R.M.D. ENGINEERING COLLEGE

(An Autonomous Institution)

REGULATIONS 2022

B.Tech. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

CURRICULUM & SYLLABI

(For the students admitted during 2022-2023)

R.M.D. ENGINEERING COLLEGE
(An Autonomous Institution)
REGULATIONS 2022
CHOICE BASED CREDIT SYSTEM

B.Tech. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates can

PEOI: Work effectively in inter-disciplinary field with the knowledge of Artificial Intelligence and Machine Learning to develop appropriate solutions to real-world problems.

PEO2: Apply their knowledge to the technological revolution through life-long learning.

PEO3: Excel as socially committed engineers or entrepreneurs with high ethical and moral values.

PEO4: Pursue advanced studies and engage in innovative research in the field of Artificial Intelligence and Machine Learning.

II. PROGRAM OUTCOMES (POs)

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 ofmathematics, 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, andmodern 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 needfor 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 toengage in independent and life-long learning in the broadest context of technological change.

III. PROGRAM SPECIFIC OUTCOMES (PSOs)

The Students will be able to

PSO1: Apply fundamental concepts of Artificial Intelligence and Data Science to solve technical problems.

PSO2: Utilize Artificial Intelligence and Data Science tools to provide innovative business solutions.

PSO3: Implement the domain knowledge to achieve successful career as an employee, entrepreneur and an engineering professional.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES(PEOs) WITH PROGRAMME OUTCOMES(POs)

A broad relation between the programme objective and the outcomes is given in thefollowing table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	1	2	3	4	5	6	7	8	9	10	11	12
I	3	3	3	3	2	2	2	1	1	1	1	1
II	3	3	3	3	2	1	1	1	3	3	1	3
III	2	2	2	2	2	3	2	3	3	1	1	1
IV	3	3	3	3	2	2	2	3	3	3	2	1

MAPPING OF PROGRAM SPECIFIC OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is givenin the following table

PROGRAMME SPECIFIC OBJECTIVES	PROGRAMME OUTCOMES											
	1	2	3	4	5	6	7	8	9	10	11	12
I	3	3	3	3	3	3	2	1	1	1	1	2

II	3	3	3	3	3	3	2	1	1	1	1	2
III	2	2	2	2	3	2	2	2	3	2	3	3

Contribution **1: Reasonable** **2: Significant** **3: Strong**

R.M.D. ENGINEERING COLLEGE
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REGULATIONS 2022

B.Tech. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR SEMESTERS I TO VIII
(For the students admitted during 2022-2023)

SEMESTER I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES WITH LABORATORY COMPONENT								
1	22MA101	Matrices and Calculus	BSC	5	3	0	2	4
2	22CH101	Engineering Chemistry	BSC	5	3	0	2	4
3	22CS101	Problem Solving using C++	ESC	5	3	0	2	4
4	22CS102	Software Development Practices	ESC	5	3	0	2	4
5	22EC101	Digital Principles and System Design	ESC	5	3	0	2	4
LABORATORY COURSES WITH THEORY COMPONENT								
6	22GE111	Computer Aided Engineering Graphics	ESC	3	1	0	2	2
LABORATORY COURSES								
7	22GE112	Product Development Lab-I	EEC	2	0	0	2	1
MANDATORY COURSES								
8	22MC101	Induction Program (Non Credit)	MC	3 Weeks				
TOTAL				**30**	**16**	**0**	**14**	**23**

SEMESTER II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES								
1	22GE101	Heritage of Tamils	HSMC	1	1	0	0	1
THEORY COURSES WITH LABORATORY COMPONENT								
2	22MA201	Transforms and Numerical Methods	BSC	5	3	0	2	4
3	22CS201	Data Structures	ESC	5	3	0	2	4
4	22PH201	Physics for Computer Science and Information	BSC	5	3	0	2	4
5	22HS101	Professional Communication	HSMC	4	2	0	2	3
6	22CS202	Java Programming	ESC	5	3	0	2	4
7	22IT201	Database Management System	PCC	5	3	0	2	4
LABORATORY COURSES								
8	22GE211	Product Development Lab – II	EEC	2	0	0	2	1
MANDATORY COURSES								
9	22CH102	Environmental Sciences and Sustainability (Non Credit)	MC	2	2	0	0	0
AUDIT COURSES								
10	22AC201	Yoga for Stress Management	AC	1	1	0	0	0
TOTAL				**35**	**21**	**0**	**14**	**25**

SEMESTER III

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES								
1.	22MA301	Discrete Mathematics	BSC	4	3	1	0	4
2.	22GE301	Universal Human Values II: Understanding Harmony	HSMC	3	3	0	0	3
3.	22CS302	Computer Organization and Architecture	ESC	3	3	0	0	3
4.	22GE201	Tamils and Technology	HSMC	1	1	0	0	1
THEORY COURSES WITH LABORATORY COMPONENT								
5.	22CS303	Design and Analysis of Algorithms	PCC	4	2	0	2	3
6.	22CS304	Operating Systems	PCC	4	2	0	2	3
7.	22AM301	Artificial Intelligence	PCC	5	3	0	2	4
LABORATORY COURSES								
8.	22GE311	Product Development Lab-III	EEC	2	0	0	2	1
EMPLOYABILITY ENHANCEMENT COURSES								
9.	22CS311	Aptitude and Coding Skills- I	EEC	2	0	0	2	1
10.	22AM311	Internship and Seminar	EEC	2	0	0	2	1
AUDIT COURSES								
11.	22AC301	Value Education (Non Credit)	AC	1	1	0	0	0
TOTAL				**31**	**18**	**1**	**12**	**24**

*2 weeks for one credit. Internship during 2 Semester Summer Vacation

SEMESTER IV

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES WITH LABORATORY COMPONENT								
1.	22MA401	Probability and Statistics	BSC	5	3	0	2	4
2.	22AM401	Neural Networks	PCC	4	2	0	2	3
3.	22AM402	Machine Learning Essentials	PCC	5	3	0	2	4
4.	22CS401	Distributed and Cloud Computing	PCC	4	2	0	2	3
5.	22CS402	Web Development Frameworks	PCC	5	3	0	2	4
6.		Professional Elective- I	PEC	4	2	0	2	3
LABORATORY COURSES								
7.	22GE411	Product Development Lab-IV	EEC	2	0	0	2	1
EMPLOYABILITY ENHANCEMENT COURSES								
8.	22CS411	Aptitude and Coding Skills - II	EEC	2	0	0	2	1
9.	22CS412	Mini Project and Design Thinking	EEC	2	0	0	2	1
AUDIT COURSES								
10.	22AC401	Yoga/Personality Development(Non-Credit)	AC	1	1	0	0	0
TOTAL				**34**	**16**	**0**	**18**	**24**

SEMESTER V

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES								
1.		Open Elective- I	OEC	3	3	0	0	3
2.		Professional Elective -II	PEC	3	3	0	0	3
3.		Professional Elective-III	PEC	3	3	0	0	3
THEORY COURSES WITH LABORATORY COMPONENT								
4.	22AM501	Deep Learning	PCC	5	3	0	2	4
5.	22AM502	Data Exploration, Feature Engineering and Visualization	PCC	4	2	0	2	3
EMPLOYABILITY ENHANCEMENT COURSES								
6.	22CS511	Advanced Aptitude and Coding Skills-I	EEC	2	0	0	2	1
7.	22AM511	Internship and Career Readiness Course	EEC	2	0	0	2	1
MANDATORY COURSES								
8.	22MC501	Indian Constitution (Non Credit)	MC	1	1	0	0	0
TOTAL				**23**	**15**	**0**	**8**	**18**

SEMESTER VI

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES								
1.	22AM601	Automata Theory and Compiler Design	PCC	3	3	0	0	3
2.		Open Elective - II	OEC	3	3	0	0	3
3.		Professional Elective- IV	PEC	3	3	0	0	3
4.		Professional Elective -V	PEC	3	3	0	0	3
THEORY COURSES WITH LABORATORY COMPONENT								
5.	22AM602	Foundation of Reinforcement Learning and Ensemble Methods	PCC	5	3	0	2	4
6.	22CS602	Object Oriented Software Engineering	PCC	4	2	0	2	3
EMPLOYABILITY ENHANCEMENT COURSES								
7.	22CS611	Advanced Aptitude and Coding Skills - II	EEC	2	0	0	2	1
8.	22AM611	Mini Project	EEC	2	0	0	2	1

TOTAL	**25**	**17**	**0**	**8**	**21**	

SEMESTER VII

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY COURSES								
1.		Professional Ethics	HSMC	3	3	0	0	3
2.		Open Elective -III	OEC	3	3	0	0	3
3.		Open Elective -IV	OEC	3	3	0	0	3
4.		Professional Elective -VI	PEC	3	3	0	0	3
THEORY COURSES WITH LABORATORY COMPONENT								
5.	22AM701	Natural Language Processing	PCC	5	3	0	2	4
6.	.22AM702	Computer Vision	PCC	3	3	0	0	3
LABORATORY COURSE								
7.	22AM711	MLOps	PCC	2	0	0	2	1
MANDATORY COURSES								
8.	22MC711	Essence of Indian Knowledge Tradition (Non Credit)	MC	1	1	0	0	0
TOTAL				**24**	**18**	**0**	**6**	**20**

SEMESTER VIII

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
EMPLOYABILITY ENHANCEMENT COURSES								
1.	22AM811	Project Work	EEC	16	0	0	16	8
TOTAL				**16**	**0**	**0**	**16**	**8**

TOTAL NO. OF CREDITS: 163

CREDIT SUMMARY

S. No.	Subject Area	Credits Per Semester								Credit Total	Percentage
		I	II	III	IV	V	VI	VII	VIII		
1	HSMC	-	4	4	-	-	-	3	-	11	6.75%
2	BSC	8	8	4	4	-	-	-	-	24	14.72%
3	ESC	14	8	3	-	-	-	-	-	25	15.34%
4	PCC	-	4	10	14	8	11	9	-	56	33.13%
5	PEC	-	-	-	3	6	6	3	-	18	11.04%
8	OEC	-	-	-	-	3	3	6	-	12	7.36%
7	EEC	1	1	3	3	2	2	-	8	20	11.66%
8	MC			✓	✓	✓		✓			
	Total	23	25	24	24	18	21	20	8	163	

HSMC – Humanities and Social Sciences including Management courses; **BSC** – Basic Science Courses; **ESC** – Engineering Science Courses including workshop, drawing, basics of electrical/mechanical/computer etc.; **PCC** – Professional Core Courses; **PEC** – Professional Elective Courses relevant to chosen specialization/branch; **OEC** – Open Subjects–Electives from other technical and/or emerging subjects **EEC** – Project Work, Seminar and Internship in Industry or elsewhere

PROFESSIONAL ELECTIVES:

PROFESSIONAL ELECTIVES								
Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
DATA SCIENCE AND ANALYTICS								
1.	22AM901	Data Science using Python	PEC	4	2	0	2	3
2.	22AM902	Data Analytics	PEC	4	2	0	2	3
3.	22AM903	Social Network Analytics	PEC	3	3	0	0	3
4.	22AM904	Text and Speech Analytics	PEC	3	3	0	0	3
5.	22AM905	Image and Video Analytics	PEC	3	3	0	0	3
6.	22AM906	Stream Processing and Analytics	PEC	3	3	0	0	3
APPLIED AI								
7.	22AM907	AI in Block Chain	PEC	3	3	0	0	3
8.	22AM908	Augmented and Virtual Reality	PEC	4	2	0	2	3
9.	22AM909	Intelligent Robots	PEC	3	3	0	0	3
10.	22AM910	Generative AI	PEC	3	3	0	0	3
11.	22CS925	Game Development	PEC	3	3	0	0	3
12.	22CS921	Industrial IoT	PEC	3	3	0	0	3
AI AND CLOUD								
13.	22CS907	Cloud Foundations	PEC	4	2	0	2	3
14.	22CS909	Virtualization	PEC	3	3	0	0	3

15.	22CS910	DevOps	PEC	3	3	0	0	3
16.	22CS911	Data Engineering in Cloud	PEC	3	3	0	0	3
17.	22CS933	Machine Learning for NLP in Cloud	PEC	3	3	0	0	3
18.	22CS934	Cloud Services Management	PEC	3	3	0	0	3
HIGH PERFORMANCE COMPUTING								
19.	22AM911	Multi-Core Architecture and Programming	PEC	3	3	0	0	3
20.	22AM912	GPU Computing	PEC	3	3	0	0	3
21.	22EC601	Digital Signal Processing	PEC	3	3	0	0	3
22.	22CS924	Quantum Computing	PEC	3	3	0	0	3
23.	22AM913	Scalable Machine Learning	PEC	3	3	0	0	3
24.	22AM914	Optimization Methods in Machine Learning	PEC	3	3	0	0	3

HONOURS VERTICALS:

INTELLIGENT HEALTHCARE								
Sl. No.	**Course Code**	**Course Title**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
1.	22AM915	AI and ML for Healthcare	PEC	4	2	0	2	3
2.	22AM916	Medical Image Analysis	PEC	3	3	0	0	3
3.	22AM917	Clinical Data Science	PEC	3	3	0	0	3
4.	22AM918	Deep Learning in Genomics and Life Sciences	PEC	3	3	0	0	3
5.	22AM919	Bio-Informatics	PEC	3	3	0	0	3
6.	22AM920	Smart and Interactive Healthcare Technologies	PEC	3	3	0	0	3
7.	22AM812	Capstone Project	PEC	12	0	0	12	6

COMPUTATIONAL INTELLIGENCE								
Sl. No.	**Course Code**	**Course Title**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
1.	22AM921	Soft Computing	PEC	3	3	0	0	3
2.	22AM922	Applied AI and ML	PEC	3	3	0	0	3
3.	22AM923	Recommender Systems	PEC	3	3	0	0	3
4.	22AM924	Knowledge Engineering	PEC	3	3	0	0	3
5.	22AM925	Computational Neuroscience	PEC	3	3	0	0	3
6.	22AM926	AI Essentials	PEC	3	3	0	0	3
7.	22AM812	Capstone Project	PEC	12	0	0	12	6

OPEN ELECTIVE – OFFERED TO OTHER DEPARTMENTS								
Sl. No.	**Course Code**	**Course Title**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
1.	22AM907	AI in Block Chain	OEC	3	3	0	0	3
2.	22AM921	Soft Computing	OEC	3	3	0	0	3
3.	22AM925	Computational Neuroscience	OEC	3	3	0	0	3
4.	22AM919	Bio-Informatics	OEC	3	3	0	0	3

5.	22AM001	Introduction to Generative AI	OEC	3	3	0	0	3
6.	22AM002	Foundations of Natural Language Processing	OEC	3	3	0	0	3
7.	22AM003	Cognitive Science and Analytics	OEC	3	3	0	0	3

R2022 CURRICULUM OF
B.TECH. (HONOURS) IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
WITH SPECIALIZATION IN

SI. No	NAME OF THE HONOURS DEGREE WITH SPECIALIZATION
1.	Computational Intelligence
2.	Intelligent Healthcare

R2022 CURRICULUM OF
B.TECH. (HONOURS) IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Additional 18 credits to be completed from the courses offered in any Professional Elective Vertical

R2022
B.TECH. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING WITH MINOR DEGREE

SI. No	NAME OF THE MINOR DEGREE	OFFERRING DEPARTMENT
1.	Internet of Things	Electronics and Communication Engineering
2.	Advanced Web Development	Computer Science and Business Systems
3.	Fintech and Blockchain	Computer Science and Business Systems

R2022
MINOR DEGREE CURRICULUM OFFERED BY
DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
(for other B.E. / B.Tech. Programmes)
MINOR DEGREE IN ARTIFICIAL INTELLIGENCE

SI. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1.	22AM004	Introduction to Data Science	3	3	0	0	3
2.	22AM005	Introduction to Artificial Intelligence	3	3	0	0	3
3.	22AM006	Machine Learning Algorithms	3	3	0	0	3
4.	22AM007	Foundations of Deep Learning	3	3	0	0	3
5.	22AM812	Capstone Project	12	0	0	12	6

SYLLABUS

SEMESTER –I

22MA101	MATRICES & CALCULUS (Common to All Branches)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- Explain the concepts of matrix algebra techniques needed for practical applications.
- Determine the curvature of the curves.
- Illustrate the simple applications of multivariable calculus and vector calculus.
- Elaborate the concept and application of multiple integrals.

UNIT I	MATRICES	15

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

Theory : 9

Experiments using SCILAB:

1. Introduction to SCILAB through matrices and general syntax.
2. Finding the Eigenvalues and Eigenvectors.
3. Plotting the graph of a quadratic form.

Laboratory: 6

UNIT II	SINGLE VARIABLE CALCULUS	15

Curvature in Cartesian and Polar Co-ordinates – Centre and radius of curvature – Circle of curvature–Evolutes.

Theory: 9

Experiments using SCILAB:

1. Evaluating the radius of curvature.
2. Finding the coordinates of the center of curvature.
3. Tracing of Curves.

Laboratory: 6

UNIT III	MULTIVARIABLE CALCULUS	15

Partial derivatives (excluding Euler's theorem) – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables.

Theory: 9

Experiments using SCILAB:

1. Evaluating the maxima of functions of several variables.
2. Evaluating the minima of functions of several variables.
3. Evaluation of Jacobians.

Laboratory: 6

UNIT IV	MULTIPLE INTEGRALS	15

Double integrals – Change of order of integration – Area enclosed by plane curves – Triple integrals – Volume of solids.

Theory: 9

Experiments using SCILAB:

1. Evaluating area under a curve.
2. Evaluating area using double integral..
3. Evaluation of volume by integrals.

Laboratory: 6

UNIT V	**VECTOR CALCULUS**	**15**

Gradient, divergence and curl (excluding vector identities) – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane and Gauss divergence theorem (Statement only) – Simple applications involving cubes and rectangular parallelopipeds.

Theory: 9

Experiments using SCILAB:

1. Evaluating gradient.
2. Evaluating directional derivative.
3. Evaluating divergent and curl.

Laboratory: 6

TOTAL: 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Use the matrix algebra methods to diagonalize the matrix.
CO2: Determine the evolute of the curve.
CO3: Apply differential calculus ideas on the function of several variables.
CO4: Evaluate the area and volume by applying the concept of multiple integration.
CO5: Utilize the concept of vector calculus in evaluating integrals.

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCES:

1. M. K. Venkataraman, "Engineering Mathematics", Volume I, 4th Edition, The National Publication Company, Chennai, 2003.
2. SivaramakrishnaDass, C. Vijayakumari, "Engineering Mathematics", Pearson Education India, 4th Edition 2019.
3. H. K. Dass, and Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand Private Limited, 3rd Edition 2014.
4. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 6th Edition, New Delhi, 2008.
5. S.S. Sastry, "Engineering Mathematics", Vol. I & II, PHI Learning Private Limited, 4th Edition, New Delhi, 2014.

LIST OF EQUIPMENTS:

1. SCILAB- Open source

22CH101	ENGINEERING CHEMISTRY (Common to All Branches)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- To understand the water quality criteria and interpret its applications in water purification.
- To gain insights into the basic concepts of electrochemistry and implement its applications in chemical sensors.
- To acquire knowledge on the fundamental principle of energy storage devices and relate it to electric vehicles.
- To identify the different types of smart materials and explore their applications in Engineering and Technology.
- To assimilate the preparation, properties and applications of nanomaterials in various fields.

UNIT I	WATER TECHNOLOGY	15

Sources of water –Impurities - Drinking water quality parameters –Hardness and its types, problems - Municipal water treatment and disinfection (chlorination- break-point chlorination,UV, Ozonation). Boiler troubles- Scales and sludges, Boiler feed water: Requirements - Internal treatment (phosphate, colloidal, sodium aluminate and Calgon conditioning). External treatment –Ion exchange demineralization - Principle, process and fouling. Desalination of brackish water: Reverse osmosis –principle-types of membranes, process and fouling.

(Theory-9)

Determination of total, temporary and permanent hardness of water by EDTA method.
Determination of chloride content of water sample by argentometric method.
Determination of alkalinity in water sample

(Laboratory-6)

UNIT II	ELECTROCHEMISTRY AND SENSORS	15

Introduction- Conductance- factors affecting conductance – Electrodes– origin of electrode potential – single electrode potential, standard electrode potential – measurement of single electrode potential –over voltage - reference electrodes (standard hydrogen electrode, calomel electrode)-ion selective electrode- glass electrode - Nernst equation (derivation),numerical problems, Electrochemical series and its applications.
Chemical sensors – Principle of chemical sensors – Breath analyzer– Gas sensors – CO2 sensors- Sensor for health care – Glucose sensor.

(Theory-9)

Determination of the amount of NaOH using a conductivity meter.
Determination of the amount of acids in a mixture using a conductivity meter.
Determination of the amount of given hydrochloric acid using a pH meter.

(Laboratory-6)

UNIT III	ENERGY STORAGEDEVICES AND ENERGYSOURCES	15

Batteries –Primary alkaline battery - Secondary battery - Pb-acid battery, Fuel cell - H2 – O2 fuel cell.
Batteries used in E- vehicle: Ni-metal hydride battery, Li-ion Battery, Li-air Battery
Nuclear Energy – Nuclear fission, fusion, differences, characteristics – nuclear chain reactions – light water nuclear reactor – breeder reactor.

(Theory-9)

Determination of single electrode potential of the given electrode.
Estimation of the iron content of the given solution using apotentiometer.
Determination of electrochemical cell potential (using different electrodes/ different concentrations of electrolytes)

(Laboratory-6)

UNIT IV	SMART MATERIALS FOR ENGINEERING APPLICATIONS	15

Polymers – Definition – Classification – smart polymeric materials - Preparation, properties and applications of Piezoelectric polymer - Polyvinylidene fluoride (PVDF), Electroactive polymer- Polyaniline (PANI) and Biodegradable polymer - Polylactic acid (PLA).
Polymer composites: Definition, Classification – FRP's – Kevlar.
Shape Memory Alloys: Introduction, Shape memory effect – Functional properties of SMAs – Types of SMA - Nitinol (Ni-Ti) alloys - applications.
Chromogenic materials:Introduction – Types - applications.

(Theory-9)

Determination of themolecular weight of polymer using Ostwald viscometer.
Application of polymeric fibers in 3D printing.

(Laboratory-6)

UNIT V	NANO CHEMISTRY	15

Introduction – synthesis – top-down process (laser ablation, chemical vapor deposition), bottom-up process (precipitation, electrochemical deposition) – properties of nanomaterials – types – nanotubes -carbon nanotubes, applications of CNT - nanocomposites – General applications of nanomaterials in electronics, information technology, medical and healthcare, energy, environmental remediation, construction and transportation industries.

(Theory-9)

Determination of concentration of $BaSO_4$ nanoparticles by conductometric titrations.
Preparation of ZnO nanocrystal by precipitation method.

(Laboratory-6)

TOTAL: 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Interpret the water quality parameters and explain the various water treatment methods.
CO2: Construct the electro chemical cells and sensors.
CO3: Compare different energy storage devices and predict their relevance in electric vehicles.
CO4: Classify different types of smart materials, their properties and applications in Engineering and Technology.
CO5: Integrate the concepts of nano chemistry and enumerate its applications in various fields.

TEXT BOOKS:

1. P. C. Jain and Monika Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai PublishingCompanyPvt. Ltd., New Delhi, 2022.
2. SivasankarB., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012.

REFERENCES:

1. S.S. Daraand S.S. Umare, "A Textbook of Engineering Chemistry",12thEdition, S.Chand&Company, NewDelhi, 2013.
2. V.R. Gowarikar, Polymer Science, 2nd edition, New Age International Publishers, 2021.
3. J. C. Kuriacose and J. Rajaram, "Chemistry in Engineering and Technology", Volume - 1&Volume -2, Tata McGraw-Hill Education Pvt. Ltd., 2010.
4. Geoffrey A. Ozin, Andre C. Arsenault and Ludovico Cademartiri, "Nanochemistry: A Chemical ApproachtoNanomaterials",2ndEdition,RSC publishers,2015.
5. PrasannaChandrasekhar,"Conductingpolymers,fundamentalsandapplications–Including

Carbon Nanotubes and Graphene", Second Edition, Springer Science & Business Media, New York, 2019.
6. J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas and B. Sivasankar, "Vogel's Quantitative Chemical Analysis", 6th edition, Pearson Education Pvt. Ltd., 2019.

LIST OF EQUIPMENTS:

1. Conductivity meter – 20 Nos.
2. pH meter - 19 Nos.
3. Potentiometer - 20 Nos.

22CS101	PROBLEM SOLVING USING C++ (Common to All Branches)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- To learn problem solving and programming fundamentals.
- To gain knowledge on pointers and functions.
- To apply the principles of object orientated programming.
- To understand operator overloading, inheritance and polymorphism.
- To use the functionalities of I/O operations, files build C++ programs using exceptions.

UNIT I	PROBLEM SOLVING AND PROGRAMMING FUNDAMENTALS	15

Computational thinking for Problem solving – Algorithmic thinking for Problem solving - Building Blocks - Problem Solving and Decomposition - Dealing with Error – Evaluation.
Overview of C – Data types – Identifiers – Variables – Storage Class Specifiers – Constants – Operators - Expressions – Statements – Arrays and Strings – Single-Dimensional – Two-Dimensional Arrays – Arrays of Strings – Multidimensional Arrays.

List of Exercises:

1. Write C/C++ programs for the following:
   a. Find the sum of individual digits of a positive integer.
   b. Compute the GCD of two numbers.
   c. Find the roots of a number (Newton's method)
2. Write C/C++ programs using arrays:
   a. Find the maximum of an array of numbers.
   b. Remove duplicates from an array of numbers.
   c. Print the numbers in an array after removing even numbers.
3. Write C/C++ programs using strings:
   a. Checking for palindrome.
   b. Count the occurrences of each character in a given word.

UNIT II	POINTERS AND FUNCTIONS	15

Pointers -Variables – Operators – Expressions – Pointers and Arrays – Functions - Scope Rules – Function Arguments – return Statement – Recursion – Structures – Unions – Enumerations.

List of Exercises:

1. Generate salary slip of employees using structures and pointers. Create a structure Employee with the following members:
   EID, Ename, Designation, DOB, DOJ, Basicpay

Note that DOB and DOJ should be implemented using structure within structure.

2. Compute internal marks of students for five different subjects using structures and functions.

UNIT III	CLASSES AND OBJECTS	15

Concepts of Object Oriented Programming – Benefits of OOP – Simple C++ program - Classes and Objects - Member functions - Nesting of member functions - Private member functions - Memory Allocation for Objects - Static Data Members - Static Member functions - Array of Objects - Objects as function arguments - Returning objects - friend functions – Const Member functions - Constructors – Destructors.

List of Exercises:

1. Write a program Illustrating Class Declarations, Definition, and Accessing Class Members.
2. Program to illustrate default constructor, parameterized constructor and copy constructors.

UNIT IV	OPERATOR OVERLOADING, INHERITANCE AND POLYMORPHISM	15

Operator Overloading - Overloading Using Friend functions – Inheritance – Types of inheritance – Virtual Base Class - Abstract Class – Constructors in Derived Classes - member class: nesting of classes.

Pointer to objects – this pointer- Pointer to derived Class - Virtual functions – Pure Virtual Functions – Polymorphism.

List of Exercises:

1. Write a Program to Demonstrate the i) Operator Overloading. ii) Function Overloading.
2. Write a Program to Demonstrate Friend Function and Friend Class.
3. Program to demonstrate inline functions.
4. Program for Overriding of member functions.
5. Write C++ programs that illustrate how the following forms of inheritance are supported:
   a) Single inheritance b)Multiple inheritance c)Multi level inheritance d)Hierarchical inheritance.

UNIT V	I/O, FILES AND EXCEPTIONS	15

C++ Streams – Unformatted I/O - Formatted Console I/O – Opening and Closing File – File modes - File pointers and their manipulations – Templates – Class Templates – Function Templates - Exception handling.

List of Exercises:

1. Program to demonstrate pure virtual function implementation.
2. Count the number of account holders whose balance is less than the minimum balance using sequential access file.
3. Write a Program to Demonstrate the Catching of all Exceptions.
4. Mini project.

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Solve problems using basic constructs in C.
CO2: Implement C programs using pointers and functions.
CO3: Apply object-oriented concepts and solve real world problems.
CO4: Develop C++ programs using operator overloading and polymorphism.
CO5: Implement C++ programs using Files and exceptions.

TEXT BOOKS:

1. Herbert Schildt, “The Complete Reference C++”, 4th edition, MH, 2015. (Unit 1 & 2)

2. E Balagurusamy,"Object Oriented Programming with C++", 4th Edition, Tata McGraw-Hill Education, 2008. (Unit 3, 4 & 5)

REFERENCES:

1. Karl Beecher,"Computational Thinking: A beginner's guide to problem-solving and programming", BCS Learning & Development Ltd, 2017. (Unit 1)
2. Nell Dale, Chip Weems, "Programming and Problem Solving with C++", 5th Edition, Jones and Barklett Publishers, 2010.
3. John Hubbard, "Schaum's Outline of Programming with C++", MH, 2016.
4. Yashavant P. Kanetkar, "Let us C++", BPB Publications, 2020
5. ISRD Group, "Introduction to Object-oriented Programming and C++", Tata McGraw-Hill Publishing Company Ltd., 2007.
6. D. S. Malik, "C++ Programming: From Problem Analysis to Program Design", Third Edition, Thomson Course Technology, 2007.
7. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01297200240671948837_shared/overview

LIST OF EQUIPMENTS:

1. Standalone desktops with C/C++ compiler (or) Server with C/C++ compiler.

22EC101	DIGITAL PRINCIPLES AND SYSTEMS DESIGN (Common to All Branches)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- To acquire the knowledge in Digital fundamentals and its simplification methods.
- To familiarize the design of various combinational digital circuits using logic gates.
- To realize various sequential circuits using flip flops.
- To interpret various clocked sequential circuits.
- To elucidate various semiconductor memories and related technology.
- To build various logic functions using Programmable Logic Devices.

UNIT I	BOOLEAN ALGEBRA AND LOGIC GATES	9

Review of number systems-representation-conversions, Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms, min term and max term, Simplification of Boolean expressions-Karnaugh map,Implementation of Boolean expressions using logic gates and universal gates.

List of Experiments:

1. Implementation of Boolean expression using logic gates.

UNIT II	COMBINATIONAL LOGIC CIRCUITS	9

Design of combinational circuits - Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/De-mux, Parity Generator/Checker

List of Experiments:

1. Design of adders
2. Design ofsubtractors.
3. Design of binary adder using IC7483
4. Design of Multiplexers &Demultiplexers.
5. Design of Encoders and Decoders.

6. Implementation of a boolean function using a multiplexer.

UNIT III	SEQUENTIAL CIRCUITS	9

Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Asynchronous and Synchronous Counters Design - Shift registers, Universal Shift Register

List of Experiments:

1. Design and implementation of 3 bit ripple counters.
2. Design and implementation of 3 bit synchronous counter
3. Design and implementation of shift registers

UNIT IV	SYNCHRONOUSSEQUENTIAL CIRCUITS DESIGN	9

Design of clocked sequential circuits - Moore/Mealy models, state minimization, state assignment, circuit implementation

UNIT V	MEMORY AND PROGRAMMABLE LOGIC DEVICES	9

Basic memory structure ROM: PROM – EPROM – EEPROM –RAM – Static and dynamic RAM – Programmable Logic Devices: Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Implementation of combinational logic circuits using PLA, PAL.

TOTAL: 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Implement digital circuits using simplified Boolean functions.
CO2: Realize Combinational circuits for a given function using logic gates.
CO3: Demonstrate the operation of various counters and shift registers using Flip Flops.
CO4: Analyze Synchronous Sequential circuits.
CO5: Summarize the various types of memory devices.
CO6: Design the Combinational circuits using Programmable Logic Devices.
CO7: Perform practical exercises as an individual and / or team member to manage the task in time.
CO8: Express the experimental results with effective presentation and report.

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, Digital Design, With an Introduction to the Verilog HDL, VHDL, and System Verilog, 6th Edition, Pearson, 2018.
2. S.Salivahanan and S.Arivazhagan,Digital Circuits and Design, 5th Edition, Oxford University Press, 2018.

REFERENCES:

1. A.Anandkumar, Fundamental of digital circuits, 4th Edition, PHI Publication,2016.
2.WilliamKleitz, Digital Electronics-A Practical approach to VHDL, Prentice Hall International Inc, 2012.
3.CharlesH.Roth, Jr. andLarry L. Kinney, Fundamentals of Logic Design, 7th Edition, Thomson Learning, 2014.
4.Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson Education Inc, 2017.
5.John.M Yarbrough, Digital Logic: Applications and Design, 1st Edition, Cengage India, 2006.

NPTEL LINK: https://nptel.ac.in/courses/108/105/108105132/

22CS102	SOFTWARE DEVELOPMENT PRACTICES (Common to All Branches)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- To discuss the essence of agile development methods.
- To set up and create a GitHub repository.
- To create interactive websites using HTML
- To design interactive websites using CSS.
- To develop dynamic web page using Java script.

UNIT I	AGILE SOFTWARE DEVELOPMENT AND Git and GitHub	15

Software Engineering Practices – Waterfall Model - Agility – Agile Process – Extreme Programming - Agile Process Models – Adaptive Software Development – Scrum – Dynamic Systems Development Method – Crystal – Feature Driven Development – Lean Software Development – Agile Modeling – Agile Unified Process – Tool set for Agile Process.

Introduction to Git –Setting up a Git Repository - Recording Changes to the Repository - Viewing the Commit History - Undoing Things - Working with Remotes -Tagging - Git Aliases - Git Branching - Branches in a Nutshell - Basic Branching and Merging - Branch Management - Branching Workflows - Remote Branches - Rebasing.

Introduction to GitHub – Set up and Configuration - Contribution to Projects, Maintaining a Project – Scripting GitHub.

List of Exercises:

1. Form a Team, Decide on a project:
    a) Create a repository in GitHub for the team.
    b) Choose and follow a Git workflow
        - Each team member can create a StudentName.txt file with contents about themselves and the team project
        - Each team member can create a branch, commit the file with a proper commit message and push the branch to remote GitHub repository.
        - Team members can now create a Pull request to merge the branch to master branch or main development branch.
        - The Pull request can have two reviewers, one peer team member and one faculty. Reviewers can give at least one comment for Pull Request updating.
        - Once pull request is reviewed and merged, the master or main development branch will have files created by all team members.
2. Create a web page with at least three links to different web pages. Each of the web pages is to be designed by a team member. Follow Git workflow, pull request and peer reviews.
3. Form a Team, Decide on a project:
    c) Create a repository in GitHub for the team.
    d) Choose and follow a Git workflow
        - Each team member can create a StudentName.txt file with contents about themselves and the team project
        - Each team member can create a branch, commit the file with a proper commit message and push the branch to remote GitHub repository.
        - Team members can now create a Pull request to merge the branch to master branch or main development branch.
        - The Pull request can have two reviewers, one peer team member and one faculty. Reviewers can give at least one comment for Pull Request updation.

- Once pull request is reviewed and merged, the master or main development branch will have files created by all team members.

4. Create a web page with at least three links to different web pages. Each of the web pages is to be designed by a team member. Follow Git workflow, pull request and peer reviews.

UNIT II	HTML	15

Introduction – Web Basics – Multitier Application Architecture – Cline-Side Scripting versus Server-side Scripting – HTML5 – Headings – Linking – Images – Special Characters and Horizontal Rules – Lists – Tables – Forms – Internal Linking – meta Elements – Form input Types – input and datalist Elements – Page-Structure Elements.

List of Exercises:

1. Create web pages using the following:
   - Tables and Lists
   - Image map
   - Forms and Form elements
   - Frames

UNIT III	CSS	15

Inline Styles – Embedded Style Sheets – Conflicting Styles – Linking External Style Sheets – Positioning Elements – Backgrounds – Element Dimensions – Box Model and Text Flow – Media Types and Media Queries – Drop-Down Menus – Text Shadows – Rounded Corners – Colour – Box Shadows – Linear Gradients – Radial Gradients – Multiple Background Images – Image Borders – Animations – Transitions and Transformations – Flexible Box Layout Module – Multicolumn Layout.

List of Exercises:

1. Apply Cascading style sheets for the web pages created.

UNIT IV	JAVASCRIPT BASICS	15

Introduction to Scripting – Obtaining user input – Memory Concepts – Arithmetic – Decision Making: Equality and Relational Operators – JavaScript Control Statements – Functions – Program Modules – Programmer-defined functions – Scope rules – functions – Recursion – Arrays – Declaring and Allocating Arrays – References and Reference Parameters – Passing Arrays to Functions – Multidimensional arrays.

List of Exercises:

1. Form Validation (Date, Email, User name, Password and Number validation) using JavaScript.

UNIT V	JAVASCRIPT OBJECTS	15

Objects – Math, String, and Date, Boolean and Number, document Object – Using JSON to Represent objects – DOM: Objects and Collections – Event Handling.

List of Exercises:

1. Implement Event Handling in the web pages.

Mini Projects-Develop any one of the following web applications (not limited to one) using above technologies.

a. Online assessment system
b. Ticket reservation system

c. Online shopping
d. Student management system
e. Student result management system
f. Library management
g. Hospital management
h. Attendance management system
i. Examination automation system
j. Web based chat application

TOTAL: 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Apply agile development methods in software development practices.
CO2: Set up and create a GitHub repository.
CO3: Develop static and dynamic webpages using HTML.
CO4: Design interactive personal or professional webpages using CSS.
CO5: Develop web pages using Java script with event-handling mechanism.

TEXT BOOKS:

1. Roger S. Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill International Edition, Nineth Edition, 2020.
2. Scott Chacon, Ben Straub, "Pro GIT", Apress Publisher, 3rd Edition, 2014.
3. Deitel and Deitel and Nieto, "Internet and World Wide Web - How to Program", Pearson, 5th Edition, 2018.

REFERENCES:

1. Roman Pichler, "Agile Product Management with Scrum Creating Products that Customers Love", Pearson Education, 1 st Edition, 2010.
2. Jeffrey C and Jackson, "Web Technologies A Computer Science Perspective", Pearson Education, 2011.
3. Stephen Wynkoop and John Burke, "Running a Perfect Website", QUE, 2nd Edition, 1999.
4. Chris Bates, "Web Programming – Building Intranet Applications", 3rd Edition, Wiley Publications, 2009.
5. Gopalan N.P. and Akilandeswari J., "Web Technology", Second Edition, Prentice Hall of India, 2014.
6. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013382690411003904735_shared/overview
7. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013094421427470336209 9_shared/overview

LIST OF EQUIPMENTS:

Systems with either Netbeans or Eclipse
Java/JSP/ISP Webserver/Apache
Tomcat / MySQL / Dreamweaver or
Equivalent/ Eclipse, WAMP/XAMP

22GE111	COMPUTER AIDED ENGINEERING GRAPHICS (Common to All Branches)	L	T	P	C
		1	0	2	2

OBJECTIVES:

The Course will enable learners to:

- To help students understand universal technical drawing standards.
- To provide training on drafting software to draw part models.
- To demonstrate the concepts of orthographic and isometric projections.
- To use drawing skills for communicating concepts,ideas for engineering product design.
- Use pictorial views to visualize and draw the isometric view of the objects.

UNIT I	**INTRODUCTION TO CONVENTIONS IN ENGINEERING DRAWING AND CONIC SECTIONS**	**9**

Introduction to Engineering Drawing - Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Conic curves - Ellipse, Parabola and Hyperbola by Eccentricity method.

(Theory - 3)

Drawing of a title block with necessary text, projection symbol and lettering using drafting software.
Drafting of Conic curves - Ellipse, Parabola and Hyperbola

(Laboratory - 6)

UNIT II	**ORTHOGRAPHIC PROJECTION**	**9**

Visualization concepts and Orthographic Projection - Layout of views – Orthographic Projection- Conversion of pictorial diagram into orthographic views.

(Theory - 3)

Drawing orthographic view of simple solids like Prism, Pyramids, Cylinder, Cone, etc, and dimensioning.
Drawing of orthographic views from the given pictorial diagram.

(Laboratory -6)

UNIT III	**PROJECTION OF PLANES**	**9**

Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method.

(Theory - 3)

Drawing of plane Surface inclined to HP.
Drawing of plane Surface inclined to VP.

(Laboratory -6)

UNIT IV	**PROJECTION OF SOLIDS**	**9**

Projection of simple solids like Prisms, Pyramids, Cylinder and Cone when the axis is inclined to HP by rotating object method.

(Theory - 3)

Drawing of simple solids like prism and pyramids when the axis is inclined to HP.
Drawing of simple solids like cylinder and cone when the axis is inclined to HP.

(Laboratory -6)

UNIT V	**ISOMETRIC DRAWING**	**9**

Principles of isometric view – Isometric view of simple solids – Prism, Pyramid, Cylinder and Cone.

(Theory - 3)

Drawing isometric projection of simple solids.
Modeling of 2D to 3D objects using drafting software.

(Laboratory -6)

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the various engineering standards required for drafting and explore knowledge in conic sections.
CO2: Draw the orthographic views of 3Dprimitive objects.
CO3: Describe the projection of plane surfaces by the rotating plane method.
CO4: Apply the projection concepts and drafting tools to draw projections of solids. **CO5:** Sketch the pictorial views of the objects using CAD tools.

TEXT BOOKS:

1. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 33rd Edition, 2020.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 15th Edition, 2019.

REFERENCES:

1. Bhatt N.D. "Engineering Drawing", Charotar Publishing House, 53rd edition ,2019.
2. BasantAgarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 3rd Edition, 2019.
3. Engineering Drawing Practice for Schools and Colleges BIS SP46:2003 (R2008), Published by Bureau of Indian Standards (BIS), 2008.
4. Parthasarathy. N.S and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2019.
5. Gopalakrishna. K.R., Engineering Drawing Vol. 1 & 2, Subhas Publications, 27th Edition, 2017.

SEMESTER –II

22MA201	TRANSFORMS AND NUMERICAL METHODS	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- Introduce the concepts of Laplace transforms and Z-transforms.
- Illustrate the application of transforms in solving differential and difference equations.
- Explain the Numerical methods for handling algebraic and transcendental equations.
- Introduce the numerical techniques for interpolation, differentiation and integration.

UNIT I	LAPLACE TRANSFORMS	15

Laplace transforms – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions – Derivatives and integrals of transforms –Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform – Convolution theorem (Statement only).

Theory: 9

22GE112	PRODUCT DEVELOPMENT LAB - I (Common to All Branches)	L	T	P	C
		0	0	2	1

The students may be grouped into 3 to 4 and work under a project supervisor. The device/system/component/prototype Idea to be developed by the students and a final presentation to be done by the students about the idea generated at the end of the semester.

OBJECTIVES:

The Course will enable learners to:

- Understand the functionalities and limitation of various machine/equipment
- Demonstrate various operations that can be performed to machines
- Summarize the basic principles of machines to convert their ideas into products

I 1. Study of Manufacturing Processes (Carpentry, Plumbing, Machines and Welding).
2. Study of fundamental operations of 3D Printer and Scanner with Software.
3. Study of Smart Machining (CNC and Laser cutting) and Engraving Techniques.

II 1. Study of Fundamental of Circuit Design.
2. Study of PCB Milling Machine.
3. Study of Soldering and Desoldering.

III 1. Study of Computer Peripheral Devices (Processing Information Devices)

IV 1. Present the Product Idea Presentation - Phase – I.

TOTAL: 30 PERIODS

Note:
The students can select the prototype to be made of their choice after learning the above exercises.

OUTCOMES:

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

CO1: Understand the concept of manufacturing processes.
CO2: Describe the working of the machine element.
CO3: Discuss the various applications of engineering materials
CO4: Summarize the basics of core engineering concepts.
CO5: Describe the process for converting ideas into products

LIST OF EQUIPMENTS:

1. CNC Router – 1 No.
2. 3D Printer – 1 No.
3. 3D Scanner – 1 No.
4. Laser cutting Machine – 1 No.
5. Centre lathe – 2 Nos.
6. Arc welding transformer with cables and holders – 2 Nos.
7. Plumbing tools – 2 Nos.
8. Carpentry tools – 2 Nos.
9. Multimeter – 10 Nos.
10. Drilling Machine – 1 No.
11. Solder Stations 5 Sets
12. Desoldering Machine – 1 No.
13. PCB Milling Machine – 1 No.
14. Variable Power Supply – 1 No.
15. Electronic Components like Resistors, Transistors, Diode, Inductor, Capacitor, etc. – 10 Sets
16. Personal Desktop Computers – 30 Nos.

Experiments using SCILAB:

1. Finding Laplace transform of a function.
2. Finding inverse Laplace Transforms.
3. Determine the input for given output function of Laplace Transform.

Laboratory: 6

UNIT II	Z – TRANSFORMS	15

Z-transforms – Elementary properties – Inverse Z-transforms – partial fractions method – residues method – Convolution theorem.

Theory: 9

Experiments using SCILAB:

1. Finding Z –transform of a sequence.
2. Finding convolution of two sequences.
3. Plotting the input and output function of Z transform.

Laboratory: 6

UNIT III	SOLUTION OF DIFFERENTIAL AND DIFFERENCE EQUATIONS	15

Solution of linear ordinary differential equation of second order with constant coefficients and first order simultaneous equations with constant coefficients using Laplace transform. Formation of difference equations – Solution of first and second order difference equations with constant coefficients using Z-transform.

Theory: 9

Experiments using SCILAB:

1. Solving second order Ordinary Differential Equation.
2. Finding the Laplace transform and its inverse of a function numerically.
3. Finding the Z-transform numerically

Laboratory: 6

UNIT IV	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	15

Solution of algebraic and transcendental equations by Newton Raphson method - Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Gauss Seidel Iterative method– Eigenvalues of a matrix by Power method.

Theory: 9

Experiments using SCILAB:

1. Finding the real roots of algebraic and transcendental equations using Newton Raphson method.
2. Finding the largest Eigenvalue by power method.
3. Solving system of linear equations using Gauss Seidel Method.

Laboratory: 6

UNIT V	NUMERICAL DIFFERENTIATION AND INTEGRATION	15

Finite differences – Forward and Backward differences – Interpolation – Newton's forward and backward interpolation formulae - Lagrange's interpolation for unequal intervals - Numerical Differentiation - Newton's and Lagrange's formulae - Numerical integration using Trapezoidal and Simpson's 1/3 rules – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

Theory: 9

Experiments using SCILAB:

1. Finding approximately the missing value using Lagrange interpolation.
2. Evaluating line integrals by trapezoidal rule.
3. Evaluating line integrals by Simpson's rule.

Laboratory: 6

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Determine Laplace transform and inverse transform of simple functions.

CO2: Determine Z- transform and inverse transform of simple functions.

CO3: Solve ordinary differential equations using Laplace transform and difference equations using Z-Transform.

CO4: Compute the solutions of algebraic, transcendental and the system of equations.

CO5: Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

TEXTBOOKS:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.

REFERENCES:

1. Erwin. Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Jain R.K. and Iyengar S. R. K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics", Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
4. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
5. Sastry S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

22CS201	DATA STRUCTURES	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- To understand the concepts of List ADT.
- To learn linear data structures – stacks and queues ADTs.
- To understand and apply Tree data structures.
- To understand and apply Graph structures.
- To analyze sorting, searching and hashing algorithms.

UNIT I	LINEAR DATA STRUCTURES – LIST	15

Algorithm analysis - running time calculations - Abstract Data Types (ADTs) – List ADT – array- based implementation – linked list implementation – singly linked lists - circularly linked lists - doubly-linked lists – applications of lists – Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).

List of Exercises:

- Array implementation of List ADTs.
- Linked list implementation of List ADTs.

UNIT II	LINEAR DATA STRUCTURES – STACKS, QUEUES	15

Stack ADT – Stack Model - Implementations: Array and Linked list - Applications - Balancing symbols - Evaluating arithmetic expressions - Conversion of Infix to postfix expression - Queue ADT – Queue Model - Implementations: Array and Linked list - applications of queues - Priority Queues – Binary Heap – Applications of Priority Queues.

List of Exercises:

- Array implementation of Stack and Queue ADTs.
- Linked list implementation of Stack and Queue ADTs.
- Applications of List – Polynomial manipulations
- Applications of Stack – Infix to postfix conversion and expression evaluation.

UNIT III	NON LINEAR DATA STRUCTURES – TREES	15

Tree ADT – tree traversals - Binary Tree ADT – expression trees – applications of trees – binary search tree ADT– AVL Tree.

List of Exercises:

- Implementation of Binary Trees and operations of Binary Trees.
- Implementation of Binary Search Trees.
- Implementation of Heaps using Priority Queues.

UNIT IV	NON LINEAR DATA STRUCTURES - GRAPHS	15

Definition – Representation of Graph – Types of graph - Breadth-first traversal - Depth-first traversal – Topological Sort – Applications of graphs – BiConnectivity – Euler circuits.

List of Exercises:

- Graph representation and Traversal algorithms.

UNIT V	SEARCHING, SORTING AND HASHING TECHNIQUES	15

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

List of Exercises:

- Implement searching and sorting algorithms.

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Implement abstract data types for list.
CO2: Solve real world problems using appropriate linear data structures.
CO3: Apply appropriate tree data structures in problem solving.
CO4: Implement appropriate Graph representations and solve real-world applications.
CO5: Implement various searching and sorting algorithms.

TEXTBOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, 4th Edition, Pearson Education, 2014.
2. Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, Silicon paper publications, 2004.

REFERENCES:

1. Rajesh K. Shukla, “Data Structures using C and C++”, Wiley India Publications, 2009.
2. Narasimha Karumanchi, “Data Structure and Algorithmic Thinking with Python: Data Structure and Algorithmic Puzzles”, CareerMonk Publications, 2020.
3. Jean-Paul Tremblay and Paul Sorenson, “An Introduction to Data Structures with Application”, McGraw-Hill, 2017.
4. Mark Allen Weiss, “Data Structures and Algorithm Analysis in Java”, Third Edition, Pearson Education, 2012.
5. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Second Edition, University Press, 2008.
6. Ellis Horowitz, Sartaj Sahni, Dinesh P Mehta, “Fundamentals of Data Structures in C++”, Second Edition, Silicon Press, 2007.
7. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013501578165051392105 84/overview

22PH201	PHYSICS FOR COMPUTER SCIENCE AND INFORMATION TECHNOLOGY (Common to All Branches)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- Learn the fundamental concepts of Physics and apply this knowledge to scientific, engineering and technological problems.

- Make the students enrich basic knowledge in electronics and quantum concepts and apply the same in computing fields.

UNIT I	LASER AND FIBRE OPTICS	15

Population of energy levels – Einstein's A and B coefficients derivation - Resonant cavity - Optical amplification (qualitative) - Semiconductor lasers: homojunction and heterojunction- Engineering applications of lasers in data storage (qualitative).

Fibre optics: Principle and propagation of light through optical fibre - V-number - Types of optical fibres (Material, refractive index and mode) - Losses in optical fibre - Fibre optic communication - Fibre optic sensors (pressure and displacement).

(Theory -9)

List of Experiments:

1. Determination of divergence of laser beam
2. Determination of acceptance angle and numerical aperture of an optical fibre

(Laboratory -6)

UNIT II	ELECTRON THEORIES OF MATERIALS	15

Classical free electron theory - Expressions for electrical conductivity and thermal conductivity - Wiedemann-Franz law - Success and failures of CFT- Effect of temperature on Fermi function- Density of energy states and average energy of electron at 0 K - Energy bands in solids.

(Theory -9)

List of Experiments

1. Determination of thermal conductivity of a bad conductor by Lee's disc method
2. Measurement of the internal resistance using potentiometer

(Laboratory -6)

UNIT III	SEMICONDUCTOR PHYSICS	15

Intrinsic Semiconductors – E-kdiagram-Direct and indirect band gap semiconductors - Carrier concentration in intrinsic semiconductors- Band gap determination-Extrinsic semiconductors - Carrier concentration in n-type and p-type semiconductors -Electrical conductivity of intrinsic and extrinsic semiconductors -Variation of Fermi level with temperature and impurity concentration - Hall effect and its applications.

(Theory -9)

List of Experiments

1. Bandgap determination of intrinsic semiconductor.
2. Determination of wavelength of semiconductor laser

(Laboratory -6)

UNIT IV	INTRODUCTION TO NANO DEVICES AND QUANTUM COMPUTING	15

Introduction to nanomaterial -Electron density in a bulk material - Size dependence of Fermi energy - Quantum confinement - Quantum structures - Density of states in quantum well, quantum wire and quantum dot structures - Band gap of nanomaterial.

Quantum computing: Quantum states - classical bits - quantum bits or qubits - CNOT gate - multiple qubits - Bloch sphere - quantum gates - advantages of quantum computing over classical computing.

(Theory - 9)

List of Experiments

1. Synthesis of nanoparticles by sol-gel method
2. Determination of particle size using laser source

(Laboratory - 6)

UNIT V	MAGNETIC AND SUPERCONDUCTING MATERIALS	15

Introduction- Bohr magneton -magnetic dipole moment - origin of magnetic moments - types of magnetic materials-Ferromagnetism: Domain Theory - antiferromagnetism -

ferrimagnetism - magnetic principle in computer data storage - Magnetic hard disc (GMR sensor) - Introduction to spintronics.
Superconducting materials – properties, types of superconductors, applications – SQUID and MAGLEV trains - *superconducting qubits in quantum computing.*

(Theory -9)

List of Experiments

1. Determination of hysteresis loss using B-H loop
2. Determination of magnetic susceptibility of a paramagnetic liquid using Quincke's apparatus

(Laboratory -6)

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Discuss the basic principles of working of laser and their applications in fibre optic communication

CO2: Summarize the classical and quantum electron theories and energy band structures

CO3: Describe the conductivity in intrinsic and extrinsic semiconductors and importance of Hall effect measurements

CO4: Associate the properties of nanoscale materials and their applications in quantum computing

CO5: Interpret the properties of magnetic and superconducting materials and their applications in computer data storage

TEXTBOOKS:

1. **S.O. Kasap**,Principles of Electronic Materials and Devices, McGraw-Hill Education (Indian Edition) 2020.
2. **Jasprit Singh**, Semiconductor Devices: Basic Principles, Wiley (Indian Edition) 2007.
3. **Parag K Lala**, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition) 2020.

REFERENCES:

1. **R.P. Feynman**, The Feynman Lectures on Physics - Vol. II, The New Millennium Edition, 2012.
2. **M.A.Wahab**, Solid State Physics, 3rd Edition, Narosa Publishing House Pvt. Ltd., 2015.
3. **B.Rogers, J. Adams and S.Pennathur**,Nanotechnology: Understanding Small System, CRC Press, 2014.
4. **C.P. Williams,** Explorations in Quantum Computing, Springer-Verlag London, 2011.
5. **Wilson J.D. and Hernandez C.A.,** Physics Laboratory Experiments, Houghton Mifflin Company, New York 2005.
6. **Department of Physics,** Physics laboratory manual, R.M.K. Group of Institutions, 2021.

22HS101	PROFESSIONALCOMMUNICATION (Common to All Branches)	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners to:

- Strengthen basic reading and writing skills.
- Comprehend listening contexts competently.
- Inculcate reading habit and develop effective reading skills.
- Improve active and passive vocabulary.
- Acquire speech clarity with right pronunciation.
- Develop vocabulary of a general kind and enhance grammatical accuracy.
- Imbibe Content and Language Integrated Learning(CLIL).

UNIT I	FORMAL AND INFORMAL COMMUNICATION	12

Listening: Short Texts,Short Formal and Informal Conversations
Speaking: Self Introduction, Exchanging Personal Information
Reading: Practice in Skimming, Scanninga nd Predicting, Reading Comprehension
Writing: Free Writing, Hints Development
Grammar: Parts of Speech, Prepositions.
Vocabulary: Compound Nouns, Technical Words.

(Theory6)

1. FamiliarizationofVowelSounds-Monophthongs,DiphthongsandConsonantSounds
2. ListeningtoFormalConversations inBritishandAmericanAccents
3. GuidedWriting

(Laboratory6)

UNIT II	GRAMMAR AND LANGUAGE DEVELOPMENT	12

Listening: TelephonicConversations.
Speaking: Sharinginformationofapersonalkind-Greetings–Takingleave.
Reading: Shortcomprehensionpassages-Pre-readingandPost-reading(multiplechoicequestionsshortquestions/openandcloseendedquestions)
Writing: Instructions,Recommendations,Checklists
Grammar: Tenses,Framing 'Wh'&'Yes'or'No'questions
Vocabulary: NumericalAdjectives,Collocations

.

(Theory6)

1. CommunicationEtiquettes
2. Self-IntroductionusingSWOTAnalysis

(Laboratory6)

UNIT III	BASICTECHNICALWRITINGANDSTUDYSKILLS	12

Listening: Listening tolongertextsandfilling up thetables
Speaking: Asking about routine actions and expressing opinions
Reading: Shorttexts (ClozeTest)
Writing: Formalletters,E-mailwriting,InterpretationofChartsandGraphs
Grammar: CauseandEffectexpressions**,**ConditionalClauses
Vocabulary: Oftenmisspelledandconfusing words

(Theory6)

MechanicsofReadingSkills
NewsReading–ClozeTests

(Laboratory6)

UNIT IV	GROUPDISCUSSIONAND JOBAPPLICATIONS	12

Listening: Listeningtorecordeddialoguesofconversationsandcompletingexercisesbased onthem
Speaking: DiscussiononSocialissues.
Reading:Readingtext frommagazines
Writing: PurposeExpressions,LetterofApplication,MinutesofMeeting.
Grammar: ModalVerbs, Subject-Verbagreement
Vocabulary:SequenceWords

(Theory6)

1. Group Presentation, Group Discussion: Do's andDon'ts ofGroupDiscussion
2. Discussionsonfailureandsuccessininterviewsoffamouspersonalities SpottingErrors

(Laboratory6)

UNIT V	ARTOFREPORTING	12

Listening: Listening to TED talks
Speaking: Debate & Presentations
Reading: Biographies
Writing: Definitions(Singleline&Extended),ReportWriting(Industrialvisit,AccidentandFeasibilityreports)
Grammar: Reportedspeech
Vocabulary:VerbalAnalogies (Theory6)
1. Writingbasedonlisteningto academic lecturesanddiscussions
2. Leadershipskills,Negotiationskills
3. MechanicsofReportWriting

(Laboratory6)

LISTOFPROJECTS
1. Createapodcastonatopicthatwillbeinterestingtocollegestudents
2. ReadandReview(Movie/Book/TechnicalArticle)
3. PresentationonSocialIssues
4. Submitareporton“GlobalEnglish:Astudy”

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to:
CO1:Comprehendconversationsandshorttalksdeliveredin English
CO2:Participateefficientlyininformalconversationsanddevelopanawarenessoftheselfandapplywell-definedtechniques
CO3: Read articles of a general kind in magazines and newspapers efficiently
CO4:Write shortgeneralessays,personallettersandE-mailsinEnglishCO5: Develop vocabulary of a general kind by enriching reading skills

TEXTBOOKS:

1. **Kumar,SureshE,&Sreehari,P.** *CommunicativeEnglish*.OrientBlackSwan,2007.
2. **Richards, JackC.**InterchangeStudents’Book-2NewDelhi:CUP,2015.

REFERENCES:

1. **Bailey, Stephen.** Academic Writing: *A practical guide for students*. New York:Rutledge,2011.
2. **Dhanavel,SP.**English and SoftSkills,VolumeTwo,OrientBlackSwan.
3. **Elbow,Peter.** *WritingWithoutTeachers*.London:OxfordUniversityPress,1973.
4. **Larsen,Kristine.** *StephenHawking:ABiography*,Greenwood:PublishingGroup,2005.
5. **Redston, Chris & Gillies Cunningham.** Face2Face (Pre- intermediate Students’Book &Workbook)Cambridge UniversityPress,New Delhi:2005.
6. Lewis,Norman.WordPowerMadeEasy,LatestEdition:PenguinRandomHouseIndia:2015

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2. communicating to Succeedhttps://infyspringboard.onwingspan.com/en/app/toc/lex_auth_0126866536191 75424640_shared/overview
3. BusinessEnglishhttps://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01268322749815193627 9_shared/overviewhttps://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01326770836790476857 3/overview(labsupport)
4. BusinessWritinghttps://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012689477 60100966433_shared/overview
5. Email Etiquetteshttps://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013294623865561088 17682_shared/overview
6. Email Writing Skillshttps://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01268954363013529666_s hared/overview
7. Time Managementhttps://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01298592121073 6640721_shared/overview
8. Understanding Body Languagehttps://infyspringboard.onwingspan.com/en/app/toc/lex_auth_012979737651445760 24689_shared/overview

9. ONLINERESOURCES:
https://infyspringboard.onwingspan.com/web/en/page/home

22CS202	JAVA PROGRAMMING	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- To explain object oriented programming concepts and fundamentals of Java
- To apply the principles of packages, interfaces and exceptions
- To develop a Java application with I/O streams, threads and generic programming
- To build applications using strings and collections.
- To apply the JDBC concepts

UNIT I	JAVA FUNDAMENTALS	15

An Overview of Java - Data Types, Variables, and Arrays – Operators - Control Statements – Class Fundamentals – Declaring objects – Methods – Constructors – this keyword – Overloading methods - Overloading constructors - Access Control – Static – Final

List of Exercises:

1. Develop a Java application to generate Electricity bill. You must use one super class called EB Bill and must have two sub classes namely Domestic Bill and Commercial Bill. Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, type of EB connection (i.e domestic or commercial). Compute the bill amount using the following tariff

If the type of the EB connection is domestic, calculate the amount to be paid as follows: First 100 units - Rs. 1 per unit
101-200 units - Rs. 2.50 per unit 201 -500 units - Rs. 4 per unit
> 501 units - Rs. 6 per unit
If the type of the EB connection is commercial, calculate the amount to be paid as follows: First 100 units - Rs. 2 per unit
101-200 units - Rs. 4.50 per unit 201 -500 units - Rs. 6 per unit
> 501 units - Rs. 7 per unit

2. Arrays Manipulations: (Use Methods for implementing these in a Class)

a. Find kth smallest element in an unsorted array

b. Find the sub array with given sum

c. Matrix manipulations – Addition, Subtraction, Multiplication

d. Remove duplicate elements in an Array

e. Accept an integer value N and print the Nth digit in the integer sequence 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and so on till infinity.
Example: The 11th digit in the sequence 12345678910111213…. is 0.

UNIT II	INHERITANCE, INTERFACES AND EXCEPTION HANDLING	15

Inheritance: Inheritance basics, Using super, Method Overriding, Using Abstract Classes, Using final with Inheritance - Package and Interfaces: Packages, Packages and member access, Importing Packages, Interfaces, Static Methods in an Interface – Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java's Built-in Exceptions.

List of Exercises:

1. Develop a Java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa), time converter (hours to minutes, seconds and vice versa) using packages.
2. Develop a Java application with 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 fund. Generate pay slips for the employees with their gross and net salary.
3. Design a Java interface for ADT Stack. Implement this interface using array and built-in classes. Provide necessary exception handling in both the implementations.
4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area(). 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 the methods print Area () that prints the area of the given shape and Numberofsides() that prints the number of sides of the given shape.
5. Write a Java program to apply built-in and user defined exceptions.

UNIT III	MULTITHREADING, I/O AND GENERIC PROGRAMMING	15

Multithreaded Programming: Creating a Thread, Thread Priorities, Synchronization, Interthread Communication – I/O: I/O Basics, Reading Console Input, Writing Console Output, Reading and Writing Files – Generics: Introduction, Generic class, Bounded Types, Generic Methods, Generic Interfaces, Generic Restrictions.

List of Exercises:

1.Write a Java program to read and copy the content of one file to other by handling all file related exceptions.

UNIT IV	STRING HANDLING AND COLLECTIONS	15

Lambda Expressions - String Handling – Collections: The Collection Interfaces, The Collection Classes – Iterator – Map - Regular Expression Processing.

List of Exercises:

1.String Manipulation:

a. Reversing a set of words and count the frequency of each letter in the string.
b. Pattern Recognition - Find the number of patterns of form 1[0]1 where [0] represents any number of zeroes (minimum requirement is one 0) there should not be any other character except 0 in the [0] sequence in a given binary string.
c. Remove all the occurrences of string S2 in string S1 and print the remaining.
d. Find the longest repeating sequence in a string
e. Print the number of unique string values that can be formed by rearranging the letters in the string S.
2. Write a Java program that correctly implements producer consumer problem using the concept of inter thread communication.
3. Collections:
a. Write a program to perform string operations using ArrayList. Write functions for the following
i. Append - add at end
ii. Insert – add at particular index
iii. Search
iv. List all string starts with given letter
b. Find the frequency of words in a given text.

UNIT V	JDBC CONNECTIVITY	15

JDBC – DataSource, Configurations, Connection, Connection Pools, Driver Types, ResultSet, Prepared Statement, Named Parameter, Embedded SQL (Insert, Update, Delete, Join, union etc), ResultSet Navigation, Connection Close and Clean up.

List of Exercises:

- Mini Project (using JDBC)

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Understand the object oriented programming concepts and fundamentals of Java.
CO2: Develop Java programs with the packages, interfaces and exceptions.
CO3: Build Java applications with I/O streams, threads andgenerics programming.
CO4: Apply strings and collections in developing applications.
CO5: Implement the concepts of JDBC.

TEXTBOOKS:

1. Herbert Schildt, “Java: The Complete Reference”, 11th Edition, McGraw Hill Education, 2019.

REFERENCES:

1. Cay S. Horstmann, Gary Cornell, “Core Java Volume – I Fundamentals”, 11th Edition, Prentice Hall, 2019.
2. Paul Deitel, Harvey Deitel, Java SE 8 for programmers, 3rd Edition, Pearson, 2015.
3. Steven Holzner, Java 2 Black book, Dream tech press, 2011.
4. Timothy Budd, Understanding Object-oriented programming with Java, Third Edition, Pearson Education, 2008.
5. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_29959473947367270000_shared/overview

22IT201	DATABASE MANAGEMENT SYSTEM	L	T	P	C

		3	**0**	**2**	**4**

OBJECTIVES:

The Course will enable learners to:

- To understand the basic concepts of Data modeling and Database Systems.
- To understand SQL and effective relational database design concepts.
- To learn relational algebra, calculus and normalization.
- To know the fundamental concepts of transaction processing, concurrency control techniques, recovery procedure and data storage techniques.
- To understand query processing, efficient data querying and advanced databases.

UNIT I	**DATABASE CONCEPTS**	**15**

Concept of Database and Overview of DBMS - Characteristics of databases - Data Models, Schemas and Instances - Three-Schema Architecture - Database Languages and Interfaces - Introductions to data models types - ER Model- ER Diagrams - Enhanced ER Model - reducing ER to table Applications: ER model of University Database Application – Relational Database Design by ER- and EER-to-Relational Mapping.

List of Exercises:

1. Data Definition Commands, Data Manipulation Commands for inserting, deleting, updating and retrieving Tables and Transaction Control statements

UNIT II	**STRUCTURED QUERY LANGUAGE**	**15**

SQL Data Definition and Data Types – Constraints – Queries – INSERT, UPDATE, and DELETE in SQL - Views - Integrity Procedures, Functions, Cursor and Triggers - Embedded SQL - Dynamic SQL.

List of Exercises:

1. Database Querying – Simple queries, Nested queries, Sub queries and Joins
2. Views, Sequences, Synonyms
3. Database Programming: Implicit and Explicit Cursors

UNIT III	**RELATIONAL ALGEBRA, CALCULUS AND NORMALIZATION**	**15**

Relational Algebra – Operations - Domain Relational Calculus- Tuple Relational Calculus - Fundamental operations.

Relational Database Design - Functional Dependency – Normalization (1NF, 2NF 3NF and BCNF) – Multivalued Dependency and 4NF – Joint Dependencies and 5NF - De-normalization.

List of Exercises:

1. Procedures and Functions
2. Triggers

UNIT IV	**TRANSACTIONS, CONCURRENCY CONTROL AND DATA STORAGE**	**15**

Transaction Concepts – ACID Properties – Schedules based on Recoverability, Serializability – Concurrency Control – Need for Concurrency – Locking Protocols – Two Phase Locking – Transaction Recovery – Concepts – Deferred Update – Immediate Update.

Organization of Records in Files – Unordered, Ordered – Hashing Techniques – RAID – Ordered Indexes – Multilevel Indexes - B+ tree Index Files – B tree Index Files.

List of Exercises:

1. Exception Handling
2. Database Design using ER modeling, normalization and Implementation for any application
3. Database Connectivity with Front End Tools

UNIT V	**QUERY OPTIMIZATION AND ADVANCED DATABASES**	**15**

Query Processing Overview – Algorithms for SELECT and JOIN operations – Query optimization using Heuristics.

Distributed Database Concepts – Design – Concurrency Control and Recovery – NOSQL Systems – Document-Based NOSQL Systems and MongoDB.

List of Exercises:

1. Case Study using real life database applications anyone from the following list
a) Inventory Management for a EMart Grocery Shop
b) Society Financial Management
c) Cop Friendly App – Eseva
d) Property Management – eMall
e) Star Small and Medium Banking and Finance

● Build Entity Model diagram. The diagram should align with the business and functional goals stated in the application.
● Apply Normalization rules in designing the tables in scope.
● Prepared applicable views, triggers (for auditing purposes), functions for enabling enterprise grade features.
● Build PL SQL / Stored Procedures for Complex Functionalities, ex EOD Batch Processing for calculating the EMI for Gold Loan for each eligible Customer.
● Ability to showcase ACID Properties with sample queries with appropriate settings

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Map ER model to Relational model to perform database design effectively.
CO2: Implement SQL and effective relational database design concepts.
CO3: Apply relational algebra, calculus and normalization techniques in database design.
CO4: Understand the concepts of transaction processing, concurrency control, recovery procedure and data storage techniques.
CO5: Apply query optimization techniques and understand advanced databases.

TEXTBOOKS:

1. Elmasri R. and S. Navathe, “Fundamentals of Database Systems”, Pearson Education, 7th Edition, 2016.
2. Abraham Silberschatz, Henry F.Korth, “Database System Concepts”, Tata McGraw Hill , 7th Edition, 2021.

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1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.Raghu Ramakrishnan, Gehrke "Database Management Systems", MCGraw Hill, 3rd Edition 2014.
2. Plunkett T., B. Macdonald, "Oracle Big Data Hand Book" , McGraw Hill, First Edition, 2013
3. Gupta G K , "Database Management Systems" , Tata McGraw Hill Education Private Limited, New Delhi, 2011.
4. C. J. Date, A.Kannan, S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2015.
5. Maqsood Alam, Aalok Muley, Chaitanya Kadaru, Ashok Joshi, Oracle NoSQL Database: Real-Time Big Data Management for the Enterprise, McGraw Hill Professional, 2013.
6. Thomas Connolly, Carolyn Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Pearson, 6th Edition, 2015.
7. Database Management System Part – 1

https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01275806667282022456_shared/overview

8. Database Management System Part – 2

https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0127673005629194241_shared/overview

9. Online Resources:

https://infyspringboard.onwingspan.com/web/en/page/home

22GE211	PRODUCT DEVELOPMENT LAB - II (Common to All Branches)	L	T	P	C
		0	0	2	1

The students may be grouped into a batch of strength 3 or 4 to work under a project supervisor. The student batches should study the device/system/component and will do literature review to develop prototype idea. Further at the end of the semester they will make a final presentation to exhibit the conceptual design skills and the process to develop a product.

OBJECTIVES:

The Course will enable learners to:

- Use the innovative design methodology to articulate the product concepts.
- Summarize the requisite Engineering Principles for transforming concepts into products.
- Conduct basic tests to extract the qualitative and quantitative performance factors.

List of Exercise/Experiments

1. Study of Basic Engineering Design Concepts.
2. Conduct a literature survey on the implementation of the design concepts.
3. Prepare the design concepts for an identified literature gap.
4. Present the Product Idea Presentation – Phase II.

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Understand the working and capacity of various engineering systems.
CO2: Infer the outcomes in the product development process.
CO3: Perform basic engineering and material characterization tests.
CO4: Demonstrate the ability to provide conceptual design strategies for a product.
CO5: Implement the Science, Engineering, Technology and Mathematics (STEM) for product design.

22CH102	ENVIRONMENTAL SCIENCE AND SUSTAINABILITY (Non Credit)	L	T	P	C
		2	0	0	0

OBJECTIVES:

The Course will enable learners to:

- To gain knowledge of the environment and various natural resources.
- To identify the Scientific and Technological solutions to pollution issues and waste management.
- To understand the significance of the conservation of biodiversity.
- To recognize the needs and benefits of sustainability and its management.
- To comprehend the effects of human population on the environment.

UNIT I	NATURAL RESOURCES	7

Definition, scope and importance of environment – need for public awareness. Introduction to natural resources - Types - Forest resources: Use and over-exploitation, deforestation and its impacts, Food resources: effects of modern agriculture, organic farming, Renewable energy sources - Solar, Wind, Geothermal, Tidal, OTE and Biomass.

Field activity -Tree plantation

UNIT II	POLLUTION AND WASTE MANAGEMENT	7

Pollution - Definition –causes, effects and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution (e) Nuclear hazards - nuclear accidents and holocaust -Role of an individual in prevention of pollution –Case studies.

Waste management- Municipal solid wastes, e- waste, plastic waste.

Field study – Solid waste management of the institution

UNIT III	BIODIVERSITY AND ITS CONSERVATION	6

Biodiversity: types – values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity – endangered and endemic species, extinct, rare, vulnerable species of India – conservation of biodiversity: In-situ and ex-situ method.

Field study – Biodiversity of the institution

UNIT IV	SUSTAINABILITY AND MANAGEMENT	5

Sustainability-concept, needs and challenges-Circular economy -Sustainable Development Goals-Concept ofCarbon footprint, Environmental Impact Assessment, Clean Development Mechanism, solutions.

Field study – Carbon footprint of the institution

UNIT V	HUMAN POPULATION	5

Introduction - Population growth, variation among nations,population explosion, Environment and human health – endemic/epidemic/pandemic– Role of information technology in environment and human health.

Case Study – Pandemics of 21st century

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Investigate and use conservational practices to protect natural resources.

CO2: Identify the causes of pollutants and illustrate suitable methods for pollution abatement.

CO3: Adapt the values of biodiversity and its conservation methods.

CO4: Recognize suitable sustainable development practices and apply it in day-to-day life.

CO5: Assess the impacts of human population and suggest suitable solutions.

TEXTBOOKS:

1. Anubha Kaushik and C.P. Kaushik, "Perspectives in environmental studies",New Age International Publishers,2nd edition, 2021.
2. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2017.
3. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 3rd edition, Pearson Education, 2014.
4. Erach Bharuch, Textbook of Environmental Studies for Undergraduate Courses, Third Edition, Universities Press(I) Pvt. Ltd., Hyderabad, 2021.

REFERENCES:

1. William P.Cunningham& Mary Ann Cunningham Environmental Science: A Global Concern, McGraw Hill, 14th edition, 2017.
2. Rajagopalan, R, Environmental Studies-From Crisis to Cure, Oxford University Press, 2015.
3. G. Tyler Miller and Scott E. Spoolman, ―Environmental Science, Cengage Learning India Pvt, Ltd., Delhi, 2014.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall, 2012.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning, 2015.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006 and subsequent amendments, 2022

22GE101	Heritage of Tamils (Common to All Branches)	L	T	P	C
		1	0	0	1

OBJECTIVES:

The course is designed to

- Recognize Tamil literature and its significance in Tamil culture.
- Introduce the Tamils' rich artistic and cultural legacy.
- Familiarize the different types of folk and martial arts that are unique to Tamil Nadu.
- Acquaint the concept of Thinai in Tamil literature and culture.
- Comprehend the significance of Tamil in developing Indian culture.

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, VilluPattu, KaniyanKoothu, Oyillattam, Leatherpuppetry, 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.

TOTAL:15PERIODS

OUTCOMES:

Uponcompletionofthecourse, thestudentswill beable to:

CO1:State the role of Tamil literature in shaping Tamil Cultural roots.
CO2: Express the cultural and religious significance of Tamil art and sculptures.
CO3: Identify and describe the techniques of folk and martial arts.
CO4: Classify the role of Thinai concept in Tamil culture and literature.
CO5: Compare the idea of cultural and intellectual contributions of Tamils.

TEXT-CUM-REFERENCE BOOKS:

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

SEMESTER III

22MA301	DISCRETE MATHEMATICS (Common to CSE,IT & AIML)	L	T	P	C
		3	1	0	4

OBJECTIVES:

The course is designed to:

- Describe the arguments using connectives and rules of inference.
- Introduce the basic concept of counting and generating functions.
- Define the graphs and it's models.
- Understand the concept of group theory, lattices and Boolean algebra.

UNIT I	LOGIC AND PROOFS	15

Propositional logic - Propositional equivalences - Predicates and quantifiers - Nested quantifiers - Rules of inference - Introduction to proofs - Proof methods and strategy.

UNIT II	COMBINATORICS	15

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 and its applications.

UNIT III	GRAPHS	15

Graphs and graph models - Graph terminology and special types of graphs - Matrix representation of graphs and graph isomorphism - Connectivity - Euler and Hamilton paths.

UNIT IV	ALGEBRAIC STRUCTURES	15

Algebraic systems - Semi groups and monoids - Groups - Subgroups - Homomorphism‘s - Normal subgroup and cosets - Lagrange‘s theorem - Definitions and examples of Rings and Fields.

UNIT V	LATTICES AND BOOLEAN ALGEBRA	15

Partial ordering - Posets - Lattices as posets - Properties of lattices - Lattices as algebraic systems - Sub lattices - Direct product and homomorphism - Some special lattices - Boolean algebra.

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Validate the arguments using connectives and rule of inference.
CO2: Solve linear recurrence relations.
CO3: Determine Euler's path and Hamilton paths.
CO4: Identify algebraic structures of groups, rings, and fields.
CO5: Interpret lattices as algebraic structures.

TEXTBOOKS:

1. Rosen, K.H., "Discrete Mathematics and its Applications", 8th Edition, Tata McGraw Hill Pub. Co. Ltd., New Delhi, Special Indian Edition, 2021.
2. Tremblay, J.P. and Manohar.R, " Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Pub. Co. Ltd, New Delhi, 30th Reprint, 2017.

REFERENCES:

1. Grimaldi, R.P. "Discrete and Combinatorial Mathematics: An Applied Introduction", 5th Edition, Pearson Education Asia, Delhi, 2014.
2. Lipschutz, S. and Mark Lipson., "Discrete Mathematics", Schaum's Outlines, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 3rd Edition, 2010.
3. Koshy, T. "Discrete Mathematics with Applications", Elsevier Publications, 2006.

22CS302	COMPUTER ORGANIZATION ANDARCHITECTURE (Common to CSE and AIML)	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Describe the basic principles and operations of digital computers.
- Design arithmetic and logic unit for various fixed and floating point operations
- Construct pipeline architectures for RISC processors.
- Explain various memory systems &I/O interfacings
- Discuss parallel processor and multi-processor architectures

UNIT I	COMPUTER FUNDAMENTALS	9

Computer Types - Functional Units — Basic Operational Concepts — Number Representation and Arithmetic Operations - Performance Measurement — Instruction Set Architecture - Memory Locations and Addresses - Instructions and Instruction Sequencing - Addressing Modes.

UNIT II	COMPUTER ARITHMETIC	9

Addition and Subtraction of Signed Numbers - Design of Fast Adders - Multiplication of Unsigned Numbers - Multiplication of Signed Numbers - Fast Multiplication - Integer Division - Floating-Point Numbers and Operations.

UNIT III	BASIC PROCESSING UNIT AND PIPELINING	9

Basic Processing Unit: Concepts - Instruction Execution - Hardware Components - Instruction Fetch and Execution Steps -Control Signals - Hardwired Control.
Pipelining: Basic Concept - Pipeline Organization- Pipelining Issues - Data Dependencies - Memory Delays - Branch Delays - Resource Limitations - PerformanceEvaluation -Superscalar Operation.

UNIT IV	I/O AND MEMORY	9

Input/Output Organization: Bus Structure - Bus Operation - Arbitration - The Memory System: Basic Concepts - Semiconductor RAM Memories - Read-only Memories - Direct Memory Access - Memory Hierarchy - Cache Memories - Performance Considerations - Virtual Memory - Memory Management Requirements - Secondary Storage.

UNIT V	PARALLEL PROCESSING AND MULTICORE COMPUTERS	9

Parallel Processing: Use of Multiple Processors - Symmetric Multiprocessors - Multithreading and Chip Multiprocessors - Clusters – Non uniform Memory Access Computers Vector Computation - Multicore Organization.

TOTAL:45PERIODS

OUTCOMES:

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

CO1: Explain the basic principles and operations of digital computers.
CO2: Design Arithmetic and Logic Unit to perform fixed and floating-point operations
CO3: Develop pipeline architectures for RISC Processors.
CO4: Summarize Various Memory systems &I/O interfacings.
CO5: Recognize Parallel Processor and Multi Processor Architectures

TEXTBOOKS:

1.Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer organization, Tata McGrawHill, Sixth edition, 2012.
2.David A. Patterson and John L. Hennessy Computer Organization and Design-The Hardware/Software Interface 5th edition, Morgan Kaufmann, 2013.

REFERENCES:

1.John P.Hayes, Computer Architecture and Organization, Third Edition, TataMcGrawHill, 2012.
2.David A. Patterson and John L. Hennessy Computer Organization and Design-The Hardware/Software Interface, 6th edition, Morgan Kaufmann, 2021.
3.John L. Hennessy and David A. Patterson, Computer Architecture – A Quantitate Approach, Morgan Kaufmann / Elsevier Publishers, Fifth Edition,2012.

22GE201	TAMILS AND TECHNOLOGY (Common to All Branches)	L	T	P	C
		1	0	0	1

OBJECTIVES:

The Course will enable learners to:

- Recognize the historical significance of weaving and pottery technologies inancient Tamil civilization.
- Highlight the concepts of design and construction technology during the Sangamage.
- Provide an overview of manufacturing technology and its role in Tamil society.
- Illustrate the agricultural and irrigation techniques employed in ancient Tamil society.
- Promote scientific Tamil and Tamil computing.

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 duringSangam 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 gold-Coins 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.

TOTAL:15PERIODS

OUTCOMES:

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

CO1: Identify the role of weaving and ceramic technology in ancient Tamil Culture.

CO2: Assess the design and construction technology ideas in the current Tamil society.

CO3: Identify the different types of manufacturing technology used in Tamil society andtheir significance.

CO4: Classify agricultural and irrigation technologies in ancient Tamil society and itscurrent relevance.

CO5: Discuss the fundamentals of scientific Tamil and Tamil computing.

TEXTBOOKS& 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 நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (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 Publishedby: 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 & TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book

22CS303	DESIGN AND ANALYSIS OF ALGORITHMS (Common to CSE, IT and AIML)	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners to:

- Critically analyse the efficiency of alternative algorithmic solutions for the sameproblem Illustrate brute force and divide and conquer design techniques.
- Explain dynamic programming for solving various problems.
- Apply greedy technique and iterative improvement technique to solve optimization problems
- Examine the limitations of algorithmic power and handling it in different problems.

UNIT I	INTRODUCTION	6+6

Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving –Fundamentals of the Analysis of Algorithmic Efficiency – Asymptotic Notations and their properties. Analysis Framework –Mathematical analysis for Recursive and Non-recursive algorithms

List of Exercise/Experiments:

1. Perform the recursive algorithm analysis.
2. Perform the non-recursive algorithm analysis.

UNIT II	BRUTE FORCE ANDDIVIDE AND CONQUER	6+6

Brute Force - String Matching - Exhaustive Search - Knapsack Problem -Divide and Conquer Methodology – Binary Search – Merge sort – Quick sort - Multiplication of Large Integers – Closest-Pair and Convex Hull Problems - Transform and Conquer Method: Heap Sort

List of Exercise/Experiments:

1. Write a program to search an element using binary search
2. Write a program to sort the elements using merge sort and find time complexity.
3. Write a program to sort the elements using quick sort and find time complexity.
4. Write a program to sort the elements using heap sort

UNIT III	DYNAMIC PROGRAMMING	6+6

Dynamic programming – Principle of optimality – Floyd‘s algorithm – Multi stage graph - Optimal Binary Search Trees - Longest common subsequence - Matrix-chainmultiplication – Travelling Salesperson Problem – Knapsack Problem and Memory functions.

List of Exercise/Experiments:

1. Solve Floyd’s algorithm
2. Write a program to find optimal binary search tree for a given list of keys.
3. Solve the multi-stage graph to find shortest path using backward and forward approach
4. Write a program to find the longest common subsequence

UNIT IV	GREEDY TECHNIQUE AND ITERATIVE IMPROVEMENT	6+6

Greedy Technique – Prim‘s algorithm and Kruskal’s Algorithm –Huffman Trees. The Maximum-Flow Problem – Maximum Matching in Bipartite Graphs- The Stable marriage Problem

List of Exercise/Experiments:

1. Write a program to find minimum spanning tree using Prim’s algorithm
2. Implement Kruskal’s algorithm to find minimum spanning tree
3. Write a program to solve maximum flow problem

UNIT V	BACKTRACKING AND BRANCH AND BOUND	6+6

P, NP NP- Complete and NP Hard Problems. Backtracking – N-Queen problem - SubsetSum Problem. Branch and Bound– LIFO Search and FIFO search - Assignment problem – Knapsack Problem - Approximation Algorithms for NP-Hard Problems – Travelling Salesman problem

List of Exercise/Experiments:

1. Write a program to implement sum of subset problem.
2. Write a program to solve N-Queen problem
3. Solve the assignment problem using branch and bound technique
4. Solve knapsack problem using branch and bound technique

TOTAL:60PERIODS

OUTCOMES:

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

CO1: Solve mathematically the efficiency of recursive and non-recursive algorithms

CO2: Design and Analyse the efficiency of divide and conquer and transform andconquer algorithmic techniques

CO3: Implement and analyse the problems using dynamic programming

CO4: Solve the problems using and greedy technique and iterative improvementtechnique for optimization

CO5: Compute the limitations of algorithmic power and solve the problems usingbacktracking and branch and bound technique.

TEXTBOOKS:

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012.
2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Computer Algorithms/ C++, Second Edition, Universities Press, 2019.

REFERENCES:

1. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein,Introduction to Algorithms, Third Edition, PHI Learning Private Limited, 2012.
2. S. Sridhar, Design and Analysis of Algorithms, Oxford university press, 2014.
3. http://nptel.ac.in/

LIST OF EQUIPMENTS:

Standalone PC with C/C++/Java

22CS304	OPERATING SYSTEMS (Common to CSE, IT and AIML)	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners to:

- Explain the basic concepts of operating systems and process.
- Discuss threads and analyse various CPU scheduling algorithms.
- Describe the concept of process synchronization and deadlocks.
- Analyse various memory management schemes.
- Describe I/O management and file systems.

UNIT I	INTRODUCTION TO OPERATING SYSTEMS AND PROCESSES	6+6

Introduction: Computer system organization - architecture – Resource management - Protection and Security – Virtualization - Operating System Structures: Services - User and Operating-System Interface - System Calls - System Services - Design and Implementation - Building and Booting an Operating System – Processes: Process Concept - Process Scheduling - Operations on Processes – Inter process
Communication - IPC in Shared-Memory Systems - IPC in Message-Passing Systems

List of Exercise/Experiments:

1. Basic Unix file system commands such as ls, cd, mkdir, rmdir, cp, rm, mv, more, lpr,man, grep, sed, etc..
2. Programs using Shell Programming.
3. Implementation of Unix System Calls.
4. Implementation of IPC using message queue
   a. Get the input data (integer value) from a process called sender
   b. Use Message Queue to transfer this data from sender to receiver process
   c. The receiver does the prime number checking on the received data
   d. Communicate the verified/status result from receiver to sender process, thisstatus should be displayed in the Sender process.

Note: Simultaneously execute two or more processes. Don't do it as a single process

UNIT II	THREADS AND CPU SCHEDULING	6+6

Threads & Concurrency: Overview - Multicore Programming - Multithreading Models - Thread Libraries - Implicit Threading - Threading Issues - CPU Scheduling: Basic Concepts – Scheduling Criteria - Scheduling Algorithms - Thread Scheduling - Multi-Processor Scheduling - Real-Time CPU Scheduling

List of Exercise/Experiments:

1. Write a program to implement the following actions using pthreads
   a. Create a thread in a program and called Parent thread, this parent thread creates another thread (Child thread) to print out the numbers from 1 to 20. The Parent thread waits till the child thread finishes
   b. Create a thread in the main program, this program passes the 'count' as arguments to that thread function and this created thread function has to print your name 'count' times.
2. Write C programs to implement the various CPU Scheduling Algorithms.

UNIT III	PROCESS SYNCHRONISATION AND DEADLOCKS	6+6

Process Synchronization: The critical-section problem – Peterson's Solution, Synchronization hardware, Mutex locks, Semaphores, monitors - Classic problems of synchronization: Bounded Buffer Problem - Reader's & Writer Problem, Dinning Philosopher Problem. Deadlock: System model - Deadlock characterization, Methods for handling deadlocks - Deadlock prevention - Deadlock avoidance - Deadlock detection - Recovery from deadlock.

List of Exercise/Experiments:

1. Process Synchronization using Semaphores. A shared data has to be accessed by two categories of processes namely A and B. Satisfy the following constraints to access the data without any data loss.
   a. When a process A1 is accessing the database another process of the same category is permitted.
   b. When a process B1 is accessing the database neither process A1 nor another 74 processB2 is permitted.
   c. When a process A1 is accessing the database process B1 should not be allowed toaccess the database. Write appropriate code for both A and B satisfying all the above constraints using semaphores.

   Note: The time-stamp for accessing is approximately 10 sec.
2. Bankers Algorithm for Deadlock Avoidance

UNIT IV	MEMORY MANAGEMENT	6+6

Memory Management: Contiguous Memory Allocation - Paging - Structure of the Page Table – Swapping - Virtual Memory: Demand Paging – Copy-on write – Page Replacement – Allocation of frames – Thrashing – Memory Compression

List of Exercise/Experiments:

1. Analysis and Simulation of Memory Allocation and Management Techniques
   i. First Fit ii. Best Fit iii. Worst Fit
2. Implementation of Page Replacement Techniques
   i. FIFO ii. LRU iii. Optimal page replacement

UNIT V	STORAGE MANAGEMENT	6+6

Mass Storage Structure: Overview of Mass Storage Structure- HDD scheduling – Swap Space Management, I/O systems: I/O Hardware, Application I/O interface, Kernel I/O Subsystem, File System Interface: File Concept – Access Methods – Directory Structure – Protection, File-System Implementation: File-System Structure- File-System Operations - Directory Implementation - Allocation Methods - Free-Space Management, - Case Study-Linux

List of Exercise/Experiments:

1. Simulation of File Allocation Techniques
   i. Sequential ii. Linked list iii. indexed
2. Implementation of File Organization Strategies

Single level directory ii. Two level directory iii. Hierarchical level directory

TOTAL: 60 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to: CO1: Implement the basic concepts of operating systems and process. **CO2:**Analyse various CPU scheduling algorithms and thread mechanism.**CO3:**Implement the concepts of process synchronization and deadlocks. **CO4:**Design various memory management schemes to given situation.
CO5: Implement various I/O and file management techniques.

TEXTBOOKS:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, “Operating SystemConcepts” II, 10th Edition, John Wiley and Sons Inc., 2018.
2. Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 5th Edition, 2022 New Delhi.

REFERENCES:

1. William Stallings, "Operating Systems: Internals and Design Principles", 7th Edition,Prentice Hall, 2018.
2. Achyut S.Godbole, Atul Kahate, “Operating Systems”, McGraw Hill Education, 2016.

22AM301	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To understand the various Intelligent agents and search strategies in AI.
- To learn about different problem-solving strategies using heuristic function.
- To learn about knowledge-based agents and first order logics.
- To understand knowledge representation and planning.
- To know about the expert system.

UNIT I	ARTIFICIAL INTELLIGENCE AND INTELLIGENT AGENTS	9+6

Introduction to AI –Foundations of Artificial Intelligence - Intelligent Agents – Agents and Environments - Concept of rationality – Nature of environments – Structure of agents - Problem

solving agents – Example Problems - Search Algorithms – Uninformed Search Strategies.

Lab Programs:

1. Implement basic search strategies – 8-Puzzle, 8 - Queens problem.
2. Implement Breadth First Search & Depth first Search Algorithm
3. Implement Water Jug problem.
4. Solve Tic-Tac-Toe problem.

UNIT II	PROBLEM SOLVING	9+6

Heuristic search strategies – heuristic functions- Game Playing – Mini-max Algorithm - Optimal decisions in games – Alpha-beta search –Monte-Carlo search for Games - Constraint satisfaction problems – Constraint propagation – Backtracking search for CSP – Local search for CSP – Structure of CSP

Lab Programs:

1. Implement A* and memory bounded A* algorithms.
2. Implement Minimax algorithm & Alpha-Beta pruning for game playing.
3. Constraint Satisfaction Problem
4. Mini Project – Chess. Sudoku.

UNIT III	LOGICAL AGENTS	9+6

Knowledge-based agents – Logic - Propositional logic – Propositional theorem proving – Propositional model checking – Agents based on propositional logic

First-Order Logic – Syntax and semantics – Using First-Order Logic - Knowledge representation and engineering – Inferences in first-order logic – Propositional Vs First-Order Inference - Unification and First-Order Inference - Forward chaining – Backward chaining – Resolution.

Lab Programs:

1. Implement Unification algorithm for the given logic.
2. Implement forward chaining and backward chaining using Python.

UNIT IV	KNOWLEDGE REPRESENTATION AND PLANNING	9+6

Ontological engineering – Categories and objects – Events – Mental objects and modal logic – Reasoning systems for categories – Reasoning with default information

Classical planning – Algorithms for classical planning – Heuristics for planning – Hierarchical planning – non-deterministic domains – Time, schedule, and resources – Analysis

Lab Programs:

1. Implementation of object detection.
2. Implement classical planning algorithms.

UNIT V	LEARNING AND EXPERT SYSTEMS	9+6

Forms of Learning – Developing Machine Learning systems – Statistical Learning - Deep Learning: Simple feed-forward network - Neural Networks – Reinforcement Learning: Learning from rewards – Passive and active Reinforcement learning.

Expert Systems: Functions – Main structure – if-then rules for representing knowledge – developing the shell – Dealing with uncertainty

Lab Programs:

1. Develop an Expert system.
2. Mini-Project – Develop Machine Learning based classification Models.

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Illustrate the structure of agents and to implement various Intelligent agents.
CO2: Apply search strategies in problem solving and game playing using heuristic function.
CO3: Implement logical agents and first-order logic problems.
CO4: Apply problem-solving strategies with knowledge representation mechanism for solving hard problems.

CO5: Demonstrate the basics of expert systems and to develop models using machine learning techniques.

TEXT BOOKS:

1. Peter Norvig and Stuart Russel, Artificial Intelligence: A Modern Approach, Pearson, 4th Edition, 2020.
1. Bratko, Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCES:

1. Elaine Rich, Kevin Knight and B.Nair, Artificial Intelligence 3rd Edition, McGraw Hill, 2017.
2. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans. Series: Pelican Books, 2020
3. Ernest Friedman-Hill, Jess in Action, Rule-Based Systems in Java, Manning Publications, 2003
4. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009.
5. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems,1st Edition by Patterson, Pearson, India, 2015.
6. NPTEL Courses:
    a. An Introduction to Artificial Intelligence - https://onlinecourses.nptel.ac.in/noc23_cs05/preview
    b. Artificial Intelligence: Knowledge Representation And Reasoning - https://onlinecourses.nptel.ac.in/noc23_cs09/preview

22GE301	Universal Human Values II: Understanding Harmony	L	T	P	C
		2	2	0	3

OBJECTIVES:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection.
- Development of commitment and courage to act.

COURSE TOPICS:

The course has 28 lectures (2 lecture hours) and 14 practice sessions (2 Tutorial hour) in 5 Units:

UNIT I	Course Introduction - Need, Basic Guidelines, Content and Process for Value Education	

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- The basic requirements for fulfillment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- Method to fulfil the above human aspirations: Understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT II	**Understanding Harmony in the Human Being – Harmony in Myself!**	

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- 'Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss programs for ensuring health vs dealing with disease

UNIT III	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**	

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect; Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, Fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided society, Universal order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institutes extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT IV	Understanding Harmony in the Nature and Existence - Whole existence as coexistence	

- Understanding the harmony in nature
- Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
- Holistic perception of harmony at all levels of existence.
- Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT V	Implications of the above Holistic Understanding of Harmony on Professional Ethics	

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.
- Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
- Sum up.

Include practice exercises and case studies will be taken up in practice (tutorial) sessions eg. To discuss the conduct as an engineer or scientist etc.

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Would become more aware of themselves, and their surroundings (family, society, nature).

CO2: Would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

CO3: Would have better critical ability.

CO4: Would become sensitive to their commitment towards what they have understood (human values, human relationship, and human society).

CO5: Would be able to apply what they have learnt to their own self in different day-to-day

settings in real life, at least a beginning would be made in this direction.

TEXT BOOK:

1. R R Gaur, R Sangal, G P Bagaria, “Human Values and Professional Ethics”, Excel Books, New Delhi, Second Edition 2019.

REFERENCES:

1. A Nagaraj, “Jeevan Vidya: Ek Parichaya”, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. E. F Schumacher, "Small is Beautiful", Vintage classics, London, 1993.
3. A.N. Tripathi, “Human Values”, New Age Intl. Publishers, New Delhi, Third Edition 2020.
4. Maulana Abdul Kalam Azad, "India Wins Freedom", Oriental blackswan private limited, Hyderabad, 2020.
5. Mahatma Gandhi, “Hind Swaraj or Indian Home Rule”, Maheswari Publications, Delhi 2020.
6. Romain Rolland, "The life of Vivekananda and the universal gospel", Publication house of Ramakrishna Math, Kolkata, Thirty second edition 2018.
7. Romain Rolland, "Mahatma Gandhi: The man who become one with the universal being “, Srishti Publishers & Distributors, New Delhi, Sixth Edition 2013.
8. Heaton, Dennis P. "The story of stuff." (2010): 553-556.
9. Gandhi, Mohandas Karamchand, “The story of my experiments with truth: An autobiography”, Om Books International, 2018.
10. Andrews, Cecile, “Slow is beautiful: new visions of community, leisure, and joie de vivre”, New society publishers, 2006.
11. Kumarappa, Joseph Cornelius, “The economy of permanence. CP”, All India Village Industries Assn., 1946.

22GE311	PRODUCT DEVELOPMENT LAB – III **(Design and Analysis Phase)** (Common to All Branches)	L	T	P	C
		0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- To provide an adequate understanding of project/product concepts and creative design process.
- Create a methodology to develop solutions to complex systems.

The students can form a team of 3 or 4 to work on the approved topic by the faculty in-charge. All approved product/process topics should have the following stages as listed under activities. The faculty in-charge conducts a periodic review to endorse the work process and during the review, the faculty shall provide suggestions/ideas to improvise the project towards completion. An interim report (consisting of literature, photographs, proof of the work done, etc..) for all listed activities should be submitted by the team during periodic review for evaluation. A final project report is required at the end of the semester for evaluation.

LIST OF ACTIVITIES:

1. Develop the design stage for a product from the concept.
    - Researching it in-depth.
    - Ideating possible solutions.
    - Selecting a promising solution.
    - Make a mock-up model
    - Comprehend the design features of the mock-up model.
2. Evaluate the pros-cons of the mock-up (& with the existing product).
3. Generate the Design for Manufacturing and Assembly (DFMA) process route for the product with necessary interdisciplinary collaborations.

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1 Enhance their skills in design concepts, rules and procedures.
CO2 Develop their cognitive strategy to think, organize, learn and behave.
CO3 Demonstrate the ability to provide conceptual design strategies for a product.
CO4 Describe the procedure for designing a Mock-up model.
CO5 Recognize and apply appropriate interdisciplinary and integrative strategies for solving complex problems

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No	Equipment Name	Quantity
1	CNC Router	1 No
2	3D Printer	1 No
3	3D Scanner	1 No
4	Laser cutting Machine	1 No
5	Centre lathe	2 Nos
6	Arc welding transformer with cables and holders	2 Nos
7	Plumbing tools	2 Sets

8	Carpentry tools	2 Sets
9	Multimeter	10 Nos
10	Drilling Machine	1 No
11	Solder Stations	5 Sets
12	Desoldering Machine	1 No
13	PCB Milling Machine	1 No
14	Variable Power Supply	1 No
15	Electronic Components like Resistors, Transistors, Diode, Inductor, Capacitor, etc.	10 Sets
16	Personal Desktop Computers	30 Nos
17	3D Modelling software – Creo/ AutoCAD/ etc.,	30 Licence

22CS311	APTITUDE AND CODING SKILLS – I (Common to All Branches)	L	T	P	C
		0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Develop vocabulary for effective communication and reading skills.
- Build the logical reasoning and quantitative skills.
- Develop error correction and debugging skills in programming.

List of Exercises:

1. English – Phase I

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. Logical Reasoning – Phase I

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. Quantitative Ability - Phase I

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speedand Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability

4. Automata Fix – Phase I

Logical, Compilation and Code reuse

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Develop vocabulary for effective communication and reading skills.
CO2: Build the logical reasoning and quantitative skills.
CO3: Develop error correction and debugging skills in programming.

SEMESTER IV

22MA401	PROBABILITY AND STATISTICS (Common to CSE, IT and AIML)	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- Provide the necessary basic concepts of random variables and to introduce somestandard distributions.
- Test the hypothesis for small and large samples.
- Introduce the concepts of Analysis of Variances.
- Understand the concept of statistical quality control.

UNIT I	LOGIC AND PROOFS	15

Basic probability definitions- Independent events- Conditional probability (revisit) - Random variable - Discrete and continuous random variables - Moments - Moment generating functions - Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

List of Exercise/Experiments using R Programming:

1. Finding conditional probability.
Finding mean, variance and standard deviation.

UNIT II	TWO-DIMENSIONAL RANDOM VARIABLES	15

Joint distributions - Marginal and conditional distributions - Covariance - Correlation andlinear regression - Transformation of random variables.

List of Exercise/Experiments using R Programming:

1. Finding marginal density functions for discrete random variables.
2. Calculating correlation and regression.

UNIT III	TESTING OF HYPOTHESIS	15

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means - Tests based on t and F distributions for mean and variance - Chi-square test- Contingency table (test for independent) - Goodness of fit.

List of Exercise/Experiments using R Programming:

1. Testing of hypothesis for given data using Z - test.
2. Testing of hypothesis for given data using t - test.

UNIT IV	DESIGN OF EXPERIMENTS	15

One way and Two-way classifications - Completely randomized design - Randomized blockdesign - Latin square design.

List of Exercise/Experiments R Programming:

1. Perform one-way ANOVA test for the given data.
2. Perform two-way ANOVA test for the given data.

UNIT V	STATISTICAL QUALITY CONTROL	15

Control charts for measurements ($\bar{X}$ and R charts) - Control charts for attributes (p, c andnpcharts) - Tolerance limits.

List of Exercise/Experiments using R Programming:

1. Interpret the results for $\bar{X}$-Chart for variable data.
2. Interpret the results for R-Chart for variable data.

TOTAL: 75 PERIODS

OUTCOMES:

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

CO1: Calculate the statistical measures of standard distributions.

CO2: Compute the correlation & regression for two dimensional random variables.

CO3: Apply the concept of testing the hypothesis.

CO4: Implement the concept of analysis of variance for various experimental designs.

CO5: Demonstrate the control charts for variables and attributes**.**

TEXTBOOKS:

1. R.A. Johnson, I. Miller and J. Freund, "Miller and Freund's Probability andStatistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. J.S. Milton and J.C. Arnold, "Introduction to Probability and Statistics", Tata McGrawHill, 4th Edition, 2017.

REFERENCES:

1. J.L. Devore, "Probability and Statistics for Engineering and the Sciences",Cengage Learning, New Delhi, 9th Edition, 2016.
2. S.M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 6th Edition, Elsevier, 2020.
3. M.R. Spiegel, J. Schiller and R.A. Srinivasan, "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
4. R.E.Walpole, R.H.Myers, S.L. Myers and K.Ye, "Probability and Statistics for Engineers and Scientists". Pearson Education, Asia, 9th Edition, 2012

22AM401	NEURAL NETWORKS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand the biological neural network and to model equivalent neuron models.
- To understand the architecture, learning algorithms.
- To know the issues of various feed forward and feedback neural networks.
- To gain deep insight about Boltzmann Machine Learning
- To explore Autoencoders and Hopfield Nets

UNIT I	INTRODUCTION	6+6

A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks

Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process.

A simple example of learning – Three types of Learning – Types of Neural Network Architectures

Lab Programs:

1. Study of JAX and its installation
2. Perform matrix operations.
3. Plot multiple curves in single plot.
4. Plot Activation function used in neural network
5. Create a simple neural network

UNIT II	PERCEPTRONS	6+6

Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment – A geometrical view of Perceptrons – What perceptrons can't do Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output

Representation and Decision Rule, Computer Experiment, Feature Detection

Lab Programs:

1. Create a Perceptron.
2. Pattern Classification using Perceptron network.
3. Build a neural network by implementing the Single-layer Perceptron. Test it using appropriate data sets.

UNIT III	BACK PROPAGATION	6+6

Learning the weights of a linear neuron-error surface – learning weights of logistic output neuron-Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

Lab Programs:

1. Implement Multi-layer Perceptron and test the same using appropriate data sets.
2. Create a Back Propagation Feed-forward neural network.
3. Implement and train a Bayesian Neural network.

UNIT IV	BOLTZMANN MACHINE LEARNING	6+6

How a Boltzmann machine models data - Restricted Boltzmann machine- example of RBM learning-Collaborative filtering-learning layers of features by stacking RBMs.

Lab Programs:

1. Model real valued data with RBM.
2. Demonstrate looking for patterns in gene expression profiles in baker's yeast.

UNIT V	AUTOENCODERS AND HOPFIELD NETS	6+6

From PCA to autoencoders-Deep autoencoders-document retrieval- semantic hashing – learning binary codes for image retrieval- shallow autoencoders

Hopfield Network – Hopfield Models- Hopfield nets with hidden units

Lab Programs:

1. Design a Hopfield Network which stores 4 vectors
2. Image retreival
3. Mini Project – Face recognition

TOTAL: 30+30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the similarity of Biological networks and Neural networks

CO2: Perform the training of neural networks using various learning rules.

CO3: Understand the concepts of forward and backward propagations.

CO4: Explain Boltzmann Machine Learning.

CO5: Construct Hopfield nets and learn autoencoders.

TEXT BOOKS:

1. Neural Networks a Comprehensive Foundations, Simon S Haykin, PHI Ed
2. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.
3. Christopher M Bishop, Pattern Recognition and Machine Learning. Springer. 2011.
4. Geoffrey Hintonand Terrence J. Sejnowski,Unsupervised Learning: Foundations of Neural Computation.

REFERENCES:

1. Neural Networks for Machine Learning – Geoffrey E. Hinton, UoFT https://www.youtube.com/playlist?list=PLLssT5z_DsK_gyrQ_biidwvPYCRNGI3iv
2. Neural Networks in Computer Intelligence, Li Min Fu TMH 2003
3. Neural Networks -James A Freeman David M S Kapura Pearson Ed., 2004.
4. Artificial Neural Networks – B. Vegnanarayana Prentice Hall of India P Ltd 2005

22AM402	MACHINE LEARNING ESSENTIALS	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To discuss the basics of Machine Learning and model evaluation.
- To study dimensionality reduction techniques.
- To understand the various classification algorithms.
- To elaborate on unsupervised learning techniques.
- To design and analyze machine learning experiments.

UNIT I	INTRODUCTION	9+6

Machine Learning – Types – Applications – Preparing to Model – Activities – Data – Exploring structure of Data – Data Quality and Remediation – Data Pre-processing – Modelling and Evaluation: Selecting a Model -Training a Model – Model representation and Interpretability – Evaluating Performance of a Model – Improving Performance.

Lab Programs:

1. Implementation of Candidate Elimination algorithm
2. Implementation of ML model evaluation techniques (R-Squared/Adjusted R-Squared/Mean Absolute Error/Mean Squared Error)
3. Implementation of ML model evaluation techniques (Confusion Matrix/F1 Score/AUC-ROC Curve)

UNIT II	FEATURE ENGINEERING AND DIMENSIONALITY REDUCTION	9+6

Feature Engineering – Feature Transformation – Feature Subset Selection - Principle Component Analysis – Feature Embedding – Factor Analysis – Singular value decomposition and Matrix Factorization – Multidimensional scaling – Linear Discriminant Analysis – Canonical Correlation Analysis – Isomap – Locally linear Embedding – LaplacianEigenmaps.

Lab Programs:

1. Write python code to identify feature co-relations (PCA)
2. Interpret Canonical Covariates with Heatmap
3. Feature Engineering is the way of extracting features from data and transforming them into formats that are suitable for Machine Learning algorithms. Implement python code for Feature Selection/ Feature Transformation/ Feature Extraction.
4. Mini Project – Feature Subset Selection

UNIT III	SUPERVISED LEARNING	9+6

Linear Regression -Relation between two variables – Steps – Evaluation – Logistic Regression – Decision Tree – Algorithms – Construction – Classification using Decision Tree – Issues – Rule-based Classification – Pruning the Rule Set – Support Vector Machines – Linear SVM – Optimal Hyperplane – Radial Basis Functions – Naïve Bayes Classifier – Bayesian Belief Networks.

Lab Programs:

1. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select the appropriate data set for your experiment and draw graphs.
2. Implement and demonstrate the working of the decision tree-based ID3 algorithm
3. Build a Simple Support Vector Machines using a data set

UNIT IV	UNSUPERVISED LEARNING	9+6

Clustering – Types – Applications - Partitioning Methods – K-means Algorithm – K-Medoids – Hierarchical methods – Density based methods DBSCAN – Finding patterns using Association Rules – Hidden Markov Model.

Lab Programs:

1. Implement a k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions
2. Implement market based analysis using association rules
3. Mini Project using Clustering analysis.

UNIT V	DESIGN AND ANALYSIS OF MACHINE LEARNING EXPERIMENTS	9+6

Guidelines for Machine Learning Experiments – Cross Validation and Resampling Methods – Assessing a Classification Algorithm – Comparison – Two algorithms, multiple algorithms – Multivariate Tests

Lab Programs:

1. Construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using a standard Heart Disease Data Set
2. Apply EM algorithm to cluster a set of data. Use the same dataset for clustering using k-Means algorithm. Compare the results of these two algorithms.

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the basics of Machine Learning and model evaluation.

CO2: Study dimensionality reduction techniques.

CO3: Understand and implement various classification algorithms.

CO4: Understand and implement various unsupervised learning techniques.

CO5: Design and analyze machine learning experiments.

TEXT BOOKS:

1. SaikatDutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson, 2019. (Unit 1 – Chap 1,2,3/ Unit 2 – Chap 4 / Unit 4 – Chap 9)
2. EthemAlpaydin, Introduction to Machine Learning, Adaptive Computation and Machine Learning Series, Third Edition, MIT Press, 2014. (Unit 2 – Chap 6 / Unit 4 – chap 8.2.3 / Unit 5 – Chap 19)

REFERENCES:

1. AnuradhaSrinivasaraghavan,Vincy Joseph, Machine Learning, First Edition, Wiley, 2019. (Unit 3 – Chap 7,8,9,10,11 / Unit 4 – 13, 11.4, 11.5,12)
2. Peter Harrington, “Machine Learning in Action”, Manning Publications, 2012.
3. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
4. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.

Christoph Molnar, “Interpretable Machine Learning - A Guide for Making Black Box Models Explainable”, Creative Commons License, 2020.

5. Christoph Molnar, “Interpretable Machine Learning - A Guide for Making Black Box Models Explainable”, Creative Commons License, 2020.
6. NPTEL Courses:
   Introduction to Machine Learning - https://onlinecourses.nptel.ac.in/noc23_cs18/preview

22CS402	WEB DEVELOPMENT FRAMEWORKS	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- Simplify website development using Springboot as server-side technologies.
- Build single page applications using REACT as a reusable UI component technology as client-side technology.
- Assemble REACT as a front end technology and Nodejs as a serverside technology to develop enterprise applications
- Develop a scalable and responsive web application
- Develop an industry ready application web enterprise feature

UNITI	SPRINGBOOTANDSTRUTS	9+6

SpringBoot:IntroducingSpringBoot,gettingstartedwithspringboot,Commonspringboot task-Managing configuration, creating custom properties,executing code onSpringboot application startup,Database access with Spring data, Securing spring bootapplication.

List of Exercise/Experiments:

1. UseSpringBoottobuildaWebApplication
2. CreateRESTServiceforanEducation Site

UNITII	JAVAREACT	9+6

React: Introduction to React, Pure React- The Virtual DOM, React Elements, ReactwithJSX, Props,State,andtheComponentTree,Enhancing Components-Flux.

List of Exercise/Experiments:

1. BuildSearchfilterinReact
2. DisplayalistinReact
3. CreateSimpleLoginforminReact

UNITIII	NodeJS	9+6

Node JS: Introduction to Node JS, Setting up Node.js, Node.js Modules- Finding andloading CommonJS and JSON modules using require, Hybrid CommonJS/Node.js/ES6modulescenarios,npm-theNode.jspackagemanagementsystem.

List of Exercise/Experiments:

1. Writeanode.jsprogramformakingexternalhttpcalls
2. Writeaprograminnode.jstoparsethegivenurl.

UNITIV	WEBFRAMEWORK(ANGULAR)–I	9+6

Introduction-AngularFirstApp,AngularUIwithBootstrapCSSAuthentication,AuthenticationService,Unsubscribe,LogoutandRouteGuardCleanup,CustomerService ,Http Service, Token Interceptor, Multi Provider, Compile-time Configuration,RuntimeConfiguration,ErrorHandling.

List of Exercise/Experiments:

1. Create aDropdownusingAngular UIbootstrap
2. ModifyexistingcomponentsandgeneratingnewcomponentsusingAngular

UNITV	WEBFRAMEWORK(ANGULAR)–II	9+6

Dependancy injection in Angular,Reactive programming in Angular, Laying out pageswith Flex Layout, Implementing component communications, Change detection andcomponentlifecycle.

List of Exercise/Experiments:

1.Launchingyourapp withAngularroot module

TOTAL:75PERIODS

OUTCOMES:

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

CO1: WriteWebAPI/RESTful API application programming interface to communicate with Springboot as a server side technology.

CO2: Build single page applications using REACT as a reusable UI component technology as client side technology

CO3: Build applications using Node Js as server side technologies

CO4: Ableto develop a web application using latest Angular Framework

CO5: Apply various Angular features including directives, components, and services.

TEXTBOOKS:

1. SomnathMusib, Spring Boot in Practice,Manningpublication, June 2022(https://www.manning.com/books/spring-boot-in-practice)
2. AlexBanks,EvePorcello,"LearningReact",May2017,O'ReillyMedia,Inc.ISBN: 9781491954621 (https://www.oreilly.com/library/view/learning-react/9781491954614/)
3. DavidHerron,"Node.jsWebDevelopment-FourthEdition",2018,PacktPublishing,ISBN:9781788626859
4. SukeshMarla,"AJourneytoAngularDevelopmentPaperback ", BPBPublications.(https://in.bpbonline.com/products/a-journey-to-angular-development?_pos=1&_sid=0a0a0e9fb&_ss=r)
5. YakovFainAnton Moiseev,"AngularDevelopmentwithTypeScript", 2nd Edition.(https://www.manning.com/books/angular-development-with-typescript-second-edition)

REFERENCES:

1.SueSpielman,‖TheStrutsFramework1:APracticalguideforJava Programmers‖, 1stEdition.Elsevier2002

22CS401	DISTRIBUTED AND CLOUD COMPUTING	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To articulate the concepts and models underlying distributed computing
- To maintain consistency and perform efficient coordination in distributed systemsthrough the use of logical clocks, global states, and snapshot recording algorithms.
- To learn different distributed mutual exclusion algorithms.
- To develop the ability to understand the cloud infrastructure and virtualizationthat help in the development of cloud.
- To explain the high-level automation and orchestration systems that manage the virtualized infrastructure.

UNIT I	INTRODUCTION	6 + 6

Definition - Relation to computer system components - Message-passing systems versus shared memory systems - Primitives for distributed communication - Synchronous versus asynchronous executions. A model of distributed computations: A distributed program - A model of distributed executions - Models of communication networks - Global state of a distributed system.

List of Exercise/Experiments:

1. Implement a simple distributed program that communicates between two nodesusing Java's RMI (Remote Method Invocation) API.
2. Develop a distributed program that uses Java's messaging API (JMS) to communicate between nodes. Explore the different messaging paradigms (pub/sub, point-to-point) and evaluate their performance and scalability.
3. Develop a model of a distributed program using Java's concurrency and synchronization primitives.

UNIT II	LOGICAL TIME, GLOBAL STATE, AND SNAPSHOTALGORITHMS	6 + 6

Logical time – Scalar Time – Vector Time - Efficient implementations of vector clocks – Virtual Time. Global state and snapshot recording algorithms: System model -Snapshot algorithms for FIFO channels and non-FIFO channels.

List of Exercise/Experiments:

1. Develop a program in Java that implements vector clocks to synchronize the order of events between nodes in a distributed system.
2. Implement a snapshot algorithm for recording the global state of the distributed system using vector clocks, for both FIFO and non-FIFO channels. Test the algorithm by recording snapshots at various points in the system's execution and analyzing the resulting global state.

UNIT III	DISTRIBUTED MUTUAL EXCLUSION ALGORITHMS	6 + 6

Introduction - Lamport’s algorithm - Ricart–Agrawala algorithm - Quorum-based mutual exclusion algorithms - Maekawa’s algorithm - Suzuki–Kasami’s broadcast algorithm.

List of Exercise/Experiments:

1. Implement Lamport's algorithm for mutual exclusion in a distributed systemusing Java's RMI API.
2. Develop a program in Java that implements Maekawa's algorithm for mutual exclusion in a distributed system.
3. Implement Suzuki-Kasami's broadcast algorithm in Java to achieve reliable message delivery in a distributed system.

UNIT IV	**CLOUD INFRASTRUCTURE AND VIRTUALIZATION**	**6 + 6**

Data Center Infrastructure and Equipment – Virtual Machines – Containers – Virtual Networks - Virtual Storage.

List of Exercise/Experiments:

1. Set up a virtualized data center using a hypervisor like VMware or VirtualBox and create multiple virtual machines (VMs) on it. Configure the VMs with different operating systems, resources, and network configurations, and test their connectivity and performance.
2. Deploy a containerized application on a virtual machine using Docker or Kubernetes.

UNIT V	**AUTOMATION AND ORCHESTRATION**	**6 + 6**

Automation - Orchestration: Automated Replication and Parallelism - The MapReduce Paradigm: The MapReduce Programming Paradigm – Splitting Input – Parallelism and Data size – Data access and Data Transmission – Apache Hadoop – Parts of Hadoop – HDFS Components – Block Replication and Fault Tolerance – HDFS and MapReduce - Microservices.

List of Exercise/Experiments:

1. Set up and configure a single-node Hadoop cluster.
2. Run the word count program in Hadoop.
3. Deploy a microservices architecture using a container orchestration tool like Kubernetes or Docker Swarm.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1: Articulate the main concepts and models underlying distributed computing.

CO2: Learn how to maintain consistency and perform efficient coordination in distributed systems through the use of logical clocks, global states, and snapshot recording algorithms.

CO3: Learn different distributed mutual exclusion algorithms

CO4: Develop the ability to understand the cloud infrastructure and virtualization that help in the development of cloud.

CO5: Explain the high-level automation and orchestration systems that manage the virtualized infrastructure.

TEXT BOOKS:

1. Ajay D. Kshemkalyani, Mukesh Singhal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011. (Unit 1, 2, 3)
2. Douglass E. Comer, "The Cloud Computing Book: The future of computing explained", CRC Press, 2021. (Unit 4, 5)

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-on Approach", Universities Press Private Limited, 2014.
2. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", Tata Mcgraw Hill, 2017.
3. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
4. Hagit Attiya, Jennifer Welch, "Distributed Computing: Fundamentals, Simulations and Advanced Topics", John Wiley & Sons, Inc., 2004.

LIST OF EQUIPMENTS:

Java,VMWare/VirtualBox, Hadoop, AWS/GCP/Azure/Any cloud platform, Eclipse/Equivalent IDE.

22GE411	PRODUCT DEVELOPMENT LAB - IV (Prototype Phase) (Common to All Branches)	L	T	P	C
		0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Analyze the real-time problems in product development from an engineering perspective.
- Implement the DFMA process route to make and assemble the product.
- Test and qualify the product or a system with acquired knowledge.
- Identify the business opportunities for the developed product or process.

The student batch of PDD Lab 3 shall continue their product/ process design work under the guidance of the faculty incharge. All batches should cover the following stages of prototyping work as listed under activities. The faculty incharge shall conduct periodic reviews to endorse the work progress and during the review, the faculty shall provide suggestions/ideas to improvise the project towards completion. An interim report (consisting of BoM, Stages of Prototyping, photographs, proof of work done, etc..) for all listed activities should be submitted by the team during periodic review for evaluation. A final project report is required at the end of the semester and the evaluation is based on an oral presentation in front of the examiner panel constituted by the Head of the Department.

LIST OF ACTIVITIES:

1. Develop Engineering BoM for the approved industrial Mock-up from Phase III. Transform the Engineering BoM to develop a Prototype.
2. Devise / Plan an economically efficient manufacturing process to make the Prototype and testing.
3. Deliberation of the Product / Process outcome – Phase IV. Preparation and submission of a project report.

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1 Identify the real-time problems through literature.

CO 2 Develop feasible solutions for the problems.

CO 3 Evaluate the methods to develop solutions to the problem.

CO 4 Analyze the business opportunities for a new product.

CO 5 Prepare a detailed report for the experimental dissemination.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No	Equipment Name	Quantity
1	CNC Router	1 No
2	3D Printer	1 No
3	3D Scanner	1 No
4	Laser cutting Machine	1 No
5	Centre lathe	2 Nos
6	Arc welding transformer with cables and holders	2 Nos
7	Plumbing tools	2 Sets
8	Carpentry tools	2 Sets
9	Multimeter	10 Nos
10	Drilling Machine	1 No
11	Solder Stations	5 Sets
12	Desoldering Machine	1 No
13	PCB Milling Machine	1 No
14	Variable Power Supply	1 No
15	Electronic Components like Resistors, Transistors, Diode, Inductor, Capacitor, etc.	10 Sets
16	Personal Desktop Computers	30 Nos
17	Numerical Simulation Tools	30 Licence
18	Test bench: Mech: Digital Micrometre/ Vernier/ Bore gauge/ etc EEE : (Based on the electrical components) ECE : (Based on the electronic components)	5 Nos

22CS411	APTITUDE AND CODING SKILLS – II (Common to All Branches)	L	T	P	C
		0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Develop advanced vocabulary for effective communication and reading skills.
- Build an enhanced level of logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.
- To apply data structures and algorithms in problem solving.

List of Exercises:

1. **English – Phase II**

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. Logical Reasoning – Phase II

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. Quantitative Ability - Phase II

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations,Probability

4. Automata Fix – Phase II

Logical, Compilation and Code reuse

5. Automata -Phase II

Data Structure Concepts: Array and Matrices, Linked list, String processing andmanipulation, Stack/Queue, Sorting and Searching

Advanced Design and Analysis Techniques: Greedy Algorithms, Minimum Spanning Trees, String Matching, Divide and Conquer, Computational Geometry

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Develop advanced vocabulary for effective communication and reading skills.
CO2: Build an enhanced level of logical reasoning and quantitative skills.
CO3: Develop error correction and debugging skills in programming.
CO4: Apply data structures and algorithms in problem solving.

22CS412	MINI PROJECT AND DESIGN THINKING	L	T	P	C
		0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- Introducing students to design thinking that enhances innovation activities interms of value creation and sustainability in problem solving.
- Strengthen students' individual and collaborative capabilities to identify problems/needs, develop sound hypotheses, collect, and analyze appropriate data, develop prototypes to collect meaningful feedback in a real-world environment.

LIST OF EXERCISES:

UNIT 1

Introduction: Design thinking overview- Design Process – Principles of Design Thinking –Problems Best suited for Design Thinking - Visualization tool

Case Study: ProblemIdentification **(6)**

UNIT 2

Empathize – Information Gathering – Analysis – Story Telling tool- Innovation- Ideation Finding and Evaluating Ideas Mind Mapping Tool

Case Study: Analysing the Identified Problem. **(6)**

UNIT 3

Designing Prototypes – Tasks in Prototyping –Understanding Different Prototypes-Developing different prototypes -Demonstration –Prototyping Tools

Case Study: Prototyping the solution. **(6)**

UNIT 4

Testing and Evaluation – Testing Prototypes – Evaluation – Improving solution –Strategic Opportunities –**Case Study:** Evaluating the solution. **(6)**

UNIT 5

Applications: HealthCare and Science – Education- Transportation - Finance –Technology. **(6)**

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Understand the design thinking process and able to visualize the problem.
CO2: Analyse the problem using innovation tools
CO3: Design a prototype for an identified problem solution
CO4: Testing and evaluate strategies in improving the solution
CO5: Apply the innovation ideas to real-world applications.

SEMESTER V

22AM501	DEEP LEARNING	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To understand the basics of deep neural networks.
- To implement deep learning models.
- To elaborate CNN and RNN architectures of deep neural networks.
- To familiarize autoencoders in neural networks.
- To learn about the deep generative models.
- To apply Deep Learning to solve real-world problems.

UNIT I	DEEP NETWORKS	9+6

Challenges motivating deep learning - Deep feedforward networks - Learning XOR - Gradient based learning - Hidden Units – Architecture Design – Back Propagation – Regularization – Parameter Norm Penalties – Constrained Optimization – Under-Constrained Problems – Dataset Augmentation – Noise Robustness – Semi-Supervised Learning – Multi-Task Learning – Early Stopping – Parameter Tying and Sharing – Bagging and Other Ensemble methods – Dropout – Adversarial Training.

List of Exercises:

1. Implement a simple feed-forward neural network.
    a. Create a basic network
    b. Analyze performance by varying the batch size, number of hidden layers, learning rate.
    c. Create a confusion matrix to validate the performance of your model.
    d. Visualize a neural network.
2. Solve XOR problem using Multi Layer Perceptron.

UNIT II	OPTIMIZATION FOR TRAINING DEEP MODELS	9+6

Pure optimization – Challenges – Basic Algorithms – Parameter initialization Strategies – Algorithms with Adaptive Learning Rates – Approximate Second-Order methods – Optimization Strategies and Meta Algorithms.

List of Exercises:

1. Implement Stochastic Gradient Descent Algorithm.
2. Implement Gradient Descent with AdaGrad.

UNIT III	CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS	9+6

Convolution Operation – motivation – Pooling – Infinitely Strong prior – Variants – Structured Output – Data Types – Efficient Convolutional Algorithms – Random or Unsupervised features – Neuroscientific Basis - Deep Learning – Sequence Modelling - Computational Graphs - RNN - Bidirectional RNN – Encoder-Decoder - Sequence to Sequence RNN - Deep Recurrent Networks - Recursive Neural Networks - Long Term Dependencies; Leaky Units - Strategies for multiple time scales – LSTM and Gated RNNs - Optimization for Long Term Dependencies.

List of Exercises:

1. Implement a Recurrent Neural Networks (RNN) and process any sequential data such as characters, words or video frames.
2. Implement RNN with Long Short Term Networks (LTSM).

UNIT IV	AUTOENCODERS	9+6

Autoencoders: Undercomplete autoencoders - Regularized autoencoders – Power, Layer Size and Depth - Stochastic encoders and decoders – Denoising Autoencoders - Learning with autoencoders – contractive Autoencoders – Applications of autoencoders.

List of Exercises:

1. Implement different types of autoencoders.

UNIT V	DEEP GENERATIVE MODELS	9+6

Boltzmann Machine – Restricted Boltzmann Machine – Deep Belief Networks – Deep Boltzmann Machines - Boltzmann Machines for Real-Valued Data – Convolutional Boltzmann Machines - Boltzmann Machine for Structured or Sequential Outputs – Directed Generative Nets – Evaluating

Generative Models.

List of Exercises:

1. Solve a real world problem using CBM.

TOTAL: 45 + 30 = 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Demonstrate the basics of deep neural networks to solve real world problems.
CO2: Implement deep learning models.
CO3: Elaborate CNN and RNN architectures of deep neural networks.
CO4: Use autoencoders in neural networks.
CO5: Illustrate the various deep generative models.
CO6: Apply deep generative models to solve real world problems.

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.

REFERENCES:

1. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 2018.
2. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
3. Francois Chollet, "Deep Learning with Python", Manning Publications Co, 2018.
4. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
5. Navin Kumar Manaswi, "Deep Learning with Applications Using Python", Apress, 2018.
6. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", John Wiley & Sons Inc., 2007.

22AM502	Data Exploration, Feature Engineering and Visualization	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners to:

- To outline exploratory data analysis and the phases involved in data analysis.
- To discuss various statistical techniques for data analysis.
- To demonstrate the basics of feature engineering on different types of data.
- To perform data analysis and apply visualization techniques.
- To apply the methods of time series analysis.
- To formulate dashboards using different datasets by applying data engineering and feature extraction techniques.

UNIT I	EXPLORATORY DATA ANALYSIS	6+6

EDA fundamentals – Understanding 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 - Descriptive Statistics-types of kurtosis, quartiles, Grouping Datasets-data aggregation, group wise transformation.

List of Exercise/Experiments

1. Install the following Data Mining and data Analysis tool: Weka, KNIME, Tableau Public.
2. Perform exploratory data analysis (EDA) on with datasets like email data set. Export all your emails as a dataset, import them inside a pandas data frame, visualize them and get different insights from the data.

UNIT II	FEATURE ENGINEERING	6+6

Text Data – Visual Data – Feature-based Time-Series Analysis – Data Streams – Feature Selection and

Evaluation.

List of Exercise/Experiments

1. Implement document embeddings for fake news identification.
2. Implement feature based representations of time series
3. Implement feature selection algorithm for data streams

UNIT III	VISUALIZING DATA	6+6

The Seven Stages of Visualizing Data, Processing-load and displaying data – functions, sketching and scripting, Mapping - Location, Data, two sided data ranges, smooth interpolation of values over time - Visualization of numeric data and non-numeric data.

List of Exercise/Experiments

1. Perform text mining on a set of documents and visualize the most important words in a visualization such as word cloud.
2. Perform Data Analysis and representation on a Map using various Map data sets with Mouse Rollover effect, user interaction, etc..
3. Build cartographic visualization for multiple datasets involving various countries of the world; states and districts in India etc.

UNIT IV	TIME SERIES ANALYSIS	6+6

Overview of time series analysis - showing data as an area, drawing tabs, handling mouse input, Connections and Correlations – Preprocessing-introducing regular expression, sophisticated sorting, Scatterplot Maps-deployment issues.

List of Exercise/Experiments

1. Perform Time Series Analysis with datasets like Open Power System Data.
2. Build a time-series model on a given dataset and evaluate its accuracy.

UNIT V	TREES, HIERARCHIES, AND RECURSION	6+6

Treemaps - treemap library, directory structure, maintaining context, file item, folder item, Networks and Graphs-approaching network problems-advanced graph example, Acquiring data, Parsing data.

List of Exercise/Experiments

1. Use a case study on a data set and apply the various visualization techniques and present an analysis report.
2. Mini-Project:- Create a Dashboard for a dataset with a visualization tool.

TOTAL: 30+30 = 75 PERIODS

OUTCOMES:

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

CO1: Outline exploratory data analysis and the phases involved in data analysis.
CO2: Demonstrate various statistical techniques for data analysis.
CO3: Present the basics of feature engineering on different types of data.
CO4: Perform data analysis and apply visualization techniques.
CO5: Apply the methods of time series analysis.
CO6: Develop dashboards using different datasets by applying data engineering and feature extraction techniques.

TEXT BOOKS:

1. Suresh Kumar Mukhiya and Usman Ahmed, “Hands-on Exploratory Data Analysis with Python”, Packt Publishing , First Edition, March 2020.
2. Guozhu Dong, Huan Liu, "Feature Engineering for Machine Learning and Data Analytics", First Publication, CRC Press, First edition, 2018.
3. Ben Fry, “Visualizing Data”, O’reilly Publications, First Edition, 2007.

REFERENCES:

1. Danyel Fisher & Miriah Meyer, “Making Data Visual: A Practical Guide To Using Visualization For Insight”, O’reilly publications, 2018.
2. Claus O. Wilke, ”Fundamentals of Data Visualization”, O’reilly publications, 2019.
3. EMC Education Services, “Data Science and Big data analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley Publishers, 2015.
4. Tamara Munzner, “Visualization Analysis and Design”, A K Peters/CRC Press; 1st edition, 2014.
5. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, 2nd Edition, CRC press, 2015.

LIST OF EQUIPMENTS:

1. Systems with Python/R, Tableau Public / PowerBI

22CS511	ADVANCED APTITUDE AND CODING SKILLS - I	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To develop vocabulary for effective communication and reading skills.
- To build the logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.

LIST OF EXERCISES:

1. English – Phase I Advanced

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. Logical Reasoning – Phase I Advanced

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. Quantitative Ability - Phase I Advanced

Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability

4. Automata Fix – Phase I

Logical, Compilation and Code reuse

TOTAL: 30 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Develop vocabulary for effective communication and reading skills.

CO2: Build the logical reasoning and quantitative skills.

CO3: Develop error correction and debugging skills in programming.

22AM511	INTERNSHIP AND CAREER READINESS COURSE	L	T	P	C
		0	0	2	1

OBJECTIVES:

The Course will enable learners to:

- To outline the basics of Data Warehouse concepts.
- To write queries using SQL and NoSQL.
- To discuss the features of python.
- To understand the fundamentals of Cloud.
- To familiarize the basic algorithms in AI, ML and Prompt Engineering.

MODULE I	Data Warehouse Concepts, SQL, NoSQL

Data Warehouse concepts: Need for BI, Data Warehouse, Key terminologies related to DWH architecture: OLTP vs OLAP, ETL, Data Mart, Metadata, DWH Architecture, creating a DWH

Data Lakehouse: Data Lake to Data Swamp, SQL Relational Databases, Transactional Processing, Relational Database Workload Types, Architectural Challenges, Databricks Evolution

ETL: Extract Data Dump from source, Data format consistency, Data Quality rules, Truncate & Load, Load strategies, Load Approach, Transform, Mapping, Enriching, Joins, filter, Remove Duplicates, Aggregation, Load, Dimension, Facts, EDW Tables, Data Marts

Variety of ETL Tools: Apache Airflow, Datastage, Oracle Data Integrator, SSIS, Talend, Hadoop, AWS Glue, Azure Data Factory, Google Cloud Dataflow, Stitch, SAP, Hevo, Qlik, Airbyte

Informatica: Informatica Architecture, Informatica PowerCenter & Repository, Informatica PowerCenter Designer, Informatica PowerCenter workflow manager, Informatica PowerCenter workflow monitor, Run Mappings, Workflow creation & Deletion

SQL (Beginner): DQL, DDL, DML, Filtering and sorting Data, Grouping and Aggregating Data, Joins and Subqueries, Window Functions, Optimizing SQL queries, Automation.

SQL (Advanced): Store Procedure, Trigger, Views, Functions.

NoSQL: NoSQL Fundamentals and Comparison with SQL

Power BI: Connecting Data Sources and Data Bases, Data Modeling, Creating Calculated Fields in Power BI

MODULE II	Python, Cloud Fundamentals

Python (Beginner): Variables, Operators, functions, Libraries, Methods, Refactoring, Enum, Tuples, Dictionaries, sets, Map, filter, reduce, Class & objects, Exceptions, Overloading

Python (Advanced): Iterators, Modules, Packages, Generators, List, Comprehensions, Regular expressions, Serialization, Partial functions, closures, Decorators

AWS: Benefits of AWS, AWS Services - Computer, Storage, Database Service, Networking Service, Security Service, Management tool Service, Developer tool Service

Azure: Cloud Computing, Services in Azure - Compute, Containers, Databases, Identity, Security, Networking, Storage

GCP: Cloud Computing, Benefits of GCP, GCP services, AWS vs Azure vs GCP

Python with Deep Learning: Python Data Science Libraries, Numpy, Scipy, Pandas, Matplotlib, Scikit-Learn, Statsmodels, Pandas, Sorting, Concatenate, Preprocessing - Time Series Data, Visualization

Python with AI: Introduction, Demand of AI, What is AI, Types of AI, Why python for AI, Python Packages for AI

MODULE III	AI, ML, Prompt Engineering

Artificial Intelligence: Artificial intelligence and its types, AI Roadmap, Machine learning and its types, Linear regression Analysis, Classifications in Machine Learning

Machine Learning: AI vs ML, Classification vs regression, Supervised learning, Unsupervised learning, Training Model, Preparing Data, K-Nearest Neighbors, Naive Bayes, Logistic Regression, Support Vector Machine, Neural Networks, Tensorflow, K-Means Clustering, Principal Component Analysis, K-Means and PCA Implementations

Prompt Engineering: Introduction to AI, Linguistics, Language Models, Prompt Engineering Mindset, Zero shot and few shot prompts, AI hallucinations, Vectors/text embeddings.

Generative AI Fundamentals: Generative AI and its use cases, How do LLMS (Large Language Models) work, LLMs generates output for NLP task, LLM model decision criteria, Proprietary models, Fine tuned models, Mixing LLM flavors in workflow, Data privacy, Data security

OUTCOMES:

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

CO1: Apply the basics of Data Warehouse concepts.
CO2: Apply ETL Tools for Data processing.
CO3: Write queries using SQL and NoSQL.
CO4: Apply the features of python.
CO5: Elaborate the fundamentals of Cloud and various services.
CO6: Demonstrate the basic algorithms in AI, ML and summarize the basics of Prompt Engineering.

REFERENCES:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann, 2012
3. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", Kindle Edition, 2017
4. Elmasri R. and S. Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2016.
5. Brett Powell , Mastering Microsoft Power BI: Expert techniques for effective data analytics and business intelligence, Packt Publications, 2018.
6. Suresh Kumar Mukhiya and Usman Ahmed, "Hands-on Exploratory Data Analysis with Python", Packt publishing, March 2020.
7. Ethem Alpaydin, "Introduction to Machine Learning, Adaptive Computation and Machine Learning Series", Third Edition, MIT Press, 2015.
8. Nathan Hunter, The Art of Prompt Engineering with Chatgpt: A Hands-On Guide: 3 (Learn AI Tools the Fun Way!), Shroff/Hunter Publishers, 2023
9. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2, Packt Publications, 2021.

20IT927	INDIAN CONSTITUTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To have some knowledge about Indian Constitution.
- To understand the concept of fundamental rights
- To learn about Lok Sabha and Rajya Sabha
- To have some knowledge about Legislative Assembly and Legislative Council
- To learn about Local Self Government

UNIT I	INTRODUCTION	9

Meaning and Importance of Constitution, Preamble and Salient Features of the Constitution

UNIT II	FUNDAMENTAL RIGHTS	9

Fundamental Rights, Right to Equality, Right to Freedom, Right against exploitation, Right to freedom of religion, Cultural and Educational Rights, Right to Constitutional Remedies and Duties, Directive Principles of State Policy.

UNIT III	LOK SABHA AND RAJYA SABHA	9

Union Government – Lok Sabha and Rajya Sabha Composition, Powers, and functions: The President, The

Prime Minister, and Supreme Court: Role Position and Powers/ functions.		
UNIT IV	**LEGISLATIVE ASSEMBLY AND LEGISLATIVE COUNCIL**	**9**
State Government - Legislative Assembly and Legislative Council: Composition, Powers and functions: The Governor, Chief Minister and High Court: Role, Position and Powers/ functions		
UNIT V	**LOCAL SELF GOVERNMENT**	**9**
Local self-Government, Panchayat Raj System in India; Election Commission; Public Service Commissions, Role, powers, and function		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Interpret the knowledge on Indian Constitution.
CO2: Demonstrate the knowledge gained through fundamental rights concept.
CO3: Relate the concept of Lok Sabha and Rajya Sabha.
CO4: Illustrate the concept of Legislative Assembly and Legislative Council.
CO5: Analyze the concept of Local Self Government.

TEXT BOOK:

1. M V Pylee, An Introduction to The Constitution of India, Vikas Publishing House Pvt. Ltd., 5th Edition, 2007.

REFERENCES:

1. Durga Das Basu, Introduction to the Constitution of India, 19th Edition Reprint 2009.
2. Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, 7th Edition, 2015.

SEMESTER VI

22AM601	AUTOMATA THEORY AND COMPILER DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the fundamental concepts of automata theory.
- To understand deterministic and non-deterministic finite automata.
- To elaborate on Regular Expressions and Grammars.
- To introduce Push down Automata and Turing Machines.
- To introduce the major concepts of language translation and compiler design.
- To elaborate the code optimization and code generation in compiler design.

UNIT I	INTRODUCTION TO AUTOMATA THEORY	9

Introduction to Finite Automata: Structural Representations, Automata and Complexity, the Central Concepts of Automata Theory – Alphabets, Strings, Languages, Problems.
Nondeterministic Finite Automata: Formal Definition, an application, Text Search, Finite Automata with Epsilon-Transitions.
Deterministic Finite Automata: Definition of DFA, How A DFA Process Strings, The language of DFA, Conversion of NFA with €-transitions to NFA without €-transitions. Conversion of NFA to DFA.

UNIT II	REGULAR EXPRESSIONS AND CONTEXT FREE GRAMMARS	9

Regular Expressions: Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions, Conversion of Finite Automata to Regular Expressions.
Pumping Lemma for Regular Languages: Statement of the pumping lemma, Applications of the Pumping Lemma.
Context-Free Grammars: Definition of Context-Free Grammars, Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Parse Trees, Ambiguity in Grammars and Languages.

UNIT III	PDA AND TURING MACHINES	9

Push Down Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDA and CFG's, Acceptance by final state
Turing Machines: Introduction to Turing Machine, Formal Description, Instantaneous description, The language of a Turing machine .

UNIT IV	LEXICAL AND SYNTAX ANALYSIS	9

Introduction: The structure of a compiler,
Lexical Analysis: The Role of the Lexical Analyzer, Input Buffering, Recognition of Tokens, The Lexical- Analyzer Generator Lex,
Syntax Analysis: Introduction, Context-Free Grammars, Writing a Grammar, Top-Down Parsing, Bottom- Up Parsing, Introduction to LR Parsing: Simple LR, More Powerful LR Parsers, Parser Generators YACC.

UNIT V	CODE GENERATION AND OPTIMIZATION	9

Code generation and optimization: Issues in the design of code generator, a simple code generator, Introduction to code optimization, Basic blocks & flow graphs, DAG representation of basic blocks, Peephole optimization, the principle sources of optimization.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Construct deterministic and non-deterministic finite automata.
CO2: Design context free grammars for formal languages using regular expressions.
CO3: Use PDA and Turing Machines for recognizing context-free languages.
CO4: Design a lexical analyzer.
CO5: Design syntax analyzer.
CO6: Design a simple code generator and apply different code optimizations.

TEXT BOOKS:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, 3rd Edition, Pearson Education, 2008.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers Principles, Techniques and Tools", Second Edition, Pearson, 2013.

REFERENCES:

1. K.L.P Mishra and Chandrashekaran, Theory of Computer Science – Automata languages and computation, 3rd Edition, PHI, 2007.
2. Elain Rich, "Automata, Computability and complexity", 1st Edition, Pearson Education, 2018.
3. Peter Linz, "An introduction to Formal Languages and Automata", Jones and Bartlett Publishers, 6th Edition, 2016.
4. K Muneeswaran, "Compiler Design", Oxford University Press, 2013.
5. John C Martin, Introduction to Languages and The Theory of Computation, TMH, 4th Edition, 2010.

22AM602	FOUNDATION OF REINFORCEMNT LEARNING AND ENSEMBLE METHODS	L	T	P	C
		3	0	2	4

OBJECTIVES:

The Course will enable learners to:

- Understand the elements of Reinforcement Learning
- Implement Bandit Problems and Action Value Methods
- Understand the basic concepts of Ensemble Learning
- Analyze Bagging and Boosting techniques
- Analyze the performance of Advanced Ensemble Methods

UNIT I	INTRODUCTION	9+6

Introduction to Reinforcement Learning – Core Concepts and Elements of Reinforcement Learning –- History of Reinforcement Learning-Scope – Extended Examples –Reinforcement Learning Problem.

Lab Exercises

1. Implement the Q-learning algorithm and understand its fundamental components and behavior through a simple grid world environment.
2. Implement a Deep Q-Network (DQN) and apply it to a simple game environment, understanding the benefits and limitations of using deep learning for reinforcement learning tasks.

UNIT II	BANDIT PROBLEMS AND ACTION-VALUE METHODS	9+6

The n-Armed Bandit Problem- Action-Value Methods- Softmax Action Selection- Evaluation Versus Instruction- Incremental Implementation- Tracking a Nonstationary Problem- Optimistic Initial Values- Reinforcement Comparison- Associative Search Framework

Lab Exercises

1. Implement the basic concepts of the multi-armed bandit problem, explore different strategies for selecting actions, and analyze the performance of these strategies.
2. Implement policy evaluation and policy improvement in a finite Markov Decision Process (MDP) using dynamic programming methods.

UNIT III	INTRODUCTION TO ENSEMBLE METHODS	9+6

Basic Concepts -Popular Learning Algorithms- Evaluation and Comparison- Ensemble Methods - Applications of Ensemble Methods.

Lab Exercises

1. Implement and understand the Stacking ensemble method by combining multiple models to improve predictive performance.
2. Implement a Random Forest algorithm and tune its hyper parameters to achieve optimal performance.

UNIT IV	BOOSTING AND BAGGING ALGORITHMS	9+6

Introduction to Boosting Algorithms– AdaBoost Algorithm –Examples-Theoretical Issues -Multiclass

Extension –Noise Tolerance -XGBoost - Examples and Issues – Introduction to Bagging Algorithm – Examples and Issues – Random tree Ensembles -Combination Methods - Averaging – Voting – Combining by learning – Other Combination methods – Relevant methods

Lab Exercises

1. Implement the AdaBoost algorithm, and to analyze its performance on a simple dataset.
2. Implement the bagging algorithm using random forests, and to analyze its performance on a dataset.

UNIT V	**ADVANCED LEARNING TECHNIQUES**	**9+6**

Semi-supervised Learning-Active Learning- Cost-Sensitive Learning- Class Imbalanced Learning

Lab Exercises

1. Implement a semi-supervised learning algorithm using self-training to improve classification performance with limited labeled data.
2. Implement an active learning algorithm using uncertainty sampling to select the most informative data points for labeling.

TOTAL: 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the fundamental components of Reinforcement Learning
CO2: Implement Tabular Solution Methods
CO3: Explain the basic concepts of Ensemble Learning
CO4: Implement Bagging and Boosting Algorithm and analyze its performance
CO5: Analyze Advanced Ensemble Methods

TEXT BOOKS:

1. Sutton R. S. and Barto A. G., "Reinforcement Learning: An Introduction", MIT Press, Second Edition, 2020.
2. Zhi-Hua Zhou. Ensemble Methods Foundations and Algorithms , 2012 First Edition, Chapman & Hall/CRC Machine Learning & Pattern Recognition – Unit 4 & 5

REFERENCES:

1. Kevin Murphy, “Machine Learning - A Probabilistic Perspective” , MIT press, 2012.
2. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
3. Aurelien Geron” Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”.

22CS602	**OBJECT ORIENTED SOFTWARE ENGINEERING (Lab Integrated)**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

The Course will enable learners to:

- Explain software engineering principles and activities involved in building large software programs.
- Describe the process of requirements gathering, analysis and unified modelling
- Illustrate the object oriented design process.
- Analyse various traditional and object oriented testing methods
- Apply estimation techniques, schedule project activities and compute pricing.

UNIT I	**PRODUCT AND PROCESS**	**6+6**

The Nature of Software – Defining the Discipline – The Software Process – Process models – Prescriptive Process Models – Product and Process – Agility and Process – What is an Agile Process? - Scrum – Other Agile Frameworks – Kanban – DevOps

List of Exercise/Experiments:

1. Identify a software system that needs to be developed.

2. Document the Software Requirements Specification (SRS) for the identified system.

UNIT II	REQUIREMENTS AND UNIFIED MODELING	6+6

Requirements Engineering – Establishing the Groundwork: Nonfunctional Requirements – Requirements Gathering – Developing Use Cases – Negotiating and Validating Requirements.
Unified Modeling Language – Introduction – Static and Dynamic Models – Modelling – Introduction to the UML – UML Diagrams – UML Class Diagrams – Use-Case Diagram – UML Dynamic Modelling.

List of Exercise/Experiments:

1. Identify use cases and develop the Use Case model.
2. Identify the conceptual classes and develop a Domain Model and also derive a Class Diagram from that.

UNIT III	OBJECT ORIENTED ANALYSIS AND DESIGN	6+6

Object oriented Analysis process – Business object Analysis – Use-case driven OOA – Business process modelling – Use case model. Design Concepts – Design Process – Design Concepts – Design Model: Design Principles and Design Elements. Architectural Design – Designing class-based components - Conducting Component Level Design – User Interface Analysis and Design – Pattern-Based Software Design.

List of Exercise/Experiments:

1. Using the identified scenarios, find the interaction between objects and represent them using UML Sequence and Collaboration Diagrams
2. Draw relevant State Chart and Activity Diagrams for the same system

UNIT IV	SOFTWARE TESTING	6+6

Component Level: A Strategic Approach to Software Testing – White-Box Testing – Black Box Testing - Object Oriented Testing Integration Level: Integration Testing – AI and Regression Testing – Integration Testing in the OO Context Specialized Testing for Mobility: Web application Testing – Web Testing Strategies – Security Testing – Performance Testing – Real time Testing – Testing AI Systems – Testing Virtual Environments.

List of Exercise/Experiments:

1. Implement the system as per the detailed design
2. Test the software system for all the scenarios identified as per the usecase diagram

UNIT V	SOFTWARE PROJECT MANAGAMENT	6+6

Software Metrics and Analytics: Software Measurement – Product Metrics. Creating a Viable Software Plan: The Project Planning Process – Software Scope and Feasibility – Decomposition and Estimation Techniques – Project Scheduling. Risk Management: Reactive Versus Proactive Risk Strategies – Risk Identification – Risk Projection – The RMMM Plan.
Software Process Improvement: The SPI Process – The CMMI

List of Exercise/Experiments:

1. Improve the reusability and maintainability of the software system by applying appropriate design patterns.
2. Implement the modified system and test it for various scenarios

SUGGESTED DOMAINS FOR MINI-PROJECT:

1. Passport automation system.
2. Book bank
3. Exam registration
4. Stock maintenance system.
5. Online course reservation system
6. Airline/Railway reservation system
7. Software personnel management system
8. Credit card processing
9. E-book management system
10. Recruitment system

11. Foreign trading system
12. Conference management system
13. BPO management system
14. Library management system
15. Student information system

TOTAL: 30 + 30= 60 PERIODS

OUTCOMES:

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

CO1: Understanding Software and Software Processes
CO2: Analyze and **gather** software requirements.
CO3: Use UML to **create** static and dynamic models
CO4: Design software components using object-oriented principles.
CO5: Apply various software testing strategies.
CO6: Develop software projects effectively.

TEXT BOOKS:

1. Roger S. Pressman, "Software Engineering: A Practitioner's Approach" , McGraw Hill International Edition, Nineth Edition, 2020.
2. Ali Bahrami, "Object Oriented Systems Development", McGraw Hill International Edition,2017.

REFERENCES:

1. Micheal Blalh and James Rumbaugh, Object Oriented Modeling and Design with UML, 2nd edition Pearson 2013.
2. Ian Sommerville, "Software Engineering", Tenth Edition, Pearson Education, 2016.
3. Ivar Jacobson, Harold Bud Lawson, Pan-Wei Ng, Paul E. McMahon, Michael Goedicke, "The Essentials of Modern Software Engineering", Morgan & Claypool Publishers, 2019.
4. Booch, G, Jacobson I, Rumbaugh J, "The Unified Modeling Language User Guide", Addison Wesley, 2008.
5. Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", 3rd edition, Addison Wesley, 2003.

LIST OF EQUIPMENTS:

ArgoUML, Visual Paradigm

22CS611	ADVANCED APTITUDE AND CODING SKILLS - II	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To develop advanced vocabulary for effective communication and reading skills.
- To build an enhanced level of logical reasoning and quantitative skills.
- To develop error correction and debugging skills in programming.
- To apply data structures and algorithms in problem solving.

LIST OF EXERCISES:

1.English – Phase II Advanced

Vocabulary: Synonyms, Antonyms, Grammar: Subject-Verb Agreement, Tenses and Articles, Prepositions and Conjunctions, Speech and Voices, Comprehension: Inferential and Literal Comprehension, Contextual Vocabulary, Comprehension ordering

2. Logical Reasoning – Phase II Advanced

Deductive Reasoning: Coding deductive logic, Directional sense, Blood relations, Objective Reasoning, Selection decision tables, Puzzles, Inductive reasoning: Coding pattern and Number series pattern recognition, Analogy and Classification pattern recognition, Abductive Reasoning: Logical word sequence, Data sufficiency

3. Quantitative Ability - Phase II Advanced Basic Mathematics: Divisibility, HCF and LCM, Numbers, decimal fractions and power, Applied Mathematics: Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Engineering Mathematics: Logarithms, Permutation and Combinations, Probability **4. Automata Fix – Phase II** Logical, Compilation and Code reuse **5. Automata - Phase II** Data Structure Concepts: Array and Matrices, Linked list, String processing and manipulation, Stack/Queue, Sorting and Searching Advanced Design and Analysis Techniques: Greedy Algorithms, Minimum Spanning Trees, String Matching, Divide and Conquer, Computational Geometry
TOTAL: 30 PERIODS
OUTCOMES: **At the end of this course, the students will be able to:** **CO1:** Develop advanced vocabulary for effective communication and reading skills. **CO2:** Build an enhanced level of logical reasoning and quantitative skills. **CO3:** Develop error correction and debugging skills in programming. **CO4:** Apply data structures and algorithms in problem solving.

SEMESTER – VII

Professional Ethics

	PREFESSIONAL ETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize with Engineering Ethics and Human Values.
- To impart knowledge on codes of ethics, safety, responsibilities and rights of engineers.
- To give awareness on global issues related to environmental ethics, computer ethics, weapons development and corporate social responsibility.

UNIT I	HUMAN VALUES	9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II	ENGINEERING ETHICS	9

Senses of 'Engineering Ethics' – Variety of moral issues – 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 - Case Studies: Chernobyl and Bhopal Disasters - 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 –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Summarize the importance of human values in work place.

CO2: Discuss the senses of engineering ethics, moral dilemmas, moral autonomy and uses of ethical theories.

CO3: Describe the role of engineers as responsible experimenters and necessity of codes of ethics in engineering.

CO4: Explain safety, risk, responsibilities and rights in the society.

CO5: Analyze the global issues related to environmental ethics, computer ethics, weapons development and the role of engineers as expert witnesses and advisors.

CO6: Apply ethics in society and discuss the ethical issues related to engineering.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2017.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2013.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2012.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2018.
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2017.
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2008.

22AM701	NATURAL LANGUAGE PROCESSING	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To learn the fundamentals of natural language processing
- To discuss word level analysis.
- To discuss the different language models.
- To understand the significance of syntactic and semantic analysis.
- To learn discourse algorithms and various lexical resources.

UNIT I INTRODUCTION **9+6**

Natural Language Processing - Ambiguities in NLP - Regular Expressions – Words – Corpora - Text Normalization, Minimum Edit Distance.

Lab Exercises:

1. NLTK basic Tasks.
    a. Tokenization
    b. Stemming
    c. Lemmatization
2. Identify the Patterns from given the given text document using Regular Expressions.

UNIT II WORD LEVEL ANALYSIS **9+6**

Morphological Analysis – Morphological Parsing - Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based - HMM - Transformation-based tagging.

Lab Exercises:

1. Implement POS tagging using Hidden Markov Models.
2. Write a program to compute unsmoothed unigram and bigrams.

UNIT III	LANGUAGE MODELS	9+6

Markov Chains – Hidden Markov Model – Forward Algorithm – Decoding: Viterbi Algorithm – Training HMMs – Maximum Entropy Models – Maximum Entropy Markov Models.

Lab Exercises:

1. Identify semantic relationships between words and sentences using different measures.
2. Implement Sequence Classification using Support Vector Machine model.
3. Implement Named Entity Recognition using ML Models.

UNIT IV	SYNTACTIC AND SEMANTIC ANALYSIS	10+6

Context-Free Grammars - Grammar rules - Treebanks - Normal Forms for grammar – Finite-state – CFG - Dependency Grammar – Parsing with CFG – Search – Ambiguity - Syntax-Driven Semantic analysis – Semantic Augmentations - Semantic attachments – Unification based approaches to Semantic Analysis – Semantic Attachments – Integrating Semantic Analysis to Early Parser – WordNet.

Lab Exercises:

1. Implement Word Embedding using Word2vec, FastText, Glove model
2. Implement Transformer models using Pytorch.

UNIT V	APPLICATIONS OF NLP	8+6

Information Extraction - Question Answering and Summarization – Dialogue and Conversational Agent - Machine Translation.

Lab Exercises:

1. Implement Chatbot.
2. Implement Neural Machine Translation using Encoder –Decoder model.

TOTAL: 30 + 45 = 75 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the fundamentals of natural language processing.
CO2: Perform word level analysis in NLP.
CO3: Implement different ML models for NLP.
CO4: Analyze the syntax and semantics using various methods.
CO5: Analyze text at the word level.
CO6: Apply NLP to solve real-world problems.

TEXT BOOKS:

1. Daniel Jurafsky, James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech”, Pearson Publication, Second Edition, 2019.

REFERENCES:

1. Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, First Edition, O’Reilly Media, 2009.
2. Breck Baldwin, “Language Processing with Java and LingPipe Cookbook”, Atlantic Publisher, 2015.
3. Richard M Reese, “Natural Language Processing with Java”, O’Reilly Media, 2015.
4. Nitin Indurkhya and Fred J. Damerau, “Handbook of Natural Language Processing”, Second Edition, Chapman and Hall/CRC Press, 2010.
5. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.

22AM702	COMPUTER VISION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental concepts related to Image formation and processing.
- To learn feature detection, matching and detection.
- To become familiar with feature based alignment and motion estimation.
- To develop skills on 3D reconstruction.
- To understand image based rendering and recognition.

UNIT I	INTRODUCTION TO IMAGE FORMATION AND PROCESSING	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, MATCHING 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 range finding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos

UNIT V	IMAGE-BASED RENDERING AND RECOGNITION	9

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Analyze and apply basic image processing techniques in practical applications.
CO2: Compare the concepts related to feature detection, matching and detection.
CO3: Implement feature-based alignment and motion estimation in real-world applications.
CO4: Create and Apply 3D Reconstruction techniques in diverse applications.
CO5: Perform image-based rendering and recognition.
CO6: Implement efficient solutions to image processing and computer vision problems.

TEXT BOOKS:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Person Education, Second Edition, 2015

REFERENCES:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

22AM711	MLOps	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To design and implement a Machine Learning Project.
- To perform data engineering and ML model engineering and develop a model.
- To perform model testing and validation.
- To deploy a ML model using CI/CD pipeline.

LIST OF EXERCISES:

1. Analyze messy customer purchase data (wrangling), compress for efficiency, and visualize buying trends to improve product recommendations.
2. Train a computer vision model to classify different types of flowers in images using transfer learning, evaluating with accuracy and confusion matrix.
3. Build a text classifier to distinguish between product reviews and customer support tickets using a pre-trained NLP library, evaluating with F1-score.
4. Build a recommendation system using collaborative filtering to suggest movies to users based on their watch history and ratings provided by similar viewers.
5. Train an image classifier (cifar-10) using a CNN with MLflow to optimize hyperparameters (learning rate, epochs) for maximizing accuracy.
6. Deploy a simple web application in a Docker container on Kubernetes, collecting user interactions with Filebeat and visualizing them in Kibana dashboards.
7. Build a CI/CD pipeline in Github Actions to automate training and deployment of a machine learning model (e.g., image classifier) using Jenkins, including model profiling with a profiler tool to identify performance bottlenecks.
8. Deploy two versions of a web application (A/B test) with Google Optimize, using a Canary pattern for initial risk assessment and measuring conversion rates for each version.
9. Deploy a sample web application (e.g., flask app) to a cloud platform (AWS), monitor application health metrics (CPU, memory) with Cloudwatch, and visualize them in Grafana Cloud dashboards.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Design and implement a Machine Learning Project.
CO2: Apply data engineering and ML model engineering and develop a model.
CO3: Apply model testing and validation.
CO4: Build and Deploy a ML model using CI/CD pipeline.

LIST OF EQUIPMENTS:

Systems with Anaconda, Jupyter Notebook, Python,

20IT917	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
- Make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life.

UNIT I	INTRODUCTION TO TRADITIONAL KNOWLEDGE	9

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge.

UNIT II	PROTECTION OF TRADITIONAL KNOWLEDGE	9

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT III	LEGAL FRAMEWORK AND TK	9

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

UNIT IV	TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY	9

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge.

UNIT V	TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS	9

Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Illustrate the concepts of Indian traditional knowledge.
CO2: Apply the concept of protection of traditional knowledge.
CO3: Analyze the legal framework and traditional knowledge.
CO4: Interpret the concept of traditional knowledge and intellectual property.
CO5: Analyze and apply traditional knowledge to their day-to-day life.

TEXT BOOK:

1. Amit Jha, Traditional Knowledge System in India, Atlantic Publishers, 2002.

REFERENCES:

1. Kapil Kapoor, Michel Danino, Knowledge Traditions and Practices of India, Central Board of Secondary Education, 2012.

PROFESSIONAL ELECTIVE
VERTICAL I – DATA SCIENCE AND ANALYTICS

22AM901	DATA SCIENCE USING PYTHON (Lab Integrated)	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners to:

- To learn the fundamentals of Data Science.
- To experiment and implement python libraries for data science Learn the tools and packages in Python for Data Science.
- To apply and implement basic classification algorithms
- To apply clustering and outlier detection approaches.
- To present and interpret data using visualization libraries in Python

UNIT I	INTRODUCTION	6+6

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data.

List of Exercise/Experiments:

1. Download, install and explore the features of R/Python for data analytics
    - Installing Anaconda
    - Basic Operations in Jupyter Notebook
    - Basic Data Handling

UNIT II	PYTHON LIBRARIES FOR DATA SCIENCE	6+6

Introduction to Numpy - Multidimensional Ndarrays – Indexing – Properties – Constants – Data Visualization: Ndarray Creation – Matplotlib - Introduction to Pandas – Series – Dataframes – Visualizing the Data in Dataframes - Pandas Objects – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – Joins- Pivot Tables - String operations – Working with time series – High performance Pandas.

List of Exercise/Experiments:

1. Working with Numpy arrays - Creation of numpy array using the tuple, Determine the size, shape and dimension of the array, Manipulation with array Attributes, Creation of Sub array, Perform the reshaping of the array along the row vector and column vector, Create Two arrays and perform the concatenation among the arrays.
2. Working with Pandas data frames - Series, DataFrame , and Index, Implement the Data Selection Operations, Data indexing operations like: loc, iloc, and ix, operations of handling the missing data like None, Nan, Manipulate on the operation of Null Vaues (is null(), not null(), dropna(), fillna()).
3. Perform the Statistics operation for the data (the sum, product, median, minimum and maximum, quantiles, arg min, arg max etc.).
4. Use any data set compute the mean ,standard deviation, Percentile.

UNIT III	CLASSIFICATION	6+6

Basic Concepts – Decision Tree Induction – Bayes Classification Methods – Rule-Based Classification – Model Evaluation and Selection.

Bayesian Belief Networks – Classification by Backpropagation – Support Vector Machines – Associative Classification – K-Nearest-Neighbor Classifiers – Fuzzy Set Approaches - Multiclass Classification - Semi-Supervised Classification.

List of Exercise/Experiments:

1. Apply Decision Tree algorithms on any data set.
2. Apply SVM on any data set
3. Implement K-Nearest-Neighbor Classifiers

UNIT IV	CLUSTERING AND OUTLIER DETECTION	6+6

Cluster Analysis – Partitioning Methods – Evaluation of Clusters – Probabilistic Model-Based Clustering – Outliers and Outlier Analysis – Outlier Detection Methods – Statistical Approaches – Clustering and Classification-Based Approaches.

List of Exercise/Experiments:

1. Apply K-means algorithms for any data set.
2. Perform Outlier Analysis on any data set.

UNIT V	DATA VISUALIZATION	6+6

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.

List of Exercise/Experiments:

1. Basic plots using Matplotlib.
2. Implementation of Scatter Plot.
3. Construction of Histogram, bar plot, Subplots, Line Plots.
4. Implement the three dimensional potting.
5. Visualize a dataset with Seaborn.

TOTAL:30+30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the fundamentals of data science.
CO2: Experiment python libraries for data science.
CO3: Apply and implement basic classification algorithms.
CO4: Implement clustering and outlier detection approaches.
CO5: Present and interpret data using visualization tools in Python.
CO6: Use various data science algorithms to analyze data.

TEXT BOOKS:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. (Unit 1)
2. Ashwin Pajankar, Aditya Joshi, Hands-on Machine Learning with Python: Implement Neural Network Solutions with Scikit-learn and PyTorch, Apress, 2022.
3. Jake VanderPlas, “Python Data Science Handbook – Essential tools for working with data”, O’Reilly, 2017.

REFERENCES:

1. Roger D. Peng, R Programming for Data Science, Lulu.com, 2016
2. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann, 2012.
3. Samir Madhavan, Mastering Python for Data Science, Packt Publishing, 2015
4. Laura Igual, Santi Seguí, "Introduction to Data Science: A Python Approach to Concepts,
5. Techniques and Applications", 1st Edition, Springer, 2017
6. Peter Bruce, Andrew Bruce, "Practical Statistics for Data Scientists: 50 Essential
7. Concepts", 3rd Edition, O'Reilly, 2017
8. Hector Guerrero, “Excel Data Analysis: Modelling and Simulation”, Springer International Publishing, 2nd Edition, 2019
9. NPTEL Courses:
    a. Data Science for Engineers - https://onlinecourses.nptel.ac.in/noc23_cs17/preview
    b. Python for Data Science - https://onlinecourses.nptel.ac.in/noc23_cs21/preview

LIST OF EQUIPMENTS:
Systems with Anaconda, Jupyter Notebook, Python, Pandas, NumPy, MathPlotlib

22AM902	DATA ANALYTICS (Lab Integrated)	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To explain the fundamentals of big data and data analytics
- To discuss the Hadoop framework
- To explain about exploratory data analysis and data manipulation tools
- To analyze and interpret streaming data
- To discuss various applications of data analytics

UNIT I	INTRODUCTION	6+6

Evolution of Big Data- Definition of Big Data-Challenges with Big Data- Traditional Business Intelligence (BI) versus Big Data- Introduction to big data analytics- Classification of Analytics-Analytics Tools- Importance of big data analytics.

Lab Programs:

6. Given a data set, explore the features using exploratory data analysis using Python/R.

UNIT II	HADOOP FRAMEWORK	6+6

Introducing Hadoop- RDBMS versus Hadoop-Hadoop Overview-HDFS (Hadoop Distributed File System)- Processing Data with Hadoop- Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem.

Lab Programs:

4. Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux. After successful installation on one node, configuration of a multi-node Hadoop cluster.
5. MapReduce application for word counting on Hadoop cluster
6. Implement an MR program that processes a given dataset
7. Implement an MR program that processes a weather dataset R

UNIT III	EXPLORATORY DATA ANALYSIS	6+6

EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA –Data transformation techniques - Introduction to NoSQL – MongoDB: RDBMS Vs MongoDB – Data Types – Query Language – Hive – Hive Architecture – Data Types – File Formats – Hive Query Language (HQL) – RC File Implementation – User Defined Functions.

Lab Programs:

4. Implement an application that stores big data in Hbase / MongoDB / NoSQL / Pig using Hadoop / R.
5. Apply Bayesian and SVM techniques on Iris and Diabetes data set.
6. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API
7. Implement the following using Hadoop, Map Reduce, HDFS, Hive:
    a. Perform setting up and Installing Hadoop in its two operating modes: pseudo distributed and fully distributed.
    b. Implement the following file management tasks in Hadoop: adding files and directories, retrieving files and Deleting files.
    c. (i)Performing a MapReduce Job for word search count (look for specific keywords ina file)

    (ii) Implement stop word elimination problem: Input a large textual file containing one sentence per line and a small file containing a set of stop words (one stop word per line) and save the results in an output textual file containing the same sentences of the large input file without the words appearing in the small file.
    d. Implement a MapReduce program that processes a weather data set to:
        i. Find average, max and min temperature for each year in National Climate DataCentre data set.
        ii. Filter the readings of a set based on value of the measurement. The programmust save the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.
    e. Install, deploy & configure Apache Spark cluster. Run Apache Spark applicationsusing Scala.
    f. Install and run Hive then use Hive to create, alter, and drop databases, tables, views,functions, and indexes.

UNIT IV	MINING DATA STREAMS	6+6

The data stream model – stream queries-sampling data in a stream-general streaming problem-filtering streams-analysis of filtering- dealing with infinite streams- Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

Lab Programs:

3. Implement the following algorithms on realtime stream data sets.
    a. Support Vector Machine
    b. Decision tree classifier
    c. Clustering Algorithms
4. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API

UNIT V	APPLICATIONS	6+6

Application: Sales and Marketing – Industry Specific Data Mining – microRNA Data Analysis Case Study – Credit Scoring Case Study – Data Mining Nontabular Data.

Lab Programs:

1. Solve numerical problems on Eigen Value, Eigen Vector, etc. to understand the workingprinciples of mining techniques.
2. Mini Project: The project should contain the following components
   - Realtime dataset
   - Data preparation & Transformation
   - Handling missing Data
   - Data Storage
   - Algorithm for data analytics

Data visualization: Charts, Heatmap, Crosstab, Treemap

TOTAL: 30+30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Explain the fundamentals of big data and data analytics
CO2: Discuss the Hadoop framework
CO3: Explain about exploratory data analysis and data manipulation tools
CO4: Analyse and interpret streaming data
CO5: Illustrate various applications of data analytics

TEXT BOOKS:

2. Subhashini Chellappan, Seema Acharya, "Big Data and Analytics", 2nd edition, Wiley Publications, 2019.
3. Suresh Kumar Mukhiya and Usman Ahmed, "Hands-on Exploratory Data Analysis with Python", Packt publishing, March 2020.
4. Jure Leskovek, Anand Rajaraman and Jefrey Ullman," Mining of Massive Datasets. v2.1", Cambridge University Press,2019.
5. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II : A Practical Guide ToData Visualization, Advanced Data Mining Methods, and Applications, Wiley 2009.

REFERENCES:

1. Nelli, F., Python Data Analytics: with Pandas, NumPy and Matplotlib, Apress, 2018.
2. Bart Baesens," Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", John Wiley & Sons, 2014
3. Min Chen, Shiwen Mao, Yin Zhang, Victor CM Leung, Big Data: Related Technologies, Challenges and Future Prospects, Springer, 2014.
4. Michael Minelli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.

22AM903	SOCIAL NETWORK ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the components of the social network.
- To elaborate the modeling and visualization of the social network.
- To classify descriptive and inferential methods.
- To discuss about the evolution of the social network.
- To illustrate the applications in real time systems.

UNIT I	INTRODUCTION	9

Basics of Social Network Analysis: Introduction- The Social network and Representation -Types of

Networks-Network parts and Level of Analysis-Networks as Social Structure and Institution- Theoretical Assumptions-Causality in Social Network Studies- A Brief History of Social Network Analysis-Mathematical Foundations: Graphs-Paths and components-Adjacency matrices-Ways and modes-Matrix products-Sources of network data-Types of nodes and types of ties- Data Collection: Network questions-Question formats-Interviewee burden-Data collection and reliability-Archival data collection-Data from electronic sources.

UNIT II	MODELING AND VISUALIZATION	9

Data Management: Data import-Cleaning network data- Data transformation-Normalization-Cognitive social structure data-Matching attributes and networks-Converting attributes to matrices-Data export,- Multivariate Techniques Used in Network Analysis: Multidimensional scaling-Correspondence analysis-Hierarchical clustering,- Visualization: Layout-Embedding node attributes-Node filtering-Ego networks-Embedding tie characteristics-Visualizing network change-Exporting visualizations-Closing comments.

UNIT III	DESCRIPTIVE AND INFERENTIAL METHODS	9

Descriptive Methods in Social Network Analysis: Graph and Matrix-Social Network Representation – Density – Centrality, Centralization and Prestige- Cliques – Multidimensional Scaling(MDS) and Dendogram – Structural Equivalence -Two mode Networks and Bipartite Matrix-Inferential Methods in Social Network Analysis: Permutation and QAP (Quadratic Assignment Procedure) Correlation-P* or Exponential Random Graph Model(ERGM).

UNIT IV	EVOLUTION	9

Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

UNIT V	APPLICATIONS	9

A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Outline the internal components and terminology of the social network.
CO2: Illustrate the fundamental exploratory multivariate techniques and visualizing network data.
CO3: Discuss most common descriptive and inferential statistical tools available.
CO4: Discuss about the evolution of the social network.
CO5: Illustrate the real time applications of social network analysis.
CO6: Apply the methods in Social Network Analysis to solve real world problems.

TEXT BOOKS:

1. Song Yang , Franziska B. Keller, “Social Network Analysis Methods and Examples”, SAGE Publications Inc. 2017.
2. Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, “Analyzing Social Networks”, Second Edition, 2017.

REFERENCES:

1. Charu C. Aggarwal, “Social Network Data Analytics”, Springer; 2014 .
2. Przemyslaw Kazienko, Nitesh Chawla, “Applications of Social Media and Social Network Analysis”, Springer,2015.
3. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel, “Computational Social Network Analysis: Trends, Tools and Research Advances”, Springer, 2012.
4. Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 1st edition, 2011.

5. Guandong Xu , Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, Springer, 1st edition, 2012.

22AM904	TEXT AND SPEECH ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the tools and techniques for performing text and speech analytics in diverse contexts.
- To understand the tools and technologies involved in developing text and speech applications.
- To demonstrate the use of computing for building applications in text and speech processing.
- To use information Retrieval Techniques to build and evaluate text processing systems.
- To apply advanced speech recognition methodologies in practical applications.

UNIT I	TEXT PROCESSING	9

Speech and Language Processing - Regular Expression - Text normalization – Edit Distance - Lemmatization – Stemming – N-gram Language Models - Vector Semantics and Embeddings.

UNIT II	TEXT CLASSIFICATION	9

Text Classification Tasks – Language Model – Neural Language Models – RNNs as Language Models – Transformers and Large Language Models.

UNIT III	QUESTION ANSWERING AND DIALOGUE SYSTEMS	9

Information Retrieval – Dense Vectors – Neural IR for Question Answering – Evaluating Retrieval-based Question Answering – Frame-based Dialogue Systems – Dialogue Acts and Dialogue State – Chatbots – Dialogue System Design.

UNIT IV	TEXT TO SPEECH SYNTHESIS	9

Automatic Speech Recognition Task – Feature Extraction for ASR: Log Mel Spectrum – Speech Recognition Architecture – CTC - ASR Evaluation: Word Error Rate – TTS – Speech Tasks.

UNIT V	SPEECH RECOGNITION	9

LPC for speech recognition - Hidden Markov Model (HMM) - Training procedure for HMM- subword unit model based on HMM - Language models for large vocabulary speech recognition - Overall recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Apply the fundamental techniques in text processing for various NLP tasks.
CO2: Implement advanced language models and improve text classification accuracy.
CO3: Designing text processing systems using state-of-the-art techniques.
CO4: Design, implement, and evaluate ASR and TTS systems.
CO5: Apply advanced speech recognition methodologies in practical applications.
CO6: Use information Retrieval Techniques to build and evaluate text processing systems.

TEXT BOOKS:

1. Jurafsky, D. and J. H. Martin, Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition Pearson Publication, Third Edition, 2022.
2. Lawrence Rabiner, Biing-Hwang Juang and B.Yegnanarayana, “Fundamentals of Speech Recognition”, Pearson Education, 2009.

REFERENCES:

1. John Atkinson-Abutridy, Text Analytics: An Introduction to the Science and Applications of Unstructured Information Analysis, CRC Press, 2022.
2. Jim Schwoebel, NeuroLex, Introduction to Voice Computing in Python, 2018

3. Lawrence R. Rabiner, Ronald W. Schafe, Theory and Applications of Digital Speech Processing, First Edition, Pearson, 2010.
4. Srinivasa-Desikan, Bhargav. Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spaCy, and Keras. Packt Publishing Ltd, 2018.

22AM905	IMAGE AND VIDEO ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To understand the basics of image processing techniques for computer vision and video analysis.
- To illustrate the techniques used for image pre-processing.
- To discuss the various image Segmentation techniques.
- To understand the various Object recognition mechanisms.
- To elaborate on the motion analysis techniques for video analytics.

UNIT I	INTRODUCTION	9

Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.

UNIT II	IMAGE PRE-PROCESSING	9

Pixel brightness transformations - Geometric transformations - Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi-spectral images - Local pre-processing in the frequency domain - Line detection by local pre-processing operators - Detection of corners (interest points) - Detection of maximally stable extremal regions - Image restoration.

UNIT III	SEGMENTATION	9

Thresholding - Edge-based segmentation - Region-based segmentation – Matching - Evaluation issues in segmentation - Mean shift segmentation - Active contour models.

UNIT IV	OBJECT RECOGNITION	9

Knowledge representation - Statistical pattern recognition - Neural nets - Syntactic pattern recognition - Recognition as graph matching - Optimization techniques in recognition - Fuzzy systems - Boosting in pattern recognition - Random forests - Image understanding control strategies.

UNIT V	MOTION ANALYSIS	9

Differential motion analysis methods - Optical flow - Analysis based on correspondence of interest points - Detection of specific motion patterns - Video tracking - Motion models to aid tracking.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Understand the basics of image processing techniques for computer vision and video analysis.
CO2: Illustrate the techniques used for image pre-processing.
CO3: Analyze the various image Segmentation techniques.
CO4: Understand the various Object recognition mechanisms.
CO5: Elaborate on the motion analysis techniques for video analytics.
CO6: Apply image processing techniques in real-world applications.

TEXT BOOKS:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4nd edition, Thomson Learning, 2013.

REFERENCES:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Verlag London Limited, 2011.
2. Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, “Video Analytics for Business Intelligence”, Springer, 2012.
3. D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.
4. E. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press,2012.

22AM906	STREAM PROCESSING AND ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To outline the framework for real time stream processing.
- To learn various algorithms for data streaming.
- To identify frequent item sets by mining from data streams.
- To introduce approaches to evaluate stream learning algorithms.
- To use tools for distributed data flow management.
- To design solutions to stream processing problems.

UNIT I	INTRODUCTION TO DATA STREAMS	9

Data Stream Models – Bounds of Random variables – Poisson Process – Maintaining Simple Statistics from Data Streams – Sliding Window and computing statistics over sliding windows – Data Synopsis – Sampling – Histograms – Wavelets – DFT - Change Detection: Tracking Drifting Concepts - Monitoring the Learning Process.

UNIT II	STREAMING ALGORITHMS	9

Clustering Examples: Basic Concepts - Partitioning Clustering – Hierarchical Clustering - Micro Clustering – Grid Clustering - Clustering Variables - The Very Fast Decision Tree Algorithm (VFDT) - The Base Algorithm, Analysis of the VFDT Algorithm, Extensions to the Basic Algorithm: Processing Continuous Attributes, Functional Tree Leaves, Concept Drift.

UNIT III	FREQUENT PATTERN MINING	9

Introduction – Heavy Hitters - Mining Frequent Itemsets from Data Streams - Landmark Windows - Mining Recent Frequent Itemsets - Frequent Itemsets at Multiple Time Granularities - Sequence Pattern Mining - Reservoir Sampling for Sequential Pattern Mining over data stream.

UNIT IV	EVALUATING STREAMING ALGORITHMS	9

Learning from Data Streams - Evaluation Issues - Design of Evaluation Experiments - Evaluation Metrics - Comparative Assessment - Evaluation Methodology in Non-Stationary Environments.

UNIT V	DATA FLOW MANAGEMENT	9

Distributed Data Flows – Apache Kafka – Apace Flume - Processing Streaming Data – Storing Streaming Data – Delivering Streaming Metrics.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Outline the framework for real time stream processing.
CO2: Elaborate various algorithms for data streaming.
CO3: Illustrate frequent item sets by mining from data streams.
CO4: Apply the metrics and procedures to evaluate a model.
CO5: Use tools for distributed data flow management.
CO6: Develop solutions for real-world problems using streaming data.

TEXT BOOKS:

1. Joao Gama, “Knowledge Discovery from Data Streams”, CRC Press, 2010.
2. Byron Ellis, Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data, First Edition, WILEY Big Data Series, 2014.

REFERENCES:

1. Andrew Psaltis, Streaming Data: Paul Lewis, First Edition, Manning Publication, 2017.
2. Bugra Gedik, Deepak S. Turaga, Henrique C. M. Andrade, Fundamentals of Stream Processing: Application Design, Systems, and Analytics, Cambridge University Press, 2014.
3. Charu C. Aggarwal, "Data Streams: Models and Algorithms", Kluwer Academic Publishers, 2007.
4. David Luckham, "The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems", Addison Wesley, 2002.

VERTICAL II – APPLIED AI

22AM907	AI in BLOCK CHAIN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge in Blockchain Technologies.
- To understand how block chain and AI can be used to innovate.
- To elaborate Cryptocurrencies and AI.
- To develop applications using blockchain.
- To understand the limitations and future scope of AI in Blockchain.

UNIT I	INTRODUCTION TO BLOCKCHAIN	9

Overview – Blockchain vs Distributed Ledger Technology vs Distributed Databases – Public vs private vs permissioned blockchains – Privacy in blockchains – Blockchain platforms - Hyperledger – Hashgraph, Corda – IOTA - Consensus Algorithms – Building DApps with blockchain tools.

UNIT II	BLOCKCHAIN AND ARTIFICIAL INTELLIGENCE	9

Introduction to the AI landscape - AI and Blockchain driven Databases – Centralized vs Distributed data – Blockchain data – Big data for AI analysis – Global databases – Data Management in a DAO - Benefits of combining blockchain and AI – Aicumen Technologies -Combining blockchain and AI to humanize digital interactions.

UNIT III	CRYPTOCURRENCY AND AI	9

Bitcoins – Ethereum - Role of AI in cryptocurrency – cryptocurrency trading – Making price predictions with AI – Market making – future of cryptocurrencies.

UNIT IV	DEVELOPING BLOCKCHAIN PRODUCTS	9

Development Life Cycle of a DIApp – Designing a DIApp – Developing a DIApp – Testing – Deploying – Monitoring – Implementing DIApps.

UNIT V	LIMITATIONS AND FUTURE OF AI WITH BLOCKCHAIN	9

Technical Challenges – Business Model Challenges – Scandals and Public perception – Government Regulation – Privacy Challenges for Personal Records – Convergence of AI with Blockchain – Future – Enterprise.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Acquire knowledge in Blockchain Technologies.
CO2: Understand how block chain and AI can be used to innovate.
CO3: Elaborate Cryptocurrencies and AI.
CO4: Develop applications using blockchain.
CO5: Understand the limitations and future scope of AI in Blockchain.
CO6: Elaborate the various applications of AI in Blockchain.

TEXT BOOKS:

1. Ganesh Prasad Kumble, Anantha Krishnan, “Practical Artificial Intelligence and Blockchain: A guide to converging blockchain and AI to build smart applications for new economies”, Packt Publications, 2020.
2. Melanie Swan, “Block Chain: Blueprint for a New Economy”, O’Reilly, 2015.

REFERENCES:

1. Daniel Drescher, “Block Chain Basics”, Apress; 1st edition, 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer”, Import, 2018.

22AM908	AUGMENTED AND VIRTUAL REALITY (Lab Integrated)	L	T	P	C
		2	0	2	3

OBJECTIVES:

The Course will enable learners to:

- Get exposure on Augmented Reality.
- Introduce Virtual Reality and input and output devices.
- Acquire knowledge on computing architectures and modelling.
- Explore Virtual Reality programming and human factors.
- Learn various applications of Virtual Reality.

UNIT I	AUGMENTED REALITY (AR)	6+6

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices.

List of Exercises:

1.Develop simple AR Application like snapchat.

2.Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization.

UNIT II	INTRODUCTION TO VIRTUAL REALITY (VR) AND INPUT AND OUTPUT DEVICES	6+6

Introduction: The three I’s of Virtual Reality - - Early commercial VR technology - The five classic components of a VR system. Input devices: Three-Dimensional position trackers - tracker performance parameters - ultrasonic trackers - optical trackers - Navigation and manipulation interfaces - gesture interfaces. Output devices: graphics displays - large-volume displays - sound displays.

List of Exercises:

1. Study of tools like Unity, Maya/3DS MAX/Blender.
2. Use the primitive objects and apply various projection types by handling camera.

UNIT III	COMPUTING ARCHITECTURES AND MODELING OF A VR SYSTEM	6+6

Computing architectures for VR: The rendering pipeline - The graphics rendering pipeline - The haptics rendering pipeline - PC graphics architecture - PC graphics accelerators - Graphics benchmarks - Distributed VR architectures - Multipipeline synchronization - Colocated rendering pipelines. Modeling: geometric modeling - kinematics modeling - physical and behavior modelling

List of Exercises:

1.Download objects from asset store and apply various lighting and shading effects.

2. Model three dimensional objects using various modelling techniques and apply textures over them

UNIT IV	VR PROGRAMMING AND HUMAN FACTORS	6+6

Toolkits and scene graphs - WorldToolKit - Model geometry and appearance - The WTK scene graph - Sensors and action functions - WTK networking - Java 3D - Model geometry and appearance - Java 3D scene graph - Sensors and behaviors - Java 3D networking - WTK and Java 3D performance comparison –Human factors in VR: Methodology and terminology - user performance studies - VR health and safety issues - VR and society

List of Exercises:

1.Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.

2. Add audio and text special effects to the developed application

UNIT V	**APPLICATIONS OF VR**	**6+6**

Medical Application of VR - Virtual anatomy-Triage and diagnostic - Surgery - VR in education - VR and the Arts - Entertainment applications of VR - military VR applications - Army use of VR - VR applications in the Navy - Air force use of VR - Applications of VR in Robotics - Robot programming - Robot teleoperation

List of Exercises:

1.Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.

2.Develop VR/AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.

TOTAL =30+30=60 PERIODS

OUTCOMES:

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

- Understand Augmented Reality.
- Explore different input and output devices used in Virtual Reality system.
- Model the VR system.
- To learn about Google Toolkit's and Scene Graph.
- Apply VR in various fields.

TEXT BOOKS:

1. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016.
2. Grigore C. Burdea, Philippe Coiffet, "Virtual reality technology", Wiley, Second Edition, 2017.

REFERENCE BOOKS:

1.Sherman, William R & Craig, Alan B, "Understanding Virtual reality", Elsevier India Private Limited, Noida, 2018.
2.Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018.

SOFTWARE REQUIREMENTS:

Unity, Maya/3DS MAX/Blender.

22AM909	**INTELLIGENT ROBOTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the basics of Intelligent Robots.
- To discuss the Autonomous capabilities and Software architecture.
- To elaborate the Reactive Functionality of intelligent Robots.
- To use the various sensors in building Intelligent Robots.

- To illustrate the Deliberative Functionality of intelligent Robots.

UNIT I	INTRODUCTION	9

Overview- Definition – Components -Three Modalities – Need for Intelligent Robots – History of AI Robotics – Industrial Manipulators – Mobile Robots – Drones – Cognitive Systems.

UNIT II	AUTOMATION AND AUTONOMY	9

Autonomous Capabilities – Bounded Rationality – Automation and Autonomy – Programming Style – Hardware Design – Types of Functional Failures – Autonomous Capabilities. Types of Software Architectures – Operational Architectures – Components of a Telesystem – Human Supervisory Control.

UNIT III	REACTIVE FUNCTIONALITY	9

Behaviours : Agency and Marr's Computational Theory – Animal Behaviours – Schema Theory. Perception: Action-Perception cycle – Functions. Behaviour Coordination – Function – Cooperating Methods – Competing Methods – Sequences.

UNIT IV	SENSORS AND SENSING	9

Locomotion: Mechanical, Biomimetic, Legged Locomotion – Action Selection – Sensors and Sensing Model – Choosing – Range Sensing: Stereo – Depth from X – Sonar or Ultrasonics.

UNIT V	DELIBERATIVE FUNCTIONALITY	9

Deliberation – Strips – Navigation – Spatial Memory – Types of Path Planning – Configuration Space – Metric Path Planning – Motion Planning – Localization – Feature based Localization – Iconic Localization – Static vs Dynamic Environments – Simultaneous Localization and Mapping - Terrain Identification and Mapping – Scale and Traversability - Exploration – Mutlirobot Systems and AI – Human-Robot Interaction and areas of AI.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the basics of Intelligent Robots.
CO2: Design and implement Autonomous capabilities in Robotics systems.
CO3: Elaborate the Reactive Functionality of intelligent Robots.
CO4: Use the various sensors in building Intelligent Robots.
CO5: Illustrate the Deliberative Functionality of intelligent Robots.
CO6: Analyse the various applications of AI Robotics.

TEXT BOOKS:

1. Robin R. Murphy, "Introduction to AI Robotics", MIT Press, Second Edition, 2019.

REFERENCES:

1. Francis X. Govers, "Artificial Intelligence for Robotics: Build Intelligent Robots that Perform Human Tasks Using AI Techniques", Packt Publishing, 2018.
2. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics", MIT Press, 2005.
3. Yoon Seok Pyo, Han Cheol Cho, Ryu Woon Jung, and Tae Hoon Lim, "ROS Robot Programming", ROBOTIS Co., Ltd, 2017.

22AM910	GENERATIVE AI	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the basic concepts of Generative AI.
- Build Generative AI systems to generate outputs of different domains.
- Deploy Generative AI Models.
- Compare and use the various Large Language Models.
- Understand the basics of Prompt Engineering.

UNIT I	**GENERATIVE AI CONCEPTS**	**9**
Introduction to Generative AI – Deep Learning – Deep Neural Networks – Multi-Layer Perceptron – Convolutional Neural Network – Autoencoders - Variational Autoencoders – Latent Space.		
UNIT II	**GENERATIVE ADVERSARIAL NETWORKS**	**9**
Deep Convolutional GAN (DCGAN) - Wasserstein GAN with Gradient Penalty (WGAN-GP) - Conditional GAN (CGAN) - Autoregressive Models - Long Short-Term Memory Network (LSTM).		
UNIT III	**FLOW MODELS**	**9**
Normalizing Flows – RealNVP - Energy-Based Models - Denoising Diffusion Models (DDM).		
UNIT IV	**LARGE LANGUAGE MODELS**	**9**
Overview of LLMs - Transformers – GPT – Types of LLMs – Key concepts – other Transformers – T5 – Generative Pre-Trained Models – Multi-modal Models – DALL.E 2		
UNIT V	**PROMPT ENGINEERING**	**9**
Basics – In-Context Learning – In-Context Prompting – Techniques – Image Prompting – Prompt Hijacking – Challenges.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the basic concepts of Generative AI.
CO2: Build Generative AI systems to generate outputs of different domains.
CO3: Deploy Generative AI Models.
CO4: Compare and use the various Large Language Models.
CO5: Understand the basics of Prompt Engineering.
CO6: Apply Generative AI to solve real world applications.

TEXT BOOKS:

1. David Foster, Generative Deep Learning, 2nd Edition, O'Reilly Media, 2023.
2. Amit Bahree, Generative AI in Action, Manning Publication, First Edition, 2023.

REFERENCES:

1. Numa Dhamani and Maggie Engler, Introduction to Generative AI, Manning Publication, First Edition, 2024.
2. Valentina Alto, Modern Generative AI with ChatGPT and OpenAI Models, Packt publications, 2024.

22CS925	**GAME DEVELOPMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

The Course will enable learners to:

- To understand game programming fundamentals.
- To learn about the processes, mechanics, issues in game design.
- To gain knowledge of the game design and Artificial intelligence.
- To understand the design and scripting languages of game programming.
- To know about networked games and analyse code for sample games.

UNIT I	**INTRODUCTION**	**9**
Evolution of video game programming-The Game Loop-Time and games-Game objects-2D rendering Foundations-Sprites-Scrolling-Tile maps-Vectors -Matrices.		
UNIT II	**3D GRAPHICS FOR GAMES**	**9**
3D graphics-Basics-Coordinate-spaces-Lighting and Shading-visibility-Input Devices-Event based		

input system-Mobile Input-Basic sound-3D sound-Digital Signal Processing-Physics-Planes, Rays, and line segments-Collision geometry-Collision detection-Physics base movement-Physics middleware.		
UNIT III	**GAME DESIGN AND AI**	**9**
Cameras-Types of cameras-Perspective projection-Camera implementation-Camera support algorithm-Real AI versus Game AI-Pathfinding-State based behaviours-Strategy and planning.		
UNIT IV	**USER INTERFACE AND SCRIPTING LANGUAGES**	**9**
Menu system-HUD elements-Radar-other UI considerations-Scripting languages-Implementing a scripting language-Tokenization-Syntax Analysis-Code Execution or Generation-Data Formats-Case study UI mods in world of warcraft.		
UNIT V	**NETWORKED GAMES**	**9**
Protocols-Network Topology-Server/Client-Peer-to-Peer-Cheating-Sample game -Side scroller for iOS, Tower defence for PC/Mac-Code Analysis.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the fundamentals of game programming.
CO2: Identify the processes, mechanics, issues in game design,
CO3: Analyse the game design and artificial intelligence.
CO4: Construct a basic game engine using UI and scripting languages.
CO5: Develop code for sample games.
CO6: Understand the 3D game design

TEXT BOOKS:

1. Sanjay Madhav, Game Programming Algorithms and Techniques:A platform -Agnostic Approach-Game Design,1st Edition, Addison-Wesley Professional,2013.
2. Jouni Smed, Harri Hakonen, Algorithms and Networking for Computer Games, 2nd Edition,Wiley Publications,2017.

REFERENCES:

1. Ernest Adams and Andrew Rollings, "Fundamentals of Game Design", Prentice Hall 3rd Edition,2014.
2. JungHyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 1st Edition, 2011.

22CS921	**INDUSTRIAL IoT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

The Course will enable learners to:

- Understand the basic technologies and protocols used in Industrial IoT.
- Illustrate the models and architectures of IIoT.
- Identify and apply different sensors for various IIoT applications.
- Explain the various protocols used in IIoT.
- Build solutions for real-world problems using IIoT.
- Solve real-world problems using IIoT analytics.

UNIT I	**INTERNET OF THINGS (IoT)**	**9**
Introduction – Networking – Cyber Physical Systems – Evolution of IoT – IoT Networking Components - Addressing Strategies – IoT Sensing and Actuation.		
UNIT II	**INDUSTRIAL IoT**	**9**
Industry 4.0 – IIoT – Industrial Internet Systems – Industrial Sensing – Industrial Processes – Business Models and Reference Architecture.		
UNIT III	**SENSORS AND ACTUATORS**	**9**

Sensors – Sensor Characteristics – Sensorial Deviations – Sensing Types - Considerations – Actuators – Actuator Types – Actuator Characteristics.		
UNIT IV	**PROTOCOLS**	**9**
Processing topologies and types – Connectivity Technologies – IEEE 802.15.4 – Zigbee – RFID – LoRa – Wi-Fi – Communication Technologies – Constrained nodes – Networks – Infrastructure Protocols - IPV6 – Discovery Protocols – MQTT – MQTT-SN – SOAP - REST.		
UNIT V	**IIOT ANALYTICS AND APPLICATIONS**	**9**
IIoT Analytics – Categorization – Use – Challenges – Mapping of analytics with IIRA Architecture – Deployment of Analytics – Health care applications in industries - Inventory Management and Quality Control – Plant Safety and Security.		
		TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Elaborate the basic technologies and protocols used in Industrial IoT.
CO2: Illustrate the models and architectures of IIoT.
CO3: Interpret and apply different sensors for various IIoT applications.
CO4: Explain the various protocols used in IIoT.
CO5: Build solutions for real-world problems using IIoT.
CO6: Solve real-world problems using IIoT analytics.

TEXT BOOKS:

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
2. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press, 2020.

REFERENCES:

1. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications,1st Edition, Wiley Publications, 2013.
2. Dieter Uckelmann , Mark Harrison, Florian Michahelles, Architecting the Internet of Things, Industry 4.0: The Industrial Internet of Things, Springer-Verlag Berlin Heidelberg, 2011.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015.
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, CISCO Press, 2017.
5. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

VERTICAL III – AI AND CLOUD

22CS907	CLOUD FOUNDATIONS (Lab Integrated)	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To describe the different ways a user can interact with Cloud.
- To discover the different compute options in Cloud and implement a variety of structured and unstructured storage models.
- To confer the different application managed service options in the cloud and outline how security in the cloud is administered in Cloud.
- To demonstrate how to build secure networks in the cloud and identify cloud automation and management tools.
- To determine a variety of managed big data services in the cloud.

UNIT I	**INTRODUCTION TO CLOUD**	**6+6**
Cloud Computing - Cloud Versus Traditional Architecture - IaaS, PaaS, and SaaS - Cloud Architecture		

- The GCP Console - Understanding projects - Billing in GCP - Install and configure Cloud SDK - Use Cloud Shell - APIs - Cloud Console Mobile App.

List of Exercise/Experiments:

1. Install and configure cloud SDK.
2. Connect to computing resources hosted on Cloud via Cloud Shell.

UNIT II	**COMPUTE AND STORAGE**	**6+6**

Compute options in the cloud - Exploring IaaS with Compute Engine - Configuring elastic apps with autoscaling - Exploring PaaS - Event driven programs - Containerizing and orchestrating apps - Storage options in the cloud - Structured and unstructured storage in the cloud - Unstructured storage using Cloud Storage - SQL managed services - NoSQL managed services.

List of Exercise/Experiments:

1. Create virtual machine instances of various machine types using the Cloud Console and the command line. Connect an NGINX web server to your virtual machine.
2. Create a small App Engine application that displays a short message.
3. Create, deploy, and test a cloud function using the Cloud Shell command line.
4. Deploy a containerized application.
5. Create a storage bucket, upload objects to it, create folders and subfolders in it, and make objects publicly accessible using the Cloud command line.

UNIT III	**APIs AND SECURITY IN THE CLOUD**	**6+6**

The purpose of APIs – API Services - Managed message services - Introduction to security in the cloud - The shared security model - Encryption options - Authentication and authorization with Cloud IAM - Identify Best Practices for Authorization using Cloud IAM.

List of Exercise/Experiments:

1. Deploy a sample API with any of the API service.
2. Publish messages with managed message service using the Python client library.
3. Create two users. Assign a role to a second user and remove assigned roles associated with Cloud IAM. Explore how granting and revoking permissions works from Cloud Project Owner and Viewer roles.

UNIT IV	**NETWORKING, AUTOMATION AND MANGAEMENT TOOLS**	**6+6**

Introduction to networking in the cloud - Defining a Virtual Private Cloud - Public and private IP address basics - Cloud network architecture - Routes and firewall rules in the cloud - Multiple VPC networks - Building hybrid clouds using VPNs - Different options for load balancing - Introduction to Infrastructure as Code - Terraform - Monitoring and management tools.

List of Exercise/Experiments:

1. Create several VPC networks and VM instances and test connectivity across networks.
2. Create two nginx web servers and control external HTTP access to the web servers using tagged firewall rules.
3. Configure a HTTP Load Balancer with global backends. Stress test the Load Balancer and denylist the stress test IP.
4. Create two managed instance groups in the same region. Then, configure and test an Internal Load Balancer with the instances groups as the backends.
5. Monitor a Compute Engine virtual machine (VM) instance with Cloud Monitoring by creating uptime check, alerting policy, dashboard and chart.

UNIT V	**BIG DATA AND MACHINE LEARNING SERVICES**	**6+6**

Introduction to big data managed services in the cloud - Leverage big data operations - Build Extract, Transform, and Load pipelines - Enterprise Data Warehouse Services - Introduction to machine learning in the cloud - Building bespoke machine learning models with AI Platform - Pre-trained machine learning APIs.

List of Exercise/Experiments:

1. Create a cluster, run a simple Apache Spark job in the cluster, then modify the number of workers in the cluster.
2. Create a streaming pipeline using one of the cloud service.
3. Set up your Python development environment, get the relevant SDK for Python, and run an example pipeline using the Cloud Console.
4. Use cloud-based data preparation tool to manipulate a dataset. Import datasets, correct mismatched data, transform data, and join data.
5. Utilize a cloud-based data processing and analysis tool for data exploration and use a machine learning platform to train and deploy a custom TensorFlow Regressor model for predicting customer lifetime value.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Describe the different ways a user can interact with Cloud.

CO2: Discover the different compute options in Cloud and implement a variety of structured and unstructured storage models.

CO3: Discuss the different application managed service options in the cloud and outline how security in the cloud is administered in Cloud.

CO4: Demonstrate how to build secure networks in the cloud and identify cloud automation and management tools.

CO5: Discover a variety of managed big data services in the cloud.

CO6: Use Cloud services to build applications.

REFERENCES:

1. https://cloud.google.com/docs
2. https://www.cloudskillsboost.google/paths/36
3. https://nptel.ac.in/courses/106105223
4. Anthony J. Sequeira, "AWS Certified Cloud Practitioner (CLF-C01) Cert Guide", First Edition, Pearson Education, 2020.
5. AWS Documentation (amazon.com)
6. AWS Skill Builder
7. AWS Academy Cloud Foundations Course - https://www.awsacademy.com/vforcesite/LMS_Login

LIST OF EQUIPMENTS:

GCP / CloudSkillBoost Platform/AWS Console /AWS Academy Learner Lab.

22CS909	VIRTUALIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Explain the fundamental concepts of virtualization
- Analyze the role of hypervisors in hardware virtualization
- Apply the understanding of CPU, memory (MMU), and I/O virtualization techniques
- Assess security considerations of virtualized environments
- Discuss strategies for protecting VMs and data centers

UNIT I	INTRODUCTION	9

Virtualization - Virtual Machines - Hypervisors - Type-1 and Type-2 Hypervisors - Multiplexing and Emulation - Approaches to Virtualization and Paravirtualization - Benefits of Using Virtual Machines. Working with Virtual Machines.

UNIT II	HARDWARE VIRTUALIZATION	9

The Popek/Goldberg Theorem - Virtualization without Architectural Support: Full Virtualization - Paravirtualization - Designs Options for Type-1 Hypervisors. Hypervisors: Describing a Hypervisor - Role of Hypervisor - VMWare ESX - Citrix Hypervisor - Microsoft Hyper-V.		
UNIT III	**TYPES OF VIRTUALIZATIONS**	**10**
CPU Virtualization with VT-x: Design requirements - The VT-x Architecture - KVM. MMU Virtualization: Extended Paging - Virtualizing Memory in KVM. I/O Virtualization: Benefits of I/O Interposition - Physical I/O - Virtual I/O Without Hardware Support- Virtual I/O with Hardware Support. Virtualization Support in ARM Processors.		
UNIT IV	**VIRTUALIZATION SECURITY**	**9**
Fundamentals of Virtualization Security: Virtualization Architecture - Threats to a Virtualized Environment. Securing Hypervisors: Hypervisor Configuration and Security. Designing Virtual Networks for Security: Comparing Virtual and Physical Networks - Virtual Network Security Considerations - Configuring Virtual Switches for Security.		
UNIT V	**VIRTUALIZATION AND AVAILABILITY**	**8**
Availability - Protecting a Virtual Machine - Protecting Multiple Virtual Machines - Protecting Datacenters - Deploying Applications in a Virtual Environment - Recent Trends in Virtualization.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the basics of virtualization and its benefits.

CO2: Assess the significance of hypervisors in hardware virtualization, examining their roles and implications for system efficiency and performance

CO3: Utilize knowledge of virtualization technologies to solve practical problems and implement effective solutions

CO4: Analyze security threats and design secure virtual networks

CO5: Discuss strategies to improve availability in virtual environment and for protecting VMs and data centers

CO6: Use virtualization technology effectively to optimize system performance and resource usage in real-world settings

TEXTBOOKS:

1. Edouard Bugnion, Jason Nieh, Dan Tsafrir, “Hardware and Software Support for Virtualization”, Morgan & Claypool Publishers, 2017.
2. Matthew Portnoy, “Virtualization Essentials”, Third Edition, Sybex - John Wiley & Sons, 2023.

REFERENCES:

1. Dave Shackleford, “Virtualization Security: Protecting Virtualized Environments”, Sybex - John Wiley & Sons, 2012.
2. Nelson Ruest, Danielle Ruest, Virtualization, A beginners guide, 2009, McGrawHill.
3. Nadeau,Tim Cerng, Je Buller, Chuck Enstall, Richard Ruiz, Mastering Microsoft Virtualization, Wiley Publication, 2010.
4. William Von Hagen, Professional Xen Virtualization, Wiley Publication, 2008.

22CS910	DEVOPS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Bridge the gap between development and operations for faster, more reliable software releases.
- Automate software delivery with CI/CD pipelines.
- Package and deploy apps efficiently using Docker containers.
- Automate infrastructure with Infrastructure as Code (IaC).
- Monitor and troubleshoot applications in production.

UNIT I	INTRODUCTION TO DEVOPS	9
Software Development Methodologies - Operations Methodologies - Systems Methodologies - Development, Release, and Deployment Concepts - Infrastructure Concepts. What is DevOps? - DevOps importance and benefits -DevOps principles and practices - 7 C's of DevOps lifecycle for business agility - DevOps and continuous testing. How to choose right DevOps tools? - Challenges with DevOps implementation.		
UNIT II	**VERSION CONTROL WITH GIT**	**9**
Introduction to Git version control system - Git commands for basic operations (clone, commit, push, pull) - Branching and merging strategies - Collaboration using Git workflows.		
UNIT III	**CONTINUOUS INTEGRATION AND DELIVERY (CI/CD)**	**9**
Introduction to CI/CD pipelines - Benefits of CI/CD for faster deployments - Setting up a CI/CD pipeline with Jenkins - Automating builds, tests, and deployments.		
UNIT IV	**CONTAINERIZATION WITH DOCKER**	**9**
Introduction to containerization and its benefits - Understanding Docker concepts: images, containers, registries - Building and managing Docker containers - Docker Compose for multi-container applications - Introduction to container orchestration with Docker Swarm or Kubernetes.		
UNIT V	**INFRASTRUCTURE AS CODE (IAC) AND MONITORING**	**9**
Introduction to Infrastructure as Code (IaC) - Benefits of using IaC for repeatable infrastructure provisioning - Learning IaC with Terraform - Setting up infrastructure configurations with Terraform - Introduction to monitoring and logging tools for applications - Alerting and troubleshooting techniques.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the core principles and philosophies of DevOps.
CO2: Implement version control systems for code management and collaboration.
CO3: Automate software delivery pipelines using CI/CD tools.
CO4: Utilize containerization technologies for packaging and deploying applications.
CO5: Configure infrastructure as code (IaC) for repeatable deployments.
CO6: Monitor and maintain applications in a production environment.

TEXT BOOKS:

1. Deepak Gaikwad, Viral Thakkar, "DevOps Tools: from Practitioner's Point of View", Wiley, 2019.
2. Jennifer Davis, Ryn Daniels, "Effective DevOps", O'Reilly Media, 2016.

REFERENCES:

1. Gene Kim, Jez Humble, Patrick Debois, "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations", IT Revolution Press, 2016.
2. Jez Humble, Gene Kim, "Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation", Addison-Wesley, 2010.
3. Yevgeniy Brikman, "Terraform: Up & Running: Writing Infrastructure as Code", O'Reilly Media, 2019.
4. Joseph Muli, "Beginning DevOps with Docker", Packt Publishing, 2018.

22CS911	DATA ENGINEERING IN CLOUD	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- ✓ Grasp the fundamentals of data engineering, emphasizing cloud-based data access.
- ✓ Construct robust and secure data pipelines using Cloud services.
- ✓ Select and implement appropriate data storage solutions while prioritizing pipeline security.

- ✓ Utilize cloud tools for handling extensive data for machine learning purposes.
- ✓ Efficiently analyze, visualize, and automate data pipelines to streamline operations.

UNIT I	INTRODUCTION	8

Introduction to data Engineering - The Data Engineering Life Cycle - Data Engineering and Data Science - Data-Driven Organizations: Data-driven decisions - The data pipeline - The role of the data engineer in data-driven organizations - Modern data strategies - The Elements of Data: The five Vs of data – volume, velocity, variety, veracity, and value. Demo: Accessing and Analyzing Data by Using Amazon S3.

UNIT II	SECURE AND SCALABLE DATA PIPELINES	10

The evolution of data architectures - Modern data architecture on AWS - Modern data architecture pipeline: Ingestion and storage - Processing and consumption - Streaming analytics pipeline - Security of analytics workloads - Scaling - Creating a scalable infrastructure and components. ETL and ELT comparison - Data wrangling.

UNIT III	STORING AND ORGANIZING DATA	9

Comparing batch and stream ingestion - Batch ingestion processing - Purpose-built ingestion tools - AWS Glue for batch ingestion processing - Kinesis for stream processing - Scaling considerations for batch processing and stream processing - Storage in the modern data architecture - Data lake storage - Data warehouse storage - Purpose-built databases - Storage in support of the pipeline - Securing storage.

UNIT IV	PROCESSING BIG DATA AND DATA FOR ML	10

Big data processing concepts - Apache Hadoop - Apache Spark - Amazon EMR - Managing your Amazon EMR clusters - Apache Hudi - The ML lifecycle - Collecting data - Applying labels to training data with known targets - Preprocessing data - Feature engineering - Developing a model - Deploying a model - ML infrastructure on AWS - SageMaker - Amazon CodeWhisperer - AI/ML services on AWS.

UNIT V	DATA ANALYSIS AND VISUALIZATION	8

Analyzing and Visualizing Data: Considering factors that influence tool selection - Comparing AWS tools and services - Selecting tools for a gaming analytics use case. Automating the Pipeline: Automating infrastructure deployment - CI/CD - Automating with Step Functions.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand data engineering, pipelines & access data in the cloud.
CO2: Build secure & scalable data pipelines using AWS services.
CO3: Choose the right data storage & secure your data pipelines.
CO4: Process big data for machine learning with cloud tools.
CO5: Analyze & visualize data and automate data pipelines.
CO6: Apply best practices in data governance, compliance, and ethics throughout the data engineering process, ensuring responsible handling and usage of data.

TEXT BOOKS:

1. Martin Kleppman, “Data Engineering: Building Reliable Scalable Data Systems”, O'Reilly Media, 2017.
2. Wes McKinney, “Python for Data Analysis”, 2nd Edition, O'Reilly Media, 2017.

REFERENCES:

1. Martin Kleppman, “Designing Data-Intensive Applications”, O'Reilly Media, 2017.
2. AWS Documentation (amazon.com)
3. AWS Skill Builder
4. AWS Academy Data Engineering Course - https://www.awsacademy.com/vforcesite/LMS_Login

22CS933	MACHINE LEARNING FOR NLP IN CLOUD	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Illustrate how to apply the ML pipeline to NLP.
- Implement text extraction to obtain data from web pages.
- Build a solution that uses AWS services to transcribe and translate text from multimedia.
- Build a solution using a combination of algorithms and Amazon Machine Learning (Amazon ML) services.
- Identify use cases to use generative AI and LLMs.
- Use LLMs with AWS generative AI services.

UNIT I	Introduction to NLP	8

NLP – Business Problems Solved by NLP – NLP Roles - NLP and ML – Common NLP tasks – Apply ML to NLP problem - Evolution of NLP architectures.

UNIT II	Processing Text for NLP	10

Text processing overview - Getting text - Extracting Text from Webpages and Images - Text preprocessing - Vectorizing text - Encoding and Vectorizing Text - Advanced processing - Storing and visualizing unstructured data – Implement Sentiment Analysis - Identifying the steps for text processing - Examining the algorithms for sentiment analysis.

UNIT III	Information Extraction	9

Information extraction overview - Types of information extraction - Implementing information extraction – Working with Entities - Topic Modeling - Identifying the approach - Implementing Topic Modeling with Amazon Comprehend, Neural Topic Model (NTM).

UNIT IV	Translating Languages	9

Working with language issues - Detecting and translating languages - Transcribing and vocalizing text with AWS services - Implementing a Multilingual Solution.

UNIT V	Generative AI	9

Generative AI - Amazon Bedrock Overview - Introducing foundations models and large language models - Transformer architecture - LLMs configuration parameters - Introducing prompt engineering - Use LLMs to Perform NLP Tasks - Adapting LLMs - Application Integration.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Apply the ML pipeline to NLP.
CO2: Implement text extraction to obtain data from webpages.
CO3: Build a solution that uses AWS services to transcribe and translate text from multimedia.
CO4: Build a solution using a combination of algorithms and Amazon Machine Learning (Amazon ML) services.
CO5: Identify use cases to use generative AI and LLMs.
CO6: Use LLMs with AWS generative AI services.

TEXT BOOKS:

1. Mona M, Premkumar Rangarajan, Natural Language Processing with AWS AI Services, Packt Publications, 2021.

REFERENCES:

1. Saket S R Mengle, Maximo Gurmendez, Mastering Machine Learning on AWS: Advanced machine learning in Python using SageMaker, Apache Spark, and TensorFlow, Packt Publications, 2019.
2. AWS Documentation (amazon.com)
3. AWS Skill Builder
4. AWS Academy Machine Learning for Natural Language Processing Course - https://www.awsacademy.com/vforcesite/LMS_Login

22CS934	CLOUD SERVICES MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- ✓ Introduce Cloud Service Management terminology, definition & concepts
- ✓ Compare and contrast cloud service management with traditional IT service management
- ✓ Identify strategies to reduce risk and eliminate issues associated with adoption of cloud services
- ✓ Select appropriate structures for designing, deploying and running cloud-based services in a business environment
- ✓ Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

UNIT I	CLOUD SERVICE MANAGEMENT FUNDAMENTALS	9

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models.

UNIT II	CLOUD SERVICES STRATEGY	9

Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture.

UNIT III	CLOUD SERVICE MANAGEMENT	9

Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management.

UNIT IV	CLOUD SERVICE ECONOMICS	9

Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models.

UNIT V	CLOUD SERVICE GOVERNANCE & VALUE	9

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Exhibit cloud-design skills to build and automate business solutions using cloud technologies.

CO2: Possess Strong theoretical foundation leading to excellence and excitement towards adoption of cloud-based services

CO3: Solve the real world problems using Cloud services and technologies

CO4: Develop and deploy services on the cloud and set up a cloud environment

CO5: Explain security challenges in the cloud environment

CO6: Demonstrate proficiency in integrating cloud technologies and services to address diverse business challenges effectively.

TEXT BOOKS:

1. Enamul Haque, "Cloud Service Management and Governance: Smart Service Management in Cloud Era", Enel Publications, 2023.
1. Thomas Erl, Ricardo Puttini, Zaigham Mohammad, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall, 2013.

REFERENCES:

1. Thomas Erl, Robert Cope, Amin Naserpour, "Cloud Computing Design Patterns", Prentice Hall,

2015.
2. Praveen Ayyappa, "Economics of Cloud Computing", LAP Lambert Academic Publishing, 2020.
3. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing Foundations and Applications Programming", Elsevier, 2013.

VERTICAL IV – HIGH PERFORMANCE COMPUTING

22AM911	MULTI-CORE ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the need for multi-core processors, and their architecture.
- To understand the challenges in parallel and multi-threaded programming.
- To learn about the various parallel programming paradigms.
- To develop multi core programs.
- To design parallel solutions.

UNIT I	MULTI-CORE PROCESSORS	9

Single core to Multi-core architectures – SIMD and MIMD systems – Interconnection networks - Symmetric and Distributed Shared Memory Architectures – Cache coherence - Performance Issues – Parallel program design

UNIT II	PARALLEL PROGRAM CHALLENGES	9

Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication between threads (condition variables, signals, message queues and pipes).

UNIT III	SHARED MEMORY PROGRAMMING WITH OpenMP	9

Compiling and running OpenMP programs,The Trapezoidal rule,The parallel for directive, scheduling loops- Producers and consumers .

UNIT IV	DISTRIBUTED MEMORY PROGRAMMING WITH MPI	9

MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived datatypes – Performance evaluation.

UNIT V	PARALLEL PROGRAM DEVELOPMENT	9

Case studies - n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Illustrate multicore architectures and identify their characteristics and challenges.
CO2: Identify the issues in programming Parallel Processors.
CO3: Write programs using OpenMP and MPI.
CO4: Design parallel programming solutions to common problems.
CO5: Compare and contrast programming for serial processors and programming for parallel processors.
CO6: Elaborate on various concepts of multi-core architectures.

TEXT BOOKS:

1. Peter S. Pacheco, “An Introduction to Parallel Programming”, Morgan-Kauffman/Elsevier, 2011.
2. Darryl Gove, “Multicore Application Programming for Windows, Linux, and Oracle Solaris”, Pearson, 2011.

REFERENCES:

1. Michael J Quinn, “Parallel programming in C with MPI and OpenMP‖”, Tata McGraw Hill,2003.
2. Victor Alessandrini, “Shared Memory Application Programming Concepts and Strategies in Multicore Application Programming, ”, 1st Edition, Morgan Kaufmann, 2015.
3. Yan Solihin, “Fundamentals of Parallel Multicore Architecture”, CRC Press, 2015.

22AM912	GPU COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To understand the basics of GPU Architectures and CUDA Programming.
- To learn synchronization using CUDA.
- To discuss memories and its impact on performance.
- To understand the various parallel algorithms on GPU.
- To learn the basics of OPENCL.

UNIT I	GPU ARCHITECTURES AND CUDA PROGRAMMING	9

Heterogeneous Parallel Computing – Architecture of a modern GPU – Parallel Programming languages and models – GPU Computing – Introduction to Data Parallelism and CUDA C: Data Parallelism – CUDA Program Structure – A vector additional Kernel – Device Global Memory and Data Transfer – Kernel functions and Threading.

UNIT II	MULTI-DIMENSIONAL DATA & SYNCHRONIZATION	9

CUDA Thread Organization - Mapping Threads to Multi-Dimensional Data – Synchronization and Transparent Scalability – Assigning resources to Blocks – Querying Device Properties – Thread Scheduling and Latency Tolerance.

UNIT III	CUDA MEMORIES & PERFORMANCE	9

CUDA Memories – Memory Access Efficiency – CUDA Device Memory Types – Reducing global Memory Traffic – Performance Considerations - Warps and Thread Execution – Global Memory Bandwidth – Dynamic Partitioning of Execution Resources – Instruction Mix and Thread Granularity.

UNIT IV	ALGORITHMS ON GPU	9

Parallel Patterns: Convolution – Prefix Sum – Sparse Matrix – Vector Multiplication.

UNIT V	OPENCL BASICS	9

Introduction – OpenCL Platform Model – Execution Model – Programming model – Memory Model – OpenCL Runtime.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Understand the basics of GPU Architectures and implement simple CUDA Programs.
CO2: Discuss synchronization using CUDA.
CO3: Elaborate CUDA memories and its impact on performance.
CO4: Design various parallel algorithms on GPU.
CO5: Solve simple problems using parallel algorithms.
CO6: Apply OpenCL to solve programs and improve performance.

TEXT BOOKS:

1. David Kirk and Wen-mei Hwu, Programming Massively Parallel Processors – A hands-on Approach, Morgan Kaufmann, Second Edition, 2013.
2. Benedict Gaster,Lee Howes, David R. Kaeli , “Heterogeneous Computing with OpenCL”, Third Edition, Morgan Kaufman, 2012.

REFERENCES:

1. David Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, "Heterogeneous Computing with OpenCL 2.0", Third Edition, Morgan Kaufman, 2015.
2. John L.Hennessy and David A. Patterson, "Computer Architecture - A Quantitative Approach", Sixth Edition, Morgan Kaufman, 2017.
3. NPTEL Courses:
   a. GPU Architectures And Programming - https://onlinecourses.nptel.ac.in/noc23_cs61/preview

	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Describe discrete time signals & systems and represent in frequency domain.
- Apply the principles of z-transforms to finite difference equations.
- Get familiarized with various structures of IIR and FIR systems.
- Design and realize various digital filters for digital signal processing.
- Understand the architecture of various digital signal processors.

UNIT I	INTRODUCTION	9

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals, sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

UNIT II	DISCRETE TIME SYSTEM ANALYSIS	9

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z transform, application to discrete systems - Stability analysis, frequency response – Convolution – (Linear and circular convolution)

UNIT III	DISCRETE FOURIER TRANSFORM & COMPUTATION	9

Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure.

UNIT IV	DESIGN OF DIGITAL FILTERS	9

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. Analog filter design – Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.

UNIT V	DIGITAL SIGNAL PROCESSORS	9

Introduction – Architecture of TMS320C50X– Features – Addressing Formats – Functional modes - Architecture of TMS320C54X.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Analyze the properties of various Signals and Systems.
CO2: Apply Z transform technique in Discrete Time signal analysis.
CO3: Examine Discrete Time Linear Time-Invariant (LTI) systems utilizing Discrete-Time Fourier Transform (DTFT).
CO4: Compute decimation-in time - FFT and decimation-in-frequency - FFT for reducing the computational complexity of DFT.
CO5: Analyze IIR and FIR Filters on digital signal processors.
CO6: Summarize the architecture of programmable digital signal processors.

TEXT BOOKS:

1. S.K. Mitra, Digital Signal Processing: Computer Based Approach, 4th edition, TMH, New Delhi, India, 2013.

2. J. G. Proakis, D.G. Manolakis and D. Sharma, Digital Signal Processing Principles, Algorithms and Applications, 4th edition, Pearson Education, Noida, India-2014.
3. Lonnie C. Ludeman , "Fundamentals of Digital Signal Processing", Wiley -2013.

REFERENCES:

1. Poorna Chandra S, Sasikala. B. Digital Signal Processing, Vijay Nicole/TMH, 2013.
2. Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab", Cengage Learning, 2014.
3. Sen M. Kuo, Woon-Seng S. Gan, "Digital Signal Processors, Architecture, Implementations & Applications", Pearson, 2013.
4. Dimitris G.Manolakis, Vinay K. Ingle, applied Digital Signal Processing, Cambridge, 2012.
5. Oppenhiem V.A.V and Schaffer R.W, Discrete – time Signal Processing, 3rd edition, Prentice Hall, New Jersey, US, 2013.

22CS924	QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Analyse the behaviour of basic quantum algorithms.
- Discuss simple quantum algorithms and information channels in the quantum circuit model.
- Apply the quantum algorithms in superdense coding and quantum teleportation.
- Analyse the algorithms with super-polynomial speed-up.
- Illustrate a simple quantum error-correcting code.

UNIT I	FOUNDATION	9

Overview of traditional computing – Church-Turing thesis – circuit model of computation – reversible computation – quantum physics – quantum physics and computation – Dirac notation and Hilbert Spaces – dual vectors – operators – the spectral theorem – functions of operators – tensor products – Schmidt decomposition theorem.

UNIT II	QUBITS AND QUANTUM MODEL OF COMPUTATION	9

State of a quantum system – time evolution of a closed system – composite systems – measurement – mixed states and general quantum operations – quantum circuit model – quantum gates – universal sets of quantum gates – unitary transformations – quantum circuits.

UNIT III	QUANTUM ALGORITHMS-I	9

Superdense coding – quantum teleportation – applications of teleportation – probabilistic versus quantum algorithms – phase kick-back – the Deutsch algorithm – the Deutsch- Jozsa algorithm – Simon's algorithm – Quantum phase estimation and quantum Fourier Transform – eigenvalue estimation.

UNIT IV	QUANTUM ALGORITHMS – II	9

Order-finding problem – eigenvalue estimation approach to order finding – Shor's algorithm for order finding – finding discrete logarithms – hidden subgroups – Grover's quantum search algorithm – amplitude amplification – quantum amplitude estimation – quantum counting – searching without knowing the success probability.

UNIT V	QUANTUM COMPUTATIONAL COMPLEXITY AND ERROR CORRECTION	9

Computational complexity – black-box model – lower bounds for searching – general black-box lower bounds – polynomial method – block sensitivity – adversary methods – classical error correction – classical three-bit code – fault tolerance – quantum error correction – three- and nine-qubit quantum codes – fault-tolerant quantum computation.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Analyse the behaviour of basic quantum algorithms.
CO2: Discuss simple quantum algorithms and information channels in the quantum circuit model.
CO3: Apply the quantum algorithms in superdense coding and quantum Teleportation.
CO4: Analyse the algorithms with super polynomial speed-up.
CO5: Illustrate a simple quantum error-correcting code.
CO6: Elaborate various quantum alogirthms.

TEXT BOOKS:

4. P. Kaye, R. Laflamme, and M. Mosca, "An introduction to Quantum Computing", Oxford University Press, 2007.
5. E. Rieffel and W. Polak, "Quantum Computing A Gentle Introduction", The MIT Press Cambridge, 2011.

REFERENCES:

6. Jack D. Hidary "Quantum Computing: An Applied Approach", Springer, 2019.
7. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing Company, 2007.
8. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Quantum Information", Tenth Edition, Cambridge University Press, 2010.

22AM913	SCALABLE MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Discuss the basics of how distributed computing is applied in scaling up machine learning process.
- Use scalable machine learning frameworks for parallel learning.
- Apply parallel Machine Learning Algorithms that can scale up.
- Distinguish traditional ML algorithms and Scalable ML algorithms.
- Discuss alternative learning for scalability.
- Solve Large-scale real-world problems using GPUs and Multi-core systems.

UNIT I	INTRODUCTION	9

Scaling Up – Reasons – Key Concepts – Platforms – Distributed Machine Learning – Stages of ML Workflow – Tools and Technologies in ML Pipeline – Distributed Computing Models – Distributed Systems Architecture – Ensemble Models – Challenges.

UNIT II	FRAMEWORKS FOR SCALLING UP	9

Apache Spark Architecture – PySpark – MapReduce for Massively Parallel Learning – Uniformly Fine-Grained Data-Parallel Computing – GP-GPU.

UNIT III	LEARNING ALGORITHMS	9

PSVM: Parallel Support Vector Machines with Incomplete Cholesky Factorization - PSVM Algorithm - Massive SVM Parallelization Using Hardware Accelerators - SMO Algorithm - Large-Scale Learning to Rank Using Boosted Decision Trees – LambdaMART - Large-Scale Spectral Clustering with MapReduce and MPI.

UNIT IV	ALTERNATIVE LEARNING	9

Parallel Online Learning - Limits Due to Bandwidth and Latency - Parallelization Strategies - Delayed Update Analysis - Parallel Learning Algorithms - Global Update Rules - Distributed Transfer Learning via Cooperative Matrix Factorization - Distributed Coalitional Learning - Extension of DisCo to Classification Tasks - Parallel Large-Scale Feature Selection.

UNIT V	APPLICATIONS	9

Large-Scale Learning for Vision with GPUs - Standard Pipeline – GPUs – Approach - Feature Learning with Deep Belief Networks - Mining Tree-Structured Data on Multicore Systems - Multicore Challenge - Memory Optimizations - Adaptive Parallelization - Empirical Evaluation.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Discuss the basics of how distributed computing is applied in scaling up machine learning process.
CO2: Use scalable machine learning frameworks for parallel learning.
CO3: Apply parallel Machine Learning Algorithms that can scale up.
CO4: Distinguish traditional ML algorithms and Scalable ML algorithms.
CO5: Discuss alternative learning for scalability.
CO6: Solve Large-scale real-world problems using GPUs and Multi-core systems.

TEXT BOOKS:

1. Ron Bekkerman, Mikhail Bilenko and John Langford, Scaling Up Machine Learning: Parallel and Distributed Approaches, Cambridge University Press, 2012.
2. Adi Polak, Scaling Machine Learning with Spark, O'Reilly Media, 2023.

REFERENCES:

1. J. Joshua Thomas, S. Harini, V. Pattabiraman, Scalable and Distributed Machine Learning and Deep Learning Patterns (Advances in Computational Intelligence and Robotics), IGI Global, 2023.
2. Bastiaan Sjardin, Luca Massaron, Alberto Boschetti, Large Scale Machine Learning with Python, Packt Publications, 2016.

22AM914	OPTIMIZATION METHODS IN MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of different Submodular functions and Associated Ployhedra.
- To discuss Submodularity and its Applications.
- To analyze the various methods of Non-Smooth Convex Optimizations.
- To analyze the various Separable Optimization Problems.
- To discuss the various Submodular minimization methods and optimizations.

UNIT I	INTRODUCTION	9

Introduction – Definition – Submodularity – Associated Polyhedra – Polymatroids – Lovasz Extension – Definition – Greedy Algorithm – Links between submodularity and convexity.
Properties of Associated Polyhedra: Support functions – Facial Structure – Positive and Symmetric submodular Polyhedra.

UNIT II	SUBMODULARITY	9

Convex and Concave closures of set functions – Structured Sparsity – Convex Relaxation of Combinatorial Penalty – l_q relaxations of submodular penalties – Shaping level sets – Examples and Applications of Submodularity – Cardinality based functions – Cut functions – Set Covers – Flows – Entropies – Spectral functions of submatrices – Best Subset Selection – Matroids.

UNIT III	NON-SMOOTH CONVEX OPTIMIZATION	9

Projected Subgradient descent – Ellipsoid Method – Kelly's Method – Analytic Centre Cutting planes – Mirror descent/conditional gradient – Bundle and Simplicial Methods – Proximal Methods – Simplex algorithm for Linear Programming – Active Set Method for Quadratic Programming – Active Set Algorithms for Least-squares Problems.

UNIT IV	SEPARABLE OPTIMIZATION PROBLEMS	9

Analysis: Optimality conditions for base polyhedral – Equivalence with submodular function Minimization – Quadratic Optimization Problems – Separable problems on other polyhedra.
Algorithms: Divide-and Conquer algorithm for proximal problems – Iterative algorithms – Exact minimization-Approximate minimization.

UNIT V	SUBMODULAR MINIMIZATION AND OPTIMIZATION	9

Minimizers of Submodular Functions – Combinatorial Algorithms – Minimizing Symmetric posimodular functions – Ellipsoid method – Simplex method for Submodular function minimization – Analytic centre cutting planes -Minimum norm point algorithm – Approximate minimization through convex

optimization – Special Structure. Maximization with cardinality constraints – Submodular function minimization.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand the basics of different Submodular functions and Associated Ployhedra.
CO2: Discuss Submodularity and its Applications.
CO3: Analyze the various methods of Non-Smooth Convex Optimizations.
CO4: Analyze the various Separable Optimization Problems.
CO5: Discuss the various Submodular minimization methods and optimizations.
CO6: Apply various optimization methods to solve real-world problem in machine learning.

TEXT BOOKS:

1. Francis Bach, "Learning with Submodular Functions: A Convex Optimization Perspective", Foundations and Trends in Machine Learning, Now Publishers Inc., 2013.

REFERENCES:

1. A. Beck, "First-Order Methods in Optimization", MOS-SIAM Series on Optimization, 2017.
2. S. Bubeck, "Convex Optimization: Algorithms and Complexity, Foundations and Trends in Optimization", 2015.
3. Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press, Seventh Edition, 2009.
4. Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright, Optimization for Machine Learning, The MIT Press, 2012.

HONOURS VERTICAL – INTELLIGENT HEALTHCARE

22AM915	AI AND ML FOR HEALTHCARE	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To gain a deep insight into the key concepts of AI and Big data for healthcare.
- To familiarize the principles of drug discovery and molecular modeling.
- To learn the various techniques of machine intelligence for Cancer prediction.
- To explore the recent trends in medical imaging.
- To understand the Remote patient monitoring and AI assisted surgery techniques.

UNIT I	CURRENT HEALTHCARE, BIG DATA, AND MACHINE LEARNING	6+6

Current healthcare practice- Value-based treatments and healthcare services- Increasing data volumes in healthcare – Analytics of healthcare data – The new age of healthcare- Precision medicine- Artificial intelligence and medical visualization- Intelligent personal health records-
Robotics and artificial intelligence-powered devices- Ambient assisted living- Success factors for artificial intelligence in healthcare

List of Lab Exercises:

1. Perform Diagnostic Analytics for a medical data set
2. Perform Prescriptive Analytics for a medical data set

UNIT II	DRUG DISCOVERY AND MOLECULAR MODELING	6+6

Introduction - The scope of artificial intelligence in drug discovery- Types of machine learning in artificial intelligence- Molecular modeling and databases in AI for drug molecules- ML methods in molecular modeling- Drug characterization- Drug design for neuroreceptors using ANN techniques- Use of deep learning in drug design

List of Lab Exercises:

1. Perform drug discovery Analytics using pharmaceutical data set
2. Perform Molecular Modeling Analytics using Molecular Modeling DataBase

UNIT III	CANCER DIAGNOSTICS AND TREATMENT DECISIONS	6+6

Background- AI, ML, and deep learning in cancer- Determine cancer susceptibility- Enhanced cancer diagnosis and staging- Predict cancer treatment response- Predict cancer recurrence and survival- Personalized cancer pharmacotherapy

List of Lab Exercises:

1. Perform Cancer Detection Analytics using a medical data set.
2. Perform Cancer Treatment Decision Analytics using a medical data set.

UNIT IV	ARTIFICIAL INTELLIGENCE FOR MEDICAL IMAGING	6+6

Introduction – AI in radiology/medical imaging – overcoming the hurdles - X-rays and AI in medical imaging - Ultrasound and AI in medical imaging- Application of AI in medical imaging - The development of AI in medical devices - Limitations of AI in medical devices - The future frontiers of AI in medical devices

List of Lab Exercises:

1. Perform Xray Image Analysis using a medical data set.
2. Perform Ultrasound Analysis using a medical data set.

UNIT V	REMOTE PATIENT MONITORING USING AI	6+6

Introduction - Deploying patient monitoring - The role of AI in remote patient monitoring - Diabetes prediction and monitoring using AI - Cardiac monitoring using AI - Neural applications and remote patient monitoring - Artificial intelligence assisted surgery- Preoperative – Intraoperative - Postoperative

List of Lab Exercises:

1. Develop a IOT based Remote Patient Monitoring system Project

TOTAL: 30+30=60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the key concepts of AI and Big data for healthcare.
CO2: Illustrate the principles of drug discovery and molecular modeling.
CO3: Implement various techniques of machine intelligence for Healthcare applications.
CO4: Identify the recent trends in medical imaging.
CO5: Understand the Remote patient monitoring system.
CO6: Apply various algorithms of AI and ML to solve Healthcare problems.

TEXT BOOKS:

1. Adam Bohr, Kaveh Memarzadeh, Artificial Intelligence in Healthcare, Academic Press is an imprint of Elsevier, 2020.

REFERENCES:

1. Arjun Panesar ,Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes, APress, 2019.
2. Rangaraj M. Rangayyan, Biomedical Image Analysis, 2004.
3. Ranjay Krishna, "Computer Vision: Foundations and Applications", Standford University, 2017.
4. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer 2011.
5. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, 3rd Edition, Wiley, 2018.

LIST OF EQUIPMENTS:

Systems with Anaconda, Jupyter Notebook, Python

22AM916	MEDICAL IMAGE ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand of various medical imaging modalities.
- Explore advanced deep learning techniques for medical image analysis.

- Develop solutions by preprocessing medical images, implementing machine learning and deep learning algorithms.
- Examine the ethical implications and societal impact of deploying machine learning models in healthcare.
- Elaborate on recent advances and research trends in machine intelligence for medical image analysis.

UNIT I	INTRODUCTION TO MEDICAL IMAGING	9

Overview of medical imaging modalities -MRI, CT, X-ray, Ultrasound-Basics of image acquisition, processing, and visualization in medical imaging-Challenges and importance of medical image analysis-Introduction to common medical imaging datasets.

UNIT II	FUNDAMENTALS OF MACHINE LEARNING	9

Introduction to machine learning concepts-Supervised, unsupervised, and semi-supervised learning-Feature extraction and feature selection techniques-Evaluation metrics for machine learning models.

UNIT III	DEEP LEARNING FUNDAMENTALS	9

Basics of artificial neural networks (ANNs)-Convolutional Neural Networks (CNNs) for image analysis-Recurrent Neural Networks (RNNs) for sequential data analysis-Transfer learning and pre-trained models.

UNIT IV	MEDICAL IMAGE PREPROCESSING	9

Image preprocessing techniques specific to medical images -noise reduction, normalization-Segmentation techniques-thresholding, region growing-Registration and alignment of medical images-Data augmentation for medical image datasets

UNIT V	MEDICAL IMAGE ANALYSIS	9

Classification of medical images using machine learning algorithms-Object detection and localization in medical images-Case studies and applications of machine learning in medical image analysis.
Overview of deep learning architectures for medical image analysis-Semantic segmentation for medical images-Generative models for medical image synthesis-Ethical considerations and challenges in deploying deep learning models in healthcare.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Demonstrate a comprehensive understanding of various medical imaging modalities.
CO2: Apply machine learning and deep learning techniques.
CO3: Develop solutions by preprocessing medical images, implementing machine learning and deep learning algorithms.
CO4: Understand the ethical considerations and regulatory requirements associated with deploying machine intelligence models in healthcare settings.
CO5: Elaborate on recent advances and research trends in machine intelligence for medical image analysis.
CO6: Illustrate the applications of ML and DL in medical image analysis.

TEXT BOOKS:

1. Le Lu, Yefeng Zheng, Gustavo Carneiro, Lin Yang , Deep Learning and Convolutional Neural Networks for Medical Image Computing Precision Medicine, High Performance and Large-Scale Dataset, Springer, 2017.
2. Atam P. Dhawan, “Medical Image Analysis", Wiley Publications, 2010.

REFERENCES:

1. Ton J. Cleophas and Aeilko H. Zwinderman , Machine Learning in Medicine - A Complete Overview", Springer, 2015.
2. Nadine Barrie Smith and Andrew Webb, “Introduction to Medical Imaging: Physics, Engineering and Clinical Applications", Cambridge University Press, 2010.

22AM917	CLINICAL DATA SCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Discuss standards to generate clinical data from electronic medical records.
- Elaborate various Modelling methods on Clinical Data.
- Illustrate methods to perform clinical data analysis using various data analysis techniques.
- Interpret clinical data analysis to support decision making.
- Apply statistics to improve the quality of decision making.
- Develop applications using Clinical Data.

UNIT I	INTRODUCTION	9

Data Sources – Electronic Medical Records – Laboratory Information Management Systems - GDPR – Data Types – Data Standards – Big Clinical Data – Data Landscape – Standardizing Clinical Data.

UNIT II	CLINICAL DATA TO MODELS	9

Preparing Data for Predictive Modelling – Designs for Model Development – Sample size – Missing Data – Time-Domain Processing – Frequency-Domain Processing – Prediction Modelling Methodology.

UNIT III	CLINICAL DATA ANALYSIS	9

Clinical Trials – Classifications – Discrete Data Analysis – Failure-time Data Analysis – Quantitative Data Analysis – Multiplicity Analysis.

UNIT IV	MEDICAL STATISTICS	9

Prove Prior Hypothesis – Improve the quality of research – Testing Randomness – Quality criteria.

UNIT V	APPLICATIONS	9

Clinical Decision Support System – Types – Challenges - Best Knowledge & Continuous Improvement of Knowledge and CDSS Methods – Mobile CDSS – Care Process – Operational Excellence – Process Mining - Sociotechnical Systems & Leadership - Value-Based Health Care Supported by Data Science.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Generate clinical data from electronic medical records.
CO2: Employ various Modelling methods on Clinical Data.
CO3: Perform clinical data analysis using various data analysis techniques.
CO4: Interpret clinical data to support decision making.
CO5: Apply statistics to improve the quality of decision making.
CO6: Develop applications using Clinical Data.

TEXT BOOKS:

1. Pieter Kubben, Michel Dumontier, Andre Dekker, Fundamentals of Clinical Data Science, Springer, 2019.
2. Ton J. Cleophas, Aeilko H. Zwinderman, Understanding Clinical Data Analysis: Learning Statistical Principles from Published Clinical Research, Springer, 2016.

REFERENCES:

1. Aeilko H. Zwinderman, Ton J. Cleophas, Machine Learning in Medicine - A Complete Overview, Springer, 2021.

22AM918	DEEP LEARNING IN GENOMICS AND LIFE SCIENCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Represent molecules and proteins as features for building machine learning models.
- Emphasize how to extract interpretable, biological insights from deep learning models.

- Illustrate the applications of deep learning in genomics.
- Analyze different models for Genomic applications.
- Employ various deep learning tools for genomics.
- Apply GANs for improving the models.

UNIT I	MACHINE LEARNING IN GENOMICS	9

Machine Learning for Genomics - Biopython – Genomics Data Analysis – Genome – Genome sequencing – Sanger sequencing of nucleic acids – Evolution of next generation sequencing – Analysis – steps – Calculating GC content – nucleotide content- Dinucleotide content – Modelling – Motif finder.
Case Study: Sequence Analysis of Covid-19

UNIT II	BIOPHYSICAL MACHINE LEARNING	9

Molecule - Molecular Bonds - Molecular Graphs - Molecular Conformations - Chirality of Molecules - Featurizing a Molecule - Graph Convolutions - Protein Structures - Protein Sequences - Biophysical Featurizations - Grid Featurization - Atomic Featurization.
Case Study: Analyzing the PDBBind Dataset.

UNIT III	DEEP LEARNING FOR GENOMIC APPLICATIONS	9

DNNs for Genomics – workflow for Genomics – Protein structure predictions – Regulatory genomics – Gene regulatory Networks – Single-cell RNA sequencing – Deep learning libraries for genomics.
Case Study: Disease prediction

UNIT IV	CNN AND RNN FOR GENOMICS	9

Transfer Learning – CNNs for Genomics – Applications – Deep Bind – DeepInsight – DeepChrome – DeepVariant – Applications and use cases of RNNs in Genomics – DeepNano – ProLanGo – DanQ – Autoencoders for genomics – Gene Expression.
Case Study: Predicting Gene expression from TCGA pan-cancer RNA-S using denoising autoencoders.

UNIT V	MODEL IMPROVEMENT	9

GANs for Improving Models – Difference between Discriminative and Generative Models – Challenges – synthetic data – Applications – Analysis of ScRNA-Seq data – Generation of DNA.
Case Study: Personalized Medicine

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Represent molecules and proteins as features for building machine learning models.
CO2: Extract interpretable, biological insights from deep learning models.
CO3: Illustrate the applications of deep learning in genomics.
CO4: Analyze different models for Genomic applications.
CO5: Employ various deep learning tools for genomics.
CO6: Apply GANs for improving the models.

TEXT BOOKS:

1. Upendra Kumar Devisetty, Deep Learning for Genomics: Data-driven approaches for genomics applications in life sciences and biotechnology, packt Publications, 2022.
2. Bharath Ramsundar, Peter Eastman, Patrick Walters, Vijay Pande, Deep Learning for the Life Sciences: Applying Deep Learning to Genomics, Microscopy, Drug Discovery & More, O'Reilly, 2019.

REFERENCES:

1. Sanjiban Sekhar Roy, Y.-H. Taguchi, Handbook of Machine Learning Applications for Genomics, Springer, 2022.
2. Shailza Singh, Machine Learning and Systems Biology in Genomics and Health, Springer, 2022.

22AM919	BIO-INFORMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand and develop models for Biological Data.
- Implement image processing Techniques to Bioinformatics Data
- Implement Micro Array analysis over Genome Expression.
- Understand the study of simbiology.
- Understand the pharmacokinetic modeling.
- Understand the working model of biological data in Matlab.

UNIT I	INTRODUCTION	9

Overview of Bioinformatics Technologies – Structural Bioinformatics – Data Format and Processing – Secondary Resources and Applications – Role of Structural Bioinformatics – Biological Data Integration System

UNIT II	BIOINFORMATICS TOOL BOX	9

Sequence Analysis – NGS – Graph Theory – Gene Ontology – Importing Data and Deploying.

UNIT III	BIOLOGICAL DATA ANALYSIS	9

Microarray Data Analysis – Mass Spectrometry Data Analysis – Statistical Classification of Biological Data.

UNIT IV	IMAGE PROCESSING	9

Key Features of Image Processing – Importing and Exporting Images – Image File Formats and Format Conversion – Pre and Post Processing Images – Spatial Transformations and Image Registration – Microarray Image Analysis.

UNIT V	SYSTEMS BIOLOGY	9

Basics of Enzyme Kinetics – Kinetic Laws – Modeling Biological System: Simulation, Sensitivity Analysis, Parameter Estimation using Simbiology – Pharmacokinetic Modeling: Simulation, Population Study – Model of the Yeast Heterotrimeric G Protein Cycle and Glycoly .

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Develop models for Biological Data.
CO2: Implement image processing Techniques to Bioinformatics Data
CO3: Implement Micro Array analysis over Genome Expression.
CO4: Understand the study of simbiology.
CO5: Illustrate the pharmacokinetic modeling.
CO6: Elaborate the working model of biological data in Matlab.

TEXT BOOKS:

1. Yi-Ping Phoebe Chen(Ed),"Bioinformatics Technologies", Springer Publications, 2015
2. G. Alterovitz, M. F. Ramoni, "Systems Bioinformatics: An Engineering Case-Based Approach", Artech House, 2017.

REFERENCES:

1. Michael R. King, Nipa A. Mody, "Numerical and Statistical Methods for Bioengineering: Applications in MATLAB", Cambridge University Press, 2011.
2. John L. Semmlow, "Bio signal and Medical Image Processing", CRC Press, 2004.
3. Frank C. Hoppensteadt, Charles S. Peskin, "Modeling and Simulation in Medicine and Life Sciences", Springer, 2010.
4. C. Gibas, Per Jambeck, "Developing bio- informatics computer skills", O'Reilly Media, 2001

22AM920	SMART AND INTERACTIVE HEALTHCARE TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Illustrate the need and challenges of personalized healthcare.
- Explore the basic aspects of telehealth and telemedicine.
- Enumerate mHealth evolution, regulation and applications.
- Demonstrate the use of virtual reality and games in healthcare.
- Elaborate the importance of IoT in healthcare through its applications.

UNIT I	PERSONALISED HEALTHCARE	9

Personalization of healthcare: the relationship between data, Digital technologies and advanced analytics – Digital health measures – Examples in digital health technologies in clinical research - Examples in digital health technologies in care delivery pathway –Challenges in bringing digital health technologies to market –Challenges in adoption of digital health technologies.

UNIT II	TELEHEALTH AND TELEMEDICINE	9

Telemedicine versus telehealth – Definitions - Technology vs services – Telemedicine technological requirements – Telehealth technological requirements – Distant health examples – Smart medical shirts – Haptic platform – Overgrown cities – Rural health – Satellite telehealth – Telemedicine critical technologies – Present challenges and benefits – Groundwork for a good telehealth application – Enabling telehealth for existing medical application – Case study – Panic disorder – Case study – Diabetes telehealth framework – Case study – telehealth support for unit care – Medicolegal, ethical and regulatory guidelines pertaining to telehealth.

UNIT III	M-HEALTH	9

Evolution from telemedicine to m-Health – Initial and recent applications – Mobile apps for mHealth - Overview of mHealth apps – Regulation of mHealth apps - Cloud computing definition and selected applications – closed loop solutions for personalized health interventions – Challenges in sensor design and fabrication – Challenges in mining and managing Big health data – Common mHealth and ICT applications – Evidence for mHealth impact –New frontiers in mHealth - Case study –Sleep problems and their implications.

UNIT IV	VIRTUAL REALITY AND GAMES FOR HEALTHCARE	9

Augmenting mental healthcare – Mobilizing services with virtual reality – Pain – Anxiety and phobias – Stress management – Rehabilitation – Games for improving healthcare – Homo Ludens – Learning through challenges and fun – Physical and functional fidelity – Games for health – Rehabilitation – Crowdsourcing science – Gaming doctor – Games in official Medical programs – Games in skills training outing operating room – Financial and Ethical aspects.

UNIT V	IOT FOR HEALTHCARE	9

Concept of IoT-Based Healthcare Technology – Ambient intelligence in Healthcare Technologies – Benefits – Challenges – Data handling and resource management – Security and Privacy – Interoperability – Stake holder collaboration and implementation – Technologies that enable IoT – Healthcare – Internet of Medical things – Applications of IoT in Healthcare – Benefits – Challenges.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Illustrate the need and challenges of personalized healthcare.
CO2: Apply basic aspects of telehealth and telemedicine.
CO3: Demonstrate M-Health evolution, regulation and applications.
CO4: Elaborate the use of virtual reality and games in healthcare.
CO5: Elaborate the importance of IoT in healthcare through its applications.
CO6: Apply smart and interactive technologies for healthcare applications.

TEXT BOOKS:

1. Halit Eren and John G Webster, "Telemedicine and Electronic Medicine", CRC Press, Taylor and Francis Group, New York, 2nd edition, 2016.
2. Shabbir Syed-Abdul, Xinxin Zhu, Luis Fernandez-Luque, "Digital Health: Mobile and Wearable Devices for participatory Health Applications", Elsevier, Cambridge, 2021.
3. Shashi Gogia, "Fundamentals of Telemedicine and Telehealth", Elsevier, Cambridge, USA, 1st Edition, 2020.

REFERENCES:

1. Homero Rivas and Katarzyna Wac, "Digital Health: Scaling Healthcare to the World", Health Informatics, Springer, Switzerland, 2018.
2. Nishu Gupta and Sara Paiva, "IoT and ICT for Healthcare Applications", Springer Innovations in Communication and Computing, 2020.

HONOURS VERTICAL – COMPUTATIONAL INTELLIGENCE

22AM921	SOFT COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To learn the basic concepts of Soft Computing.
- To understand artificial neural networks.
- To elaborate fuzzy systems.
- To illustrate Genetic Algorithms.
- To discuss the various Hybrid algorithms and various Swarm Intelligence algorithms.

UNIT I	INTRODUCTION	9

Neural Networks - Application Scope of Neural Networks - Fuzzy Logic - Genetic Algorithm - Hybrid Systems - Soft Computing - Artificial Neural Network - Evolution of Neural Networks - Basic Models of ANN – Weights – Bias – Threshold – Learning Rate – Momentum Factor – Vigilance Parameter- McCulloch–Pitts Neuron - Linear Separability - Hebb Network.

UNIT II	ARTIFICIAL NEURAL NETWORKS	9

Perceptron Networks - Adaptive Linear Neuron - Multiple Adaptive Linear Neurons - Back-Propagation Network - Radial Basis Function Network - Pattern Association – Auto associative and Hetero associative Memory Networks - Bidirectional Associative Memory (BAM) - Hopfield Networks - Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps.

UNIT III	FUZZY SYSTEMS	9

Fuzzy Logic - Classical Sets (Crisp Sets) - Fuzzy Sets – Fuzzy Relation - Features of the Membership Functions - Fuzzification - Methods of Membership Value Assignments - Defuzzification - Lambda-Cuts for Fuzzy Sets (Alpha-Cuts) - Lambda-Cuts for Fuzzy Relations - Defuzzification Methods – Fuzzy Reasoning – Fuzzy Inference Systems.

UNIT IV	GENETIC ALGORITHMS	9

Biological Background - Traditional Optimization and Search Techniques- Genetic Algorithm and Search Space- - Simple GA - General Genetic Algorithm - Operators - Stopping Condition - Constraints - Problem Solving - The Schema Theorem- Classification - Holland Classifier Systems- Genetic Programming - Advantages and Limitations- Applications.

UNIT V	HYBRID SOFT COMPUTING AND SWARM INTELLIGENCE ALGORITHMS	9

Neuro-Fuzzy Hybrid Systems - Genetic Neuro-Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems - Simplified Fuzzy ARTMAP – Swarm Intelligence Algorithms - Ant Colony Optimization – Artificial Bee Colony – Particle Swarm Optimization – Firefly Algorithm.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Elaborate the basic concepts of Soft Computing.
CO2: Discuss Artificial neural networks and its applications.
CO3: Apply Fuzzy logic to solve different applications.
CO4: Solving problems using Genetic algorithms.
CO5: Discuss various algorithms in Soft computing with its applications and limitations.
CO6: Use various algorithms in Soft computing to solve real-world problems.

TEXT BOOKS:

1. S. N. Sivanandam , S. N. Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., 2nd Edition, 2019.
2. Adam Slovik, “Swarm Intelligence Algorithms: Modification and Applications”, Taylor & Francis, First Edition, 2020.

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2002.
2. Kwang H. Lee, First course on Fuzzy Theory and Applications‖, Springer, 2005.
3. N.P. Padhy, S. P. Simon, "Soft Computing with MATLAB Programming", Oxford University Press, 2015.
4. S. Rajasekaran, G. A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications ", PHI Learning Pvt. Ltd., 2017.
5. NPTEL Courses:
    a. Introduction To Soft Computing - https://onlinecourses.nptel.ac.in/noc23_cs40/preview

22AM922	APPLIED AI and ML	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand and apply statistical methods to analyze and interpret data.
- Analyze and cluster genomic data using appropriate algorithms.
- Implement linear regression models to predict outcomes.
- Evaluate and improve model performance in binary classification tasks.
- Implement and train neural networks for various tasks.

UNIT I	FOUNDATION OF DATA SCIENCE	9

Python for Data Science- NumPy & Pandas - Data Cleaning and Preparation- Statistics for Data Science- Types of Data- Levels of Measurement-Descriptive Statistics-Probability theory -Inferential Statistics-Advanced Visualization Techniques.

Case Study: Cardio Good Fitness Data Analysis

Projects:1. Food Hub Analysis
2. FIFO World Cup Analysis
3. Mobile Internet Usage Analysis

UNIT II	MAKING SENSE OF UNSTRUCTURED DATA	9

Introduction to Supervised & Unsupervised Learning- Handling Imbalanced Datasets-K-Means Clustering algorithm, Dimensionality Reduction techniques (PCA, t-SNE)-Visualizing High Dimensional Data-Comparsion of t-SNE with PCA-Combining PCA with t-SNE.

Case Study: Genomic Data Clustering

Project: Fantasy Sports Clustering Analysis

UNIT III	REGRESSION AND PREDICTION	9

Introduction to Linear Regression-OLS Method-Cost function and Optimization-Gradient Descent Algorithm-Multiple Linear Regression-Elastic Net, Model Evaluation Techniques in solving Real World Regression Problems.

Case Studies: 1. Hospital LOS Prediction
2.Big Mart Sales Prediction

Project: Super Kart Sales Prediction

UNIT IV	**CLASSIFICATION AND HYPOTHESIS TESTING**	**9**

Concepts of Classification algorithms- Model Performance- Application of Binary Classification-Multi class classification-Multi label classification-Challenges in solving real world classification problems.

Case Studies: 1.HR Employee Attrition Prediction
2. KC Roasters Coffee Quality Prediction

Projects: 1. Travel Package Purchase Prediction
2. Potential Customers Prediction

UNIT V	**DEEP LEARNING**	**9**

Implementation of Neural Networks-Data Quality & Quantity-Data Augmentation- Hyper parameter tuning-Computational Challenges -Transformer Networks-Transfer learning -solving real world Neural Network based Problems.

Case Study: 1. Audio MNLST Digit Recognition,
2.Street View Housing Number Digit Recognition

Project: Food Image Classification

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Apply statistical techniques to interpret data and make data-driven decisions.

CO2: Utilize dimensionality reduction techniques such as PCA and t-SNE to simplify complex datasets.

CO3: Apply regression techniques to real-world problems.

CO4: Perform hypothesis testing to validate assumptions and make inferences from data.

CO5: Apply deep learning techniques to solve practical problems.

CO6: Implement the concepts of AI and ML to solve various applications.

TEXT BOOKS:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson, 2019.
2. Ethem Alpaydin, Introduction to Machine Learning, Adaptive Computation and Machine Learning Series, Third Edition, MIT Press, 2014.
3. Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017.
4. Deep Learning, Ian Goodfellow, Yoshua Bengio Aaron Courville, MIT Press, 2017.
5. Neural Networks and Deep Learning, Michael Nielsen, Determination Press, 2015.

REFERENCES:

1. Anuradha Srinivasaraghavan, Vincy Joseph, Machine Learning, First Edition, Wiley, 2019.
2. Peter Harrington, “Machine Learning in Action”, Manning Publications, 2012.
3. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
4. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
5. Christoph Molnar, “Interpretable Machine Learning - A Guide for Making Black Box Models Explainable”, Creative Commons License, 2020.
6. Deep Learning with TensorFlow: Explore neural networks with Python, Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy, Packt Publisher, 2017.
7. Deep Learning with Keras, Antonio Gulli, SujitPal , Packt Publishers, 2017.
8. Deep Learning with Python", Francois Chollet, Manning Publications, 2017
9. https://olympus.mygreatlearning.com/courses

22AM923	RECOMMENDER SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To understand the foundations of the recommender system.
- To learn about collaborative filtering.
- To discuss content-based recommendation systems.
- To elaborate on the evaluation paradigms for a recommendation system.
- To make students design and implement a recommender system.

UNIT I	INTRODUCTION TO RECOMMENDER SYSTEMS	9

Introduction - Basic Models of Recommender Systems - Domain-Specific Challenges in Recommender Systems - Cold-Start Problem – Attack-Resistant Recommender Systems – Group – Multi-Criteria – Active-Learning – Privacy - Application Domains.

UNIT II	COLLABORATIVE FILTERING	9

Neighborhood-Based Collaborative Filtering - Key Properties - Predicting Ratings – Clustering - Dimensionality Reduction - A Regression Modeling - Graph Models – Model-based Collaborative Filtering - Decision and Regression Trees - Rule-Based Collaborative Filtering - Naive Bayes Collaborative Filtering – Latent Factor Models.

UNIT III	CONTENT-BASED RECOMMENDATION	9

Basic Components of Content-Based Systems - Preprocessing and Feature Extraction - Learning User Profiles and Filtering - Content-Based Versus Collaborative Recommendations - Using Content-Based Models for Collaborative Filtering.

UNIT IV	DESIGN EVALUATION	9

Evaluating Paradigms – General Goals of Evaluation Design-Design Issues in Offline Recommender Evaluation-Accuracy Metrics in Offline Evaluation-Limitations of Evaluation Measures.

UNIT V	TYPES OF RECOMMENDATION SYSTEMS	9

Content-based Recommender Systems – Basic Components – Constraint-based Recommender Systems – Context-sensitive Recommender Systems – Social and Trust-Centric Recommender Systems.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Elaborate the foundations of the recommender system.
CO2: Use collaborative filtering to design recommendation systems.
CO3: Discuss content-based recommendation systems.
CO4: Elaborate on the evaluation paradigms for a recommendation system.
CO5: Use appropriate type of recommendation systems to solve real-world problems.
CO6: Design, implement and evaluate a recommendation algorithm.

TEXT BOOKS:

1. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. Jannach D., Zanker M., FelFering A., Friedrich G., Recommender Systems: An Introduction, Cambridge University Press, First Edition, 2011.

REFERENCES:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, 3rd edition, Cambridge University Press, 2020.
2. Ricci, F., Rokach, L. and Shapira, B., Introduction to recommender systems handbook. In Recommender systems handbook, Springer, 2011.
3. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer, First Edition, 2013.

22AM924	KNOWLEDGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Knowledge Engineering.
- To discuss reasoning under uncertainty.
- To design and develop ontologies.
- To apply reasoning with ontologies and rules.
- To understand learning and rule learning.

UNIT I	INTRODUCTION	9

Knowledge, Representation and Reasoning - Need for Logic – First order logic – Syntax – Semantics – Pragmatics- Implicit and Explicit Belief - Expressing Knowledge - Resolution – Propositional case - Horn Logic – Horn clauses - Procedural Control of Reasoning.

UNIT II	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 – Evidence-based reasoning task: Intelligent Analysis.

UNIT III	ONTOLOGIES – DESIGN AND DEVELOPMENT	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 Understanding and Concept Elicitation – Modelling-based Ontology Specification.

UNIT IV	REASONIING WITH ONTOLOGIES AND RULES	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 - Rules in Production Systems - Object-Oriented Representation - Structured Descriptions.

UNIT V	LEARNING AND RULE LEARNING	9

Machine Learning – Concepts – Generalization and Specialization Rules – Types – Inductive concept learning from Examples – Learning with an Incomplete Representation Language – Formal definition of Generalization.
Modelling, Learning and Problem Solving – Rule learning and Refinement – Overview.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the basics of Knowledge Representation and Knowledge Engineering.
CO2: Develop reasoning under uncertainty.
CO3: Design and develop ontologies.
CO4: Implement ontology-based reasoning systems.
CO5: Understand learning and rule learning.
CO6: Integrating knowledge representation and reasoning in intelligent systems.

TEXT BOOKS:

1. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
2. Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum, Knowledge Engineering Building Cognitive Assistants for Evidence-based Reasoning, Cambridge University Press, First Edition, 2016.

REFERENCES:

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

22AM925	COMPUTATIONAL NEUROSCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand what nervous systems do and determine how they function.
- To explore the computational principles governing various aspects of vision, sensory-motor control, learning, and memory.
- To analyze neural models.
- To learn to extract information through neural encoding and decoding.
- To investigate models of synaptic plasticity and learning in the brain.

UNIT I	NEURAL ENCODING	9

Firing Rates and Spike Statistics: Introduction- Spike Trains and Firing Rates - What Makes a Neuron Fire? Spike-Train Statistics – The Neural Code
Reverse Correlation and Visual Receptive Fields – Estimating Firing Rates Introduction to the Early Visual System Reverse-Correlation Methods: Simple Cells Static Non linearities: Complex Cells - Receptive Fields in the Retina and LGN Constructing Visual Receptive Fields

UNIT II	NEURAL DECODING AND INFORMATION THEORY	9

Discrimination - Population Decoding - Spike-Train Decoding
Information Theory: Entropy and Mutual Information – Information and Entropy Maximization – Entropy and Information for Spike Trains

UNIT III	MODEL NEURONS	9

Phase Plane Analysis – I - Phase Plane Analysis – II - Analyzing HHE – Bifurcations - Other Point Models – Levels of Neuron Modeling-Conductance-Based Models – The Cable Equation- Multi-compartment models

UNIT IV	NETWORK MODELS	9

Firing Rate Models – Feedforward Networks – Recurrent Networks – Excitatory-Inhibitory Networks – Stochastic Networks

UNIT V	PLASTICITY	9

Synaptic Transmission and Synaptic Strength - Ways of Modification of Synaptic Strength - Types of Plasticity - Short Term Plasticity - Long Term Plasticity – Computational Implications

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the fundamentals of neural encoding.
CO2: Apply neural encoding techniques.
CO3: Use Information Theory to decode neural signals.
CO4: Analyze and model the dynamics of neurons.
CO5: Design and analyze neural networks.

CO6: Implement the concepts of synaptic plasticity.

TEXT BOOKS:

1. Dayan, Peter, and L. F. Abbott, Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems. Cambridge, MA: MIT Press, 2005. ISBN: 9780262041997.
2. Paul Miller, An Introductory Course in Computational Neuroscience, MIT Press, 2018.

REFERENCES:

1. Signal and Systems, Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab Prentice Hall, 1997.
2. Methods in Neuronal Modeling, Second Edition From Ions to Networks , Edited by Christof Koch and Idan Segev, MIT Press
3. Ionic Channels of Excitable Membranes, Second Edition, Bertil Hille, Sinauer Associates Inc.,1992
4. NPTEL: Computational Neuroscience - Course (nptel.ac.in)

22AM926	AI ESSENTIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners:

- To familiarize the concepts and recent technologies in AI.
- To use generative AI in building applications.
- To learn to design inputs for AI tools by using prompt engineering.
- To use tools and frameworks in explainable AI.
- To build AI systems with the principles of responsible AI.
- To understand the basics of Quantum AI.

UNIT I	GENERATIVE AI	9

Introduction - Types of Generative AI models – GANs – VAE – Diffusion Models – DALL-E 2 model – Stability AI and Midjourney – Speech – Large Language Models – Language and Intelligence – NLP – Word2Vec Model – Transformers – Dials – BERT – GPT Systems and ChatGPT- Auto Code Generation – Working – Copilot.

UNIT II	PROMPT ENGINEERING	9

Basics – In-Context Learning – In-Context Prompting – Techniques – Image Prompting – Prompt Hijacking – Challenges.

UNIT III	EXPLAINABLE AI	9

Introduction – Proposed AI Model – Proposed Architecture – XAI Methods and their classifications – Forms of Explanation – Frameworks for Model Interpretability and Explanation – Methods and Metrics for Explaining AI Models – Evaluation measures and applications for Explainable AI.

UNIT IV	RESPONSIVE AI	9

Ethical Decision Making – Approaches to Ethical Reasoning by AI – Designing Artificial Moral Agents – Ethical Deliberations – Levels of Ethical Behaviour – Ethical Status of AI Systems – Governance for Responsible AI – Codes of Conduct – Inclusion and Diversity – AI and Society – Super-intelligence – Responsible AI.

UNIT V	QUANTUM ML	9

Quantum ML – Grover search algorithm – Quantum RL – Quantum annealing – Quantum Neural Networks – Topographic representation – Quantum ML – Brain – Topographic basis maps – Topographic qubit maps – conversions between representations – applications.

TOTAL:45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the concepts and recent technologies in AI.
CO2: Apply generative AI in building applications.
CO3: Design inputs for AI tools by using prompt engineering.
CO4: Use tools and frameworks in explainable AI.
CO5: Build AI systems with the principles of responsible AI.
CO6: Understand the basics of Quantum AI.

TEXT BOOKS:

1. Tom Taulli, "Generative AI - How Chatgpt and other AI Tools will Revolutionize Business", Apress, 2023.
2. Mayuri Mehta, Vasile Palade, Indranath Chatterjee, Explainable AI: Foundations, Methodologies and Applications, Springer, 2023.
3. Virginia Dignum, Responsible Artificial Intelligence, How to Develop and Use AI in a Responsible Way, Springer, 2019.
4. Siddhartha Bhattacharyya, Indrajit Pan, Ashish Mani, Sourav De, Elizabeth Behrman, Susanta Chakraborti, "Quantum Machine Learning", De Gruyter Frontiers in Computational Intelligence, 2020.

REFERENCES:

1. Ben Auffarth, Generative AI with Lang Chain, Packt Publishing, 2023.
2. Amit Bahree, Generative AI in Action, Manning Publication, First Edition, 2023.
3. Gabriele Gianini, Pierre-Edouard Portier, "Advances in Explainable Artificial Intelligence", MDPI, 2024.
4. Santanu Pattanayak, Quantum Machine Learning with Python - Using Cirq from Google Research and IBM Qiskit, Apress, 2021.

OPEN ELECTIVE (Offered to Other Departments by AIML)

22AM907	AI in BLOCK CHAIN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge in Blockchain Technologies.
- To understand how block chain and AI can be used to innovate.
- To elaborate Cryptocurrencies and AI.
- To develop applications using blockchain.
- To understand the limitations and future scope of AI in Blockchain.

UNIT I	INTRODUCTION TO BLOCKCHAIN	9

Overview – Blockchain vs Distributed Ledger Technology vs Distributed Databases – Public vs private vs permissioned blockchains – Privacy in blockchains – Blockchain platforms - Hyperledger – Hashgraph, Corda – IOTA - Consensus Algorithms – Building DApps with blockchain tools.

UNIT II	BLOCKCHAIN AND ARTIFICIAL INTELLIGENCE	9

Introduction to the AI landscape - AI and Blockchain driven Databases – Centralized vs Distributed data – Blockchain data – Big data for AI analysis – Global databases – Data Management in a DAO - Benefits of combining blockchain and AI – Aicumen Technologies -Combining blockchain and AI to humanize digital interactions.

UNIT III	CRYPTOCURRENCY AND AI	9

Bitcoins – Ethereum - Role of AI in cryptocurrency – cryptocurrency trading – Making price predictions with AI – Market making – future of cryptocurrencies.

UNIT IV	DEVELOPING BLOCKCHAIN PRODUCTS	9

Development Life Cycle of a DIApp – Designing a DIApp – Developing a DIApp – Testing – Deploying – Monitoring – Implementing DIApps.

UNIT V	LIMITATIONS AND FUTURE OF AI WITH BLOCKCHAIN	9

Technical Challenges – Business Model Challenges – Scandals and Public perception – Government Regulation – Privacy Challenges for Personal Records – Convergence of AI with Blockchain – Future – Enterprise.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Acquire knowledge in Blockchain Technologies.
CO2: Understand how block chain and AI can be used to innovate.
CO3: Elaborate Cryptocurrencies and AI.
CO4: Develop applications using blockchain.
CO5: Understand the limitations and future scope of AI in Blockchain.
CO6: Elaborate the various applications of AI in Blockchain.

TEXT BOOKS:

1. Ganesh Prasad Kumble, Anantha Krishnan, "Practical Artificial Intelligence and Blockchain: A guide to converging blockchain and AI to build smart applications for new economies", Packt Publications, 2020.
2. Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015.

REFERENCES:

1. Daniel Drescher, "Block Chain Basics", Apress; 1st edition, 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer", Import, 2018.

22AM921	SOFT COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To learn the basic concepts of Soft Computing.
- To understand artificial neural networks.
- To apply fuzzy systems to solve problems.
- To solve problems using Genetic Algorithms.
- To discuss the various Hybrid algorithms and various Swarm Intelligence algorithms.

UNIT I	INTRODUCTION	9

Neural Networks - Application Scope of Neural Networks - Fuzzy Logic - Genetic Algorithm - Hybrid Systems - Soft Computing - Artificial Neural Network - Evolution of Neural Networks - Basic Models of ANN – Weights – Bias – Threshold – Learning Rate – Momentum Factor – Vigilance Parameter- McCulloch–Pitts Neuron - Linear Separability - Hebb Network.

UNIT II	ARTIFICIAL NEURAL NETWORKS	9

Perceptron Networks - Adaptive Linear Neuron - Multiple Adaptive Linear Neurons - Back-Propagation Network - Radial Basis Function Network - Pattern Association – Auto associative and Hetero associative Memory Networks - Bidirectional Associative Memory (BAM) - Hopfield Networks - Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps.

UNIT III	FUZZY SYSTEMS	9

Fuzzy Logic - Classical Sets (Crisp Sets) - Fuzzy Sets – Fuzzy Relation - Features of the Membership

Functions - Fuzzification - Methods of Membership Value Assignments - Defuzzification - Lambda-Cuts for Fuzzy Sets (Alpha-Cuts) - Lambda-Cuts for Fuzzy Relations - Defuzzification Methods – Fuzzy Reasoning – Fuzzy Inference Systems.

UNIT IV	GENETIC ALGORITHMS	9

Biological Background - Traditional Optimization and Search Techniques- Genetic Algorithm and Search Space- - Simple GA - General Genetic Algorithm - Operators - Stopping Condition - Constraints - Problem Solving - The Schema Theorem- Classification - Holland Classifier Systems- Genetic Programming - Advantages and Limitations- Applications.

UNIT V	HYBRID SOFT COMPUTING AND SWARM INTELLIGENCE ALGORITHMS	9

Neuro-Fuzzy Hybrid Systems - Genetic Neuro-Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems - Simplified Fuzzy ARTMAP – Swarm Intelligence Algorithms - Ant Colony Optimization – Artificial Bee Colony – Particle Swarm Optimization – Firefly Algorithm.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Elaborate the basic concepts of Soft Computing.
CO2: Discuss Artificial neural networks and its applications.
CO3: Apply Fuzzy logic to solve different applications.
CO4: Solving problems using Genetic algorithms.
CO5: Discuss various algorithms in Soft computing with its applications and limitations.
CO6: Use various algorithms in Soft computing to solve real-world problems.

TEXT BOOKS:

1. S. N. Sivanandam , S. N. Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., 2nd Edition, 2019.
2. Adam Slovik, “Swarm Intelligence Algorithms: Modification and Applications”, Taylor & Francis, First Edition, 2020.

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2002.
2. Kwang H. Lee, First course on Fuzzy Theory and Applications‖, Springer, 2005.
3. N.P. Padhy, S. P. Simon, "Soft Computing with MATLAB Programming", Oxford University Press, 2015.
4. S. Rajasekaran, G. A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications ", PHI Learning Pvt. Ltd., 2017.
5. NPTEL Courses:
   a. Introduction To Soft Computing - https://onlinecourses.nptel.ac.in/noc23_cs40/preview

22AM925	COMPUTATIONAL NEUROSCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand what nervous systems do and determine how they function.
- To explore the computational principles governing various aspects of vision, sensory-motor control, learning, and memory.
- To analyze neural models.
- To learn to extract information through neural encoding and decoding.
- To investigate models of synaptic plasticity and learning in the brain.

UNIT I	NEURAL ENCODING	9

Firing Rates and Spike Statistics: Introduction- Spike Trains and Firing Rates - What Makes a Neuron

Fire? Spike-Train Statistics – The Neural Code Reverse Correlation and Visual Receptive Fields – Estimating Firing Rates Introduction to the Early Visual System Reverse-Correlation Methods: Simple Cells Static Non linearities: Complex Cells - Receptive Fields in the Retina and LGN Constructing Visual Receptive Fields		
UNIT II	**NEURAL DECODING AND INFORMATION THEORY**	**9**
Discrimination - Population Decoding - Spike-Train Decoding Information Theory: Entropy and Mutual Information – Information and Entropy Maximization – Entropy and Information for Spike Trains		
UNIT III	**MODEL NEURONS**	**9**
Phase Plane Analysis – I - Phase Plane Analysis – II - Analyzing HHE – Bifurcations - Other Point Models – Levels of Neuron Modeling-Conductance-Based Models – The Cable Equation- Multi-compartment models		
UNIT IV	**NETWORK MODELS**	**9**
Firing Rate Models – Feedforward Networks – Recurrent Networks – Excitatory-Inhibitory Networks – Stochastic Networks		
UNIT V	**PLASTICITY**	**9**
Synaptic Transmission and Synaptic Strength - Ways of Modification of Synaptic Strength - Types of Plasticity - Short Term Plasticity - Long Term Plasticity – Computational Implications		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the fundamentals of neural encoding.
CO2: Apply neural encoding techniques.
CO3: Use Information Theory to decode neural signals.
CO4: Analyze and model the dynamics of neurons.
CO5: Design and analyze neural networks.
CO6: Implement the concepts of synaptic plasticity.

TEXT BOOKS:

3. Dayan, Peter, and L. F. Abbott, Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems. Cambridge, MA: MIT Press, 2005. ISBN: 9780262041997.
4. Paul Miller, An Introductory Course in Computational Neuroscience, MIT Press, 2018.

REFERENCES:

5. Signal and Systems, Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab Prentice Hall, 1997.
6. Methods in Neuronal Modeling, Second Edition From Ions to Networks , Edited by Christof Koch and Idan Segev, MIT Press
7. Ionic Channels of Excitable Membranes, Second Edition, Bertil Hille, Sinauer Associates Inc.,1992
8. NPTEL: Computational Neuroscience - Course (nptel.ac.in)

22AM919	BIO-INFORMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand and develop models for Biological Data.
- Implement image processing Techniques to Bioinformatics Data
- Implement Micro Array analysis over Genome Expression.
- Understand the study of simbiology.
- Understand the pharmacokinetic modeling.

- Understand the working model of biological data in Matlab.

UNIT I	INTRODUCTION	9

Overview of Bioinformatics Technologies – Structural Bioinformatics – Data Format and Processing – Secondary Resources and Applications – Role of Structural Bioinformatics – Biological Data Integration System

UNIT II	BIOINFORMATICS TOOL BOX	9

Sequence Analysis – NGS – Graph Theory – Gene Ontology – Importing Data and Deploying.

UNIT III	BIOLOGICAL DATA ANALYSIS	9

Microarray Data Analysis – Mass Spectrometry Data Analysis – Statistical Classification of Biological Data.

UNIT IV	IMAGE PROCESSING	9

Key Features of Image Processing – Importing and Exporting Images – Image File Formats and Format Conversion – Pre and Post Processing Images – Spatial Transformations and Image Registration – Microarray Image Analysis.

UNIT V	SYSTEMS BIOLOGY	9

Basics of Enzyme Kinetics – Kinetic Laws – Modeling Biological System: Simulation, Sensitivity Analysis, Parameter Estimation using Simbiology – Pharmacokinetic Modeling: Simulation, Population Study – Model of the Yeast Heterotrimeric G Protein Cycle and Glycoly .

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Develop models for Biological Data.
CO2: Implement image processing Techniques to Bioinformatics Data
CO3: Implement Micro Array analysis over Genome Expression.
CO4: Understand the study of simbiology.
CO5: Illustrate the pharmacokinetic modeling.
CO6: Elaborate the working model of biological data in Matlab.

TEXT BOOKS:

1. Yi-Ping Phoebe Chen(Ed),"Bioinformatics Technologies", Springer Publications, 2015
2. G. Alterovitz, M. F. Ramoni, "Systems Bioinformatics: An Engineering Case-Based Approach", Artech House, 2017.

REFERENCES:

1. Michael R. King, Nipa A. Mody, "Numerical and Statistical Methods for Bioengineering: Applications in MATLAB", Cambridge University Press, 2011.
2. John L. Semmlow, "Bio signal and Medical Image Processing", CRC Press, 2004.
3. Frank C. Hoppensteadt, Charles S. Peskin, "Modeling and Simulation in Medicine and Life Sciences", Springer, 2010.
4. C. Gibas, Per Jambeck, "Developing bio- informatics computer skills", O'Reilly Media, 2001

22AM001	INTRODUCTION TO GENERATIVE AI	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of Generative AI.
- To build Generative AI systems to generate images.
- To understand the concept used in Generative AI Models.
- To use various Generative AI models.
- To compare and use the various Large Language Models.
- To understand the basics of Prompt Engineering.

UNIT I	INTRODUCTION	9
Generative Models – Image transformation – Challenges - Deep Neural Networks – Perceptron – back propagation – CNN – RNN – Optimizer.		
UNIT II	**IMAGE GENERATION**	**9**
Creating encodings of images – variational objective – Inverse Autoregressive flow – Importing CIFAR – Creating the network from TensorFlow 2.		
UNIT III	**GENERATIVE ADVERSARIAL NETWORKS**	**9**
Generative Adversarial Networks – Vanilla GAN – Improved GANs – Progressive GAN – Challenges – Paired style transfer – Unpaired style transfer – Deepfakes – Modes of operation – key feature set – High level flow – Replacement – Re-enactment.		
UNIT IV	**LARGE LANGUAGE MODELS**	**9**
Overview of LLMs - Transformers – GPT – Types of LLMs – Key concepts – other Transformers – T5 – Generative Pre-Training Models – Multi-modal Models – DALL.E 2		
UNIT V	**PROMPT ENGINEERING**	**9**
Basics – In-Context Learning – In-Context Prompting – Techniques – Image Prompting – Prompt Hijacking – Challenges.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the basic concepts of Generative AI.
CO2: Build Generative AI systems to generate images.
CO3: Apply the concepts used in Generative AI Models.
CO4: Use various Generative AI models.
CO5: Compare and use the various Large Language Models.
CO6: Analyze the basics of Prompt Engineering.

TEXT BOOKS:

1. Ben Auffarth, Generative AI with Lang Chain, Packt Publishing, 2023.
2. Amit Bahree, Generative AI in Action, Manning Publication, First Edition, 2023.

REFERENCES:

1. David Foster, Generative Deep Learning, 2nd Edition, O'Reilly Media, 2023.
2. Numa Dhamani and Maggie Engler, Introduction to Generative AI, Manning Publication, First Edition, 2024.
3. Valentina Alto, Modern Generative AI with ChatGPT and OpenAI Models, Packt publications, 2024.

22AM002	FOUNDATIONS OF NATURAL LANGUAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the fundamentals of natural language processing
- To discuss word level analysis.
- To discuss the different language models.
- To understand the significance of syntactic and semantic analysis.
- To learn discourse algorithms and various lexical resources.

UNIT I	INTRODUCTION	9
Natural Language Processing - Ambiguities in NLP - Regular Expressions – Words – Corpora - Text Normalization, Minimum Edit Distance.		
UNIT II	**WORD LEVEL ANALYSIS**	**9**
Morphological Analysis – Morphological Parsing - Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based - HMM - Transformation-based tagging.		

UNIT III	LANGUAGE MODELS	9
Markov Chains – Hidden Markov Model – Forward Algorithm – Decoding: Viterbi Algorithm – Training HMMs – Maximum Entropy Models – Maximum Entropy Markov Models.		
UNIT IV	**SYNTACTIC AND SEMANTIC ANALYSIS**	**10**
Context-Free Grammars - Grammar rules - Treebanks - Normal Forms for grammar – Finite-state – CFG - Dependency Grammar – Parsing with CFG – Search – Ambiguity - Syntax-Driven Semantic analysis – Semantic Augmentations - Semantic attachments – Unification based approaches to Semantic Analysis – Semantic Attachments – Integrating Semantic Analysis to Early Parser – WordNet.		
UNIT V	**APPLICATIONS OF NLP**	**8**
Information Extraction - Question Answering and Summarization – Dialogue and Conversational Agent - Machine Translation.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the fundamentals of natural language processing.
CO2: Perform word level analysis in NLP.
CO3: Illustrate different ML models for NLP.
CO4: Analyze the syntax and semantics using various methods.
CO5: Analyze text at the word level.
CO6: Apply NLP to solve real-world problems.

TEXT BOOKS:

1. Daniel Jurafsky, James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, Second Edition, 2019.

REFERENCES:

1. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", First Edition, O'Reilly Media, 2009.
2. Breck Baldwin, "Language Processing with Java and LingPipe Cookbook", Atlantic Publisher, 2015.
3. Richard M Reese, "Natural Language Processing with Java", O'Reilly Media, 2015.
4. Nitin Indurkhya and Fred J. Damerau, "Handbook of Natural Language Processing", Second Edition, Chapman and Hall/CRC Press, 2010.
5. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.

22AM003	COGNITIVE SCIENCE AND ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand cognitive computing.
- To know about design principles and NLP for Cognitive systems.
- To distinguish between Big Data and Cognitive computing.
- To discuss implications of cognitive computing in business.
- To develop applications of cognitive computing.

UNIT I	FOUNDATIONS OF COGNITIVE SCIENCE	9
Foundation of Cognitive Computing: cognitive computing as a new generation- the uses of cognitive systems- system cognitive- gaining insights from data- Artificial Intelligence as the foundation of cognitive computing- understanding cognition.		
UNIT II	**DESIGN PRINCIPLES FOR COGNITIVE SYSTEMS AND NLP IN COGNITIVE SYSTEMS**	**9**
Components of a cognitive system- building the corpus- bringing data into cognitive system-		

machine learning- hypotheses generation and scoring- presentation and visualization services. Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system- semantic web- Applying Natural language technologies to Business problems.		
UNIT III	**BIG DATA Vs COGNITIVE COMPUTING**	**9**
Relationship between Big Data and Cognitive Computing: Dealing with human-generated data- defining big data- architectural foundation- analytical data warehouses- Hadoop- data in motion and streaming data- integration of big data with traditional data.		
UNIT IV	**THE BUSINESS IMPLICATIONS OF COGNITIVE COMPUTING**	**9**
Preparing for change- advantages of new disruptive models- knowledge meaning to business- difference with a cognitive systems approach- meshing data together differently- using business knowledge to plan for the future- answering business questions in new ways- building business specific solutions- making cognitive computing a reality- cognitive application changing the market- IBM Watson as a cognitive system.		
UNIT V	**APPLICATIONS OF COGNITIVE COMPUTING**	**9**
Build a cognitive health care application - Build a cognitive application on Smarter cities - Applicate Cognitive Computing principle in building a Government related application.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the concepts of cognitive science and computing.
CO2: Design and Implementation of Cognitive Systems.
CO3: Apply NLP in cognitive systems.
CO4: Integrate Big Data and Cognitive computing.
CO5: Discuss implications of cognitive computing in business.
CO6: Develop various applications of cognitive computing.

TEXT BOOKS:

1. Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive computing and Big Data Analytics” , Wiley, 2015.

REFERENCES:

1. Vijay Raghvan, Venu Govindaraju, C.R. Rao, “Cognitive Computing: Theory and Applications“, Elsevier publications, North Holland Publication, 1st Edition, 2016.
2. Mallick, Pradeep Kumar, Borah, Samarjeet, "Emerging Trends and Applications in Cognitive Computing”, IGI Global Publishers, 2019.

R2022

HONOURS DEGREE

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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

(For the Students admitted during 2022-2023 & 2023-2024)

R2022 CURRICULUM OF
B.TECH. (HONOURS) IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
WITH SPECIALIZATION IN

SI. No	NAME OF THE HONOURS DEGREE WITH SPECIALIZATION
1.	Computational Intelligence
2.	Intelligent Healthcare

R2022 CURRICULUM OF
B.TECH. (HONOURS) IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Additional 18 credits to be completed from the courses offered in any Professional Elective Vertical

HONOURS VERTICALS:

INTELLIGENT HEALTHCARE								
Sl. No.	**Course Code**	**Course Title**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
1.	22AM915	AI and ML for Healthcare	PEC	4	2	0	2	3
2.	22AM916	Medical Image Analysis	PEC	3	3	0	0	3
3.	22AM917	Clinical Data Science	PEC	3	3	0	0	3
4.	22AM918	Deep Learning in Genomics and Life Sciences	PEC	3	3	0	0	3
5.	22AM919	Bio-Informatics	PEC	3	3	0	0	3
6.	22AM920	Smart and Interactive Healthcare Technologies	PEC	3	3	0	0	3
7.	22AM812	Capstone Project	PEC	12	0	0	12	6

COMPUTATIONAL INTELLIGENCE								
Sl. No.	**Course Code**	**Course Title**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
1.	22AM921	Soft Computing	PEC	3	3	0	0	3
2.	22AM922	Applied AI and ML	PEC	3	3	0	0	3
3.	22AM923	Recommender Systems	PEC	3	3	0	0	3
4.	22AM924	Knowledge Engineering	PEC	3	3	0	0	3
5.	22AM925	Computational Neuroscience	PEC	3	3	0	0	3
6.	22AM926	AI Essentials	PEC	3	3	0	0	3
7.	22AM812	Capstone Project	PEC	12	0	0	12	6

HONOURS VERTICAL – INTELLIGENT HEALTHCARE

22AM915	AI AND ML FOR HEALTHCARE	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To gain a deep insight into the key concepts of AI and Big data for healthcare.
- To familiarize the principles of drug discovery and molecular modeling.
- To learn the various techniques of machine intelligence for Cancer prediction.
- To explore the recent trends in medical imaging.
- To understand the Remote patient monitoring and AI assisted surgery techniques.

UNIT I	CURRENT HEALTHCARE, BIG DATA, AND MACHINE LEARNING	6+6

Current healthcare practice- Value-based treatments and healthcare services- Increasing data volumes in healthcare – Analytics of healthcare data – The new age of healthcare- Precision medicine- Artificial intelligence and medical visualization- Intelligent personal health records-
Robotics and artificial intelligence-powered devices- Ambient assisted living- Success factors for artificial intelligence in healthcare

List of Lab Exercises:

1. Perform Diagnostic Analytics for a medical data set
2. Perform Prescriptive Analytics for a medical data set

UNIT II	DRUG DISCOVERY AND MOLECULAR MODELING	6+6

Introduction - The scope of artificial intelligence in drug discovery- Types of machine learning in artificial intelligence- Molecular modeling and databases in AI for drug molecules- ML methods in molecular modeling- Drug characterization- Drug design for neuroreceptors using ANN techniques- Use of deep learning in drug design

List of Lab Exercises:

1. Perform drug discovery Analytics using pharmaceutical data set
2. Perform Molecular Modeling Analytics using Molecular Modeling DataBase

UNIT III	CANCER DIAGNOSTICS AND TREATMENT DECISIONS	6+6

Background- AI, ML, and deep learning in cancer- Determine cancer susceptibility- Enhanced cancer diagnosis and staging- Predict cancer treatment response- Predict cancer recurrence and survival- Personalized cancer pharmacotherapy

List of Lab Exercises:

1. Perform Cancer Detection Analytics using a medical data set.
2. Perform Cancer Treatment Decision Analytics using a medical data set.

UNIT IV	ARTIFICIAL INTELLIGENCE FOR MEDICAL IMAGING	6+6

Introduction – AI in radiology/medical imaging – overcoming the hurdles - X-rays and AI in medical imaging - Ultrasound and AI in medical imaging- Application of AI in medical imaging - The development of AI in medical devices - Limitations of AI in medical devices - The future frontiers of AI in medical devices

List of Lab Exercises:

1. Perform Xray Image Analysis using a medical data set.
2. Perform Ultrasound Analysis using a medical data set.

UNIT V	REMOTE PATIENT MONITORING USING AI	6+6

Introduction - Deploying patient monitoring - The role of AI in remote patient monitoring - Diabetes prediction and monitoring using AI - Cardiac monitoring using AI - Neural applications and remote patient monitoring - Artificial intelligence assisted surgery- Preoperative – Intraoperative - Postoperative

List of Lab Exercises:

1. Develop a IOT based Remote Patient Monitoring system Project

TOTAL: 30+30=60 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the key concepts of AI and Big data for healthcare.
CO2: Illustrate the principles of drug discovery and molecular modeling.
CO3: Implement various techniques of machine intelligence for Healthcare applications.
CO4: Identify the recent trends in medical imaging.
CO5: Understand the Remote patient monitoring system.
CO6: Apply various algorithms of AI and ML to solve Healthcare problems.

TEXT BOOKS:

1. Adam Bohr, Kaveh Memarzadeh, Artificial Intelligence in Healthcare, Academic Press is an imprint of Elsevier, 2020.

REFERENCES:

1. Arjun Panesar ,Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes, APress, 2019.
2. Rangaraj M. Rangayyan, Biomedical Image Analysis, 2004.
3. Ranjay Krishna, "Computer Vision: Foundations and Applications", Standford University, 2017.
4. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer 2011.
5. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, 3rd Edition, Wiley, 2018.

LIST OF EQUIPMENTS:

Systems with Anaconda, Jupyter Notebook, Python

22AM916	MEDICAL IMAGE ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand of various medical imaging modalities.
- Explore advanced deep learning techniques for medical image analysis.
- Develop solutions by preprocessing medical images, implementing machine learning and deep learning algorithms.
- Examine the ethical implications and societal impact of deploying machine learning models in healthcare.
- Elaborate on recent advances and research trends in machine intelligence for medical image analysis.

UNIT I	INTRODUCTION TO MEDICAL IMAGING	9

Overview of medical imaging modalities -MRI, CT, X-ray, Ultrasound-Basics of image acquisition, processing, and visualization in medical imaging-Challenges and importance of medical image analysis-Introduction to common medical imaging datasets.

UNIT II	FUNDAMENTALS OF MACHINE LEARNING	9

Introduction to machine learning concepts-Supervised, unsupervised, and semi-supervised learning-Feature extraction and feature selection techniques-Evaluation metrics for machine learning models.

UNIT III	DEEP LEARNING FUNDAMENTALS	9

Basics of artificial neural networks (ANNs)-Convolutional Neural Networks (CNNs) for image analysis-Recurrent Neural Networks (RNNs) for sequential data analysis-Transfer learning and pre-trained models.

UNIT IV	MEDICAL IMAGE PREPROCESSING	9

Image preprocessing techniques specific to medical images -noise reduction, normalization-

Segmentation techniques-thresholding, region growing-Registration and alignment of medical images-Data augmentation for medical image datasets		
UNIT V	**MEDICAL IMAGE ANALYSIS**	**9**
Classification of medical images using machine learning algorithms-Object detection and localization in medical images-Case studies and applications of machine learning in medical image analysis. Overview of deep learning architectures for medical image analysis-Semantic segmentation for medical images-Generative models for medical image synthesis-Ethical considerations and challenges in deploying deep learning models in healthcare.		
TOTAL: 45 PERIODS		

OUTCOMES:

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

CO1: Demonstrate a comprehensive understanding of various medical imaging modalities.

CO2: Apply machine learning and deep learning techniques.

CO3: Develop solutions by preprocessing medical images, implementing machine learning and deep learning algorithms.

CO4: Understand the ethical considerations and regulatory requirements associated with deploying machine intelligence models in healthcare settings.

CO5: Elaborate on recent advances and research trends in machine intelligence for medical image analysis.

CO6: Illustrate the applications of ML and DL in medical image analysis.

TEXT BOOKS:

1. Le Lu, Yefeng Zheng, Gustavo Carneiro, Lin Yang , Deep Learning and Convolutional Neural Networks for Medical Image Computing Precision Medicine, High Performance and Large-Scale Dataset, Springer, 2017.
2. Atam P. Dhawan, “Medical Image Analysis", Wiley Publications, 2010.

REFERENCES:

1. Ton J. Cleophas and Aeilko H. Zwinderman , Machine Learning in Medicine - A Complete Overview", Springer, 2015.
2. Nadine Barrie Smith and Andrew Webb, “Introduction to Medical Imaging: Physics, Engineering and Clinical Applications", Cambridge University Press, 2010.

22AM917	**CLINICAL DATA SCIENCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Discuss standards to generate clinical data from electronic medical records.
- Elaborate various Modelling methods on Clinical Data.
- Illustrate methods to perform clinical data analysis using various data analysis techniques.
- Interpret clinical data analysis to support decision making.
- Apply statistics to improve the quality of decision making.
- Develop applications using Clinical Data.

UNIT I	**INTRODUCTION**	**9**
Data Sources – Electronic Medical Records – Laboratory Information Management Systems - GDPR – Data Types – Data Standards – Big Clinical Data – Data Landscape – Standardizing Clinical Data.		
UNIT II	**CLINICAL DATA TO MODELS**	**9**
Preparing Data for Predictive Modelling – Designs for Model Development – Sample size – Missing Data – Time-Domain Processing – Frequency-Domain Processing – Prediction Modelling Methodology.		
UNIT III	**CLINICAL DATA ANALYSIS**	**9**

Clinical Trials – Classifications – Discrete Data Analysis – Failure-time Data Analysis – Quantitative Data Analysis – Multiplicity Analysis.		
UNIT IV	**MEDICAL STATISTICS**	**9**
Prove Prior Hypothesis – Improve the quality of research – Testing Randomness – Quality criteria.		
UNIT V	**APPLICATIONS**	**9**
Clinical Decision Support System – Types – Challenges - Best Knowledge & Continuous Improvement of Knowledge and CDSS Methods – Mobile CDSS – Care Process – Operational Excellence – Process Mining - Sociotechnical Systems & Leadership - Value-Based Health Care Supported by Data Science.		
		TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Generate clinical data from electronic medical records.
CO2: Employ various Modelling methods on Clinical Data.
CO3: Perform clinical data analysis using various data analysis techniques.
CO4: Interpret clinical data to support decision making.
CO5: Apply statistics to improve the quality of decision making.
CO6: Develop applications using Clinical Data.

TEXT BOOKS:

1. Pieter Kubben, Michel Dumontier, Andre Dekker, Fundamentals of Clinical Data Science, Springer, 2019.
2. Ton J. Cleophas, Aeilko H. Zwinderman, Understanding Clinical Data Analysis: Learning Statistical Principles from Published Clinical Research, Springer, 2016.

REFERENCES:

1. Aeilko H. Zwinderman, Ton J. Cleophas, Machine Learning in Medicine - A Complete Overview, Springer, 2021.

22AM918	**DEEP LEARNING IN GENOMICS AND LIFE SCIENCES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Represent molecules and proteins as features for building machine learning models.
- Emphasize how to extract interpretable, biological insights from deep learning models.
- Illustrate the applications of deep learning in genomics.
- Analyze different models for Genomic applications.
- Employ various deep learning tools for genomics.
- Apply GANs for improving the models.

UNIT I	**MACHINE LEARNING IN GENOMICS**	**9**
Machine Learning for Genomics - Biopython – Genomics Data Analysis – Genome – Genome sequencing – Sanger sequencing of nucleic acids – Evolution of next generation sequencing – Analysis – steps – Calculating GC content – nucleotide content- Dinucleotide content – Modelling – Motif finder. **Case Study:** Sequence Analysis of Covid-19		
UNIT II	**BIOPHYSICAL MACHINE LEARNING**	**9**
Molecule - Molecular Bonds - Molecular Graphs - Molecular Conformations - Chirality of Molecules - Featurizing a Molecule - Graph Convolutions - Protein Structures - Protein Sequences - Biophysical Featurizations - Grid Featurization - Atomic Featurization. **Case Study:** Analyzing the PDBBind Dataset.		
UNIT III	**DEEP LEARNING FOR GENOMIC APPLICATIONS**	**9**

DNNs for Genomics – workflow for Genomics – Protein structure predictions – Regulatory genomics – Gene regulatory Networks – Single-cell RNA sequencing – Deep learning libraries for genomics.
Case Study: Disease prediction

UNIT IV	**CNN AND RNN FOR GENOMICS**	**9**

Transfer Learning – CNNs for Genomics – Applications – Deep Bind – DeepInsight – DeepChrome – DeepVariant – Applications and use cases of RNNs in Genomics – DeepNano – ProLanGo – DanQ – Autoencoders for genomics – Gene Expression.
Case Study: Predicting Gene expression from TCGA pan-cancer RNA-S using denoising autoencoders.

UNIT V	**MODEL IMPROVEMENT**	**9**

GANs for Improving Models – Difference between Discriminative and Generative Models – Challenges – synthetic data – Applications – Analysis of ScRNA-Seq data – Generation of DNA.
Case Study: Personalized Medicine

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students will be able to:
CO1: Represent molecules and proteins as features for building machine learning models.
CO2: Extract interpretable, biological insights from deep learning models.
CO3: Illustrate the applications of deep learning in genomics.
CO4: Analyze different models for Genomic applications.
CO5: Employ various deep learning tools for genomics.
CO6: Apply GANs for improving the models.

TEXT BOOKS:
1. Upendra Kumar Devisetty, Deep Learning for Genomics: Data-driven approaches for genomics applications in life sciences and biotechnology, packt Publications, 2022.
2. Bharath Ramsundar, Peter Eastman, Patrick Walters, Vijay Pande, Deep Learning for the Life Sciences: Applying Deep Learning to Genomics, Microscopy, Drug Discovery & More, O'Reilly, 2019.

REFERENCES:
1. Sanjiban Sekhar Roy, Y.-H. Taguchi, Handbook of Machine Learning Applications for Genomics, Springer, 2022.
2. Shailza Singh, Machine Learning and Systems Biology in Genomics and Health, Springer, 2022.

22AM919	**BIO-INFORMATICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:
The Course will enable learners to:
- Understand and develop models for Biological Data.
- Implement image processing Techniques to Bioinformatics Data
- Implement Micro Array analysis over Genome Expression.
- Understand the study of simbiology.
- Understand the pharmacokinetic modeling.
- Understand the working model of biological data in Matlab.

UNIT I	**INTRODUCTION**	**9**

Overview of Bioinformatics Technologies – Structural Bioinformatics – Data Format and Processing – Secondary Resources and Applications – Role of Structural Bioinformatics – Biological Data Integration System

UNIT II	**BIOINFORMATICS TOOL BOX**	**9**

Sequence Analysis – NGS – Graph Theory – Gene Ontology – Importing Data and Deploying.

UNIT III	BIOLOGICAL DATA ANALYSIS	9

Microarray Data Analysis – Mass Spectrometry Data Analysis – Statistical Classification of Biological Data.

UNIT IV	IMAGE PROCESSING	9

Key Features of Image Processing – Importing and Exporting Images – Image File Formats and Format Conversion – Pre and Post Processing Images – Spatial Transformations and Image Registration – Microarray Image Analysis.

UNIT V	SYSTEMS BIOLOGY	9

Basics of Enzyme Kinetics – Kinetic Laws – Modeling Biological System: Simulation, Sensitivity Analysis, Parameter Estimation using Simbiology – Pharmacokinetic Modeling: Simulation, Population Study – Model of the Yeast Heterotrimeric G Protein Cycle and Glycoly .

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Develop models for Biological Data.
CO2: Implement image processing Techniques to Bioinformatics Data
CO3: Implement Micro Array analysis over Genome Expression.
CO4: Understand the study of simbiology.
CO5: Illustrate the pharmacokinetic modeling.
CO6: Elaborate the working model of biological data in Matlab.

TEXT BOOKS:

1. Yi-Ping Phoebe Chen(Ed),"Bioinformatics Technologies", Springer Publications, 2015
2. G. Alterovitz, M. F. Ramoni, "Systems Bioinformatics: An Engineering Case-Based Approach", Artech House, 2017.

REFERENCES:

1. Michael R. King, Nipa A. Mody, "Numerical and Statistical Methods for Bioengineering: Applications in MATLAB", Cambridge University Press, 2011.
2. John L. Semmlow, "Bio signal and Medical Image Processing", CRC Press, 2004.
3. Frank C. Hoppensteadt, Charles S. Peskin, "Modeling and Simulation in Medicine and Life Sciences", Springer, 2010.
4. C. Gibas, Per Jambeck, "Developing bio- informatics computer skills", O'Reilly Media, 2001

22AM920	SMART AND INTERACTIVE HEALTHCARE TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Illustrate the need and challenges of personalized healthcare.
- Explore the basic aspects of telehealth and telemedicine.
- Enumerate mHealth evolution, regulation and applications.
- Demonstrate the use of virtual reality and games in healthcare.
- Elaborate the importance of IoT in healthcare through its applications.

UNIT I	PERSONALISED HEALTHCARE	9

Personalization of healthcare: the relationship between data, Digital technologies and advanced analytics – Digital health measures – Examples in digital health technologies in clinical research - Examples in digital health technologies in care delivery pathway –Challenges in bringing digital health technologies to market –Challenges in adoption of digital health technologies.

UNIT II	TELEHEALTH AND TELEMEDICINE	9

Telemedicine versus telehealth – Definitions - Technology vs services – Telemedicine technological requirements – Telehealth technological requirements – Distant health examples – Smart medical shirts – Haptic platform – Overgrown cities – Rural health – Satellite telehealth – Telemedicine critical technologies – Present challenges and benefits – Groundwork for a good telehealth application – Enabling telehealth for existing medical application – Case study – Panic disorder – Case study – Diabetes telehealth framework – Case study – telehealth support for unit care – Medicolegal, ethical and regulatory guidelines pertaining to telehealth.

UNIT III	M-HEALTH	9

Evolution from telemedicine to m-Health – Initial and recent applications – Mobile apps for mHealth - Overview of mHealth apps – Regulation of mHealth apps - Cloud computing definition and selected applications – closed loop solutions for personalized health interventions – Challenges in sensor design and fabrication – Challenges in mining and managing Big health data – Common mHealth and ICT applications – Evidence for mHealth impact –New frontiers in mHealth - Case study –Sleep problems and their implications.

UNIT IV	VIRTUAL REALITY AND GAMES FOR HEALTHCARE	9

Augmenting mental healthcare – Mobilizing services with virtual reality – Pain – Anxiety and phobias – Stress management – Rehabilitation – Games for improving healthcare – Homo Ludens – Learning through challenges and fun – Physical and functional fidelity – Games for health – Rehabilitation – Crowdsourcing science – Gaming doctor – Games in official Medical programs – Games in skills training outing operating room – Financial and Ethical aspects.

UNIT V	IOT FOR HEALTHCARE	9

Concept of IoT-Based Healthcare Technology – Ambient intelligence in Healthcare Technologies – Benefits – Challenges – Data handling and resource management – Security and Privacy – Interoperability – Stake holder collaboration and implementation – Technologies that enable IoT – Healthcare – Internet of Medical things – Applications of IoT in Healthcare – Benefits – Challenges.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Illustrate the need and challenges of personalized healthcare.
CO2: Apply basic aspects of telehealth and telemedicine.
CO3: Demonstrate M-Health evolution, regulation and applications.
CO4: Elaborate the use of virtual reality and games in healthcare.
CO5: Elaborate the importance of IoT in healthcare through its applications.
CO6: Apply smart and interactive technologies for healthcare applications.

TEXT BOOKS:

1. Halit Eren and John G Webster, “Telemedicine and Electronic Medicine”, CRC Press, Taylor and Francis Group, New York, 2nd edition, 2016.
2. Shabbir Syed-Abdul, Xinxin Zhu, Luis Fernandez-Luque, “Digital Health: Mobile and Wearable Devices for participatory Health Applications”, Elsevier, Cambridge, 2021.
3. Shashi Gogia, “Fundamentals of Telemedicine and Telehealth”, Elsevier, Cambridge, USA, 1st Edition, 2020.

REFERENCES:

1. Homero Rivas and Katarzyna Wac, “Digital Health: Scaling Healthcare to the World”, Health Informatics, Springer, Switzerland, 2018.
2. Nishu Gupta and Sara Paiva, “IoT and ICT for Healthcare Applications”, Springer Innovations in Communication and Computing, 2020.

HONOURS VERTICAL – COMPUTATIONAL INTELLIGENCE

22AM921	SOFT COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To learn the basic concepts of Soft Computing.
- To understand artificial neural networks.
- To elaborate fuzzy systems.
- To illustrate Genetic Algorithms.
- To discuss the various Hybrid algorithms and various Swarm Intelligence algorithms.

UNIT I	INTRODUCTION	9

Neural Networks - Application Scope of Neural Networks - Fuzzy Logic - Genetic Algorithm - Hybrid Systems - Soft Computing - Artificial Neural Network - Evolution of Neural Networks - Basic Models of ANN – Weights – Bias – Threshold – Learning Rate – Momentum Factor – Vigilance Parameter- McCulloch–Pitts Neuron - Linear Separability - Hebb Network.

UNIT II	ARTIFICIAL NEURAL NETWORKS	9

Perceptron Networks - Adaptive Linear Neuron - Multiple Adaptive Linear Neurons - Back-Propagation Network - Radial Basis Function Network - Pattern Association – Auto associative and Hetero associative Memory Networks - Bidirectional Associative Memory (BAM) - Hopfield Networks - Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps.

UNIT III	FUZZY SYSTEMS	9

Fuzzy Logic - Classical Sets (Crisp Sets) - Fuzzy Sets – Fuzzy Relation - Features of the Membership Functions - Fuzzification - Methods of Membership Value Assignments - Defuzzification - Lambda-Cuts for Fuzzy Sets (Alpha-Cuts) - Lambda-Cuts for Fuzzy Relations - Defuzzification Methods – Fuzzy Reasoning – Fuzzy Inference Systems.

UNIT IV	GENETIC ALGORITHMS	9

Biological Background - Traditional Optimization and Search Techniques- Genetic Algorithm and Search Space- - Simple GA - General Genetic Algorithm - Operators - Stopping Condition - Constraints - Problem Solving - The Schema Theorem- Classification - Holland Classifier Systems- Genetic Programming - Advantages and Limitations- Applications.

UNIT V	HYBRID SOFT COMPUTING AND SWARM INTELLIGENCE ALGORITHMS	9

Neuro-Fuzzy Hybrid Systems - Genetic Neuro-Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems - Simplified Fuzzy ARTMAP – Swarm Intelligence Algorithms - Ant Colony Optimization – Artificial Bee Colony – Particle Swarm Optimization – Firefly Algorithm.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Elaborate the basic concepts of Soft Computing.
CO2: Discuss Artificial neural networks and its applications.
CO3: Apply Fuzzy logic to solve different applications.
CO4: Solving problems using Genetic algorithms.
CO5: Discuss various algorithms in Soft computing with its applications and limitations.
CO6: Use various algorithms in Soft computing to solve real-world problems.

TEXT BOOKS:

1. S. N. Sivanandam , S. N. Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., 2nd Edition, 2019.
2. Adam Slovik, “Swarm Intelligence Algorithms: Modification and Applications”, Taylor & Francis, First Edition, 2020.

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2002.
2. Kwang H. Lee, First course on Fuzzy Theory and Applications‖, Springer, 2005.
3. N.P. Padhy, S. P. Simon, "Soft Computing with MATLAB Programming", Oxford University Press, 2015.
4. S. Rajasekaran, G. A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications ", PHI Learning Pvt. Ltd., 2017.
5. NPTEL Courses:
   a. Introduction To Soft Computing - https://onlinecourses.nptel.ac.in/noc23_cs40/preview

22AM922	APPLIED AI and ML	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- Understand and apply statistical methods to analyze and interpret data.
- Analyze and cluster genomic data using appropriate algorithms.
- Implement linear regression models to predict outcomes.
- Evaluate and improve model performance in binary classification tasks.
- Implement and train neural networks for various tasks.

UNIT I	FOUNDATION OF DATA SCIENCE	9

Python for Data Science- NumPy & Pandas - Data Cleaning and Preparation- Statistics for Data Science- Types of Data- Levels of Measurement-Descriptive Statistics-Probability theory -Inferential Statistics-Advanced Visualization Techniques.

Case Study: Cardio Good Fitness Data Analysis

Projects:1. Food Hub Analysis
2. FIFO World Cup Analysis
3. Mobile Internet Usage Analysis

UNIT II	MAKING SENSE OF UNSTRUCTURED DATA	9

Introduction to Supervised & Unsupervised Learning- Handling Imbalanced Datasets-K-Means Clustering algorithm, Dimensionality Reduction techniques (PCA, t-SNE)-Visualizing High Dimensional Data-Comparsion of t-SNE with PCA-Combining PCA with t-SNE.

Case Study: Genomic Data Clustering

Project: Fantasy Sports Clustering Analysis

UNIT III	REGRESSION AND PREDICTION	9

Introduction to Linear Regression-OLS Method-Cost function and Optimization-Gradient Descent Algorithm-Multiple Linear Regression-Elastic Net, Model Evaluation Techniques in solving Real World Regression Problems.

Case Studies: 1. Hospital LOS Prediction
2.Big Mart Sales Prediction

Project: Super Kart Sales Prediction

UNIT IV	CLASSIFICATION AND HYPOTHESIS TESTING	9

Concepts of Classification algorithms- Model Performance- Application of Binary Classification- Multi class classification-Multi label classification-Challenges in solving real world classification problems.

Case Studies: 1.HR Employee Attrition Prediction
2. KC Roasters Coffee Quality Prediction

Projects: 1. Travel Package Purchase Prediction
2. Potential Customers Prediction

UNIT V	DEEP LEARNING	9

Implementation of Neural Networks-Data Quality & Quantity-Data Augmentation- Hyper parameter tuning-Computational Challenges -Transformer Networks-Transfer learning -solving real world Neural Network based Problems.

Case Study: 1. Audio MNLST Digit Recognition,
2.Street View Housing Number Digit Recognition

Project: Food Image Classification

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Apply statistical techniques to interpret data and make data-driven decisions.

CO2: Utilize dimensionality reduction techniques such as PCA and t-SNE to simplify complex datasets.

CO3: Apply regression techniques to real-world problems.

CO4: Perform hypothesis testing to validate assumptions and make inferences from data.

CO5: Apply deep learning techniques to solve practical problems.

CO6: Implement the concepts of AI and ML to solve various applications.

TEXT BOOKS:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson, 2019.
2. Ethem Alpaydin, Introduction to Machine Learning, Adaptive Computation and Machine Learning Series, Third Edition, MIT Press, 2014.
3. Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017.
4. Deep Learning, Ian Goodfellow, Yoshua Bengio Aaron Courville, MIT Press, 2017.
5. Neural Networks and Deep Learning, Michael Nielsen, Determination Press, 2015.

REFERENCES:

1. Anuradha Srinivasaraghavan, Vincy Joseph, Machine Learning, First Edition, Wiley, 2019.
2. Peter Harrington, “Machine Learning in Action”, Manning Publications, 2012.
3. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
4. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
5. Christoph Molnar, “Interpretable Machine Learning - A Guide for Making Black Box Models Explainable”, Creative Commons License, 2020.
6. Deep Learning with TensorFlow: Explore neural networks with Python, Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy, Packt Publisher, 2017.
7. Deep Learning with Keras, Antonio Gulli, SujitPal , Packt Publishers, 2017.
8. Deep Learning with Python", Francois Chollet, Manning Publications, 2017
9. https://olympus.mygreatlearning.com/courses

22AM923	RECOMMENDER SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners to:

- To understand the foundations of the recommender system.
- To learn about collaborative filtering.
- To discuss content-based recommendation systems.
- To elaborate on the evaluation paradigms for a recommendation system.
- To make students design and implement a recommender system.

UNIT I	INTRODUCTION TO RECOMMENDER SYSTEMS	9

Introduction - Basic Models of Recommender Systems - Domain-Specific Challenges in Recommender Systems - Cold-Start Problem – Attack-Resistant Recommender Systems – Group – Multi-Criteria – Active-Learning – Privacy - Application Domains.

UNIT II	COLLABORATIVE FILTERING	9

Neighborhood-Based Collaborative Filtering - Key Properties - Predicting Ratings – Clustering - Dimensionality Reduction - A Regression Modeling - Graph Models – Model-based Collaborative Filtering - Decision and Regression Trees - Rule-Based Collaborative Filtering - Naive Bayes Collaborative Filtering – Latent Factor Models.

UNIT III	CONTENT-BASED RECOMMENDATION	9

Basic Components of Content-Based Systems - Preprocessing and Feature Extraction - Learning User Profiles and Filtering - Content-Based Versus Collaborative Recommendations - Using Content-Based Models for Collaborative Filtering.

UNIT IV	DESIGN EVALUATION	9

Evaluating Paradigms – General Goals of Evaluation Design-Design Issues in Offline Recommender Evaluation-Accuracy Metrics in Offline Evaluation-Limitations of Evaluation Measures.

UNIT V	TYPES OF RECOMMENDATION SYSTEMS	9

Content-based Recommender Systems – Basic Components – Constraint-based Recommender Systems – Context-sensitive Recommender Systems – Social and Trust-Centric Recommender Systems.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Elaborate the foundations of the recommender system.
CO2: Use collaborative filtering to design recommendation systems.
CO3: Discuss content-based recommendation systems.
CO4: Elaborate on the evaluation paradigms for a recommendation system.
CO5: Use appropriate type of recommendation systems to solve real-world problems.
CO6: Design, implement and evaluate a recommendation algorithm.

TEXT BOOKS:

1. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. Jannach D., Zanker M., FelFering A., Friedrich G., Recommender Systems: An Introduction, Cambridge University Press, First Edition, 2011.

REFERENCES:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, 3rd edition, Cambridge University Press, 2020.
2. Ricci, F., Rokach, L. and Shapira, B., Introduction to recommender systems handbook. In Recommender systems handbook, Springer, 2011.
3. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer, First Edition, 2013.

22AM924	KNOWLEDGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Knowledge Engineering.
- To discuss reasoning under uncertainty.
- To design and develop ontologies.
- To apply reasoning with ontologies and rules.
- To understand learning and rule learning.

UNIT I	INTRODUCTION	9

Knowledge, Representation and Reasoning - Need for Logic – First order logic – Syntax – Semantics – Pragmatics- Implicit and Explicit Belief - Expressing Knowledge - Resolution – Propositional case - Horn Logic – Horn clauses - Procedural Control of Reasoning.

UNIT II	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 – Evidence-based reasoning task: Intelligent Analysis.

UNIT III	ONTOLOGIES – DESIGN AND DEVELOPMENT	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 Understanding and Concept Elicitation – Modelling-based Ontology Specification.

UNIT IV	REASONIING WITH ONTOLOGIES AND RULES	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 - Rules in Production Systems - Object-Oriented Representation - Structured Descriptions.

UNIT V	LEARNING AND RULE LEARNING	9

Machine Learning – Concepts – Generalization and Specialization Rules – Types – Inductive concept learning from Examples – Learning with an Incomplete Representation Language – Formal definition of Generalization.
Modelling, Learning and Problem Solving – Rule learning and Refinement – Overview.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the basics of Knowledge Representation and Knowledge Engineering.
CO2: Develop reasoning under uncertainty.
CO3: Design and develop ontologies.
CO4: Implement ontology-based reasoning systems.
CO5: Understand learning and rule learning.

CO6: Integrating knowledge representation and reasoning in intelligent systems.

TEXT BOOKS:

1. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
2. Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum, Knowledge Engineering Building Cognitive Assistants for Evidence-based Reasoning, Cambridge University Press, First Edition, 2016.

REFERENCES:

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

22AM925	COMPUTATIONAL NEUROSCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand what nervous systems do and determine how they function.
- To explore the computational principles governing various aspects of vision, sensory-motor control, learning, and memory.
- To analyze neural models.
- To learn to extract information through neural encoding and decoding.
- To investigate models of synaptic plasticity and learning in the brain.

UNIT I	NEURAL ENCODING	9

Firing Rates and Spike Statistics: Introduction- Spike Trains and Firing Rates - What Makes a Neuron Fire? Spike-Train Statistics – The Neural Code

Reverse Correlation and Visual Receptive Fields – Estimating Firing Rates Introduction to the Early Visual System Reverse-Correlation Methods: Simple Cells Static Non linearities: Complex Cells - Receptive Fields in the Retina and LGN Constructing Visual Receptive Fields

UNIT II	NEURAL DECODING AND INFORMATION THEORY	9

Discrimination - Population Decoding - Spike-Train Decoding

Information Theory: Entropy and Mutual Information – Information and Entropy Maximization – Entropy and Information for Spike Trains

UNIT III	MODEL NEURONS	9

Phase Plane Analysis – I - Phase Plane Analysis – II - Analyzing HHE – Bifurcations - Other Point Models – Levels of Neuron Modeling-Conductance-Based Models – The Cable Equation- Multi-compartment models

UNIT IV	NETWORK MODELS	9

Firing Rate Models – Feedforward Networks – Recurrent Networks – Excitatory-Inhibitory Networks – Stochastic Networks

UNIT V	PLASTICITY	9

Synaptic Transmission and Synaptic Strength - Ways of Modification of Synaptic Strength - Types of Plasticity - Short Term Plasticity - Long Term Plasticity – Computational Implications

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the fundamentals of neural encoding.
CO2: Apply neural encoding techniques.
CO3: Use Information Theory to decode neural signals.
CO4: Analyze and model the dynamics of neurons.
CO5: Design and analyze neural networks.
CO6: Implement the concepts of synaptic plasticity.

TEXT BOOKS:

1. Dayan, Peter, and L. F. Abbott, Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems. Cambridge, MA: MIT Press, 2005. ISBN: 9780262041997.
2. Paul Miller, An Introductory Course in Computational Neuroscience, MIT Press, 2018.

REFERENCES:

1. Signal and Systems, Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab Prentice Hall, 1997.
2. Methods in Neuronal Modeling, Second Edition From Ions to Networks , Edited by Christof Koch and Idan Segev, MIT Press
3. Ionic Channels of Excitable Membranes, Second Edition, Bertil Hille, Sinauer Associates Inc.,1992
4. NPTEL: Computational Neuroscience - Course (nptel.ac.in)

22AM926	AI ESSENTIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The Course will enable learners:

- To familiarize the concepts and recent technologies in AI.
- To use generative AI in building applications.
- To learn to design inputs for AI tools by using prompt engineering.
- To use tools and frameworks in explainable AI.
- To build AI systems with the principles of responsible AI.
- To understand the basics of Quantum AI.

UNIT I	GENERATIVE AI	9

Introduction - Types of Generative AI models – GANs – VAE – Diffusion Models – DALL-E 2 model – Stability AI and Midjourney – Speech – Large Language Models – Language and Intelligence – NLP – Word2Vec Model – Transformers – Dials – BERT – GPT Systems and ChatGPT- Auto Code Generation – Working – Copilot.

UNIT II	PROMPT ENGINEERING	9

Basics – In-Context Learning – In-Context Prompting – Techniques – Image Prompting – Prompt Hijacking – Challenges.

UNIT III	EXPLAINABLE AI	9

Introduction – Proposed AI Model – Proposed Architecture – XAI Methods and their classifications – Forms of Explanation – Frameworks for Model Interpretability and Explanation – Methods and Metrics for Explaining AI Models – Evaluation measures and applications for Explainable AI.

UNIT IV	RESPONSIVE AI	9

Ethical Decision Making – Approaches to Ethical Reasoning by AI – Designing Artificial Moral Agents – Ethical Deliberations – Levels of Ethical Behaviour – Ethical Status of AI Systems – Governance for

Responsible AI – Codes of Conduct – Inclusion and Diversity – AI and Society – Super-intelligence – Responsible AI.

UNIT V	**QUANTUM ML**	**9**

Quantum ML – Grover search algorithm – Quantum RL – Quantum annealing – Quantum Neural Networks – Topographic representation – Quantum ML – Brain – Topographic basis maps – Topographic qubit maps – conversions between representations – applications.

TOTAL:45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Elaborate the concepts and recent technologies in AI.
CO2: Apply generative AI in building applications.
CO3: Design inputs for AI tools by using prompt engineering.
CO4: Use tools and frameworks in explainable AI.
CO5: Build AI systems with the principles of responsible AI.
CO6: Understand the basics of Quantum AI.

TEXT BOOKS:

1. Tom Taulli, "Generative AI - How Chatgpt and other AI Tools will Revolutionize Business", Apress, 2023.
2. Mayuri Mehta, Vasile Palade, Indranath Chatterjee, Explainable AI: Foundations, Methodologies and Applications, Springer, 2023.
3. Virginia Dignum, Responsible Artificial Intelligence, How to Develop and Use AI in a Responsible Way, Springer, 2019.
4. Siddhartha Bhattacharyya, Indrajit Pan, Ashish Mani, Sourav De, Elizabeth Behrman, Susanta Chakraborti, "Quantum Machine Learning", De Gruyter Frontiers in Computational Intelligence, 2020.

REFERENCES:

1. Ben Auffarth, Generative AI with Lang Chain, Packt Publishing, 2023.
2. Amit Bahree, Generative AI in Action, Manning Publication, First Edition, 2023.
3. Gabriele Gianini, Pierre-Edouard Portier, "Advances in Explainable Artificial Intelligence", MDPI, 2024.
4. Santanu Pattanayak, Quantum Machine Learning with Python - Using Cirq from Google Research and IBM Qiskit, Apress, 2021.

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MINOR DEGREE CURRICULUM OFFERED BY DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (for other B.E. / B.Tech. Programmes)

MINOR DEGREE IN ARTIFICIAL INTELLIGENCE

CURRICULUM

SI. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1.	22AM004	Introduction to Data Science	3	3	0	0	3
2.	22AM005	Introduction to Artificial Intelligence	3	3	0	0	3
3.	22AM006	Machine Learning Algorithms	3	3	0	0	3
4.	22AM007	Foundations of Deep Learning	3	3	0	0	3
5.	22AM812	Capstone Project	12	0	0	12	6

SYLLABUS

22AM004	INTRODUCTION TO DATA SCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To elaborate the fundamentals of data science process.
- To demonstrate various python libraries for data science
- To discuss the various classification algorithms.
- To discuss the clustering and outlier detection approaches.
- To present data using visualization tools in Python.

UNIT I	INTRODUCTION	9

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

UNIT II	PYTHON LIBRARIES FOR DATA SCIENCE	9

Launching the IPython Shell - Launching the Jupyter Notebook - IPython Magic Commands - The Basics of NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance Pandas.

UNIT III	CLASSIFICATION	9

Basic Concepts – Decision Tree Induction – Bayes Classification Methods – Rule-Based Classification – Model Evaluation and Selection.

Bayesian Belief Networks – Classification by Backpropagation – Support Vector Machines – Associative Classification – K-Nearest-Neighbor Classifiers – Fuzzy Set Approaches - Multiclass Classification - Semi-Supervised Classification.

UNIT IV	CLUSTERING AND OUTLIER DETECTION	9

Cluster Analysis – Partitioning Methods – Evaluation of Clusters – Probabilistic Model-Based Clustering – Outliers and Outlier Analysis – Outlier Detection Methods – Statistical Approaches – Clustering and Classification-Based Approaches.

UNIT V	DATA VISUALIZATION	9

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Interpret the fundamentals of data science process.
CO2: Apply python libraries for data science applications.
CO3: Apply and interpret basic classification algorithms.
CO4: Outline clustering and outlier detection approaches.
CO5: Present and interpret data using visualization tools in Python.
CO6: Implement basic data science techniques using Python.

TEXT BOOKS:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.

2. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann, 2012.
3. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", Kindle Edition, 2017.

REFERENCES:

1. Roger D. Peng, R Programming for Data Science, Lulu.com, 2016.
2. Laura Igual, Santi Seguí, "Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications", 1st Edition, Springer, 2017.
3. Peter Bruce, Andrew Bruce, "Practical Statistics for Data Scientists: 50 Essential Concepts", 3rd Edition, O'Reilly, 2017.
4. Avrim Blum, John Hopcroft, Ravi Kannan, "Foundations of Data Science", 1st Edition, Cambridge University Press, 2020.

NPTEL:

5. Data Science for Engineers - https://onlinecourses.nptel.ac.in/noc24_cs53/preview
6. Foundation of Data Science - https://onlinecourses.swayam2.ac.in/imb24_mg31/preview
7. Python for Data Science - https://onlinecourses.nptel.ac.in/noc24_cs54/preview

22AM005	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To discuss the foundations of AI and various intelligent agents
- To discuss problem solving search strategies and game playing
- To describe logical agents and first-order logic
- To illustrate problem-solving strategies with knowledge representation mechanism for solving hard problems
- To summarize the basics of learning and expert systems.

UNIT I	ARTIFICIAL INTELLIGENCE AND INTELLIGENT AGENTS	9

Introduction to AI – Foundations of Artificial Intelligence - Intelligent Agents – Agents and Environments - Concept of rationality – Nature of environments – Structure of agents - Problem solving agents – Example Problems - Search Algorithms – Uninformed Search Strategies

UNIT II	PROBLEM SOLVING	9

Heuristic search strategies – heuristic functions- Game Playing – Mini-max Algorithm - Optimal decisions in games – Alpha-beta search –Monte-Carlo search for Games - Constraint satisfaction problems – Constraint propagation – Backtracking search for CSP – Local search for CSP – Structure of CSP

UNIT III	LOGICAL AGENTS	9

Knowledge-based agents – Logic - Propositional logic – Propositional theorem proving – Propositional model checking – Agents based on propositional logic

First-Order Logic – Syntax and semantics – Using First-Order Logic - Knowledge representation and engineering – Inferences in first-order logic – Propositional Vs First-Order Inference - Unification and First-Order Inference - Forward chaining – Backward chaining - Resolution

UNIT IV	KNOWLEDGE REPRESENTATION AND PLANNING	9

Ontological engineering – Categories and objects – Events – Mental objects and modal logic – Reasoning systems for categories – Reasoning with default information

Classical planning – Algorithms for classical planning – Heuristics for planning – Hierarchical planning – Non-deterministic domains – Time, schedule, and resources - Analysis

UNIT V	LEARNING AND EXPERT SYSTEMS	9

Forms of Learning – Developing Machine Learning systems – Statistical Learning - Deep Learning: Simple feed-forward network - Neural Networks – Reinforcement Learning: Learning from rewards – Passive and active Reinforcement learning.
Expert Systems: Functions – Main structure – if-then rules for representing knowledge – developing the shell – Dealing with uncertainty.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Summarize the foundations of AI and various Intelligent agents.
CO2: Apply search strategies in problem solving and game playing.
CO3: Outline logical agents and first-order logic.
CO4: Apply problem-solving strategies with knowledge representation mechanism for solving hard problems.
CO5: Use the different forms of learning and expert systems.
CO6: Elaborate on the various concepts and algorithms of artificial intelligence.

TEXT BOOKS:

1. Peter Norvig and Stuart Russel, Artificial Intelligence: A Modern Approach, Pearson, 4th Edition, 2020.
2. Bratko, Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCES:

1. Elaine Rich, Kevin Knight and B.Nair, Artificial Intelligence 3rd Edition, McGraw Hill, 2017.
2. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans. Series: Pelican Books, 2020
3. Ernest Friedman-Hill, Jess in Action, Rule-Based Systems in Java, Manning Publications, 2003
4. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009.
5. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems,1st Edition by Patterson, Pearson, India, 2015

NPTEL:

6. Introduction to Artificial Intelligence - https://onlinecourses.nptel.ac.in/noc24_cs08/
7. Fundamentals of Artificial intelligence - https://onlinecourses.nptel.ac.in/noc24_ge47/
8. Artificial Intelligence : Search Methods For Problem solving - https://onlinecourses.nptel.ac.in/noc24_cs88/

22AM006	MACHINE LEARNING ALGORITHMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To discuss the basics of Machine Learning and Supervised Algorithms.
- To understand the various classification algorithms.
- To study dimensionality reduction techniques.
- To elaborate on unsupervised learning techniques.
- To discuss various Graphical models and understand the basics of reinforcement learning.

UNIT I	INTRODUCTION	9

Machine Learning – Types – Applications – Preparing to Model – Activities – Data – Exploring structure of Data – Data Quality and Remediation – Data Pre-processing – Modelling and Evaluation: Selecting a Model -Training a Model – Model representation and Interpretability – Evaluating Performance of a Model – Improving Performance.

UNIT II	FEATURE ENGINEERING AND DIMENSIONALITY REDUCTION	9
Feature Engineering – Feature Transformation – Feature Subset Selection - Principle Component Analysis – Feature Embedding – Factor Analysis – Singular value decomposition and Matrix Factorization – Multidimensional scaling – Linear Discriminant Analysis – Canonical Correlation Analysis – Isomap – Locally linear Embedding – Laplacian Eigenmaps.		
UNIT III	**SUPERVISED LEARNING**	**9**
Linear Regression -Relation between two variables – Steps – Evaluation – Logistic Regression – Decision Tree – Algorithms – Construction – Classification using Decision Tree – Issues – Rule-based Classification – Pruning the Rule Set – Support Vector Machines – Linear SVM – Optimal Hyperplane – Radial Basis Functions – Naïve Bayes Classifier – Bayesian Belief Networks.		
UNIT IV	**UNSUPERVISED LEARNING**	**9**
Clustering – Types – Applications - Partitioning Methods – K-means Algorithm – K-Medoids – Hierarchical methods – Density based methods DBSCAN – Finding patterns using Association Rules – Hidden Markov Model.		
UNIT V	**NEURAL NETWORKS AND TYPES OF LEARNING**	**9**
Biological Neuron – Artificial Neuron – Types of Activation function – Implementations of ANN – Architectures of Neural Networks – Learning Process in ANN – Back propagation – Deep Learning – Representation Learning – Active Learning – Instance based Learning – Association Rule Learning – Ensemble Learning Algorithm – Regularization Algorithm- Reinforcement Learning – Elements- Model-based- Temporal Difference Learning.		
TOTAL: 45 PERIODS		

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Differentiate the basics of Machine Learning and Supervised Algorithms.
CO2: Apply the various classification algorithms.
CO3: Study dimensionality reduction techniques.
CO4: Elaborate on unsupervised learning techniques.
CO5: Outline various Graphical models and understand the basics of reinforcement learning.
CO6: Solve real-world problems using machine learning algorithms.

TEXT BOOKS:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, "Machine Learning", Pearson, 2019.
2. Ethem Alpaydin, "Introduction to Machine Learning, Adaptive Computation and Machine Learning Series", Third Edition, MIT Press, 2014.

REFERENCES:

1. Anuradha Srinivasaraghavan, Vincy Joseph, "Machine Learning", First Edition, Wiley, 2019.
2. Peter Harrington, "Machine Learning in Action", Manning Publications, 2012.
3. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
4. Tom M Mitchell, "Machine Learning", First Edition, McGraw Hill Education, 2013.
5. Christoph Molnar, "Interpretable Machine Learning - A Guide for Making Black Box Models Explainable", Creative Commons License, 2020.

NPTEL:

6. Introduction to Machine Learning - https://onlinecourses.nptel.ac.in/noc24_cs101/

22AM007	FOUNDATIONS OF DEEP LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To outline the basics of deep neural networks.
- To discuss advanced deep learning models.
- To discuss CNN and RNN architectures of deep neural networks.
- To elaborate autoencoders in neural networks.
- To discuss the deep generative models.

UNIT I	DEEP NETWORKS	9

Challenges motivating deep learning - Deep feedforward networks - Learning XOR - Gradient based learning - Hidden Units – Architecture Design – Back Propagation – Regularization – Parameter Norm Penalties – Constrained Optimization – Under-Constrained Problems – Dataset Augmentation – Noise Robustness – Semi-Supervised Learning – Multi-Task Learning – Early Stopping – Parameter Tying and Sharing – Bagging and Other Ensemble methods – Dropout – Adversarial Training.

UNIT II	OPTIMIZATION FOR TRAINING DEEP MODELS	9

Pure optimization – Challenges – Basic Algorithms – Parameter initialization Strategies – Algorithms with Adaptive Learning Rates – Approximate Second-Order methods – Optimization Strategies and Meta Algorithms.

UNIT III	CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS	9

Convolution Operation – motivation – Pooling – Infinitely Strong prior – Variants – Structured Output – Data Types – Efficient Convolutional Algorithms – Random or Unsupervised features – Neuroscientific Basis - Deep Learning – Sequence Modelling - Computational Graphs - RNN - Bidirectional RNN – Encoder-Decoder - Sequence to Sequence RNN - Deep Recurrent Networks - Recursive Neural Networks -- Long Term Dependencies; Leaky Units – Strategies for multiple time scales – LSTM and Gated RNNs – Optimization for Long Term Dependencies.

UNIT IV	AUTOENCODERS	9

Autoencoders: Undercomplete autoencoders - Regularized autoencoders – Power, Layer Size and Depth - Stochastic encoders and decoders – Denoising Autoencoders - Learning with autoencoders – contractive Autoencoders – Applications of autoencoders.

UNIT V	DEEP GENERATIVE MODELS	9

Boltzmann Machine – Restricted Boltzmann Machine – Deep Belief Networks – Deep Boltzmann Machines - Boltzmann Machines for Real-Valued Data – Convolutional Boltzmann Machines - Boltzmann Machine for Structured or Sequential Outputs – Directed Generative Nets – Evaluating Generative Models.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Outline the basics of deep neural networks.
CO2: Develop advanced deep learning models.
CO3: Implement CNN and RNN architectures of deep neural networks.
CO4: Interpret autoencoders in neural networks.
CO5: Apply deep generative models to solve real world problems.
CO6: Build deep learning models and evaluate them.

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning", MIT Press, 2016.

REFERENCES:

1. Charu C. Aggarwal, ``Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 2018.
2. Yoav Goldberg, ``Neural Network Methods for Natural Language Processing", Synthesis

Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
3. Francois Chollet, ``Deep Learning with Python'', Manning Publications Co, 2018.
4. Josh Patterson, Adam Gibson, ``Deep Learning: A Practitioner's Approach'', O'Reilly Media, 2017.
5. Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.

NPTEL:

6. Deep Learning - https://onlinecourses.nptel.ac.in/noc24_ee04/preview
7. Deep Learning - IIT Ropar - https://onlinecourses.nptel.ac.in/noc24_cs59/preview