaccheus Entertainment, 2017
10. Scott Swan, Michael G. Luchs and Abbie Griffin, "Design Thinking: New Product Development Essentials", Wiley-Blackwell, 2016

11. Thomas Lockwood, "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", Allworth Press, 2009

MENTOR ACTIVITIES:

Educating the design thinking process: basics, Ideation tools and empathy map through case studies – presentation 10 Hours

Forming multidisciplinary batches among the students- Guide the batches to select a real-world task- Apply and practice the different stages of Design thinking process to bring out innovative solutions 20 Hours

Evaluating the students' activities through their presentations

End semester Assessments can be made through:

- Design Thinking presentation(PowerPoint format)
- Design Thinking poster preparation and presentation (PDF format, in color and monochrome, printable in A3 size)

Other points:

This course is for all department students

- A class/section should be with all department students
- A course instructor will be responsible for the academic process.
- In a project batch, maximum number of students should be four and no two students from same discipline possibly.
- The course has no pre-requisite and may be offered to second/fourth semester students.

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: develop simple Python programs. (K3)

CO2: structure simple Python programs using control flow structures and functions for solving problems (K3)

CO3: represent compound data using Python lists, tuples, and dictionaries. (K3)

CO4: understand file management concepts and study modules using Python Programs. (K2)

CO5: Study and Implement python packages (K3)

UNIT I DATA, EXPRESSIONS, STATEMENTS 6

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Modules and functions, function definition and use, flow of execution, parameters and arguments.

UNIT II CONTROL FLOW, FUNCTIONS 6

Conditionals: Boolean values and operators - conditional (if) - alternative (if-else) – chained conditional (if-elif-else) - Iteration: state – while – for – break – continue - pass - Fruitful functions: Function argument and its types - return values – parameters - local and global scope - function composition – recursion - Documenting Function

UNIT III LISTS, TUPLES, DICTIONARIES 6

Strings: string slices – immutability - string functions and methods - string module - Lists: list operations - list slices - list methods - list loop – mutability – aliasing - cloning lists – list Parameters - Lists as arrays - Tuples: tuple assignment - tuple as return value - Dictionaries: operations and methods - advanced list processing - list comprehension - Sets: Creating Sets – Operations and methods – Set comprehension

UNIT IV FILES, MODULES 6

Files and exception: text files - reading and writing files - format operator - command line arguments - errors and exceptions - handling exceptions – Modules – from import statement – Name of Module – Making your own modules.

UNIT V PACKAGES 6

Introduction - Basics of NumPy - N-dimensional Array in NumPy – Methods and Properties - Basics of SciPy - Broadcasting in NumPy Array Operations - Array Indexing in NumPy, Pandas - Introduction - Series - DataFrame - Matplotlib - Basics - Figures and Axes - Method subplot() - Axis container

L: 30; P: 30; E:30; TOTAL: 90 PERIODS

TEXT BOOKS

1. Paul Barry, "Head-First Python: A Brain-Friendly Guide", 2nd Edition, O'Reilly Media, Inc.,2016
2. John M Zelle, "Python Programming: An Introduction to Computer Science", Franklin Beedle & Associates Inc., 2016
3. Eric Matthes, "Python Crash Course: A Hands-On, Project-Based Introduction to Programming", William pollock publisher, 2019
4. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly Media, Inc., 2016.
5. Richard L. Halterman, "Learning to Program with Python", 2019.

REFERENCES

1. Timothy A.Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Limited, 2015.
2. Charles Dierbach, "Introduction to Computer Science using python: A Computational Problem-solving Focus, Wiley India Edition, 2015.
3. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3.6", 2nd edition, Pragmatic Programmers, LLC, 2018.
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd, 2016.

LIST OF EXPERIMENTS

1. Develop simple programs
2. Implementation of control flow
3. Implementation of functions
4. Exercises on Strings and its Operations
5. Exercises on Regular Expressions
6. Implementation of List and its operations
7. Implementation of Dictionaries: operations
8. Implementation of Tuples and its operations
9. Develop programs on Set and its operations
10. Develop programs on Functions, Recursions
11. Exercises on Files and its Operations
12. Exercises on Modules and packages.

Sample Question Bank (Exercises not limited to this)

1. Simple Programs

- a. Simple Program to display Hello world in Python
- b. To calculate the average of numbers
- c. To read two numbers and print their quotient and remainder

2. Programs using control flow

- a. To compute prime factors of an integer
- b. To form an integer that has the number of digits at ten's place and the least significant digit of the entered integer at one's place
- c. To get the marks of students for 5 subjects and display their grade as per the 2019 regulation.
- d. To print all numbers in a range divisible by a given number
- e. To accept three digits and print all possible combinations from the digits

3. Programs using functions

- a. To determine all Pythagorean triplets in the range
- b. Given a square matrix with n rows and n columns, you have to write a program to rotate this matrix such that each element is shifted by one place in a clockwise manner.
- c. To check whether a string is a palindrome or not using recursion

4. Programs using strings

- a. To detect if two strings are anagrams

- b. To accept a hyphen separated sequence of words as input and print the words in a hyphen-separated sequence after sorting them alphabetically

5. Programs using lists

- a. To find the second largest number in a list
- b. To merge two lists and sort it

6. Programs using dictionaries

- a. There is a robot which wants to go the charging point to charge itself. The robot moves in a 2-d plane from the original point (0,0). The robot can move toward up, down, left and right with given steps.

The trace of robot movement is shown as the following:

- i. Up 5
- ii. Down 3
- iii. Left 3
- iv. Right 2

Write a program to compute the distance between the current position after a sequence of movement and original point. If the distance is a float, then just print the nearest integer (use round() function for that and then convert it into an integer).

- b. Consider a cricket series containing five matches between india and australia read the scores of individual players of both teams and finally identity the man of the series.

7. Programs using files

- a. To count the number of words and number of lines in a text file
- b. That reads a text file and counts the number of times a certain letter appears in the text file

8. Programs using modules and packages.

Software Requirements

1. Python 3.x
2. Anaconda Navigator

List of Experienced learning exercises (Exercises not limited to this)

1. Evaluation of Mathematical expressions - Circulate the values of n variables - Square root (Newton's method) - GCD - Sum an Array of Numbers.
2. Searching: Linear search, Binary search.
3. Sorting: Selection sort, Insertion sort, Merge Sort
4. Implementation of Histogram
5. Implementation of data manipulation with pandas
6. Mathematical Computations with NumPy
7. Implementation of data visualization using matplotlib
8. Analysis of Time Series data
9. Create a GUI app using Tkinter in Python

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COURSE OUTCOMES

Upon completion of this course, students will be able to

CO1: enable learners to develop their communicative competence (K2)

CO2: participate in group discussions confidently (K3)

CO3: make presentations on general and technical topics (K3)

CO4: collaborate and work in teams successfully (K4)

UNIT I **6**

Lab session: Listening and responding to audio files

Practice session: Mini Presentation related to Business English & Picture description.

UNIT II **6**

Lab session: Role Play – News Reader

Practice session: Resume and cover letter Preparation

UNIT III **6**

Practice session: Presentation, Group discussion

UNIT IV **6**

Project: Preparing a project report with a team of five members on recent topics about technology.

P:30; TOTAL:30 PERIODS

REFERENCES

1. Dhanavel, S. P. "English and Soft Skills" Vol.1, Orient BlackSwan, Chennai 2010
2. Lewis. S and Weintraub. R, "InCredible Communication: Uncover the Invaluable Art of Selling Yourself." 1st Edition, London: Bloomsbury, 2022.
3. Sudha Rani, D. "Advanced Communication Skills Laboratory Manual." New Delhi: Pearson, 2010.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1:Check the validity of the arguments.(K2)

CO2:Understand the concepts of Sets, Relations and Functions.(K2)

CO3:Perform the principles of counting and solve recurrence relations. (K3)

CO4:Interpret the basic concepts of graphs.(K2)

CO5:Find all Spanning Trees of a graph and understand the concepts of coloring of graphs (K3)

UNIT I MATHEMATICAL LOGIC 12

Propositional Logic – Equivalences and Implications – Normal forms –Predicate Calculus and Quantifiers - Rules of inference – Proof methods and Strategies - Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

UNIT II SETS, RELATIONS AND FUNCTIONS 12

Basic Definitions - Set operations – Laws of set theory – Relations – Properties of relations- Partial Ordering Relation - Equivalence Relation - Matrices of relations - Closure of relations – Functions - Bijective functions - Inverse and Compositions of functions.

UNIT III COMBINATORICS 12

Mathematical induction - Strong induction and well ordering -The basics of counting –The Pigeonhole principle - Permutations and combinations – Recurrence relations – Solving linear recurrence relations – Generating functions - Inclusion and exclusion principle.

UNIT IV GRAPH THEORY 12

Graphs and their properties - Special types of graphs – Matrix representation of graphs and graph isomorphism- connectivity, Cut vertex and cut edge - Euler and Hamiltonian graphs.

UNIT V GRAPH COLOURING AND TREES 12

Graph Colouring - Colouring Vertices, Colouring Edges - Perfect Graph, properties – Trees – Some properties of Trees – Pendant vertices in a Tree – Distance and centers in a Tree – Rooted and Binary Trees - Spanning Trees.

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Kenneth H.Rosen, "Discrete Mathematics and its Applications (with Combinatory and Graph Theory)", Special Indian Edition, Tata McGraw-Hill Publishing Company Limited, 8th Edition ,2021.
2. Treshchev Ivan and Vatolina Anastasiya Sergeevna ,"Discrete Math: For students of technical specialties", 2020.
3. Trembly J.P and Manohar.R. "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill Pub. Company Limited, 1st Edition, 2017.

REFERENCES

1. J P Chauhan ,"Discrete Structures & Graph Theory " , 9th Edition, 2020.
2. Dr.Sambhu Charan Barman, Dr.Sovan Samanta , "Beginners guide to Graph theory",2020

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand fundamentals of data analytics.(K2)

CO2: Describe and visualize the data.(K3)

CO3: Perform statistical inferences from data.(K3)

CO4: Analyze the variance in the data.(K2)

CO5: Build models for predictive analytics.(K3)

UNIT I**INTRODUCTION TO DATA SCIENCE****12**

Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications.

UNIT II**DESCRIPTIVE ANALYTICS****12**

Frequency distributions – Outliers –interpreting distributions – graphs – averages - describing variability – interquartile range – variability for qualitative and ranked data - Normal distributions – z scores –correlation – scatter plots – regression – regression line – least squares regression line – standard error of estimate – interpretation of r² – multiple regression equations – regression toward the mean.

UNIT III**INFERENCE STATISTICS****12**

Populations – samples – random sampling – Sampling distribution- standard error of the mean - Hypothesis testing – z-test – z-test procedure –decision rule – calculations – decisions – interpretations - one-tailed and two-tailed tests – Estimation – point estimate – confidence interval – level of confidence – effect of sample size

UNIT IV**ANALYSIS OF VARIANCE****12**

t-test for one sample – sampling distribution of t – t-test procedure – t-test for two independent samples – p-value – statistical significance – t-test for two related samples. F-test – ANOVA – Two factor experiments – three f-tests – two-factor ANOVA –Introduction to chi-square tests.

UNIT V**PREDICTIVE ANALYTICS****12**

Linear least squares – implementation – goodness of fit – testing a linear model – weighted resampling. Regression using Stats Models – multiple regression – nonlinear relationships – logistic regression – estimating parameters – Time series analysis – moving averages – missing values – serial correlation – autocorrelation. Introduction to survival analysis.

L: 45; T: 15; TOTAL: 60 PERIODS**TEXT BOOKS**

1. Jake VanderPlas, “Python Data Science Handbook”, 2nd edition, O’Reilly, 2022.
2. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
3. Robert S. Witte and John S. Witte, “Statistics”, 11th Edition, Wiley Publications, 2017.

REFERENCES

1. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, “Fundamentals of Data Science”, CRC Press, 2022.
2. Vineet Raina, Srinath Krishnamurthy, “Building an Effective Data Science Practice: A Framework to Bootstrap and Manage a Successful Data Science Practice”, Apress, 2021.
3. Chirag Shah, “A Hands-On Introduction to Data Science”, Cambridge University Press, 2020.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1:** Study the various services of an operating system. (K2)
- CO2:** Solve process scheduling, synchronization and deadlock problems. (K3)
- CO3:** Apply knowledge on mechanisms of memory management. (K3)
- CO4:** Illustrate the various storage management techniques. (K2)
- CO5:** Demonstrate Virtualization concepts and Mobile OS.(K3)

UNIT I**INTRODUCTION****7**

Operating System Overview - Objectives and Functions - Evolution of Operating System; Operating System Structures – Operating System Services - User Operating System Interface - System Calls – System Programs - Design and Implementation - Structuring method.

UNIT II**PROCESS MANAGEMENT****11**

Processes - Process Concept - Process Scheduling - Operations on Processes - Inter-process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms: Threads - Multithread Models – Threading issues; Process Synchronization - The critical-section problem - Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.

UNIT III**MEMORY MANAGEMENT****10**

Main Memory - Swapping - Contiguous Memory Allocation – Paging - Structure of the Page Table - Segmentation, Segmentation with paging; Virtual Memory - Demand Paging – Copy on Write - Page Replacement - Allocation of Frames –Thrashing.

UNIT IV**STORAGE MANAGEMENT****10**

Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection; File System Implementation - File System Structure - Directory implementation - Allocation Methods - Free Space Management; I/O Systems – I/O Hardware, Application I/O interface, Kernel I/O subsystem.

UNIT V**VIRTUAL MACHINES AND MOBILE OS****7**

Virtual Machines – History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components; Mobile OS - iOS and Android.

L: 45; TOTAL: 45 PERIODS**TEXT BOOKS**

1. Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 5th Edition, 2022.
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", John Wiley and Sons Inc., 10th Edition, 2018.

REFERENCES

1. Mr.D.Maghesh Kumar and Dr. A.B. Karthick Anand Babu, "Eagle View on Operating System", 2021
2. William Stallings, "Operating Systems: Internals and Design Principles", 7th Edition, Prentice Hall, 2018.
3. AchyutS.Godbole, Atul Kahate, "Operating Systems", McGraw Hill Education, 2017.

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Apply the concepts of linked list for solving problems. (K3)
CO2: Implement stacks and queues using arrays and linked lists(K3)
CO3: Construct different types of trees. (K3)
CO4: Understand sorting, searching and hashing algorithms(K2)
CO5: Apply graph data structure concepts to solve problems. (K3)

UNIT I LINKED LISTS 9

Introduction – Abstract Data Types - Arrays: Operations – List ADT –singly linked lists- Operations on a Linked List. Insertion, Deletion, Traversal - doubly-linked lists – circularly linked lists- applications of lists – Polynomial Manipulation.

UNIT II STACK AND QUEUE 9

Stack ADT – Operations – Applications – Evaluating arithmetic expressions- Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – deQueue – applications of queues – Array implementation of Stacks and Queues - Linked list implementation of Stacks and Queues.

UNIT III TREE STRUCTURES 9

Basic Tree Terminologies - Different types of Trees: Binary Tree - Binary Search Tree - Threaded Binary Tree- Expression tree –Tree traversal - Operations on each of the trees and their Algorithms. AVL Tree: Single and double rotations. Applications of Trees – Complexity Analysis – Tries-Ternary search tree.

UNIT IV SEARCHING, SORTING AND HASHING TECHNIQUES 9

Searching- Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Merge Sort – Quick sort - Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

UNIT V GRAPH STRUCTURES 9

Definition – Representation of Graph – Types of graph-Topological Sort – Bi-connectivity – Cut vertex– Dijkstra's algorithm – Minimum Spanning Tree – Prim's algorithm – Kruskal's algorithm - Applications of graphs.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Dr Shriram K. Vasudevan, Mr Abhishek S. Nagarajan, "Data Structures Using Python", 2021.
2. Mark Allen Weiss, "Data structures and algorithm analysis in Java", Boston: Peason Addison-Wesley publishers, 3rd Edition, 2022.
3. Faizanparvez "Data Structures in Java – A Beginners Guide", 2023
4. Hemant Jain,"Problem Solving in Data Structures & Algorithms Using C", 2022

REFERENCES

1. Hemant Jain , "Problem Solving in Data Structures & Algorithms Using Python", 2022
2. Michael T. Goodrich; Roberto Tamassia; Michael H. Goldwasser; Subhasish Banerjee, "Data Structures and Algorithms in Java", An Indian Adaptation Publisher, 6th Edition, 2022.
3. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed," Fundamentals of Data Structures in C", Universities Press, 2nd Edition, 2011.
4. Duane A. Bailey, "Java Structures: Data Structures in Java for the Principled Programmer", 2007.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Explain the basic layers and its functions in computer networks. (K2)

CO2: Understand the data flows from one node to another. (K3)

CO3: Analyze routing algorithms. (K3)

CO4: Describe protocols for various functions in the network. (K3)

CO5: Analyze the working of various application layer protocols. (K3)

UNIT I INTRODUCTION AND PHYSICAL LAYER 10

Building a Network - Network Edge and Core - Layering and Protocols - TCP/IP Protocol suite - OSI Reference Model - Network Topologies - Internet Architecture–Physical Layer: Signal Characteristics – Transmission media – Signal Encoding Techniques – Performance Metrics.

UNIT II DATA LINK LAYER & MEDIA ACCESS 8

Introduction – Link-Layer Addressing – DLC Services – Data-Link Layer Protocols – HDLC – PPP – Media Access Control – Wired LANs: Ethernet – Wireless LANs – Introduction – IEEE 802.11, Bluetooth – Connecting Devices.

UNIT III SWITCHING AND ROUTING LAYER 9

Switching : Circuit Switching - Packet Switching - IPV4 - Global Address - Datagram Forwarding - Subnetting - CIDR - ICMP - Routing Algorithms: Distance Vector Routing and Link State Routing - IPV6 Addressing – IPV6 Protocol.

UNIT IV TRANSPORT LAYER 9

Overview of Transport Layer - UDP - TCP – Reliable Byte Stream - Connection Management - Flow Control - Congestion Control – SCTP.

UNIT V APPLICATION LAYER SERVICES 9

Needs/Principles of Application Layer Protocols – Role of proxy, Web and HTTP - FTP - Electronic Mail (SMTP - POP3 - IMAP - MIME) - Telnet –SSH – DNS – SNMP -DHCP - DNS - DASH - QUIC.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. James F Kurose, Keith W Ross, "Computer Networking - A Top-Down Approach Featuring the Internet", Pearson Education, 8th Edition, 2021.
2. Larry L Peterson, Bruce S Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, 5th Edition, 2012.

REFERENCES

1. Prakash C Gupta, "Data Communication and Computer Networks", Prentice Hall of India, 2nd Edition, 2014.
2. William Stallings, "Data and Computer Communications", Pearson Education, 10th Edition, 2013.
3. Nader F Mir, "Computer and Communication Networks", Pearson Prentice Hall, 2014.
3. 4. Andrew S Tanenbaum, David J Wetherall, "Computer Networks", Prentice Hall of India, Pearson Education, 5th Edition, 2012.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1:Apply the concepts of classes and objects to solve simple problems.(K3)

CO2:Develop programs using inheritance, packages and interfaces.(K3)

CO3:Use of exception handling and multithreaded model to solve real world problems.(K3)

CO4:Build Java applications with I/O packages, string classes, Collections and generics concepts.(K3)

CO5:Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications.(K3)

UNIT I INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors- Methods -Access specifiers - Static members- Java Doc comments

UNIT II INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

UNIT III EXCEPTION HANDLING AND MULTI THREADING 9

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java’s Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

UNIT IV I/O, GENERICS AND STRING HANDLING 9

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

UNIT V JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu – Menu bars – MenuItem.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

- 1.Herbert Schildt, “Java: The Complete Reference”, McGraw Hill Education,11th Edition, 2020
- 2.Herbert Schildt, “Introducing JavaFX 8 Programming”, McGraw Hill Education,1st Edition, 2015

REFERENCES

1. E.Balagurusamy,“Programming with Java”,6th Edition, 2019
2. Cay S. Horstmann, “Core Java Fundamentals”, Volume 1, Prentice Hall, 11th Edition,2018

UNIT I WEAVING AND CERAMIC TECHNOLOGY**3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY**3** Designing and

Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY**3** Art of Ship

Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and goldCoins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY**3** Dam, Tank,

ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING**3** Development of

Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

L: 15; TOTAL : 15 PERIODS**REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல.சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரீகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.)
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

அலகு I நெசவு மற்றும் பாணைத் தொழில்நுட்பம் 3

சங்க காலத்தில் நெசவுத் தொழில் - பாணைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரம் சிற்பங்களும், கோவில்களும் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக்கலை.

அலகு III உற்பத்தித் தொழில்நுட்பம் 3

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் 3

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குழுவித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி - கணினித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக் கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

L: 15; TOTAL: 15 PERIODS**REFERENCE BOOKS**

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல.சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4. பொருறை - ஆற்றங்கரை நாகரீகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) - Reference Book.

19AD37C

DATA SCIENCE LABORATORY

L	T	P	C
0	0	3	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Develop python programs to handle data using Numpy and Pandas.(K3)

CO 2: Perform descriptive analytics and data exploration using Matplotlib.(K3)

CO 3: Perform inferential data analytics and build models of predictive analytics.(K3)

LIST OF EXERCISES:

1. Working with Numpy arrays
2. Working with Pandas data frames
3. Basic plots using Matplotlib
4. Frequency distributions, Averages, Variability
5. Normal curves, Correlation and scatter plots, Correlation coefficient
6. Implementation of Regression using real time dataset
7. Working with Z-test
8. Working with T-test
9. Working with ANOVA
10. Building and validating linear models
11. Building and validating logistic models
12. Time series analysis using dynamic data

P: 45; TOTAL: 45 PERIODS

SOFTWARE REQUIREMENTS:

Python, Numpy, Scipy, Matplotlib, Pandas, statmodels, seaborn, plotly, bokeh

19AD38C

DATA STRUCTURES LABORATORY

L	T	P	C
0	0	3	1.5

COURSE OUTCOMES

Upon Completion of this course, the students will be able to

CO1: Implement Linear data structure algorithms.(K3)

CO2: Implement Binary Search tree and AVL tree operations.(K3)

CO3: Implement graph algorithm and various searching and sorting algorithms.(K3)

LIST OF EXERCISES:

1. Implementation of Linked List.
2. Implementation of stack and Queue.
3. Array implementation of stack and queue.
4. Implementation of Polynomial Manipulation using Linked list.
5. Development on binary search trees.
6. Applications of binary search tree and AVL Tree.
7. Implementation of hashing with open addressing methods.
8. Implementation of Graph traversal algorithm.
9. Implementation of Dijkstra's Algorithm

10. Implementation of Prim's Algorithm
11. Implementation of sorting techniques.

P: 45; TOTAL: 45 PERIODS

SOFTWARE REQUIREMENTS

- C/Java/Python
- OS – LINUX/ Windows 8.1

19AD39C	OBJECT ORIENTED PROGRAMMING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1: Design and develop java programs using object oriented programming concepts (K3).

CO2: Develop simple applications using object oriented concepts such as package, exceptions Multithreading, and generics concepts (K3).

CO3: Create GUIs and event driven programming applications for real world problems (K3).

LIST OF EXERCISES:

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2. Develop stack and queue data structures using classes and objects.
3. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea() that prints the area of the given shape.
5. Solve the above problem using an interface.
6. Implement exception handling and creation of user defined exceptions.
7. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
8. Write a program to perform file operations.
9. Develop applications to demonstrate the features of generics classes.
10. Develop applications using JavaFX controls, layouts and menus.
11. Develop a mini project for any application using Java concepts.

P: 45 TOTAL: 45 PERIODS

SOFTWARE REQUIREMENTS

- Java/Python/C++
- OS - LINUX/ Windows 7/ 8

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Explain the basic concepts of machine learning. (K2)
- CO2:** Construct supervised learning models. (K3)
- CO3:** Construct unsupervised learning models. (K3)
- CO4:** Understand neural networks concepts. (K2)
- CO5:** Evaluate and compare different models. (K3)

UNIT I INTRODUCTION**8**

Review of Linear Algebra for machine learning; Introduction and motivation for machine learning; Examples of machine learning applications, Vapnik-Chervonenkis (VC) dimension, Probably Approximately Correct (PAC) learning, Hypothesis spaces, Inductive bias, Generalization, Bias variance trade-off.

UNIT II SUPERVISED LEARNING**11**

Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Perceptron algorithm, Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random Forests

UNIT III ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**9**

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT IV NEURAL NETWORKS**9**

Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks – vanishing gradient problem – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

UNIT V EVALUATION OF MODELS**8**

Cross Validation (CV) and resampling – K-fold CV, bootstrapping, measuring classifier performance, assessing a single classification algorithm and comparing two classification algorithms – t test, McNemar's test, K-fold CV paired t test.

L: 45; T: 15; TOTAL: 60 PERIODS**TEXT BOOKS**

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 4th Edition, 2020.
2. S Sridhar, M Vijayalakshmi, "Machine Learning", 2021
3. Stephen Marsland, "Machine Learning: An Algorithmic Perspective, CRC Press, 2nd Edition, 2014.

REFERENCES

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2016.
2. Tom Mitchell, "Machine Learning", McGraw Hill, 1st Edition, 2013.

3. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2nd Edition, 2018.
4. Ian Good fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
5. Sebastain Raschka, Vahid Mirjalili , "Python Machine Learning", Packet publishing, 3rd Edition, 2019.

19AD43C	DATABASE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Apply the SQL concepts and operations in a relational database design (K3)
- CO2:**Apply the Sub-Queries and Join concept in relational database design (K3)
- CO3:**Illustrate the use of T-SQL and stored procedures in real time scenarios (K3)
- CO4:**Demonstrate the normalization design concept for effective query processing.(K3)
- CO5:**Acquire knowledge about No-SQL databases in emerging applications (K3)

UNIT I RELATIONAL DATABASES 9

Introduction to Database System --Views of data –Database System Architecture – ER Models – Enhanced-ER Model - Relational Model- ER-to-Relational Mapping - SQL : SQL Syntax – Data types – Operators - SQL Keys - DDL Statements - DML Statements- SQL Aliases – Operators - SQL Aggregate Function.

UNIT II ADVANCED QUERY STRUCTURES 9

SQL Clauses - Group By – Having - Sub Query – Nested Sub Query –Data Control Language - Null Functions –Indexes - Sequences – Clone tables – SQL Joins – Basics -Types: Self Join - Inner Join - Outer Join - Left Join – Right Join-Full outer Join – views - SQL Injections.

UNIT III T-SQL AND STORED PROCEDURES 9

T-SQL: Scripts and Batches Declaring Variables - Using Statements - Error Handling - Global Variables Using Dynamic SQL - Stored Procedures : PL/SQL Functionalities - Control statements –Functions –Triggers – ODBC/JDBC connectivity – ODBC/JDBC Implementation - Case Study: Banking / University database system.

UNIT IV NORMALIZATION AND TRANSACTION MANAGEMENT 9

Functional Dependencies –Non loss Decomposition–Normalization: First, Second, Third Normal Forms, Dependency Preservation –Boyce/Code Normal Form – Transaction: Basic Concepts - Transaction Recovery –ACID Properties - Concurrency - Deadlock - RAID - B+ Tree Indexing.

UNIT V NO-SQL DATABASES 9

Introduction - Four types of No-SQL databases : Document-oriented, Key/Value Pairs, Column-oriented and Graph - CRUD Operations - MongoDB, Cassandra, HBASE, Neo4j use and deployment - Use Cases: Event Logging - Content Management Systems - Ecommerce Applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, 7th Edition, McGraw Hill, 2021.
2. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, 8th Edition, Pearson Education, 2017.
3. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Pearson Education, 8th Edition, 2012.

REFERENCES

1. Mahesh Mali, "Database Management System", 2022.
2. Peter Membrey, “MongoDB Basics”, Apress; 1st Edition, 2014.

19AD44C	DESIGN AND ANALYSIS OF ALGORITHMS	L	T	P	C
		3	1	0	4

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Apply algorithm analysis techniques to solve real time problems. (K3)
- CO2:** Apply divide-and-conquer and greedy technique to solve a given problem. (K3)
- CO3:** Solve the combinatorial problem using dynamic programming techniques. (K3)
- CO4:** Apply backtracking and branch & bound algorithms. (K3)
- CO5:** Understand and solve problems using approximation and randomization algorithms(K2)

UNIT I INTRODUCTION 12

Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithm Efficiency – Analysis Framework – Asymptotic Notations and its properties – Recurrence equations – Solving recurrence equations: Substitution method, Recursion tree method and Masters’ theorem.

UNIT II DIVIDE-AND-CONQUER AND GREEDY TECHNIQUE 12

Divide and conquer methodology – Merge sort – Binary search – Multiplication of Large Integers – Strassen’s Matrix Multiplication - Greedy Technique – Container loading problem – Prim’s algorithm and Kruskal’s Algorithm – Knapsack problem – Huffman Trees.

UNIT III DYNAMIC PROGRAMMING 12

Dynamic Programming: Principle of optimality – Coin changing problem - Binomial Coefficient – Warshall and Floyd’s algorithm - Multistage Graphs – Knapsack Problem and Memory functions.

UNIT IV BACKTRACKING AND BRANCH AND BOUND 12

Backtracking: n-Queens problem – Hamiltonian Circuit Problem – Subset Sum Problem - Graph coloring – Branch and Bound: Knapsack Problem – Traveling Salesman Problem.

UNIT V APPROXIMATION ALGORITHMS 12

Approximation Algorithms - Travelling Salesman problem – Knapsack problem – Set cover, Vertex cover - Bin packing - Introduction to NP-Hard and NP-Completeness

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Michael T. Goodrich and Roberto Tamassia, “Design and Analysis of Algorithms, An Indian Adaptation”, 2021
2. Anany Levitin, “Introduction to the Design and Analysis of Algorithms”, Pearson Education, 3rd Edition, 2012.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Computer Algorithms / C++”, Universities Press, 2nd Edition, 2019.
4. Vijay V. Vazirani, “Approximation Algorithms”, Springer, 1st Edition, 2003.

REFERENCES

1. Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivest and Clifford Stein, “Introduction to Algorithms”, PHI Learning Private Limited, 4th Edition, 2022.
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D.Ullman, “Data Structures and Algorithms”, Pearson Education, Reprint 2006.
3. Harsh Bhasin, “Algorithms Design and Analysis”, Oxford university press, 2016.
4. S. Sridhar, “Design and Analysis of Algorithms”, Oxford university press, 2014.

COURSE OUTCOMES

Upon Completion of this course, the students will be able to

CO1: Implement supervised machine learning algorithms and unsupervised learning algorithms on standard datasets and evaluate the performance. (K3)

CO2: Build the graph based learning models for standard data sets. (K3)

CO3: Demonstrate the performance of different ML algorithms and select the suitable one based on the application. (K4)

LIST OF EXERCISES:

1. For a given set of training data examples stored in a .CSV file, implement and demonstrate the **Candidate-Elimination algorithm** to output a description of the set of all hypotheses consistent with the training examples.
2. Write a program to demonstrate the working of the decision tree based **ID3 algorithm**. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
3. Build an Artificial Neural Network by implementing the **Backpropagation algorithm** and test the same using appropriate data sets.
4. Write a program to implement the **naïve Bayesian classifier** for a sample training data set stored as a .CSV file and compute the accuracy with a few test data sets.
5. Implement **naïve Bayesian Classifier** model to classify a set of documents and measure the accuracy, precision, and recall.
6. Write a program to construct a **Bayesian network** to diagnose CORONA infection using standard WHO Data Set.
7. Apply **EM algorithm** to cluster a set of data stored in a .CSV file. Use the same data set for clustering using the k-Means **algorithm**. Compare the results of these two algorithms.
8. Write a program to implement **k-Nearest Neighbour algorithm** to classify the iris data set. Print both correct and wrong predictions.
9. Implement the non-parametric **Locally Weighted Regression algorithm** in order to fit data points. Select an appropriate data set for your experiment and draw graphs.

P: 45;TOTAL: 45 PERIODS

SOFTWARE REQUIREMENTS

Python / R.

19AD46C

**DATABASE MANAGEMENT SYSTEMS
LABORATORY**

L	T	P	C
0	0	3	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Demonstrate the use of various OOPs concepts (Class and Objects, Abstraction, Encapsulation, Inheritance and Polymorphism) with the help of JAVA program (K3)

CO2: Demonstrate the usage of exception handling mechanisms to handle runtime errors and to demonstrate the design of generic programming. (K3)

CO3: Implement rich data handling through files and streaming. (K3)

LIST OF EXERCISES:

1. Database creation and use of DDL commands.
2. Perform DML commands.
3. Implement DCL/TCL commands.
4. Perform database operations using advanced queries like ORDER BY and GROUP BY.
5. Demonstrate all types of join operations for the given database schema.
6. Design all the appropriate normal forms for the given database schema.
7. Write a PL/SQL block to satisfy some constraints.
8. Create procedures in PL/SQL block.
9. Implement triggers in PL/SQL block.
10. Design a NoSQL database.
11. Design a mini project using Database Management Systems Concepts

P: 45; TOTAL: 45 PERIODS

SOFTWARE REQUIREMENTS

- Software tools: Oracle, MySQL, ERD plus
- GUI development: Python / JAVA/Visual C++

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Understand Intelligent agents.(K2)
- CO2:** Develop problem solving agents.(K3)
- CO3:** Apply game playing and CSP techniques. (K3)
- CO4:** Perform logical reasoning.(K3)
- CO5:** Perform probabilistic reasoning under uncertainty. (K3)

UNIT I INTELLIGENT AGENTS 6

Introduction to AI – Agents and Environments – concept of rationality – nature of environments – structure of agents. Problem solving agents – search algorithms – uninformed search strategies.

UNIT II PROBLEM SOLVING AGENTS 6

Heuristic search strategies – heuristic functions. Local search and optimization problems – local search in continuous space – search with non-deterministic actions – search in partially observable environments – online search agents and unknown environments

UNIT III GAME PLAYING AND CSP 6

Game theory – optimal decisions in games – alpha-beta search – monte-carlo tree search – stochastic games – partially observable games. Constraint satisfaction problems – constraint propagation – backtracking search for CSP – local search for CSP – structure of CSP.

UNIT IV LOGICAL REASONING 6

Knowledge-based agents – propositional logic – propositional theorem proving – propositional model checking – agents based on propositional logic. First-order logic – syntax and semantics – knowledge representation and engineering – inferences in first-order logic – forward chaining – backward chaining – resolution.

UNIT V PROBABILISTIC REASONING 6

Acting under uncertainty – Bayesian inference – naïve Bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

L: 30; P: 30; E:30; TOTAL: 90 PERIODS

TEXT BOOKS

1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Pearson Education, 4th Edition, 2021.
2. Utpal Chakraborty, “Artificial Intelligence for All: Transforming Every Aspect of Our Life”, BPB Publications, 1st Edition, 2020.

REFERENCES

1. Elaine Rich, Kevin Knight and Shivashankar B Nair , "Artificial Intelligence", Tata McGraw Hill Publishing Company, 3rd Edition,2017.
2. Patrick H. Winston, "Artificial Intelligence", Pearson Education, 3rd Edition, 2006.
3. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013.

LIST OF EXERCISES:

1. Implement basic search strategies – 8-Puzzle, 8 - Queens problem, Crypt arithmetic.
2. Implement A* and memory bounded A* algorithms
3. Implement Minimax algorithm for game playing (Alpha-Beta pruning)
4. Solve constraint satisfaction problems
5. Implement propositional model checking algorithms
6. Implement forward chaining, backward chaining, and resolution strategies
7. Build naïve Bayes models
8. Implement Bayesian networks and perform inferences
9. Develop a mini project for a real time automated system.

SOFTWARE REQUIREMENTS

- Java /Python Software

19AD51C	PROFESSIONAL ETHICS AND HUMAN VALUES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

CO1: Recognize the core human values that shape the ethical behavior of an engineer. (K2)

CO2: Expose awareness on professional ethics. (K2)

CO3: Analyze the engineering ethical breach from past study. (K2)

CO4: Distinguish and apply safety, responsibility and rights in workplaces. (K2)

CO5: Discuss about the global issues with regard to ethics. (K2)

UNIT I HUMAN VALUES 9

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Civic Virtue -Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage – Valuing Time - Co-operation - Commitment - Empathy - Self-Confidence - Character – Spirituality.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas- moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy -Models of professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - The three mile island and chernobyl case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime -professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

UNIT V GLOBAL ISSUES 9

Multinational corporations - Environmental ethics - computer ethics – weapons development - engineers as managers - consulting engineers - engineers as expert witnesses and advisors - Moral leadership - sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India, etc.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, 5th Edition, 2022.
2. M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", 2013.

REFERENCES

1. Behnam Taebi, "Ethics and Engineering: An Introduction", Cambridge University Press,2021
2. Charles E Harris, Michael S Protchard and Michael J Rabins, "Engineering Ethics -Concepts and Cases", Wadsworth Thompson Learning, 6th Edition, 2019.
3. John R Boatright,-Ethics and the Conduct of Business, Pearson Education, 8th edition, 2017.
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford 2001.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the basis of Deep Learning. (K2)

CO2: Implement and analyze of Convolutional Neural Algorithms. (K3)

CO3: Build Recurrent Neural networks for various applications. (K3)

CO4: Build the Deep Learning Algorithms. (K3)

CO5: Understand Bayesian and Reinforcement techniques in deep learning.(K2)

UNIT I INTRODUCTION**9**

Linear Algebra: Scalars - Vectors -- Matrices and tensors; Probability Distributions -Gradient-based Optimization - Machine Learning Basics: Capacity –Overfitting and underfitting– Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent - Challenges motivating deep learning; Deep Networks: Deep feedforward networks; Regularization - Optimization.

UNIT II CONVOLUTIONAL NEURAL NETWORKS**9**

Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers -- Gradient Computation - Applications of CNN.

UNIT III RECURRENT NEURAL NETWORKS**9**

Recurrent Neural Networks Architecture –Backpropagation through time (BPTT) - Vanishing and Exploding Gradients – Bidirectional RNN - Truncated BPTT – GRU- LSTMs – Neural Turing Machine - Recursive Neural Networks - Applications of RNN.

UNIT IV ARTIFICIAL NEURAL NETWORKS**9**

Artificial Neural Networks – Linear Associative Networks – Perceptrons–Backpropagation Algorithm - Hopfield Nets - Boltzmann Machines - Deep RBMs –Variational Autoencoders - Deep Backprop Networks- Autoencoders

UNIT V GENERATIVE, BAYESIAN, REINFORCEMENT DEEP LEARNING**9**

Generative Modeling – Generative Adversarial Networks – Bayesian Deep Learning – Deep Reinforcement Learning.

L: 45; TOTAL: 45 PERIODS**TEXT BOOKS**

1. S Lovelyn Rose, L Ashok Kumar, D KarthikaRenuka , "Deep Learning using Python", Wiley India Pvt. Ltd., 2019.
2. Francois Chollet , "Deep Learning with Python", Manning Publications, 2018.

REFERENCES

1. Thomas Farth, "Deep Learning: A Comprehensive Guide for Beginners", Atlantic Publishers, 2019.
2. David Foster, "Generative Deep Learning", O'Reilly Media, Inc., 2019.
3. Eugene Charniak, "Introduction to Deep Learning", MIT Press, 2018.
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville , "Deep Learning", MIT Press, 2016.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Study the fundamentals of data visualization.(K2)

CO2: Analyze the different data types, visualization types.(K3)

CO3: Apply univariate & bivariate data exploration and analysis. (K3)

CO4: Apply visualization techniques for multivariate and time series data. (K3)

CO5: Design visualization dashboard to support decision making on large scale data.(K3)

UNIT I INTRODUCTION 9

Overview of data visualization - Data Abstraction - Task Abstraction - Dimensions and Measures - Analysis: Four Levels for Validation. Statistical charts-Bar Chart - stacked bar chart – Line Chart - Histogram - Pie chart - Frequency Polygon - Box plot - Scatter plot - Regression curves. Introduction to various data visualization tools - Scalar and point techniques - vector visualization techniques - multidimensional techniques - visualizing cluster analysis – K-means and Hierarchical Cluster techniques.

UNIT II SPATIO-TEMPORAL DATA VISUALIZATION AND VISUAL ANALYTICS 9

Time Series data visualization – Text data visualization – Spatial Data Visualization - Visual Analytics : Networks and Trees - Heat Map – Tree Map - Map Color and Other Channels Manipulate View - Visual Attributes

UNIT III UNIVARIATE AND BIVARIATE ANALYSIS 9

Introduction to Single variable: Distributions and Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality - Smoothing Time Series.Relationships between Two Variables - Percentage Tables - Analyzing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines – Transformations

UNIT IV MULTIVARIATE DATA VISUALIZATION 9

Multivariate data visualization – Geometric projection techniques - Icon-based techniques - Pixel-oriented techniques - Hierarchical techniques - Scatterplot matrix - Hyper box - Trellis display - Parallel coordinates

UNIT V DASHBOARD AND APPLICATIONS 9

Data Dashboard- Taxonomies- User Interaction- Organizational Functions-Dashboard Design – Worksheets - Workbooks – Workbook Optimization - Protection and common mistakes. Case study: Dashboard creation using visualization tool: Finance-marketing-insurance-healthcare applications.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, “Data Visualization: Exploring and Explaining with Data”, South-Western College Publishing, 2021
2. Tamara Munzer, “Visualization Analysis and Design”, CRC Press, 1st Edition, 2015.
3. Claus O.Wilke, “Fundamentals of Data Visualization”, O’reilly publications, 2019.

REFERENCES

1. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, CRC press, 2nd Edition, 2015.
2. Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008.
3. Stephen Few, “Now you see it: Simple Visualization Techniques for Quantitative Analysis”,

Analytics Press, 2009.

4. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.

19AD54C	EMBEDDED SYSTEMS AND IOT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the elements of Embedded System. (K2)

CO2: Write simple interfacing program using ARM Programming.(K3)

CO3: Understand Arduino Fundamentals and Programming.(K2)

CO4: Understand IOT Communication and Open Platforms.(K2)

CO5: Design IoT applications using Arduino/Raspberry Pi /open platform. (K3)

UNIT I INTRODUCTION 12

Embedded system, Intelligent System, Expert system – software architecture, hardware Architecture; Embedded System design process–ARM Processor- CPU:Programming input and output-Supervisor mode, exception and traps Binary image creation from source file. Role of boot loader-significant of Device driver and Device tree. Arm Architecture Variants

UNIT II ARM PROGRAMMING 6

Introduction – Interface with LEDs and Switches - Serial IO interfacing (UART) – LCD interface - Motor Interfacing – Sensor Interfacing (Temperature, Pressure).

UNIT III ARDUINO PROGRAMMING 9

Arduino IDE Overview-Operators in Arduino – Function Libraries – Control Statement –Loops – Arrays – String - Math library - Random Number – Interrupts – Integration of Sensors and Actuators with Arduino -sensor Interface with Arduino -Working model of Digital Humidity and Temperature Sensor – Basic Working Principle of Servo-Actuator –Case Study : Traffic Control System

UNIT IV IOT COMMUNICATION AND OPEN PLATFORMS 9

IoT Communication Models and APIs – IoT Communication Protocols – Bluetooth – WiFi – ZigBee – GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture –Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins –Cloud Interface.

UNIT V EMBEDDED SYSTEM PROGRAMMING 9

Raspberry Pi Introduction - Raspberry Pi programming Arithmetic – flow control – loops. Lists-Strings – File handling – Functions – modules.Graphical programming – (GUI) – Simple Interfaces

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.
2. ArshdeepBahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015.

REFERENCES

1. Michael J. Pont, "Embedded C", Pearson Education, 2007.
2. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.
3. Andrew N Sloss, D. Symes, C. Wright, "Arm System Developer's Guide", Morgan Kauffman/ Elsevier, 2006.

19AD55C	DEEP LEARNING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1:** Apply Convolution Neural Network for image processing. (K3)
- CO2:** Apply Recurrent Neural Network and its variants for text analysis. (K3)
- CO3:** Develop a real world application using suitable deep neural networks. (K4)

LIST OF EXERCISES:

1. Solving XOR problem using Multilayer perceptron
2. Implement character and Digit Recognition using ANN.
3. Implement the analysis of X-ray image using auto encoders
4. Implement Speech Recognition using NLP
5. Develop a code to design object detection and classification for traffic analysis using CNN
6. Implement online fraud detection of share market data using any one of the data analytics tools.
7. Implement image augmentation using deep RBM.
8. Implement Sentiment Analysis using LSTM.
9. Mini Project: Number plate recognition of traffic video analysis.

P:45; TOTAL: 45 PERIODS

Hardware/Software Requirements

Software:

- Understanding on Working of Colab and Transfer Learning Networks
- High end GPU Systems for Huge Computation with large datasets

19AD56C	EMBEDDED SYSTEMS AND IOT LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Work with arduino chipset for interfacing external sensors. (K3)

CO2: Work with ARM chipset for interfacing external sensors. (K3)

CO3: Work with raspberry pi chipset for interfacing external sensors. (K3)

LIST OF EXERCISES:

I. Arduino Experiments

1. LCD Display Interfacing
2. IR Sensor Interfacing
3. PIR Sensor Interfacing
4. I2C Communication

II. ARM LPC2148 Interfacing Experiments

1. PWM – LED Interfacing
2. Switches – Buzzer Interfacing
3. Motor Interface
4. LCD Display Interfacing

III. Raspberry Pi Interfacing Experiments

1. Distance Measurement using HCSR 04 Sensor.
2. Temperature measurement using DHT11 sensor
3. Pressure measurement using BMP280 sensor
4. Analog sensor interfacing using LM35D and ADC080
5. Onboard web server for External Communication

P: 45; TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand basic knowledge, theories and methods in image processing and computer vision. (K2)

CO2: Implement basic and some advanced image processing techniques in OpenCV.(K3)

CO3: Apply 2D feature-based based image alignment, segmentation and motion estimations. (K3)

CO4: Apply 3D image reconstruction techniques.(K3)

CO5: Design and develop innovative image processing and computer vision applications. (K3)

UNIT I INTRODUCTION**9**

Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.

UNIT II FEATURE DETECTION AND SEGMENTATION**9**

Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

UNIT III FEATURE-BASED ALIGNMENT & MOTION ESTIMATION**9**

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

UNIT IV 3D RECONSTRUCTION**9**

Shape from X - Active rangefinding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedos.

UNIT V IMAGE RENDERING AND RECOGNITION**9**

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.

L: 45;P:30;TOTAL: 75 PERIODS**TEXT BOOKS**

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Texts in Computer Science, 2nd Edition, 2022.
2. Dr Ruchi Doshi, Dr Kamal Kant Hiran, "Machine Learning", 2021.

REFERENCES

1. E. R. Davies, "Computer and Machine Vision", 4th Edition, Academic Press, 2012.
2. Christopher M. Bishop; "Pattern Recognition and Machine Learning", Springer, 2006
3. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2nd Edition, 2015.

LIST OF EXERCISES

1. Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Blob detection
2. Image Annotation – Drawing lines, text circle, rectangle, ellipse on images
3. Image Enhancement - Understanding Color spaces, color space conversion, Histogram equalization, Convolution, Image smoothing, Gradients, Edge Detection
4. Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Feature matching based image alignment
5. Image segmentation using Graphcut / Grabcut
6. Camera Calibration with circular grid
7. Pose Estimation
8. 3D Reconstruction – Creating Depth map from stereo images
9. Object Detection and Tracking using Kalman Filter, Camshift

SOFTWARE REQUIREMENTS:

OpenCV computer vision Library for OpenCV in Python / PyCharm or C++ / Visual Studio or or equivalent

19AD61C

FINANCE AND ACCOUNTING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1:** Explain the basic concepts and process of accounting and finance. (K2)
- CO2:** Describe the financial status of an organization. (K2)
- CO3:** Identify the concepts and operations of CVP analysis for decision making. (K3)
- CO4:** Apply techniques like budgetary control and capital budgeting for planning and Controlling in an organization. (K3)
- CO5:** Explain the application of accounting software. (K2)

UNIT I INTRODUCTION TO ACCOUNTING 9

Introduction and Definition - Accounting concepts and conventions - Final Accounts - Preparation of Trading, Profit and Loss Account and Balance Sheet.

UNIT II ANALYSIS AND INTERPRETATION OF FINANCIAL STATEMENTS 9

Meaning and importance - Comparative statement, Common size statement – Trend analysis and accounting ratios - latest trend in presenting financial data.

UNIT III ACCOUNTING FOR DECISION MAKING 9

CVP Analysis - Relevant Costs and Revenue for Decision Making - Pricing Decisions - Operational Decisions - Exploring New markets - Make or buy decisions.

UNIT IV ACCOUNTING FOR PLANNING AND CONTROLLING 9

Budgets, Budgetary Control – Meaning – Importance and applications - Capital budgeting- Meaning – Importance - steps in capital budgeting - Information needed - Methods of evaluating capital budgeting decisions.

UNIT V COMPUTERIZED ACCOUNTING SYSTEM 9

Meaning - Concept - Comparison between Manual and Computerized Accounting - Sourcing of Accounting Software - Accounting Packages.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Manoj Bansal, Ajay Sharma, “Computerized Accounting System”, Sahitya Bhawan Publications, 1st Edition, 2019.
2. V.K.Gupta, R.L.Gupta, “Financial Accounting”, S.Chand, 3rd Edition, 2016.
3. Dr.V.R.Palanivelu, “Accounting for Management”, University science press, 3rd Edition, 2013.

REFERENCES

1. S.N.Maheshwari, Suneel K.Maheshwari, Sharad K.Maheshwar, “Financial Accounting”, Vikas Publishing House, 2nd Edition, 2018.
2. Peter Atrill, Eddie McLaney “Financial Accounting for Decision Makers”, Pearson Education, 7th Edition, 2013.
3. Dr.AlokDwivedi, Prof.C.M.Tembhurnekar, “Computerized Accounting”, 1st Edition, Sai Jyo Publications, 2016.

19AD62C

BIG DATA ANALYTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the characteristics of big data and concepts.(K2)

CO2: Understand the importance of visualization and analytics .(K3)

CO3: Apply the Big Data Analytics System for Hadoop. (K3)

CO4: Analyze Spark and its uses for big data processing. (K2)

CO5: Apply the Analytical methods, technology and tools in the industry.(K3)

UNIT I INTRODUCTION TO BIG DATA 9

Basics of big data – Issues -Team challenge – Big data sources - Acquisition – Features of Big Data – Evolution of Big data– Challenges for Big data Analytics - Big data characteristics.

UNIT II DATA ANALYTICS AND VISUALIZATION 9

Predictive Analytics- Simple linear regression- Multiple linear regression- classification – clustering - association. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications. Case Studies: social media data analysis

UNIT III HADOOP ENVIRONMENT 9

Introduction – Components of Hadoop – Analysis of Hadoop – Scaling out - Hadoop Streaming - Design of HDFS - Java interfaces to HDFS Basics - Map Reduce concepts - Failures - Job Scheduling - Shuffle and Sort – Task execution - Map Reduce Types and Formats - Map Reduce Features

UNIT IV SPARK 9

Introduction - Spark applications - Jobs - Stages and Tasks - Resilient Distributed databases - Anatomy of a Spark Job Run - Spark on YARN - SCALA: Introduction - Classes and objects - Basic types and operators – Built-in control structures – functions and closures - inheritance.

UNIT V UNSTRUCTURED DATA ANALYTICS 9

The Hadoop Ecosystem – NoSQL - In-Database Analytics - SQL Essentials - Text Analysis - Advanced SQL.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publication, 2nd Edition, 2020.
2. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 1st Edition, 2018.

REFERENCES

1. Kim H. Pries, Robert Dunnigan, “Big Data Analytics: A Practical Guide for Managers”, CRC Press, 2015.
2. Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia “Learning Spark”, O'Reilly, 1st Edition, 2015.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1:** Apply pre-processing methods based on characteristics of data. (K3)
- CO2:** Comprehend features of classification techniques.(K2)
- CO3:** Identify appropriate clustering technique to analyze the data.(K3)
- CO4:** Apply association rule mining to generate rules. (K3)
- CO5:** Use recent trends of Data mining in Business applications. (K3)

UNIT I DATA PREPROCESSING 9

Introduction to KDD process – Knowledge discovery from databases – Need for data preprocessing – Data cleaning – Data integration and transformation – Data reduction – Data discretization and concept hierarchy generation.

UNIT II CLASSIFICATION 9

Basic concepts – decision tree induction – bayes classification methods – rule based classification – model evaluation and selection – techniques to improve classification accuracy – classification: advanced concepts – bayesian belief networks - support vector machine – classification using frequent patterns.

UNIT III CLUSTER ANALYSIS 9

Cluster Analysis: Basic concepts and Methods – Cluster Analysis – Partitioning methods - Hierarchical methods – Density Based Methods– Grid Based Methods - Evaluation of Clustering – Advanced Cluster Analysis: Probabilistic model Based clustering – Clustering High Dimensional Data.

UNIT IV ASSOCIATION RULE MINING 12

Association Rule Mining: Market Basket Analysis - Frequent pattern mining – Apriori algorithm - Generating Association rules from frequent items - Improving the efficiency of Apriori algorithm – Mining Multilevel association rules - Multidimensional association rules – Constraint based association Mining. Applications of Data Mining-Temporal and Sequence Mining, Web and Text Mining.

UNIT V APPLICATIONS 6

Dataset Collection- Disease Prediction-Weather Prediction-Student’s future learning behavior prediction- Anomaly detection-Stock market Analysis-Commercial applications.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Jiawei Han, Micheline Kamber and Jian Pei “Data Mining: Concepts and Techniques”, Elsevier, 4th Edition, 2022.
2. Alex Berson and Stephen J.Smith, “Data Warehousing, Data Mining & OLAP”, Tata McGraw Hill Edition, 10th Edition, 2017.
3. Charu C.Aggarwal, “Data Mining: The Textbook”, Springer International Publisher, 2015.

REFERENCES

1. Pawel Cichosz, “Data Mining Algorithms: Explained Using R”, John Wiley & Sons, 2015.
2. Pang-Ning Tan, Vipin Kumar, Michael Steinbach, “Introduction to Data Mining”, Pearson Education India, 2012.
3. Daniel T. Larose, “Data Mining and Predictive Analytics”, John Wiley & Sons, 2015.

19MC01C

CONSTITUTION OF INDIA

L	T	P	C
3	0	0	0

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the salient features of the Indian Constitution. (K2)

CO2: Discuss the structure and functions of parliament. (K2)

CO3: Elaborate the structure and functions of state legislature. (K2)

CO4: Explain the fundamentals of organization and working of the Judiciary. (K2)

CO5: Discuss the foreign policy of India. (K2)

UNIT I INDIAN CONSTITUTION

9

Salient Features – Preamble-Pillars of constitution - Fundamental Rights – Directive Principles of State Policy - Fundamental Duties.

UNIT II PARLIAMENTARY SYSTEM

9

Powers and Functions of President and Prime Minister - Council of Ministers – The Legislature Structure and Functions of Lok Sabha and Rajya Sabha – Speaker.

UNIT III FEDERAL SYSTEM

9

Features of Federal System - Administrative Relationship between Union and States - Powers and Functions of Governor and Chief Minister – Council of Ministers –State Legislature.

UNIT IV THE JUDICIARY

9

Organization and Composition of Judiciary - Powers and Functions of the Supreme Court - Judicial Review – High Courts.

UNIT V INTERNATIONAL POLITICS

9

Foreign Policy of India – VISA Application Process- International Institutions like UNO, WTO, SAARC and Environmentalism.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Basu D.D, "Introduction to Indian Constitution", Prentice Hall of India, 2015.
2. Gupta D.C, "Indian Government and Politics", Vikas Publishing House, 2010.

REFERENCES

1. Pylee M.V, "Introduction to the Constitution of India", Vikas Publishing House, 2011.
2. Kashyap S, "Our Constitution", National Book Trust, 2010.
3. Shukla V N, "Constitution of India", Eastern Book Company Ltd., 2011.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Set up multi-node Hadoop Clusters and integrated infrastructure of Hadoop.(K3)

CO2: Apply Big Data processing techniques.(K3)

LIST OF EXERCISES:

1. Installation of Apache Hadoop using Hortonworks Data Platform / Clustered
2. Big Data processing with Hive and HCatalog.
3. Query Processing using Hive and Beeswax.
4. Develop a map reduce program for word count
5. Writing data processing scripts using Pig.
6. Classification analysis using big data set
7. Clustering analysis using big data set
8. HashTag (social media) analysis using R / python
9. Data Visualization for Big dataset
10. Integration R with Hadoop for data processing
11. Develop a mini project for a big data set real time applications.

P: 45; TOTAL: 45 PERIODS

SOFTWARE REQUIREMENTS

Hadoop Integrated Programming Environment using Python/ R

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1:** Enhance the comprehensive knowledge for attending interviews and competitive exams. (K4)
- CO2:** Pursue their higher education and research. (K3)
- CO3:** Undergo entrance exams such as GATE, GMAT. (K3)
- CO4:** Demonstrate the comprehensive knowledge being acquired through core engineering courses. (K3)
- CO5:** Develop logical and analytical skills to ensure on campus placement. (K4)

COURSE CONTENT AND LAYOUT

The students will be engaged to review the fundamental core courses also based on their area of interest, they can select any 2 courses under below Special Interest Group (SIG).

FUNDAMENTAL CORE COURSES

The highlights of the following core courses will be reviewed through Aptitude Test and Mock interviews to improve their competency

- Fundamentals of Data Science
- Machine Learning
- Artificial Intelligence
- Database Management Systems
- Deep Learning
- Computer Vision
- Big Data Analytics
- Data Mining

SPECIAL INTEREST GROUPING

To bring deeper understanding and exchange information among special interest groups(not limited) by concentrating on any two area of specializations as listed below

- Data Engineering
 - Business Analytics
 - Exploratory Data Analytics
 - Cognitive Science and Decision Making
 - Reinforcement Learning
 - Natural Language Processing
- The staff-coordinator is responsible for scheduling the session plans, monitoring the activities and recording the continual assessments.
 - The technical seminars and group discussions will be assisted by subject experts in the department.
 - Each student must participate in all the activities and their performance assessment must be recorded.

P: 30; TOTAL: 30 PERIODS

REFERENCES

1. Jake VanderPlas, "Python Data Science Handbook", 2nd edition, O'Reilly, 2022
2. EthemAlpaydin, "Introduction to Machine Learning", MIT Press, 4th Edition, 2020
3. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education,4th Edition, 2021.
4. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Texts in Computer Science, 2nd Edition, 2022.
5. S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka , "Deep Learning using Python", Wiley India Pvt. Ltd.,2019
6. JiaweiHan, Micheline Kamber and Jian Pei "Data Mining: Concepts and Techniques", Elsevier, 3rd Edition,2012.

ASSESSMENT PROCEDURE

- The staff-coordinator per group is responsible for scheduling the session plans, monitoring the activities and recording the continual assessments.
- The technical seminars, group discussions and comprehensive viva will be conducted and assisted by subject experts in the department.
 1. Technical Seminars: Each student will be required to make one technical presentation for minimum 15 minutes duration in this course. Individual topics will be assigned to the students by the department.
 2. Group Discussion: Assessment must focus on evaluating Team spirit and Body Language of student's participation.
 3. Comprehensive Viva: Viva should be handled on their area of interest in both written / oral mode.
- Each student must participate in the suggested activities and their performance assessment must be recorded.

Suggested Activities for improving placements:

1. *Written Test:*

- a. Verbal
 - Synonyms
 - Antonyms
 - Sentence completion
 - Passage writing
- b. Aptitude
 - Quantitative and Logical
- c. Analytical
 - Critical Reasoning

2. *Mock Interviews:*

- a. *Pure HR Panel*
 - Communication Skills
 - Attitude
 - Interpersonal Skills
 - Openness to learn
 - Eligibility Check
 - Stress test
 - Co-curricular achievements
 - Extra-curricular achievements

b. Management Interview

- Industry Orientation
- Industry Trends
- Career Goals
- Adaptability
- Culture Fitment

c. Tech Panel:

- Programming languages you know about.
- Data Structures
- Project related
- Subject Knowledge
- Practical applicability of basic concepts
- Certifications
- Problem Solving

Suggested Activities for Encouraging Higher Studies

1. Mock GATE Examination

- Solving previous year question papers
- Objective type test for Aptitude and Verbal practices.

2. Technical Review (Suggested to practice any Two Interview process)

Set one Interview Process

Written Test procedure:

1. Verbal – Synonyms, Antonyms, Sentence completion & passage
2. Aptitude – Quantitative and Logical reasoning, Old TCS questions
3. Analytical – Critical Reasoning - Refer Barron's GRE

Technical interview procedure:

- **Technical interview:** C, C++ & java. And interviewer will ask the questions based on your Area of Interest
- **HR interview:** It will be like stress interview. There is a possibility for asking the technical questions. But technical questions will ask to test the patience and coolness of a candidate. Some interviewer asks questions rapidly. Sometimes candidate will be asked to talk about current affairs.

Round 1: AMCAT ONLINE TEST

computer programming, quantitative, logical and verbal

In this round, there will be one HR, face to face process.

Round 2: TECHNICAL HR

Only way to clear this round SPEAK SPEAKSPEAK. Be confident and maintain eye contact

Round 3: FINAL HR

It took around 10 min...There were 2HRs – Personal Questions

Set Two Interview Process

Set Three Interview Process

1. Written Test procedure:

- Verbal – Synonyms, Antonyms, Sentence completion & passage
- Aptitude – Quantitative and Logical reasoning, Old TCS questions
- Analytical - Critical Reasoning - Refer Barron's GRE

2. Group Discussion: A GD is a methodology used by an organization to gauge whether the candidate has certain personality traits and/or skills (Communication skills, Interpersonal Skills, Leadership Skills, Motivational Skills, Team Building Skills)

3. HR Interview: Both Technical and personal Interview.

19AD71C

BUSINESS PROCESS MANAGEMENT

L	T	P	C
2	0	0	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1:** Define the required processes and able to identify process improvement opportunities /strategies.(K2)
- CO 2:** Plan a BPM strategy for an organization. (K3)
- CO 3:** Propose business solutions in written and verbal forms for process innovation and redesign Projects. (K2)
- CO 4:** Explain the role of Information Technology and other resources in BPM. (K2)
- CO 5:** Synthesis the principles of organizational strategy and process design. (K2)

UNIT I INTRODUCTION TO BUSINESS PROCESS MANAGEMENT 6

Ingredients of Business Process, BPM Life Cycle, Process Identification – The context of Process identification, Definition of the process architecture, process selection.

UNIT II PROCESS MODELING 6

Essential Process Modeling – First Steps with BPMN, Branching and merging, Business Objects, Resources, Process decomposition, Process model reuse.

UNIT III ADVANCED PROCESS MODELING 6

Rework and repetition, Handling events, Handling exceptions, Process and Business rules- Process Discovery - The setting of process discovery, process discovery methods, process modeling methods.

UNIT IV QUALITATIVE AND QUANTITATIVE PROCESS ANALYSIS 6

Value added analysis, waste analysis, Stake holder analysis and issue documentation, root cause analysis. Flow analysis, Queues, Simulation.

UNIT V PROCESS AWARE INFORMATION SYSTEM 6

Types of Process Aware Information System, Advantages of Introducing a BPMS, Challenges of Introducing a BPMS. Process implementation with executable models.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Marlon Dumas, Marcello La Rosa, Jan Mendling, Hajo A. Reijers, “Fundamentals of Business Process Management”, Springer, 2nd Edition, 2018.
2. Akhil Kumar, “Business Process Management”, Routledge, 1st Edition, 2018.

REFERENCES

1. Carl F. Lehmann, “Strategy and Business Process Management: Techniques for Improving Execution, Adaptability, and Consistency”, CRC Press, 2016.
2. Van der Aalst, Wil, “Process Mining: Data Science in Action”, Springer, 2nd Edition, 2016.
3. John Jeston, Johan Nelis, “Business Process Management”, Routledge, 3rd Edition, 2014.

19AD72C

PROJECT WORK – I

L	T	P	C
0	0	6	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Identify an innovate or creative idea / concept / solution to a problem (K3)

CO2: Perform the detailed literature survey related to concept / idea (K2)

CO3: Implement basic prototype to demonstrate the concept (K4)

1. The Project is a theoretical study/analysis / prototype design / modeling and simulation or a combination of these.
2. Should be done as group (preferably four students) project.
3. The progress of the project is evaluated based on a minimum three reviews and final viva-voce examination.
4. A project report is required to be submitted in the standard prescribed format.

P: 90; TOTAL: 90 PERIODS

19AD73C

RESEARCH PAPER AND PATENT REVIEW – SEMINAR

L	T	P	C
0	0	2	1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the emerging technology/research development in the engineering Field (K2)

CO2: Acquaint with the concepts published in reputed journals on their area of interest (K2)

CO3: Examine patents and procedures available in the data base. (K3)

CO4: Effectively communicate the contents to the target audience and handle the questions with confidence (K3)

CO5: Check for patent plagiarism (K2)

The Students will make a technical presentation on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of semester covering the various aspects of his/her presentation.

P: 30 TOTAL: 30 PERIODS

19AD81C	PROJECT WORK – II / INDUSTRY PRACTICE	L	T	P	C
		0	0	12	6

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Design and develop the working model (K3)

CO2: Work independently to complete the project along with team members (K2)

CO3: Demonstrate the results and documents the report (K4)

Project work shall be based on any of the following:

1. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
2. Experimental / Theoretical verification of principles used in the concept.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.
4. Research findings, Recommendations and future scope.

P: 180; TOTAL: 180 PERIODS

19AD82C	INTERNSHIP / IN-PLANT TRAINING	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Acquire the knowledge of different industrial / organizational activities (K2)

CO2: Document the work and communicate effectively through technical presentation.(K2)

1. Student shall undergo internship/in-plant training after getting prior permission from the department
2. A report should be submitted after the successful completion of internship / in-plant training.

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1:** Illustrate the process of importing and handling Relational data in Hadoop using Sqoop.(K2)
- CO2:** Describe the process of Exporting and Handling Relational Data in Hadoop using Sqoop.(K2)
- CO3:** Describe the Hive architecture and execute SQL queries on sample data sets.(K2)
- CO4:** Implement Scripting, Indexing and Joins in Apache hive.(K3)
- CO5:** Describe the Flume architecture, data lakes with Spark and Kafka.(K2)

UNIT I RELATIONAL DATA IN HADOOP USING SQOOP 9

Relational database management in Hadoop- Bi directional data transfer between Hadoop and external database- Importing data- Transferring an entire table-importing subset data- use different file format-Incremental import – import new data-incrementally import data-preserving the value – case study

UNIT II EXPORTING RELATIONAL DATA IN HADOOP USING SQOOP 9

Exporting–Transfer data from Hadoop- update the data- update at the same time- export subset of columns-Hadoop-ecosystem integration import data to hive- using partitioned hive tables- replace special delimiters - case study

UNIT III APACHE HIVE FUNDAMENTALS 9

Introduction - Hive modules - Data types and file formats- Hive QL-Data Definition and Data Manipulation.

UNIT IV APACHE HIVE ADVANCED CONCEPTS 9

Hive QL queries-Hive QL views- reduce query complexity-Hive scripts-Hive QL Indexes- create-show drop- Aggregate functions-Bucketing vs Partitioning-Joins – Case study

UNIT V FLUME, DATA LAKES WITH SPARK AND KAFKA 9

Architecture- Data flow- Fetching Data using Flume- Purpose and evolution of data lakes-Use Spark to run ELT processes and analytics on data of diverse sources- structures and vintages- Components and issues of data lakes- Fundamentals-Stream processing-Kafka streams- Integration with spark – Case Study

L:45; TOTAL:45 PERIODS

TEXTBOOKS

1. Joe Reis, Matt Housley, "Fundamentals of Data Engineering: Plan and Build Robust Data Systems", 2022.
2. Gwen Shapira, Todd Palino, Rajini Sivaram , "Kafka: The Definitive Guide - Real-Time Data and Stream Processing at Scale", 2022.
3. Kathleen Ting, Jarek Jarcec Cecho, "Apache Sqoop Cookbook", O'Reilly Media Inc, 2013
4. Jason Rutherglen, Dean Wampler, Edward Capriolo, "Programming Hive", O'Reilly Media Inc, 2012.
5. Neha Narkhede, Gwen Shapira & Todd Palino, "Kafka- The definitive guide", O'ReillyMedia Inc, 2017

REFERENCES

1. Charleen Fossett, "Apache Spark Framework: Master Apache Spark with Learning Spark", 2023.
2. Ahmad Osama, "Azure Data Engineering Cookbook: Design and implement batch and Streaming analytics using Azure Cloud Services", 2021.
3. Ben Sharma, "Architecting Data Lakes", 2nd Edition, O'Reilly Media Inc, 2018
4. Muhammad AsifAbbasi , "Learning Apache Spark 2", Packet publishing , 2017
5. Hari Shreedharan, "Using Flume: Flexible, Scalable, and Reliable Data Streaming", O'Reilly Media Inc, 2014.

19AD02E

BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Describe the concepts and methods of business analytics and solve decision problems. (K2)
- CO2:** Design effective data visualizations techniques and evaluate different data mining concepts.(K3)
- CO3:** Describe statistical inference and regression.(K2)
- CO4:** Apply appropriate analytical methods to find solutions to business problems.(K3)
- CO5:** Analyze the variety of performance measures for various optimizations problems.(K3)

UNIT I

INTRODUCTION

9

Business Analytics Definition, Decision Making, A Categorization of Analytical Methods and Models, Big Data, applications, Descriptive Statistics: Types of Data, Modifying Data in Excel, Creating Distributions from Data, Measures of Location & Variability, Analyzing Distributions, Measures of Association between Two Variables, Data Cleansing.

UNIT II

DATA VISUALIZATION AND DESCRIPTIVE DATA MINING

9

Data Visualization: Overview of Data Visualization, Tables, Charts, Advanced Data Visualization, Data Dashboards. Descriptive Data Mining: Cluster Analysis, Association Rules, Text Mining. Probability: Conditional Probability, Random Variables, Discrete Probability Distributions, Continuous Probability Distributions.

UNIT III

STATISTICAL INFERENCE AND REGRESSION

9

Statistical Inference: Point Estimation, Sampling Distributions, Interval Estimation, Hypothesis Tests, Big Data, Statistical Inference, and Practical Significance. Linear Regression: Simple Linear Regression Model, Least Squares Method, Assessing the Fit of the Simple Linear Regression Model, the Multiple Regression Model. Inference and Regression: Categorical Independent Variables, Modeling Nonlinear Relationships, Model Fitting, Big Data and Regression

UNIT IV

TIME SERIES ANALYSIS AND PREDICTIVE DATA MINING

9

Time Series Analysis and Forecasting: Time Series Patterns, Forecast Accuracy, Moving Averages and Exponential Smoothing, Regression Analysis for Forecasting. Predictive Data Mining: Data Sampling, Preparation, and Partitioning, Performance Measures, Logistic Regression, k-Nearest Neighbors, Classification and Regression Trees.

UNIT V OPTIMIZATION MODELS**9**

Linear Optimization Models: A Simple Maximization and Minimization Problem, General Linear Programming Notation and More Examples. Integer Linear Optimization Models: Types, Solving Integer Optimization Problems with Excel Solver, Applications Involving Binary Variables, Modelling Flexibility Provided by Binary Variables. Nonlinear Optimization Models: Local and Global Optima, A Location Problem, Markowitz Portfolio Model.

L: 45; TOTAL:45 PERIODS**TEXT BOOKS**

1. "Basic Business Analytics", by SIA Publishers & Distributors Pvt Ltd , 2023
2. Ramesh Sharda, Dursun Delen, Efraim Turban, "Business Intelligence, Analytics, and Data Science : A Managerial Perspective", Pearson, 4th Edition, 2021.

REFERENCES

1. Sanjiv Jaggia , Kevin Lertwachara, Alison Kelly, Leida chen, Apratim Guha, "Business Analytics: Communicating with numbers", McGraw Hill publication, 1st Edition, 2020.
2. David L. Olson, Majid Nabavi, " Introduction to Business Analytics", Business Expert Press publisher, 2nd Edition, 2020.

19AD03E**SOCIAL NETWORK ANALYSIS**

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Develop semantic web applications(K3)
- CO2:**Represent knowledge using ontology (K3)
- CO3:**Describe the Extraction and Mining Communities In Web Social Networks (K3)
- CO4:**Predict Human Behaviour and Privacy Issues (K3)
- CO5:**Visualize social networks (K3)

UNIT I INTRODUCTION**9**

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis.

UNIT II MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION**9**

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations.

UNIT III EXTRACTION AND MINING COMMUNITIES IN WEB**9**

Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting

communities social network infrastructures and communities - Decentralized online social networks - Multi-Relational characterization of dynamic social network communities.

UNIT IV PREDICTING HUMAN BEHAVIOUR AND PRIVACY ISSUES 9

Describing and predicting human behavior for social communities - User data management - Inference and Distribution - Enabling new human experiences - Reality mining - Context Awareness - Privacy in online social networks - Trust in online environment - Trust models based on subjective logic- Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and countermeasures.

UNIT V VISUALIZATION AND APPLICATIONS 9

Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Tanmoy Chakraborty, "Social Network Analysis", Wiley, 2021.
2. Maksim Tsvetovat , Alexander Kouznetsov , "Social Network Analysis for Start-ups: Finding connections on the social", O'Reilly, 2015.

REFERENCES

1. Xiaoming Fu, Jar-Der Luo , Margarete Boos , "Social Network Analysis: Interdisciplinary Approaches and Case Studies", CRC Press, 1st Edition, 2017.
2. Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Network Techniques and applications", Springer, 1st Edition, 2011.
3. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1st Edition, 2010.

19AD04E

HEALTH CARE ANALYTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Apply machine learning and deep learning algorithms for health data analysis (K3)
- CO2:**Apply the data management techniques for healthcare data (K3)
- CO3:**Evaluate the need of healthcare data analysis in e-healthcare, telemedicine and other criticalcare applications (K3)
- CO4:**Design health data analytics for real time applications (K3)
- CO5:**Demonstrate the data management techniques for healthcare data (K3)

UNIT I INTRODUCTION TO HEALTHCARE ANALYSIS 9

Overview - History of Healthcare Analysis Parameters on medical care systems- Health care policy- Standardized code sets – Data Formats – Machine Learning Foundations-Tree Like reasoning-Probabilistic reasoning and Bayes Theorem - Weighted sum approach.

UNIT II ANALYTICS ON MACHINE LEARNING 9

Machine Learning Pipeline – Pre-processing –Visualization – Feature Selection – Training model parameter – Evaluation model – Sensitivity- Specificity - PPV – NPV- FPR - Accuracy - ROC -

Precision Recall Curves - Valued target variables –Python - Variables and types- Data Structures and containers-Pandas Data Frame -Operations – Scikit –Learn -Pre-processing - Feature Selection.

UNIT III HEALTH CARE MANAGEMENT 9

IOT- Smart Sensors – Migration of Healthcare Relational database to NoSQL Cloud Database – Decision Support System – Matrix block Cipher System – Semantic Framework Analysis – Histogram binShifting and RC6 Encryption – Clinical Prediction Models – Visual Analytics for Healthcare.

UNIT IV HEALTHCARE AND DEEP LEARNING 9

Introduction on Deep Learning – DFF network CNN- RNN for Sequences – Biomedical Image and Signal Analysis – Natural Language Processing and Data Mining for Clinical Data – Mobile Imaging and Analytics – Clinical Decision Support System. Case studies - Predicting Mortality for cardiology Practice–Smart Ambulance System using IOT

UNIT V APPLICATIONS 9

Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries Clinical Decision Support Systems. Case Studies– Hospital Acquired Conditions (HAC) program- Healthcare and Emerging Technologies – ECG Data Analysis.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Chandan K. Reddy and Charu C Aggarwal, “Healthcare data analytics”, 1st Edition, Taylor & Francis, 2020
2. Hui Yang and Eva K. Lee, “Healthcare Analytics: From Data to Knowledge to HealthcareImprovement”, 1st Edition, Wiley, 2016.

REFERENCES

1. Kulkarni, Siarry, Singh ,Abraham, Zhang, Zomaya , Baki, “Big Data Analytics in HealthCare”, Springer,1st Edition, 2020.
2. Vikas Kumar, “Health Care Analysis Made Simple”, Packt Publishing, 1st Edition, 2018.
3. Nilanjan Dey, Amira Ashour , Simon James Fong, Chintan Bhatl, “Health Care DataAnalysis and Management, 1st Edition, Academic Press, 2018

19AD05E	WEB ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Describe the concepts and terminologies required for web analytics. (K2)
- CO2:** Comprehend the principles, methods and concepts used in web analytics.(K2)
- CO3:** Apply the appropriate metrics to analyze the web data. (K4)
- CO4:** Study the concept of web goals and apply suitable filter in web analytics for tracking e-commerce sites. (K3)
- CO5:** Implement the use of tools and techniques involved in web analytics.(K2)

UNIT I INTRODUCTION 9

Web Analytics – Basics – Traditional Ways – Expectations – Data Collection – Click stream Data – Weblogs – Beacons – JavaScript Tags – Packet Sniffing –Outcomes data – Competitive data – SearchEngine Data.

UNIT II WEB ANALYTIC CONCEPTS 9
 URLs – Cookies – Time on site – Page views – Describe standard reports – Website content quality– Navigation reports – Search Analytics – Internal search, SEO and PPC – Measuring Email and Multichannel Marketing - Competitive intelligence and Web 2.0Analytics – egmentation – Connectable reports.

UNIT III WEB METRICS AND KPIS 9
 Measuring Reach – Measuring Acquisition – Measuring Conversion – Measuring Retention – Focuson ‘Critical Few’- Key Performance Indicators – Case Studies.

UNIT IV WEB GOALS AND FUNNELS 9
 Filters - Ecommerce Tracking - Real Time Reports - Customer Data Alert - Adwords Linking - Adsense Linking -Attribution Modeling - Segmentation -Campaign Tracking - Multi-Channel Attribution

UNIT V WEB ANALYTIC TOOLS 9
 Content organization tool – Process measurement tools- Visitor Segmentation Tools-Campaign Analysis – Commerce Measurement Tools -Google Analytics- Piwik Web Analytics – Emerging Analytics.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. Michael Loban, Alex Yastrebenetsky, "Crawl, Walk, Run : Advancing Analytical Maturity withGoogle Marketing Platform", Lioncrest Publishing, 2nd Edition,2020.
2. Eric Fettman, Shiraz Asif, Feras Alhlou, "Google Analytics Breakthrough", John Wiley & Sons,1st Edition, 2016.

REFERENCES

1. Brian Clifton," Successful Analytics: Gain Business Insights by Managing Google Analytics", Advanced Web Metrics Ltd, 1st Edition, 2015.
2. Brian Clifton, "Advanced Web Metrics with Google Analytics", Sybex, 3rd Edition, 2012.
3. Michael Beasley, "Practical Web Analytics for User Experience: How Analytics can help youDescribe your Users", Morgan Kaufmann publisher,1st Edition 2013.
4. Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds., "Game Analytics : Maximizing the Value of Player Data", Springer, 2013.

19AD06E	BIO INFORMATICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Describe the fundamental concepts in molecular biology and genomics. (K2)
- CO2:** Analyze gene sequences using appropriate sequence alignment methods. (K3)
- CO3:** Analyze alignments and Phylogenetic trees. (K3)
- CO4:** Illustrate the structure of protein, its classification and functions in drug discovery and development. (K2)
- CO5:** Demonstrate the usage of sequence alignment tools and bioinformatics search engines to retrieve data. (K3)

UNIT I	INTRODUCTION	9
Introduction- Historical overview- Definition-Applications- Major Databases- Data management & Analysis - Molecular Biology and Bioinformatics - Central Dogma of Molecular Biology. Information search & data retrieval: Introduction, Tools for Web Search, Data Retrieval Tools and Data Mining of Biological Databases.		
UNIT II	GENOME ANALYSIS IDENTIFICATION AND PREDICTION	9
Introduction - Genome Analysis - Genome Mapping - The Sequence Assembly Program - Cloning the entire Genome - Genome Sequencing - The Human Genome Project. Gene identification & prediction: Basis of Gene Prediction, Pattern Recognition, Gene Prediction Methods.		
UNIT III	ALIGNMENTS AND PHYLOGENETIC TREES	9
Introduction to Sequence Alignment - The dotplot - Dotplots and Sequence Alignments - Measures of Sequence similarity -Computing the Alignment of two sequences - The dynamic programming algorithm Signature of alignments - Multiple sequence alignment - Applications - Phylogeny - Phylogenetic trees.		
UNIT IV	PROTEIN STRUCTURE AND DRUG DISCOVERY	9
Protein Stability and Folding - Applications of Hydrophobicity - Superposition of structures - DALI - Evolution of Protein Structures - Classification of Protein Structures - Protein Structure prediction and modeling - Assignment of protein structures to genomes - Prediction of protein function - Drug discovery.		
UNIT V	TOOLS IN BIOINFORMATICS	9
Sequence Alignment Tools: FASTA - BLAST - CLUSTAL. Accessing Database Archives: ENTREZ -ExpASy-SRS-Ensembl.		

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. S Gladis Hepsyba Helen, "Basic Bioinformatics", Mjp Publisher,2021
2. Arthur M Lesk, "Introduction to Bioinformatics", Oxford University Press, India, 2nd Edition, 2021.
3. Sharma V , " Textbook of Bioinformatics", Rastogi publications, 2016

REFERENCES

1. Dr. Zhumur Ghosh, Dr. Bibek anand Mallick, "Bioinformatics. Principles and Application", Oxford University Press, 2008.
2. Jin Xiong, "Essential Bioinformatics", Cambridge University Press, 2007.

19AD07E	EXPLORATORY DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1:** Describe the fundamentals of exploratory data analysis.(K2)
- CO2:** Implement the data visualization using Matplotlib.(K3)
- CO3:** Perform univariate data exploration and analysis (K3)
- CO4:** Apply bivariate data exploration and analysis.(K3)

CO5: Apply Data exploration and visualization techniques for multivariate and time series data.(K3)

UNIT I INTRODUCTION 9

EDA fundamentals – Describing data science – Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA - Visual Aids for EDA- Data transformation techniques-merging database, reshaping and pivoting, Transformation techniques.

UNIT II EDA USING PYTHON 9

Data Manipulation using Pandas – Pandas Objects – Data Indexing and Selection – Operating on Data – Handling Missing Data – Hierarchical Indexing – Combining datasets – Concat, Append, Merge and Join – Aggregation and grouping – Pivot Tables – Vectorized String Operations.

UNIT III UNIVARIATE ANALYSIS 9

Introduction to Single variable: Distribution Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality.

UNIT IV BIVARIATE ANALYSIS 9

Relationships between Two Variables - Percentage Tables - Analyzing Contingency Tables - Handling Several Batches – Scatter plots and Resistant Lines.

UNIT V MULTIVARIATE AND TIME SERIES ANALYSIS 9

Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing– Grouping – Resampling.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”, Packt Publishing, 2020.
2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", 2nd Edition, OReilly, 2022.
3. Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008.

REFERENCES

1. Ernesto Pellegrino , Manuel Andre Bottiglieri, et al., “Managing and Visualizing Your BIM Data: Describe the fundamentals of computer science for data visualization using Autodesk Dynamo, Revit, and Microsoft Power BI”, 2021.
2. Eric Pimpler, Data Visualization and Exploration with R, Geo Spatial Training service, 2017.
3. Claus O. Wilke, “Fundamentals of Data Visualization”, O’reilly publications, 2019.

19AD08E	TEXT AND SPEECH ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Apply the text preprocessing concepts for a query for TF-IDF model.(K3)
- CO2:**Apply different algorithms for text classification(K3)
- CO3:**Construct a dialog system using Information retrieval model(K2)

CO4:Study question-answering systems, chatbots and dialogue systems(K2)

CO5:Apply deep learning models for building speech recognition and text-to-speech systems.(K3)

UNIT I INTRODUCTION 9

Text Preprocessing and Wrangling – Text tokenization – Stemming – Lemmatization – Removing stop- words – Feature Engineering for Text representation – Bag of Words model- Bag of N-Grams model – TF-IDF model – Case study: Analysis of Text Preprocessing using NLTK, Implementation of TF-IDF models.

UNIT II TEXT CLASSIFICATION 9

Vector Semantics and Embeddings -Word Embeddings - Word2Vec model – Glove model – Fast Text model – Overview of Deep Learning models – RNN – Transformers – Overview of Text summarization and Topic Models – Case Study.

UNIT III QUESTION ANSWERING AND DIALOGUE SYSTEMS 9

Information retrieval – IR-based question answering – knowledge-based question answering – language models for QA – classic QA models – chatbots – Design of dialogue systems – evaluating dialogue systems Case Study : Developing a knowledge-based question-answering system, Classic QA model development.

UNIT IV TEXT-TO-SPEECH SYNTHESIS 9

Overview-Text normalization-Letter-to-sound-Prosody- Evaluation-Signal processing - Concatenate and parametric approaches-WaveNet and other deep learning-based TTS systems.

UNIT V AUTOMATIC SPEECH RECOGNITION 9

Speech recognition: Acoustic modelling – Feature Extraction - HMM, HMM-DNN systems.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson India publication, 3rd Edition, 2022.
2. Dipanjan Sarkar, “Text Analytics with Python: A Practical Real-World approach to Gaining Actionable insights from your data”, APress, 2018.

REFERENCES

1. Tanveer Siddiqui, Tiwary U S, “Natural Language Processing and Information Retrieval”, OxfordUniversity Press, 2008.
2. Lawrence Rabiner, Biing-Hwang Juang, B. Yegna narayana, “Fundamentals of Speech Recognition” ,1st Edition, Pearson, 2009.
3. Steven Bird, Ewan Klein, and Edward Loper, “Natural language processing with Python”, O’Reilly, 2009

19AD09E	IMAGE ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

CO1:Describe the concept of computer vision and operations of image(K2)

CO2:Develop image classification models using CNN.(K3)

- CO3:**Apply object detection techniques using CNN.(K3)
CO4:Analyze, track and recognize an object in video K3)
CO5:Apply deep learning models for image segmentation.(K3)

UNIT I	COMPUTER VISION	9
Introduction -Structure of Human Eye and Vision- Color Models- Image Processing goals and tasks- Contrast and brightness correction- Image Convolution –Edge Detection.		
UNIT II	CONVOLUTIONS AND IMAGE CLASSIFICATION	9
Describing Convolutions: CNN Model Parameters- pooling layers- CNN with Tensor Flow – Image Classification: AlexNet, VGG and Inception architectures- ResNet- Fine grained Image recognition –Detection and Classification of facial attributes – Content- based image retrieval-semantic image embeddings using CNN- Indexing structures for efficient retrieval of semantic neighbors- Face verification – Facial key points regression – convolution features for visual recognition.		
UNIT III	OBJECT DETECTION	9
Introduction– Sliding windows – HOG-based detector – Detector training – Viola-Jones Face detector – Attentional Cascades And Neural – Region-based Convolutional Neural – From R- CNN to Fast R – Faster R-CNN – Region-based Fully-Convolutional Network – Single Shot detector.		
UNIT IV	VIDEO ANALYSIS AND ACTION RECOGNITION	9
Introduction to Video Analysis – Optical flow – Deep learning in optical flow estimation – Visual object tracking – Multiple object tracking – Action Recognition – Action classification – Action localization.		
UNIT V	IMAGE SEGMENTATION AND SYNTHESIS	9
Image segmentation – Deep learning models for image segmentation – Human pose estimation as image segmentation – Style transfer – Generative adversarial networks – Image transformation with neural networks – Image segmentation and synthesis.		

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Vaibhav Verdhan,” Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras”,Apress,2021
2. Raja lingappaa Shanmugamani, “Deep Learning for Computer Vision”, O’Reilly, 2018.
3. Debjyoti Paul and Charan Puvvala, “Video Analytics using Deep Learning: Building Applications with Tensorflow, Keras and YOLO”, Apress, 1st Edition, 2020.
4. Rafael C.Gonzalez and Richard E. Woods, “Digital Image Processing”, PearsonInternational Edition, 4th Edition, 2018.

REFERENCES

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, SpringerVerlag London Limited, 2nd Edition, 2021.
2. Deep Learning into Computer Vision: <https://www.coursera.org/learn/deep-learning-in-computer-vision>
3. Image Describing with Tensorflow on GCP: [http:// www. coursera.org/learn/image-Describeing-tensorflow-gcp](http://www.coursera.org/learn/image-describing-tensorflow-gcp)

19AD09E

IMAGE ANALYTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the underlying theory behind cognition. (K2)

CO2: Connect to the cognition elements computationally. (K3)

CO3: Implement mathematical functions through Web PPL. (K3)

CO4: Develop applications using cognitive inference model. (K3)

CO5: Develop applications using cognitive learning model. (K3)

UNIT I PHILOSOPHY, PSYCHOLOGY AND NEUROSCIENCE 9

Philosophy: Mental-physical Relation – From Materialism to Mental Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science – Science of Information Processing –Cognitive Neuroscience – Perception – Decision – Learning and Memory – Language Describing and Processing.

UNIT II COMPUTATIONAL INTELLIGENCE 9

Machines and Cognition – Artificial Intelligence – Architectures of Cognition – Knowledge Based Systems– Logical Representation and Reasoning – Logical Decision Making –Learning – Language – Vision

UNIT III PROBABILISTIC PROGRAMMING LANGUAGE 9

WebPPL Language – Syntax – Using Java script Libraries – Manipulating probability types and distributions – Finding Inference – Exploring random computation – Coroutines: Functions that receive continuations –Enumeration

UNIT IV INFERENCE MODELS OF COGNITION 9

Generative Models – Conditioning – Causal and statistical dependence – Conditional dependence – DataAnalysis –Algorithms for Inference.

UNIT V LEARNING MODELS OF COGNITION 9

Learning as Conditional Inference – Learning with a Language of Thought – Hierarchical Models– Learning (Deep) Continuous Functions – Mixture Models.

L:45;TOTAL:45 PERIODS

TEXTBOOKS

1. Jose Luis Bermúdez, “Cognitive Science -An Introduction to the Science of the Mind”, CambridgeUniversity Press, 2020
2. Vijay V Raghavan,Venkat N.Gudivada, Venu Govindaraju, C.R.Rao, “Cognitive Computing: Theory and Applications”, Elsevier publications, 2016
3. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive Computing and Big Data Analytics”,Wiley Publications, 2015
4. Robert A. Wilson, Frank C. Keil, “The MIT Encyclopedia of the Cognitive Sciences”, The MIT Press,1999.

REFERENCES

1. Jose Luis Bermudez , “COGNITIVE SCIENCE: An Introduction to the Science of the Mind”, 2022
2. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, “Probabilistic Models ofCognition”, 2nd Edition, 2016.

19AD11E	REINFORCEMENT LEARNING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Explain the basics of Reinforcement learning using dynamic programming. (K2)
- CO2:** Study the markov process using linear model. (K2)
- CO3:** Describe distance models for RL. (K2)
- CO4:** Describe tree and rule models for RL. (K2)
- CO5:** Apply reinforcement learning techniques for real life problems. (K3)

UNIT I INTRODUCTION 9

Origin Reinforcement Learning research, Dynamic Programming (Value iteration, Policy iteration, and Q-learning) - Probability Primer- Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

UNIT II LINEAR MODELS 9

Introduction to RL, Markov property, Markov chains, Markov reward process (MRP), proof of Bellman equations for MRPs proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

UNIT III DISTANCE-BASED MODELS 9

Overview of dynamic programming for MDP, Formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.

UNIT IV TREE AND RULE MODELS 9

Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.

UNIT V PREDICTION AND EVALUATION METHODS 9

Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q- Learning and their variants.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

- Richard Sutton and Andrew Barto, "Reinforcement Learning: An Introduction", 2nd Edition, The MIT Press, Cambridge, 2018.
- Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan & Claypool Publishers, Series Edition, 2010.

REFERENCES

- Maxim Lapan, "Deep Reinforcement Learning Hands-On: Apply modern RL methods to practical problems of chat bots, robotics, discrete optimization, web automation, and more", Packt Publishing, 2nd Edition , 2020.
- Jason Bell, "Machine learning-Hands on for Developers and Technical Professionals", 1st Edition, Wiley Publishers, 2014

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Describe the fundamentals of natural language processing. (K2)
- CO2:** Design an innovative application using NLP components.(K3)
- CO3:** Describe the usage of CFG and PCFG in NLP.(K2)
- CO4:** Construct a rule-based system using morphology/syntax of a language. (K3)
- CO5:** Build question-answering systems, chatbots and dialogue systems.(K3)

UNIT I INTRODUCTION 9

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.

UNIT II WORD LEVEL ANALYSIS 10

Word level analysis - Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT III SYNTACTIC ANALYSIS 10

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.

UNIT IV SEMANTICS 10

Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

UNIT V NLP TASKS 6

Information Extraction - Question Answering - Summarization – Chatbots

L: 45; TOTAL:45 PERIODS

TEXT BOOKS

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Prentice Hall, 3rd Edition, 2022.
2. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", 1st Edition, O'Reilly Media, 2009.

REFERENCES

1. Jacob Eisenstein, "Introduction to Natural Language Processing", 1st Edition, MIT Press, 2019.
2. Hobson Lane, Hannes Hapke, Cole Howard, "Natural Language Processing in Action: Describing, analyzing, and generating text with Python", 1st Edition, Manning Publications, 2019.

- Grant S. Ingersoll, Thomas S. Morton, Drew Farris, "Taming Text: How to Find, Organize, and Manipulate It", 1st Edition, Manning Publications, 2013.
- James Allen, "Natural Language Describeing", 1st Edition, Pearson Education, 2003.

19AD13E	KNOWLEDGE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Describe the basics of Knowledge Engineering.(K2)
- CO2:**Apply methodologies and modeling for Agent Design and Development.(K3)
- CO3:**Develop ontologies for real time systems.(K3)
- CO4:**Apply reasoning with ontologies and rules.(K3)
- CO5:**Describe learning and rule learning(K2)

UNIT I REASONING UNDER UNCERTAINTY 9

Introduction – Abductive reasoning – Probabilistic reasoning: Enumerative Probabilities – Subjective Bayesian view – Belief Functions – Baconian Probability – Fuzzy Probability – Uncertainty methods - Evidence-based reasoning – Intelligent Agent – Mixed-Initiative Reasoning – Knowledge Engineering.

UNIT II METHODOLOGY AND MODELING 9

Conventional Design and Development – Development tools and Reusable Ontologies – Agent Design and Development using Learning Technology – Problem Solving through Analysis and Synthesis – Inquiry-driven Analysis and Synthesis – Evidence-based Assessment – Believability Assessment – Drill-Down Analysis, Assumption-based Reasoning, and What-If Scenarios.

UNIT III ONTOLOGIES 9

Concepts and Instances – Generalization Hierarchies – Object Features – Defining Features – Representation – Transitivity – Inheritance – Concepts as Feature Values – Ontology Matching. Design and Development Methodologies – Steps in Ontology Development – Domain Describeing and Concept Elicitation – Modelling-based Ontology Specification.

UNIT IV REASONING WITH ONTOLOGIES 9

Production System Architecture – Complex Ontology-based Concepts – Reduction and Synthesis rules and the Inference Engine – Evidence-based hypothesis analysis – Rule and Ontology Matching – Partially Learned Knowledge – Reasoning with Partially Learned Knowledge.

UNIT V LEARNING AND RULE LEARNING 9

Machine Learning – Concepts – Generalization and Specialization Rules – Types – Formal definition of Generalization. Modeling, Learning and Problem Solving – Rule learning and Refinement – Overview –Rule Generation and Analysis – Hypothesis Learning.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

- Anand Sharma, Charu Gupta , Prateek Agrawal, Sandeep Kautish, Saurav Nanda, Vishu Madaan “Knowledge Engineering for Modern Information Systems: Methods, Models and Tools”, Publisher De Gruyter, 2022
- Hamed Fazlollahtabar, “Knowledge Engineering - The Process Paradigm”, CRC Press, 2020.
- Gheorghe Tecuci, DorinMarcu, MihaiBoicu, David A. Schum, Knowledge Engineering

Building Cognitive Assistants for Evidence-based Reasoning, Cambridge University Press, 1st Edition, 2016.

REFERENCES

1. Ela Kumar, "Knowledge Engineering", I K International Publisher House, 2018.
2. King, "Knowledge Management and Organizational Learning", Springer, 2009.
3. John F.Sowa: "Knowledge Representation: Logical, Philosophical, and computational Foundations", Brooks/Cole, Thomson Learning publishers, 2000.
4. Jay Liebowitz, "Knowledge Management Learning from Knowledge Engineering", CRC press, 1st Edition, 2001.

19AD15E	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

CO1: Formulate and solve linear programming problems (LPP)(K2)

CO2: Evaluate Integer Programming Problems, Transportation and Assignment Problems.(K3)

CO3: Obtain a solution to network problems using CPM and PERT techniques.(K3)

CO4: Able to optimize the function subject to the constraints.(K2)

CO5: Identify and solve problems under Markovian queuing models(K2)

UNIT I **LINEAR MODELS** **9**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Two-Phase method.

UNIT II **INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS** **9**

Integer programming: Branch and bound method- Transportation and Assignment problems – Traveling salesman problem.

UNIT III **PROJECT SCHEDULING** **9**

Project network -Diagram representation – Floats - Critical path method (CPM) – PERT- Cost considerations in PERT and CPM

UNIT IV **CLASSICAL OPTIMIZATION THEORY** **9**

Unconstrained problems – necessary and sufficient conditions - Newton-Raphson method, Constrained problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.

UNIT V **QUEUING MODELS** **9**

Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models, multiple service channels.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. Hamdy A Taha, "Operations Research: An Introduction", Pearson, 10th Edition, 2019.
2. Vikrant Sharma, Vinod Kumar Jain, Atul Kumar, "An Introduction to Optimization Techniques", Chapman and Hall/CRC, 1st Edition, 2021

REFERENCES

1. ND Vohra, Hitesh Arora, "Quantitative Techniques in Management", Tata McGraw Hill, 6th Edition, 2021.
2. Arun Kumar, Alka Chaudhary, "Linear Programming & Computational Techniques", Krishna's Educational Publishers, 3rd Edition, 2021
3. J. K. Sharma, "Operations Research Theory and Applications", Macmillan, 5th Edition, 2012.
4. Hiller F.S, Liberman G.J., "Introduction to Operations Research", McGraw Hill, 10th Edition, 2017.
5. Ravindran A., Philip D.T., and Solberg J.J., Operations Research, John Wiley, 2nd Edition, 2007.

19AD16E

MOBILE ROBOTS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

CO1: Evaluate the appropriate mobile robots for the desired application. (K2)

CO2: Describe the kinematics for given wheeled and legged robot (K3)

CO3: Analyze the sensors for the intelligence of mobile robotics (K3)

CO4: Describe the localization strategies and mapping technique for mobile robot. (K2)

CO5: Analyze the collaborative mobile robotics for planning, navigation and intelligence for desired applications. (K3)

UNIT I INTRODUCTION

9

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

UNIT II KINEMATICS

9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints
– Degree of Mobility and Steer ability – Maneuverability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

UNIT III PERCEPTION

9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

UNIT IV LOCALIZATION

9

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS

9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Edition, Pearson Education, 2020.
2. R. Siegwart, I. R. Nourbakhsh, and D. Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, MIT Press, 2011.

REFERENCE BOOKS

1. John Wiley & Sons Ltd., "Autonomous Mobile Robots and Multi-Robot Systems: Motion Planning, Communication, and Swarming", 2020.
2. Danny Staple, "Learn Robotics Programming: Build and control autonomous robots using Raspberry Pi 3 and Python", Packt Publishing, 1st Edition, 2018.
3. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
4. Mohanta Jagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
5. Peter Corke, "Robotics, Vision and Control", Springer, 2017.

19AD17E

INTERNET OF THINGS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

CO1: Describe the basics of IoT and its application sectors (K2)

CO2: Recognize and apply IoT protocols appropriately (K2)

CO3: Realize the IoT Reference Architecture and Real-World Design Constraints (K2)

CO4: Design a portable IoT using Raspberry Pi (K3)

CO5: Deploy an IoT application and connect to the cloud (K3)

UNIT I

INTRODUCTION

9

Functional requirements –IoT conceptual framework – IoT architectural view - Components of Internet of Things: Control units – Sensors – Communication modules – Power sources. Communication technologies: RFID – Bluetooth – ZigBee – WiFi – RF Links – Mobile Internet – Wired Communication - M2M communication – Examples of IoT.

UNIT II

NETWORKING AND COMMUNICATION PROTOCOLS

9

Sensor technology – Actuator - Participatory sensing, industrial IoT and automotive IoT –Data acquiring and storage – organizing the data – analytics – knowledge acquiring, managing and storing processes - Sensor data communication protocols - Functions of CoAP, MQTT, OAuth2, XMPP, CoAPvs HTTP, CoAP Structure Model, Security Protocol and Application for CoAP.

UNIT III

IOT PLATFORMS

9

Arduino Platform -Data from Sensors - Communication: Arduino with a mobile device – Bluetooth communication -USB -Wifi / Ethernet.

UNIT IV

RASPBERRY PI AND CLOUD SERVICES

9

Basic building blocks of an IoT Device - Raspberry Pi - Linux on Raspberry Pi – Raspberry Pi Interfaces - Programming Raspberry Pi with Python - Cloud Storage Models & Communication APIs - WAMP – Auto Bahn for IoT - Xively Cloud for IoT.

UNIT V CASE STUDIES 9

The Future Web of Things - Set up cloud environment -data from microcontroller to cloud-Case Studies Illustrating IoT Design: IoT in Cities / IoT in the Home/ IoT in Healthcare / IoT in Agriculture. Autonomous vehicles, Google Assistant based IO Control. IoT Platforms Design Methodology case studies: Intel IoT Framework, Qualcomm IoT Framework, Microsoft IoT Framework.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. Sudhir K. Routray and Sasmita Mohanty ,”Principles and Applications of Narrowband Internet of Things (NBloT)”,IGI Global Timely knowledge publication, 2021.
2. Agus Kurniawan ,”Beginning Arduino Nano 33 IoT: Step-By-Step Internet of Things Projects”, APress, 1st Edition, 2020.

REFERENCES

1. Oliver Hersent, David Boswarthick, Omar Elloumy, “The Internet of Things”, Wiewy, 1st Edition,2015.
2. Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, VPT,1st Edition, 2014.
3. Marco Schwatz, “Internet of Things with Arduino Cookbook”, Packt Publications, 1st Edition, 2016.
4. Nick Antonopoulos and Lee Gillam, “Cloud Computing: Principles, Systems and Applications”,2nd Edition, Springer, 2017.

19AD18E	ROBOTICS PROCESS AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Describe the key distinctions between RPA and platforms.(K2)
- CO2:**Study UiPath to design control flows and work flows for the target process.(K2)
- CO3:**Implement recording, web scraping and process mining by automation.(K3)
- CO4:**Study exception detecting and handling in automation processes.(K2)
- CO5:**Implement and use Orchestrator for creation, monitoring, scheduling, and controlling of automated bots and processes.(K3)

UNIT I INTRODUCTION 9

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, WorkflowFiles.

UNIT II AUTOMATION PROCESS ACTIVITIES 9

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, Ui Implemente, Events – Case study.

UNIT III APP INTEGRATION, RECORDING AND SCRAPING 9

App Integration, Recording, Scraping, Selector, Workflow Activities. mouse and keyboard actionsto perform operation, Scraping data from website and writing to CSV. Process Mining – Case study.

UNIT IV EXCEPTION HANDLING AND CODE MANAGEMENT 9

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine – Case study.

UNIT V DEPLOYMENT AND MAINTENANCE 9

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA– Case study.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. Tom Taulli , “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Apress publications, 2020.
2. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018.

REFERENCES

1. A Gerardus Blokdyk, “Robotic Process Automation Rpa A Complete Guide “,5starcook publication, 2020
2. Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston,“Introduction to Robotic Process Automation: a Primer”, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018.
3. Richard Murdoch, “Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant”, Amazon Asia-Pacific Holdings Private Limited, 2018.

19AD20E	INTERNET AND WEB TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students can able to:

- CO1:** Develop a website using HTML.(K3)
- CO2:** Study a dynamic styling websites using CSS.(K2)
- CO3:** Develop a web page with validation using Java script. (K3)
- CO4:** Design a web page in PHP and deploy an Enterprise Application. (K3)
- CO5:** Design a web application using angular JS and web application frameworks.(K3)

UNIT I INTRODUCTION, HTML 5.0 9

Web Essentials: Clients, Servers and Communication – World Wide Web – HTTP Request Message –HTTP Response Message – Web Clients – Web Servers – HTML5: Tables – Lists – Image- Frames - Forms - control elements.

UNIT II CASCADING STYLE SHEETS 3.0 9

CSS3- Inline, embedded and external style sheets – Rule cascading – Backgrounds – Border Images - Colors – Shadows – Text – Transformations – Transitions – Animations – Bootstrap Framework

UNIT III CLIENT SIDE PROGRAMMING 9

Java script: An Introduction to JavaScript-Java script (DOM)Model-Exception Handling-validation-Built-in objects-Event Handling-DHTML with Javascript-JSON: Introduction-Syntax-Function Files

UNIT IV SERVER SIDE PROGRAMMING 9

Servlets: Java Servlet Architecture- Servlet Life Cycle- GET and POST actions- Session Handling –Cookies-JDBC-PHP: Introduction - Variables- Program control- Built-in functions-Form Validation.

UNIT V ANGULAR AND WEB APPLICATION FRAMEWORKS 9

Introduction to AngularJS:MVC Architecture-Expressions and Data Binding-Conditional Directives-styledirectives-Controllers-Filters-Forms-Routers-Modules-ServicesIntroduction to Angular16-Web Applications Frameworks and tools-Firebase-Docker-Node JS-React-Django-UI&UX.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Kedar Nath Rout,Saroj Kumar Rout, "Internet and Web Technology", B.K.Publications Pvt. Ltd, 2ndEdition, 2019
2. Paul Deitel, Harvey Dietel and Abbey deitel, "Internet and World Wide Web-How to Program", Prentice Hall, 5th Edition, 2018.
3. Brad Dayley, "Learning AngularJS", Addison-wesley professional, 1st Edition, 2014.

REFERENCES

1. Jennifer Kyrnin Laura Lemay, Rafe Colburn, "Mastering HTML, CSS & JavaScript" Web Publishing,2021.
2. Chris Bates, "Web Programming – Building Intranet Applications", Wiley Publications, 3rd Edition, 2018.
3. Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2nd Edition, 2014.
4. Laura Lemay, Rafe Colburn and Jennifer Kyrnin, "Mastering HTML, CSS & Javascript WebPublishing", BPB Publications, 1st Edition, 2016.

19AD21E	APP DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Develop native applications with GUI Components (K3).
- CO2:**Develop hybrid applications with basic event handling (K3)
- CO3:**Design cross-platform applications with data storage capabilities (K3)
- CO4:**Design cross platform applications with basic GUI and event handling (K3)
- CO5:**Develop web applications with cloud database access (K3)

UNIT I FUNDAMENTALS OF MOBILE & WEB APPLICATION DEVELOPMENT 9

Basics of Web and Mobile application development-Native App- Hybrid App-Cross-platform App, Progressive Web App-Responsive Web design

UNIT II NATIVE APP DEVELOPMENT USING JAVA 9

Native Web App-Benefits of Native App-Scenarios to create Native App-Tools for creating NativeApp, Cons of Native App-Popular Native App Development Frameworks-Java & Kotlin for Android- Swift & Objective-C for iOS-Basics of React Native-Native Components-JSX-State-Props

UNIT III HYBRID APP DEVELOPMENT 9

Hybrid Web App:Introduction– Pros and Cons - Criteria for creating Native App, Tools for creating Hybrid App, Popular Hybrid App Development Frameworks, Ionic, Apache Cordova

UNIT IV CROSS-PLATFORM APP DEVELOPMENT USING REACT-NATIVE 9

Cross-platform App, Introduction – Pros and Cons - Criteria for creating Cross-platform App, Tools for creating Cross-platform App, Popular Cross-platform App Development Frameworks: Flutter, Xamarin, React-Native, Basics of React Native, Native Components, JSX, State, Props

UNIT V NON-FUNCTIONAL CHARACTERISTICS OF APP FRAMEWORKS 9

Comparison of different App frameworks, Build Performance, App Performance, Debugging capabilities, Time to Market, Maintainability, Ease of Development, UI/UX, Reusability

L: 45;TOTAL:45 PERIODS

TEXT BOOKS

1. Hazem Saleh, Ethan Holmes, Tom Bray, Sani Yusuf , “Mobile Application Development: JavaScript Frameworks “,Packt Publishing Limited ,2016
2. Zigurd Mednieks, Laird Dornin, G.BlakeMeike and Masumi Nakamura, “Programming Android”, O’Reilly, 2011.
3. Reto Meier, “Professional Android 2 Application Development”, Wrox Wiley, 2010.

REFERENCES

1. Alasdair Allan, “iPhone Programming”, O’Reilly, 2010.
2. Wei-Meng Lee, “Beginning iPhone SDK Programming with Objective-C”, Wrox Wiley, 2010.

19AD22E	PROGRAMMING PARADIGMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1:**Describe syntax and semantics of programming languages (K2)
- CO2:**Explain data, data types, and basic statements of programming languages (K2)
- CO3:**Design and implement subprogram constructs (K3)
- CO4:**Apply object-oriented, concurrency, and event handling programming constructs and Develop programs in Scheme, ML, and Prolog (K3)
- CO5:**Describe and adopt new programming languages (K2)

UNIT I SYNTAX AND SEMANTICS 9

Evolution of programming languages – describing syntax – context-free grammars – attribute grammars –describing semantics – lexical analysis – parsing – recursive-descent – bottom up parsing

UNIT II DATA, DATA TYPES, AND STATEMENTS 9

Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection – primitive data types – strings – array types – associative arrays – record types – union types – pointers and references – Arithmetic expressions – overloaded operators – type conversions – relational and boolean expressions – assignment statements – mixed mode assignments – control structures – selection – Iterations – branching – guarded statements

UNIT III SUBPROGRAMS AND IMPLEMENTATIONS 9

Subprograms – design issues – local referencing – parameter passing – overloaded methods – genericmethods – design issues for functions – semantics of call and return – implementing simple subprograms – stack and dynamic local variables – nested subprograms – blocks – dynamic scoping

UNIT IV OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING 9

Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency – semaphores – monitors – message passing – threads – statement level concurrency – exception handling – event handling

UNIT V FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES 9

Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog - multi-paradigm languages

L:45; TOTAL:45 PERIODS

TEXTBOOKS

1. Robert W. Sebesta, "Concepts of Programming Languages", 12th Edition, Pearson, 2022.
2. Michael L. Scott, "Programming Language Pragmatics", 4th Edition, Elsevier, 2018.
3. R. Kent Dybvig, "The Scheme programming language", 4th Edition, Prentice Hall, 2011.

REFERENCES

1. Maurizio Gabbriellini, Simone Martini, "Programming Languages: Principles and Paradigms", Springer London Ltd, 2010.
2. Michael Scott, "Programming Language Pragmatics", Morgan Kaufmann Publishers In, 4th Edition, 2015.

19AD23E	AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:**Implement the interactive techniques in Virtual Reality.(K2)
- CO2:**Develop the simple framework of virtual Reality.(K3)
- CO3:**Implement the research issues in Virtual Reality.(K3)
- CO4:**Implement the interactive techniques in Augmented Reality.(K3)
- CO5:**Develop the simple framework of Augmented and Mixed reality.(K3)

UNIT I VIRTUAL REALITY 9

Introduction - Fundamental Concept and Components - Primary Features and Present Development on Virtual Reality. Multiple Models of Input and Output Interface in Virtual Reality: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3D Scanner etc. Output – Visual /Auditory / Haptic Devices.

UNIT II VISUAL COMPUTATION IN VIRTUAL REALITY 9

Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering. Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp.

UNIT III FRAMEWORKS AND APPLICATIONS 9

Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc. Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games - Demonstration of Digital Entertainment by VR.

UNIT IV AUGMENTED REALITY 9
 Introduction - Concepts-Hardware-Software- Taxonomy - Technology and features - Augmented reality methods - visualization techniques for augmented reality.

UNIT V AUGMENTED AND MIXED REALITY 9
 Augmented Reality: Challenges – systems – functionality - wireless displays in educational augmented reality applications-mobile projection interfaces - marker-less tracking for augmented reality - enhancing interactivity in AR environments – evaluating AR systems.

L: 45;TOTAL:45 PERIODS

TEXT BOOKS

1. Jonathan Linowes, “Augmented Reality with Unity AR Foundation: A practical guide to cross-platform AR development with Unity”, Packt Publication Ltd, 2021.
2. Jesse Glover, Jonathan Linowes, “Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications”, Packt Publication Ltd,1st Edition, 2019.
3. Alan B. Craig, “Describeing Augmented Reality, Concepts and Applications”, Morgan Kaufmann, 2013.
4. Alan Craig, William Sherman and Jeffrey Will, “Developing Virtual Reality Applications, Foundations of Effective Design”, Morgan Kaufmann, 2009.

REFERENCES

1. Chetankumar G Shetty ,”Augmented Reality - Theory, Design and Development”, McGraw Hill, 1st Edition, 2020
2. Ahmed Fathi Bekhit, “Computer Vision and Augmented Reality in iOS: OpenCV and ARKit Applications”, APress, 1st Edition, 2021.

19AD24E	UI AND UX DESIGN	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Describe UI for user Applications. (K2)
- CO2:** Evaluate UX design of any product or application. (K3)
- CO3:** Demonstrate UX Skills in product development. (K2)
- CO4:** Implement Sketching principles. (K3)
- CO5:** Create Wireframe and Prototype. (K3)

UNIT I INTRODUCTION 9
 UI vs. UX Design - Core Stages of Design Thinking - Divergent and Convergent Thinking - Brainstorming and Game storming - Observational Empathy.

UNIT II UI DESIGN 9
 Visual and UI Principles - UI Elements and Patterns - Interaction Behaviors and Principles – Branding -Style Guides.

UNIT III UX DESIGN 9
 Introduction to User Experience - Why You Should Care about User Experience - Describing User Experience - Defining the UX Design Process and its Methodology - Research in User Experience Design - Tools and Method used for Research - User Needs and its Goals - Know about Business Goals.

UNIT IV RESEARCH, DESIGNING, IDEATING, & INFORMATION ARCHITECTURE 9

Identifying and Writing Problem Statements - Identifying Appropriate Research Methods - Creating Personas - Solution Ideation - Creating User Stories - Creating Scenarios - Flow Diagrams - Flow Mapping - Information Architecture.

UNIT V WIREFRAMING, PROTOTYPING AND TESTING 9

Sketching Principles - Sketching Red Routes - Responsive Design – Wireframing - Creating Wireflows - Building a Prototype - Building High-Fidelity Mockups - Designing Efficiently with Tools - Interaction Patterns - Conducting Usability Tests - Other Evaluative User Research Methods - Synthesizing Test Findings - Prototype Iteration.

L:45;TOTAL:45 PERIODS

TEXT BOOKS

1. Joel Marsh, "UX for Beginners", O'Reilly, 2022.
2. Jon Yablonski, "Laws of UX using Psychology to Design Better Product & Services", O'Reilly 2021

REFERENCES

1. Fabio Staiano, Designing and Prototyping Interfaces with Figma: Learn essential UX/UI design principles by creating interactive prototypes for mobile, tablet, and desktop", Packt Publication Ltd, 2022
2. Jenifer Tidwell, Charles Brewer, Aynne Valencia, "Designing Interface", 3rd Edition, O'Reilly 2020.
3. Pamala Deacon And Pamala Deacon ,"Ux And Ui Strategy: A Step By Step Guide On UX And UI Design", Independently published, 2020
4. Steve Schoger, Adam Wathan "Refactoring UI", 2018.

19AD25E	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Describe fundamental concepts of Cloud Computing (K2)
- CO2:** Describe various types of virtualization and its importance (K2)
- CO3:** Implement the various cloud infrastructures and application (K2)
- CO4:** Analyze the methods used for secure cloud access and application development (K3)
- CO5:** Analyze the various cloud platforms to provide cloud based services for complex applications. (K3)

UNIT I INTRODUCTION 9

Introduction to Cloud Computing-Layers and Types of Clouds Desired Features of a Cloud-Cloud Infrastructure Management – Infrastructure As A Service Providers-Platform As Service Providers-Challenges and Risks-Cloud Migrations: Broad Approaches to Migrating into the Cloud-The Seven- Step Model of Migration.

UNIT II VIRTUALIZATION 9

Basics of Virtualization: Characteristics – Taxonomy of Virtualization Techniques – Hardware Level Virtualization – Operating System Level Virtualization – Virtualization and Cloud Computing – Pros and Cons of Virtualization – Case Study: XEN, VMware.

UNIT III CLOUD ARCHITECTURE AND SERVICES 9
 Cloud Architecture – Cloud Services: Infrastructure as a Service – Platform as a Service – Software as a Service – Types of Cloud: Private Cloud – Public Cloud – Hybrid Cloud – Community Cloud – Challenges – Cloud Applications- Scientific Applications – Business Applications.

UNIT IV IAAS & PAAS 9
 Virtual Machines Provisioning and Migration Services - Provisioning and Manageability- Migration Services - VM Provisioning and Migration in Action - Provisioning in the Cloud Context - Aneka-Integration of Private and Public Clouds - Technologies and Tools for Cloud Computing - Aneka Cloud Platform - Aneka Resource Provisioning Service - Hybrid Cloud Implementation – Comet Cloud Architecture - Autonomic Behaviour of Comet Cloud – Comet Cloud-based Applications.

UNIT V INDUSTRIAL PLATFORMS AND APPLICATION DEVELOPMENT 9
 Service creation environments - Compute Services – Storage Services – Communication Services – Additional Services - Google App Engine – Architecture core concepts – Application life cycle – Cost model – Azure core concepts – SQL Azure – platform appliance- Develop cloud based applications.

L: 45; TOTAL:45 PERIODS

TEXT BOOKS

1. Judith Hurwitz, Daniel Kirsch, “Cloud Computing for Dummies”, Wiley, 2nd Edition, 2020.
2. Rajkumar Buyya, Christian Vecchiola and Thamarai Selvi S, “Mastering in Cloud Computing”, Tata McGraw Hill Education Private Limited , 1st Edition, 2017.
3. Rajkumar Buyya, James Broberg, Andrzej Goscinski “Cloud Computing Principles and Paradigms” John Wiley & Sons, Inc., Hoboken, New Jersey, 1st Edition, 2013.

REFERENCES

1. Rajiv Misra, Yashwant Singh Patel, “Cloud and Distributed Computing : Algorithms And Systems”, Wiley, 2020
2. Barrie Sosinsky, Cloud Computing Bible, Wiley Publishing Inc, 1st Edition, 2014.

19AD26E	SOFT COMPUTING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of the course, students will be able to:

- CO1:** Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.(K3)
- CO2:** Describe different types of Artificial Neural Networks.(K2)
- CO3:** Implement neural networks to pattern classification and regression problems.(K3)
- CO4:** Apply genetic algorithms to combinatorial optimization problems.(K3)
- CO5:** Apply existing software tools to solve real problems using a soft computing Approach.(K3)

UNIT I FUZZY SYSTEMS 9
 Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions- Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems –Fuzzy Decision Making - Fuzzy Tool box in Matlab.

Passing Systems versus Shared Memory Systems – Primitives for Distributed Communication – Synchronous versus Asynchronous Executions – Design Issues and Challenges; A Model of Distributed Computations: A Distributed Program – A Model of Distributed Executions – Models of Communication Networks – Global State of a Distributed System.

UNIT II LOGICAL TIME AND GLOBAL STATE 9

Logical Time: Physical Clock Synchronization: NTP – A Framework for a System of Logical Clocks – Scalar Time – Vector Time; Message Ordering and Group Communication: Message Ordering Paradigms – Asynchronous Execution with Synchronous Communication – Synchronous Program Order on Asynchronous System – Group Communication – Causal Order – Total Order; Global State and Snapshot Recording Algorithms: Introduction – System Model and Definitions – Snapshot Algorithms for FIFO Channels.

UNIT III DISTRIBUTED MUTEX AND DEADLOCK 9

Distributed Mutual exclusion Algorithms: Introduction – Preliminaries – Lamport’s algorithm – Ricart- Agrawala’s Algorithm — Token-Based Algorithms – Suzuki-Kasami’s Broadcast Algorithm; Deadlock Detection in Distributed Systems: Introduction – System Model – Preliminaries – Models of Deadlocks – Chandy-Misra-Haas Algorithm for the AND model and OR Model.

UNIT IV CONSENSUS AND RECOVERY 9

Consensus and Agreement Algorithms: Problem Definition – Overview of Results – Agreement in a Failure-Free System (Synchronous and Asynchronous) – Agreement in Synchronous Systems with Failures; Check pointing and Rollback Recovery: Introduction – Background and Definitions – Issues in Failure Recovery – Checkpoint-based Recovery – Coordinated Check pointing Algorithm - Algorithm for Asynchronous Check pointing and Recovery

UNIT V CLOUD COMPUTING 9

Definition of Cloud Computing – Characteristics of Cloud – Cloud Deployment Models – Cloud Service Models – Driving Factors and Challenges of Cloud – Virtualization – Load Balancing – Scalability and Elasticity – Replication – Monitoring – Cloud Services and Platforms: Compute Services – Storage Services – Application Services

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Andrew S Tanenbaum, Maarten Van Steen, "Distributed Systems", 2023
2. Roberto Vitillo, "Describeing Distributed Systems: What every developer should know about large distributed applications", 2021

REFERENCES

1. Mukesh Singhal, Niranjan G Shivaratri, "Advanced Concepts in Operating systems", Mc-Graw Hill Publishers, 2017.
2. Arshdeep Bagga, Vijay Madiseti, "Cloud Computing: A Hands-On Approach", Universities Press, 2014.

COURSE OBJECTIVES

- To empower students with overall Professional and Technical skills required to solve a real world problem.
- To mentor the students to approach a solution through various stages of Ideation, Research, Design Thinking, workflows, architecture and building a prototype in keeping with the end-user and client needs.
- To provide experiential learning to enhance the Entrepreneurship and employability skills of the students.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Upskill in emerging technologies and apply to real industry-level use cases

CO2: Understand agile development process

CO3: Develop career readiness competencies, Team Skills / Leadership qualities

CO4: Develop Time management, Project management skills and Communication Skills

CO5: Use Critical Thinking for Innovative Problem Solving

CO6: Develop entrepreneurship skills to independently work on products

TABLE 1: ACTIVITIES

Activity Name	Activity Description	Time (weeks)
Choosing a Project	Selecting a project from the list of projects categorized various technologies & business domains	2
Team Formation	Students shall form a team of 4 Members before enrolling to a project. Team members shall distribute the project activities among themselves.	1
Hands on Training	Students will be provided with hands-on training on selected technology in which they are going to develop the project.	2
Project Development	Project shall be developed in agile mode. The status of the project shall be updated to the mentors via appropriate platform	6
Code submission, Project Doc and Demo	Project deliverables must include the working code, project document and demonstration video. All the project deliverables are to be uploaded to cloud based repository such as GitHub.	3
Mentor Review and Approval	Mentor will be reviewing the project deliverables as per the milestone schedule and the feedback will be provided to the team.	1
Evaluation and scoring	Evaluators will be assigned to the team to evaluate the project deliverables, and the scoring will be provided based on the evaluation metrics	1

Activity Name	Activity Description	Time (weeks)
TOTAL		16 WEEKS

Essentially, it involves 15 weeks of learning and doing, and one week for evaluation. The evaluation will be carried out to assess technical and soft skills as given in Table 2.

TABLE 2: EVALUATION SCHEMA

TECHNICAL SKILLS		SOFT SKILLS	
<i>Criteria</i>	<i>Weightage</i>	<i>Criteria</i>	<i>Weightage</i>
Project Design using Design Thinking	10	Teamwork	5
Innovation & Problem Solving	10	Time Management	10
Requirements Analysis using Critical Thinking	10	Attendance and Punctuality	5
Project Planning using Agile Methodologies	5	Project Documentation	5
Technology Stack (APIs, tools, Platforms)	5	Project Demonstration	5
Coding & Solutioning	15		
User Acceptance Testing	5		
Performance of Product / Application	5		
Technical Training & Assignments	5		
Total	70	Total	30
Total Weightage		100	
Passing Requirement		50	
CONTINUOUS ASSESSMENT ONLY			

P: 90; TOTAL: 90 PERIODS

11. Correlation and N-Fold cross validation in R
12. Visualizing data using R with different type of graphs and charts

P:30; TOTAL:30 PERIODS

SOFTWARE REQUIREMENTS

- **Operating System:** Windows.
- **Software:** RStudio.

REFERENCES

1. Garrett Golemund, Hadley Wickham, "R for Data Science", O Reilly, 2016.
2. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison Wesley, 2018.
3. Hicham, Mohamed Ibnalkadi, "Introduction to R Programming", 2021.
4. Ajit Singh, "R Programming : Simply In Depth", 2020.
5. Garrett Golemund, "Hands on Programming with R: Write Your Own Functions and Simulations", O Reilly, 2014.