Learning Outcomes based Curricular Framework

The Curriculum Book

Bachelor of Technology
(AIML)
4-YEAR PROGRAMME

Choice Based Credit System
w. e. f. 2023-24

Scheme of Examination and Detailed Syllabus

(III - VIII Semester)

Faculty of Engineering and Technology
Chaudhary Devi Lal University
Sirsa-125055

Table 3(a): Courses' codes, titles, and credits (Group–A)

Course Code	Course Title	Workload/Credit			
	Semester I	Theory	Tutorial	Practical	Total
BSC/1-T BSC/1-T(i) BSC/1-T(iv)	Physics: Introduction to Electromagnetic Theory (EE/ECE) Oscillations, Waves and Optics (ME)	3/3	1/1	-	4/4
BSC/3-T	Mathematics-I	3/3	1/1	-	4/4
ESC/1-T	Basic Electrical Engineering	3/3	1/1	-	4/4
ESC/4-T	Workshop/Manufacturing Practices	3/3	-	-	3/3
BSC/1-P BSC/1-P(i) BSC/1-P(iv)	Physics Lab: Introduction to Electromagnetic Theory (EE/ECE) Oscillations, Waves and Optics (ME)	-	-	4/2	4/2
ESC/1-P	Basic Electrical Engineering Lab	-	-	2/1	2/1
ESC/4-P	Workshop/Manufacturing Practices Lab	-	-	4/2	4/2
MC/1	Induction Training	-	-	-	-
		12/12	**3/3**	**10/5**	**25/20**
	Semester II	Theory	Tutorial	Practical	Total
BSC/2-T	Chemistry	3/3	1/1	-	4/4
BSC/4-T	Mathematics-II	3/3	1/1	-	4/4
ESC/3-T	Programming for Problem Solving	4/4	-	-	4/4
HSMC/1-T	English	2/2	-	-	2/2
MC/2-T	Environmental Science	3/-	-	-	3/-
BSC/2-P	Chemistry Lab	-	-	4/2	4/2
ESC/2-P	Engineering Graphics and Design Lab	-	-	4/2	4/2
ESC/3-P	Programming for Problem Solving Lab	-	-	4/2	4/2
HSMC/1-P	English Lab	-	-	2/1	2/1
Total		**15/12**	**2/2**	**14/7**	**31/21**

Courses' codes, titles, and credits (Group–B)

Course Code	Course Title	Workload/Credit			
	Semester I	Theory	Tutorial	Practical	Total
BSC/2-T	Chemistry	3/3	1/1	-	4/4
BSC/3-T BSC/5-T	Mathematics-I Mathematics-I (for CSE/IT/AI&ML)	3/3	1/1	-	4/4
ESC/3-T	Programming for Problem Solving	4/4	-	-	4/4
HSMC/1-T	English	2/2	-	-	2/2
BSC/2-P	Chemistry Lab	-	-	4/2	4/2
ESC/2-P	Engineering Graphics and Design Lab	-	-	4/2	4/2
ESC/3-P	Programming for Problem Solving Lab	-	-	4/2	4/2
HSMC/1-P	English Lab	-	-	2/1	2/1
MC/1	Induction Training	-	-	-	-
Total		**12/12**	**2/2**	**14/7**	**28/21**
	Semester II	Theory	Tutorial	Practical	Total
BSC/1-T BSC/1-T(ii) BSC/1-T(v)	Physics: Introduction to Mechanics (for CE) Semiconductor Physics (CSE/IT/AI &ML)	3/3	1/1	-	4/4
BSC/4-T BSC/6-T	Mathematics-II Mathematics-II (for CSE/IT/AI&ML)	3/3	1/1	-	4/4
ESC/1-T	Basic Electrical Engineering	3/3	1/1	-	4/4
ESC/4-T	Workshop/Manufacturing Practices	3/3	-	-	3/3
MC/3-T	Indian Constitution	3/-	-	-	3/-
BSC/1-P BSC/1-P(ii) BSC/1-P(v)	Physics Lab: Introduction to Mechanics (for CE) Semiconductor Physics (CSE/IT/AI&ML)	-	-	4/2	4/2
ESC/1-P	Basic Electrical Engineering Lab	-	-	2/1	2/1
ESC/4-P	Workshop/Manufacturing Practices Lab	-	-	4/2	4/2
Total		**15/12**	**3/3**	**10/5**	**28/20**

B.Tech. AI & ML III & IV Semester

Semester	Basic Sciences' Courses BSC		Engineering Sciences'/Programme Core/Programme Elective/Open Elective Courses ESC/PC/PE/OE		Humanities, Social Sciences, Management Courses HSMC		Mandatory Courses MC		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
3rd	01	03	07	18	00	00	01	0	21
4th	00	00	10	23	00	00	00	0	23

Courses' codes, titles, and credits (Semester- III)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	BSC/7-T	Mathematics for Machine Learning	3/3	-/-	-	3/3
2	PC/AIML/31-T	Data Structures and Algorithms	3/3	-/-	-	3/3
3	PC/AIML/32-T	Object Oriented Programming using C++	3/3	-/-	-	3/3
4	PC/AIML/33-T	Data Analytics using R	3/3	-/-	-	3/3
5	*MC/2-T	Environmental Science	3/-	-/-	-	3/-
6	PC/AIML/34-T	Fundamentals of AI&ML	3/3	-/-	-	3/3
7	PC/AIML/31-P	Data Structures and Algorithms using C/C++ Lab	-/-	-/-	4/2	4/2
8	PC/AIML/32-P	Object Oriented Programming using C++ Lab.	-/-	-/-	4/2	4/2
9	PC/AIML/33-P	Data Analytics using R Lab.			4/2	4/2
					Total Credit	30/21

Courses' codes, titles, and credits (Semester- IV)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/41-T	Computer Organisation and Architecture	3/3	-/-	-	3/3
2	PC/AIML/42-T	Data Mining Techniques	3/3	-/-	-	3/3
3	PC/AIML/43-T	Operating Systems	3/3	-/-	-	3/3
4	PC/AIML/44-T	Database Management System	3/3	-/-	-	3/3
5	PC/AIML/45-T	Discrete Mathematics	3/3	-/-	-	3/3
6	PC/AIML/46-T	Python Programming	3/3	-/-	-	3/3
7	PC/AIML/42-P	Data Mining using R/Python/WEKA Lab.	-/-	-/-	4/2	4/2
8	PC/AIML/44-P	Database Management SystemLab.	-/-	-/-	2/1	2/1
9	PC/AIML/46-P	Python Programming Lab.	-/-	-/-	4/2	4/2
					Total Credit	28/23
B.Tech. AIML student must undergo 6/8-week Summer Industrial Training after IV semester.						
1.	**EEC/AIML/51-P	Industrial Training/ Internship-I	-/-	-/-	4/2	4/2

*Non-credit qualifying mandatory course. The assessment will be completely internal.

****The students will have to undergo Industrial/Practical Training/ Internship for 6-8 weeks during summer vacations after the examination of 4^{th} semester which will be evaluated in 5^{th} semester.

Note: Students will be allowed to use non-programmable scientific calculators only, however, sharing of calculator should not be permitted.

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B.Tech. AI & ML V & VI Semester

Semester	Basic Sciences' Courses BSC		Engineering Sciences'/Programme Core/Programme Elective/Open Elective Courses ESC/PC/PE/OE		Humanities, Social Sciences, Management Courses HSMC		Mandatory Courses MC		IndustrialTrainimng(EEC/AIML-)		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
5th	00	0	07	18	01	02	00	00	01	02	22
6th	00	00	07	18	01	02	01	00	01	02	22

Courses' codes, titles, and credits (Semester- V)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/51-T	Machine Learning	3/3	-/-	-	3/3
2	PC/AIML/52-T	Computer Networks	3/3	-/-	-	3/3
3	PC/AIML/53-T	Formal Language and Automata Theory	3/3	-/-	-	3/3
4	PC/AIML/54-T	Evolutionary and Swarm Intelligence for Optimization	3/-	-/-	-	3/3
5	OE-I	Open Elective Course to be opted by Students from another branch	3/-	-/-	-	3/3
6	HSMC/4-T	Economics for Engineers	2/2	-/-	-	2/2
7	MC/4-T	*Essence of Indian Traditional Knowledge	3/-	-/-	-	3/-
8	PC/AIML/51-P	Machine Learning Lab.	-/-	-/-	4/2	4/2
9	PC/AIML/52-P	Computer Networks Lab			2/1	2/1
10	**EEC/AIML/51-P	Industrial Training/ Internship-I	-/-	-/-	4/2	4/2
					Total Credit	30/22
***The students will have to prepare and submit a Micro Project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of IV semester under the supervision of faculty duringVsemester.						

Courses' codes, titles, and credits (Semester- VI)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/61-T	Neural Networks	3/3	-/-	-	3/3
2	PC/AIML/62-T	Cloud Computing	3/3	-/-	-	3/3
3	PC/AIML/63-T	Analysis and Design of Algorithms	3/3	-/-	-	3/3
4	PE/AIML/61-T To PE/AIML/65-T	Programme Elective Course to be opted by students **(Electives I)**	3/-	-/-	-	3/3
5	HSMC/3-T	Fundamentals of Management for Engineers	2/2	-/-	-	2/2

6	OE-II	OpenElectiveCourse to beopted by Students from another branch	3/3	-/-	-	3/3
7	PC/AIML/61-P	Neural Networks Lab.	-/-	-/-	3/1.5	3/1.5
8	PC/AIML/62-P	Cloud Computing Lab.			3/1.5	3/1.5
9	***EEC/AIML/61-P	Minor Project I			4/2	4/2
					Total Credit	27/22
***AMini-Project/Trainingbasedonopen-source tools						

***The students will have to undergo Industrial Training/Internship for 6-8 weeks during **summer** vacations after the examination of VI semester which will be evaluated in VII semester.

List of Programme Elective I

1. PE/AIML/61-T: Computer Graphics
2. PE/AIML/62-T/ PEC-CSE409-T/PEC-IT409-T: Internet of Things
3. PE/AIML/63-T/ PEC-CSE304-T/ PEC-IT304-T: Bio-informatics
4. PE/AIML/64-T: Information Retrieval Systems
5. PE/AIML/65-T: Microprocessor and Embedded Systems

B.Tech. AI & ML VII & VIII Semester

Semester	Basic Sciences' Courses BSC		Engineering Sciences'/Programme Core/Programme Elective/Open Elective Courses ESC/PC/PE/OE		Humanities, Social Sciences, Management Courses HSMC		Mandatory Courses MC		IndustrialTrainimng(EEC/AIML-)		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
5th	00	0	06	17	00	00	00	00	02	06	23
6th	00	00	04	11	00	00	00	00	01	06	17

Courses' codes, titles, and credits (Semester- VII)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/71-T	Deep Learning	3/3	-/-	-/-	3/3
2	PC/AIML/72-T	Cryptography and Network Security	3/3	-/-	-/-	3/3
3	PE/AIML/71-T to PE/AIML/74-T	Programme ElectiveCourse to be opted by students	3/3	-/-	-/-	3/3
4	PE/AIML/75-T to PE/AIML/79-T	Programme ElectiveCourse to be opted by students	3/3	-/-	-/-	3/3
5	OE-III	Open Elective Course to be opted by Students from another branch	3/3	-/-	-/-	3/3
6	PC/AIML/71-P	Deep Learning Tools Lab. (Python Packages, Tensor Flow, Keras, Google Colab etc.)	-/-	-/-	4/2	4/2
7	EEC/AIML/71-P	*Major Project Part I	-/-	-/-	8/4	8/4
8	EEC/AIML/72-P	AMini-Project/Training based on open-source tools	-/-	-/-	4/2	4/2
					Total Credit	31/23

*******The students will have to prepare and submit a mini project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty duringVIIsemester.

List of Programme ElectiveII

1. PE/AIML/71-T: Wireless and Mobile Communication
2. PE/AIML/72-T: Compiler Design
3. PE/AIML/73-T:Data Visualization Techniques
4. PE/AIML/74-T: Software Defined Networks

List of Programme ElectiveIII

1. PE/AIML/75-T: Digital Image Processing
2. PE/AIML/76-T: Reinforcement Learning
3. PE/AIML/77-T: Edge and Fog Computing
4. PE/AIML/78-T: Natural Language Processing
5. PE/AIML/79-T: Cognitive Systems

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Courses' codes, titles, and credits (Semester- VIII)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/ 81-T	Big Data Analytics	3/3	-/-	-/-	3/3
2	PE/AIML/81-T to PE/AIML/84-T	Programme ElectiveCourse to be opted by students	3/3	-/-	-/-	3/3
3	PE/AIML/85-T to PE/AIML/89-T	Programme ElectiveCourse to be opted by students	3/3	-/-	-/-	3/3
4	PC/AIML/ 81-P	Big Data Analytics Lab	-/-	-/-	4/2	4/2
5	EEC/AIML/81-P	*Major Project Part II	-/-	-/-	12/6	12/6
					Total Credit	25/17

*Major Project Part II will be evaluated by internal examiner and external examiner appointed by Chairperson and COE respectively.

List of Programme ElectiveIV

1. PE/AIML/81-T :Digital Forensics
2. PE/AIML/82-T: Social Network Analysis
3. PE/AIML/83-T: Computer Vision
4. PE/AIML/84-T: Pattern Recognition

List of Programme ElectiveV

1. PE/AIML/85-T: Quantum Computing
2. PE/AIML/86-T : Optimization Methods
3. PE/AIML/87-T: Blockchain Technology
4. PE/AIML/88-T: Introduction to Augmented and Virtual Reality
5. PE/AIML/89-T: Federated Learning

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(LISTOFOPEN ELECTIVES COURSES TO BE OFFERED BY AIML BRANCH TO THE STUDENTS OF OTHER BRANCH/ DEPARTMENT)

List of Open electives (For 5th semester):

OE/AIML/51-T: Internet&Application
OE/AIML/52-T: Introduction to Software Engineering
OE/AIML/53-T: Fundamental of Computer Networks
OE/AIML/54-T: Fundamentals of PythonProgramming

List of Open electives (For 6th semester):

OE/AIML/61-T: Basics of Digital Marketing
OE/AIML/62-T: Cyber Laws and IPR
OE/AIML/63-T: Fundamentals of Information Security
OE/AIML/64-T: Big Data
OE/AIML/65-T: Introduction to Data Science

List of Open electives (For 7th semester):

OE/AIML/71-T: Basics of Cloud computing
OE/AIML/72-T: Introduction to Software Project Management
OE/AIML/73-T: Cyber security
OE/AIML/74-T: IntelligentSystems
OE/AIML/75-T: Basics of Machine Learning

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Scheme of Examination &Detailed Syllabusof BTech (AI&ML)2nd Year

(III & IV Semester)

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Program Specific Outcomes (PSOs)

PSO1 **Developing Computational Systems**: Use principles of various programming languages, data structures, database management systems, computer algorithms, theory of computation, networking and software engineering for designing and implementing computational systems.

PSO2 **Designing Intelligent Machine Learning Systems:** Utilize the principles and tools of artificial intelligence, soft computing, data mining and machine learning, data analytics, robotics, IoT, augmented reality etc. for designing and working with intelligent systems that learn from their environment.

Programme Outcomes (POs) of Bachelor Programmes in Engineering & Technology have been specified in First Year common curriculum of B.Tech. programmes.

Course Code	**Definition/ Category**
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
MC	Mandatory Audit Courses
PC	Program Core
PE	Program Elective Courses
OE	Open Elective Courses
EEC	Employability Enhancement Courses (Project work/ Summer Training/ Industrial Training/ Practical Training/ Internship/Seminar, etc.)

B.Tech. AI & ML III & IVSemester

Semester	Basic Sciences' Courses BSC		Engineering Sciences'/Programme Core/Programme Elective/Open Elective Courses ESC/PC/PE/OE		Humanities, Social Sciences, Management Courses HSMC		Mandatory Courses MC		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
III	01	03	07	18	00	00	01	0	21
IV	00	00	10	23	00	00	00	0	23

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Courses' codes, titles, and credits (Semester- III)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	BSC/7-T	Mathematics for Machine Learning	3/3	-/-	-	3/3
2	PC/AIML/31-T	Data Structures and Algorithms	3/3	-/-	-	3/3
3	PC/AIML/32-T	Object Oriented Programming using C++	3/3	-/-	-	3/3
4	PC/AIML/33-T	Data Analytics using R	3/3	-/-	-	3/3
5	*MC/2-T	Environmental Science	3/-	-/-	-	3/-
6	PC/AIML/34-T	Fundamentals of AI&ML	3/3	-/-	-	3/3
7	PC/AIML/31-P	Data Structures and Algorithms using C/C++ Lab	-/-	-/-	4/2	4/2
8	PC/AIML/32-P	Object Oriented Programming using C++ Lab.	-/-	-/-	4/2	4/2
9	PC/AIML/33-P	Data Analytics using R Lab.			4/2	4/2
					Total Credit	30/21

Courses' codes, titles, and credits (Semester- IV)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/41-T	Computer Organisation and Architecture	3/3	-/-	-	3/3
2	PC/AIML/42-T	Data Mining Techniques	3/3	-/-	-	3/3
3	PC/AIML/43-T	Operating Systems	3/3	-/-	-	3/3
4	PC/AIML/44-T	Database Management System	3/3	-/-	-	3/3
5	PC/AIML/45-T	Discrete Mathematics	3/3	-/-	-	3/3
6	PC/AIML/46-T	Python Programming	3/3	-/-	-	3/3
7	PC/AIML/42-P	Data Mining using R/Python/WEKA Lab.	-/-	-/-	4/2	4/2
8	PC/AIML/44-P	Database Management SystemLab.	-/-	-/-	2/1	2/1
9	PC/AIML/46-P	Python Programming Lab.	-/-	-/-	4/2	4/2
					Total Credit	28/23
B.Tech. AIML student must undergo 6/8-week Summer Industrial Training after IV semester.						
1.	**EEC/AIML/51-P	Industrial Training/ Internship-I	-/-	-/-	4/2	4/2

*Non-credit qualifying mandatory course. The assessment will be completely internal.

****The students will have to undergo Industrial/Practical Training/ Internship for 6-8 weeks during summer vacations after the examination of 4th semester which will be evaluated in 5th semester.

Note: Students will be allowed to use non-programmable scientific calculators only, however, sharing of calculator should not be permitted.

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Detailed Syllabus of

B.Tech.(AI&ML)

III & V Semester

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Detailed Syllabus of

III
Semester

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MATHEMATICS FOR MACHINE LEARNING(BSC/7-T)

General Course Information

Course Code: BSC/7-T Course Credits: 3 Type: Basic Sciences Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Mathematics I and Mathematics II

About the Course

This is an advanced mathematics course that offers the knowledge of Fourier Series, Fourier Transforms, Functions of Complex Variables. These concepts are essential for students to solve problems in image processing, digital signal processing and other related engineering fields.

Course Outcomes: By the end of the course studentswill be able to:

CO1.To understand the basic concepts of data science & machine learning Concepts and their application in modern context
CO2. To apply the basic statistical concepts for solving various problems
CO3.To distinguishes between various probability distributions and apply the concepts for the solution of related problems
CO4. To learn the essential tools of matrices and linear algebra including linear transformations, Eigen values, Diagonalisation, orthogonalization and factorization
CO5.To learn mathematical modelling, types of matrices
CO6.To Implement mathematical concepts using real-world data

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Course Content

UNIT I

Overview of Data Science & Machine Learning: Introduction and history of Data Science, Introduction and history of Machine Learning, Overlap between Data Science, Machine Learning and Artificial Intelligence, Applications of Data Science & Machine Learning in the modern context, Types of data, Basic Statistical Concepts:Scale of Measurements (Nominal, Ordinal, Ratio and Interval), Measures of Location, Measures of Variability/Spread, Measures of Shape.

Case Studies:-Bollywood Dataset, coronary heart disease dataset.

UNIT II

Probability Theory: Principle of counting, definitions of probability theory, independent events, mutuallyexclusive events, collectively exhaustive events, conditional probability, Bayes Theorem, Discrete probability distribution (Discrete Uniform Distribution, Poisson Distribution, Bernoulli Distribution and Binomial Distribution), covariance, correlation,Continuous probability distribution, normal distribution, Central Limit Theorem, Binomial Distribution, Continuous Uniform Distribution, Exponential Distribution, P-Value, T-Value, Confidence Interval, t distribution and chi square distribution

UNIT III

Linear Algebra: Introduction to linear algebra, notations and definitions, Elementary transformations, Elementary matrices, inverse using elementary transformations, Rank of a matrix, Normal form of a matrix, Linear dependence and independence of vectors, Consistency of linear system of equations, Eigen Values and Eigen vectors, Properties of Eigen values, Cayley Hamilton theorem, Linear Transformation, Orthogonal transformation

UNIT IV

Mathematical modelling: Similar matrices, Diagonalisation of a matrix Operations on matrices - additions, subtraction, multiplication, scalar multiplication, vector multiplication, Orthogonal Matrix, Singularity of Matrix, Matrix factorization, decomposition such as LU, QR and SVD, Conceptualizing a mathematical model/curve form first principle, concept of boundary conditions

Text and Reference Books:

1. Probability for Statistics and Machine Learning:AnirbanDasGupta - 2011
2. Probability for Machine Learning: Discover How To Harness, Jason Brownlee – 2019.
3. Machine Learning using Python: Manaranjanpradhan, U Dinesh Kumar-2020, Wiley.
4. Machine Learning using Python, PRADHAN, Manaranjan, 1st and Reprint 2019, Wiley.
5. Machine Learning (in Python and R),) MUELLER,John Paul ,Wiley India
6. AurélienGéron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
7.Python for Probability, Statistics, and Machine Learning, José Unpingco – 2019
8.Mathematics for Machine Learning, Marc peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong. Published by Cambridge University press.
9. Jeeva Jose, “Machine Learning”, Khanna Publishing House, Delhi.
10.IanGoodfellow, YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press http://www.deeplearningbook.org

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CO-PO Articulation Matrix: Mathematics for Machine Learning (BSC/7-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.To understand the basic concepts of data science & machine learning Concepts and their application in modern context	1	--	-		-	-	-	-	-	-	-	-	2	2
CO2. To apply the basic statistical concepts for solving various problems	2	2	2	2	-	-	-	-	-	-	-	-	3	2
CO3.To distinguish between various probability distributions and apply the concepts for the solution of related problems	2	2	2	2	-	-	-	-	-	-	-	-	3	2
CO4. To learn the essential tools of matrices and linear algebra including linear transformations, eigen values, diagonalisation, orthogonalization andfactorization	3	3	2	3	-	-	-	-	-	-	-	-	3	2
CO5.To learn mathematical modelling, types of matrices	3	3	2	3	-	-	-	-	-	-	-	-	3	2
CO6.To Implement mathematical concepts using real-world data	3	3	2	3	-	-	-	-	-	-	-	-	2	2

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DATA STRUCTURES AND ALGORITHMS(PC/AIML/31-T)

General Course Information

Course Code: PC/AIML/31-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Programming in C

About the Course:

Data Structure and Algorithms is a core and an essential course for every graduate in Computer Science and Engineering. This course introduces data structures like arrays, linked lists, trees and graphs etc. and various operations to be implemented on these data structures for solving real world problems. It includes various sorting and searching algorithms as well. Further, it incorporates complexity analysis of algorithms implemented on various data structures.

Course Outcomes: By the end of the course studentswill be able to:

CO1. **Describe**various types of data structures and operations that can be implemented on these data structures. (LOTS: Level 1: Remember)
CO2. **Demonstrate** the use of various data structures and their related operations. (LOTS: Level 2: Understand)
CO3. **Apply** data structure to solve computational problems. (LOTS: Level 3: Apply)
CO4. **Compare** the suitability of alternative data structures and prescribed operations for various problem situations. (HOTS: Level 4: Analyse).
CO5. **Defend** solutions with respect to effective storage of data and efficiency of the required operations for solving real world problems. (HOTS: Level 5: Evaluate)

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Course Content

UNIT I

Introduction to data structures and their types, Abstract data types, linear lists: Arrays and linked lists: memory representations, implementing operations like traversing, searching, inserting and deleting etc. Applications of arrays and linked lists. Representing sets and polynomials using linked lists.

UNIT II

Stack and Queue:Static and linked implementations, Operations and Applications. Circular queues, Tress, Binary trees and related terminology, Tree traversals (Recursive), Threaded Binary Trees, Binary Search Trees implementation and operations,Priority queues.

UNIT III

Height Balanced or AVL treesand B trees. Graph definitions and related terminology, memory representations and related operations (traversal, insertion, deletion, search), Path Matrix, Warshall'sShortest path algorithmHashing, Hash tables, hash function and collisionresolution.

UNIT IV

Sequential and binary search, Sorting algorithms: Bubble sort, Selection sort, Insertion sort,Quick sort, Merge sort, Count sort, Heap sort, Comparison of searching and sorting techniques based on their complexity analysis, Time and space complexity of algorithms: Asymptotic analysis, Big O, Omega, Theta notations.

Text and Reference Books:

1. Aho, A. V., Ullman, J. D., and Hopcroft, J. E., *Data Structures and Algorithms*, Addison-Wesley, 1983.
2. LangsamYedidyah, Augenstein J Moshe, Tenenbaum M Aaron, *Data Structures using C and C++*, 3rdedition, PHI, 2009.
3. Cormen, T. H., Leiserson, C. E., Rivest, R. L. and Stein, C., *Introduction to Algorithms*, MIT Press, 2009.
4. Robert L. Kruse, *Data Structure and Program Design in C*, Pearson Education India, 2007.
5. Weiss, M. A., *Data Structures and Algorithm Analysis in C++*, Addison-Wesley, 2007.
6. Sahni, S., *Data Structures, Algorithms, and Applications in C++*, WCB/McGraw-Hill, 2001.

CO-PO Articulation Matrix: Data Structures and Algorithms (PC/AIML/31-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Describe** various types of data structures and operations that can be implemented on these data structures. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2. **Demonstrate** the use of various data structures and their related operations. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Apply** data structure to solve computational problems. (LOTS: Level 3: Apply)	2	2	-	-	2	-	-	-	-	-	-	-	3	2
CO4. **Compare** the suitability of alternative data structures and prescribed operations for solving a problem. (HOTS: Level 4: Analyse).	2	2	-	-	-	-	-		-	-	-	-	3	2
CO5. **Defend** solutions with respect to effective storage of data and efficiency of the required operations for solving computational problems. (HOTS: Level 5: - Evaluate)	3	3	-	1	-	-	-	-	-	-	-	-	3	2
Level of Attainments PC/AIML/31-T														

OBJECT ORIENTED PROGRAMMING USING C++(PC/AIML/32-T)

General Course Information

Course Code: PC/AIML/32-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Knowledge of computer fundamentals and problemsolving using C programming

About the Course:

Objected Oriented Programming using C++ is an essential course for every graduate in Computer Science and Engineering. This course introduces the Object Orientedconceptsuch as data encapsulation, data hiding, data abstraction, reusability, exception handling etc., and their implementation using C++.

Course Outcomes: By the end of the course students will be able to:

CO1. **List**the concepts related to object oriented paradigms. (LOTS: Level 1: Remember)

CO2. **Distinguish** betweenstructured and object oriented approaches to programming. (LOTS: Level 2: Understand)

CO3. **Apply**object oriented constructs for problem solving. (LOTS: Level 3: Apply)

CO4. **Detect** logical and run time errors and suggest appropriate modifications. (HOTS: Level 4: Analyze)

CO5. **Justify** the design of a program for a given problem. (HOTS: Level 5: Evaluate)

CO6. **Design** solutions to programming problems usingmultipleobject oriented programming constructs together. (HOTS: Level 6: Create)

`

Course Content

Unit I

Introduction toobject oriented programming, C++ standard library, basics of a typical C++ environment, illustrative simple C++ programs, new features of ANSI C++ standard, OOPs concepts: Information hiding, encapsulation, data abstraction, access modifiers, controlling access to a class level, method, or variable (public, protected, private, block level, scope and mutable), other modifiers. Structure of class and struct in memory, accessing members of structures, Class scope and accessing class members, separating interface from implementation, pre-processors directives, macro programs, header files and namespaces,default constructors, chained constructor, default arguments with constructors, constant object and const member functions, object as member of class, use of destructors, virtual destructors,controlling access function and utility functions, function overloading.

Unit II

Inline function, friend function and friend classes, using this pointer, dynamic memory allocation with new and delete, static class members, proxy class, polymorphism concepts, overloading, overriding methods, abstract classes, reusability, class's behaviors, inheritance,base classes and derived classes, protected members, casting base-class pointers to derived-class pointers, using member functions, overriding base-class members in a derived-class, public, protected and private inheritance, using constructors and destructors in derived classes, implicit derived-class object to base- class object conversion, composition vs. inheritance.

Unit III

Virtual functions, abstract base classes and concrete classes, new classes and dynamic binding, virtual destructors,fundamentals of operator overloading, restrictions on operators overloading, operator functions as class members vs. as friend functions, overloading, <<, >> overloading unary operators, overloading binary operators. I/O Streams, file handling, creating a sequential access file, reading data from a sequential access file, updating sequential access files, random access files, creating a randomaccess file, writing data randomly to a random access file, reading data sequentially from a random access file.

Unit IV

Managing Console I/O,stream input/output classes and objects, stream output, stream input, unformatted I/O (with read and write), stream manipulators, stream format states, stream error states, exception handling, basics of C++ exception handling(try, throw, catch), Rethrowing an exception, specific exception, processing unexpected exceptions, stack unwinding, exception handling in constructors and destructors, inheritance with exceptionintroduction to generic classes, function templates, overloading template functions, class template, non-type parameters, templates and inheritance, templates and friends, templates and static members, container, iterator, algorithm and functional classes.

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Text and Reference Books:

1. H. M.Deitel and P. J.Deitel, *C++ How To Program*, 6th Ed., Prentice Hall, 2008.
2. Robert Lafore, *Object-Oriented Programming in C++*, 3rd Ed., Sams Publishing, 2001.
3. D. Ravichandran, *Programming with C++*, 3rd Ed., T.M.H, 2011.
4. E.Balagurusamy, *Object oriented Programming with C++*, 6th Ed., Tata McGraw-Hill,2013.
5. Horstmann, *Computing Concepts with C++ Essentials*, 3rd Ed., John Wiley,2003.
6. Herbert Schildt ,*The Complete Reference in C++*, 5th Ed., TMH, 2012.

CO-PO Articulation Matrix: Object Oriented Programming Using C++ (PC/AIML/32-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **List** the concepts related to object oriented paradigms. (LOTS: Level 1: Remember)	1	1	-	-	-	-	-	-	-	-	-	-	2	-
CO2. **distinguish**betweenstructured and object oriented approaches to programming. (LOTS: Level 2: Understand)	1	1	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Apply** object oriented constructs for problem solving. (LOTS: Level 3: Apply)	2	1	-	-	2	-	-	-	-	-	-	-	3	-
CO4. **Detect** logical and run time errors and suggest appropriate modifications. (HOTS: Level 4: Analyse)	2	2	-	-	-	-	-	-	-	-	-	-	3	-
CO5. **Justify** the design of a program for a given problem. (HOTS: Level 5: Evaluate)	2	3	-	-	-	-	-	-	1	-	-	-	3	-
CO6. **Design** solutions to programming problems using multiple object oriented programming constructs together. (HOTS: Level 6: Create)	3	3	1	-	2	-	-	-	1	-	-	-	3	-
Level of Attainments PC/AIML/32-T														

DATA ANALYTICS USING R(PC/AIML/33-T)

General Course Information

Course Code: PC/AIML/33-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic programming skills, Probability and Statistics

About the Course:

In this course, the learners will be able to develop expertise in R programming for manipulating, exploring, visualizing, applying descriptive and inferential statistics. In addition, they will learn to implement predictive modelling.

Course Outcomes: By the end of the course students will be able to:

CO1**.** **Define** the basic terms related to data analytics. (LOTS: Level 1: Remember)
CO2. **Describe** data with statistical summaries and plots. (LOTS: Level 2: Understanding)
CO3. **Build** predictive models. (LOTS: Level 3: Apply)
CO4. **Analyze** the quality of a statistical and machine learning models. (HOTS: Level 4: Analyse)
CO5. **Interpret** and evaluate statistical and predictive models. (HOTS: Level 5: Evaluate)
CO6. **Conclude** the findings of predictive modelling. (HOTS: Level 5: Evaluate)

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Course Content

UNIT I

Introduction to R programming: Data types or objects in R, Creating and manipulating objects like factors, vectors and matrices, lists and data frames, Subsetting matrices and data frames, Vectorized operations for vectors and matrices and data frames.

UNIT II

Control structure in R: If-else statements, for and while loops, loop functions like lapply, apply, sapply and mapply etc.; writing user defined functions in R. Getting data in and out of R.

UNIT III

Doing basic descriptive statistics: Data types for data analysis and their mapping to R objects, Mean, Median, Mode, Quantiles, Five-point summary, Variance, Correlation and Covariance, normal distribution, uniform distribution using R, Hypothesis testing: Chi-Square test and student's T test.

UNIT IV

Exploratory Data Analysis: Visualizing data through various plots and charts (bar charts, histogram, frequency polygon, scatter plot, box plots etc.), Applying KNN and Bayesian predictive models.

Text and Reference Books:

1. Hadley Wickham and Garrett Grolemund., *R for Data Science Import, Tidy, Transform and model Data*, O'Reilly, 2017.
2. Roger D. Peng, *R Programming for Data Science*, Lean Publishing, 2015.
3. Paul Teeter, *R Cookbook*, O'Reilly, 2011.
4. W. N. Venables, D. M. Smith and the R core Team, *An introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics*, version 3.3.2, 2016.
5. Michael J. Crawley, *Statistics, An introduction using R*, Second edition, John Wiley, 2015
6. Han, J., Kamber, M, Pei, J., *Data Mining Concepts and Techniques*, Third edition, Morgan Kaufmann, 2012.
7. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning: Data Mining, Inference and Prediction*, Springer, 2nd edition, 2009

CO-PO Articulation Matrix: Data Analytics using R (PC/AIML/33-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** the basic terms related to data analytics. (LOTS: Level 1: Remember)	1	-	-	-	1	-	-	-	-	-	-	-	-	2
CO2. **Describe** data with statistical summaries and plots. (LOTS: Level 2: Understanding)	2	2	-	-	2	-	-	-	-	-	-	-	1	3
CO3. **Build** predictive models (LOTS: Level 3: Apply).	2	2	-	-	3	-	-	-	-	-	-	-	1	3
CO4. **Analyse** the quality of a statistical and machine learning models (HOTS: Level 4: Analyse).	2	2	-	-	3	-	-		-	-	-	-	1	3
CO5.**Interpret** and evaluate statistical and predictive models. (HOTS: Level 5: Evaluate).	2	3	-	2	3	-	-	-	-	-	-	-	-	3
CO6. **Conclude** the findings of predictive modelling. (HOTS: Level 5: Evaluate).	2	3	-	2	3	-	-	-	-	-	-	-	-	3
Level of Attainments PC/AIML/33-T														

ENVIRONMENTAL SCIENCE

<table>
<tr><td>Course code</td><td colspan="5">MC/2-T</td></tr>
<tr><td>Category</td><td colspan="5">Mandatory Courses</td></tr>
<tr><td>Course title</td><td colspan="5">Environmental Sciences</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2"></td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0.0</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="5">-</td></tr>
<tr><td>Course Assessment Methods(Internal: 30; External:70)</td><td colspan="5">Internal examination:
Two minor tests each of 20marks
Class Performance measured through percentage of lectures attended (4marks)
Assignments, quiz etc. (6marks)
End semester examination:
Nine questions are to be set by theexaminer.
Questionnumberonewillbecompulsoryandbasedonthe entire syllabus.Itwillcontainsevenshortanswerstypequestions.
Rest of the eight questions is to be set with a fair weightage of all theunits.
All questions will carry equalmarks.
TheStudentswillberequiredtoattempt05questionsinall.</td></tr>
</table>

Course Outcomes

1. Students will be able to enhance and analyze human impacts on theenvironment.
2. Integrate concepts & methods from multiple discipline and apply to environmenta lproblems.
3. Design and evaluate strategic terminologies and methods for subs table management of environmentalsystems.
4. Field studies would provide students first-hand knowledge on various local environment aspects which forms an irreplaceable tool in the entire learningprocess.

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Course content

UNIT-I

Multidisciplinary nature of Environmental studies: Definition, scope and importance, need for public awareness; Concept, Structure and function of an ecosystem: Producers, consumers and decomposers, Energy flow in the ecosystem ,Ecological succession ,Food chains, Food webs and ecological pyramids; Introduction, types, characteristics features, structure and function of Forest ecosystem, Grassland ecosystem ,Desert ecosystem, Aquatic ecosystem (Ponds, Stream, lakes, rivers, oceans, estuaries); Biodiversity: Introduction, Definition: genetic, species and ecosystem diversity, Bio- geographical classification of India, Value of biodiversity: consumptive use, productive use, social ethical, aesthetic and option values; Biodiversity at global, national and local level, India as a mega- diversity nation, Hot-spot of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation ofbiodiversity.

UNIT-II

Renewable and non-renewable resources, Natural resources and associated problems ,Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people; Water resources: Use and over utilization of surface and ground water, floods, droughts conflicts over water, dams benefits and problems; Mineral resources: Use and exploitation, environmental effects of extracting and mineral resources; Food resources: World food problem, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer- pesticide problems, water logging, salinity; Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies; Land resources: Land as a resource, land degradation, main induced landslides, soil erosion and desertification, Role of an individualinconservationofnaturalresources,Equitableuseofresourcesforsuitablelifestyle.

UNIT-III

Definition of Environment Pollution; Causes, effects and control measures of: Air Pollution, Water Pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes effects and control measures of urban and industrial wastes; Role of and individual in prevention of pollution, Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies; different laws related to environment: Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.; Issues involved in enforcement of environmental legislation, Publicawareness

UNIT-IV

Social issues and the Environment: From unsustainable to Sustainable development, Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problem and concern, case studies; Environment ethics: Issues and possible solutions; Wasteland reclamation; Consumerism and waste products; Human Population growth, variation among nation, Population explosion-Family Welfare Programme, Environment and human health , Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, CaseStudies.

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Books:

1. Fundamental concepts in Environmental studies by Dr. D.D. Mishra. S. Chandpublications.
2. Essentials of Ecology and Environmental Science by Dr. S .V .S. Rana, PHI Learning Pvt. Ltd, Delhi
3. Environmental Chemistry by Anil Kumar De, Wiley EasternLimited.
4. Environmental Science by T.G. Miller, Wadsworth Publishing Co, 13thedition.

Ecology and Environment by P. D. Sharma, Rastogipublication

FUNDAMENTALS OF AI&ML(PC/AIML/34-T)

General Course Information

Course Code:PC/AIML/34-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic Knowledge of Algorithms and Probability.

About the Course:

Artificial Intelligence is a core and an essential course for every graduate in Computer Science and Engineering. This course introduces the concepts of Artificial Intelligence and challenges inherent in building intelligent systems. It includes the role of knowledge representation in problem solving and how these are used in making intelligent machine. Further it incorporates the concepts of expert system and its applications.

Course Outcomes: By the end of the course students will be able to:

CO1. **Outline** various Artificial Intelligence techniques. (LOTS: Level 1: Remember)
CO2. **Illustrate** reasoning under uncertainty. (LOTS: Level 2: Understand)
CO3. **apply** search and knowledge representation techniques to solve AI problems.(LOTS: Level 3: Apply)
CO4. **Compare** strengths and weaknesses of AI algorithms (HOTS: Level 4: Analyse).
CO5. **Combine** various AI techniques to solve intelligent systems' problems. (HOTS: Level 6: Create)

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Course Content

UNIT – I

Introduction to AI: What is AI, Turing test, cognitive modeling approach, law of thoughts, the relational agent approach, the underlying assumptions about intelligence, techniques required to solve AI problems, level of details required to model human intelligence, successfully building an intelligent problem, history of AI

UNIT II

Introduction to Machine Learning: What is Machine Learning, Learning from Data, History of Machine Learning, Big Data for Machine Learning, Leveraging Machine Learning, Descriptive vs Predictive Analytics, Machine Learning and Statistics, Artificial Intelligence and Machine Learning, Types of Machine Learning – Supervised, Unsupervised, Semi-supervised, Reinforcement Learning, Types of Machine Learning Algorithms, Classification vs Regression Problem, Bayesian, Clustering, Decision Tree, Dimensionality Reduction, Neural Network and Deep Learning, Training machine learning systems

UNIT III

AI Research Trends: Research trends in machine learning, deep learning, reinforcement learning, robotics, computer vision, natural language processing, collaborative systems, algorithmic game theory, internet of things (Io T), neuromorphic computing

Applications of AI by domain: Transportation, home/service robots, healthcare, education, low- resource communities, public safety and security, employment and workplace, entertainment, finance, banking and insurance

UNIT IV

Role of Artificial Intelligence in Society: Societal challenges AI presents, Ethical and Societal implications,policy and law for AI, fostering dialogue, sharing of best practices

Malicious Use of AI: Prevention and Mitigation: Security relevant properties of AI, Security domains and scenarios: digital security, physical security, political security, factors affecting the equilibrium of AI and security

Explainable AI: Introduction to explainable AI, why explainable AI, interpretability and explain ability, methods of interpretability and explain ability

Introduction to Data Analytics: Working with Formula and Functions, Introduction to Charts, Logical functions using Excel, Analyzing Data with Excel.

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Text and Reference Books:

1. Artificial Intelligence 3e: A Modern Approach Paperback – By Stuart J Russell & Peter Norvig; Publisher – Pearson2.Artificial Intelligence Third Edition By Kevin Knight, Elaine Rich, B. Nair – McGraw Hill
3Artificial Intelligence Third Edition By Patrick Henry Winston – Addison-Wesley Publishing Company
4 Machine Learning using Pytho, U Dinesh Kumar, ManaranjanPradhan, John Wiley & Sons.
5 A Classical Approach to Artificial Intelligence, M. C. Trivedi, Khanna Publishing House.
6 Machine Learning, V. K. Jain, Khanna Publishing House.
7 Advanced Data Analytics Using Python: With Machine Learning, Deep Learning, Sayan Mukhopadhyay, Apress.
8 Machine Learning for Absolute Beginners: A Plain English Introduction, 2nd ed., Oliver Theobal
9 Big Data and Analytics, S. Acharya, S. Chellappan, Wiley Publication.
10. Introduction to Machine Learning, Jeeva Jose, Khanna Publishing House.

CO-PO Articulation Matrix:FUNDAMENTALS OF AIML(PC/AIML/34-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Outline** various Artificial Intelligence techniques. (LOTS: Level 1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	_	3
CO2. **Illustrate** reasoning under uncertainty. (LOTS: Level 2: Understand)	1	_	_	_	_	_	_	_	_	_	_	_	_	3
CO3. **Apply** search and knowledge representation techniques to solve AI problems. (LOTS: Level 3: Apply)	2	2	_	2	2	_	_	_	_	_	_	_	_	3
CO4. **Compare** strengths and weaknesses of AI algorithms (HOTS: Level 4: Analyse).	2	2	2	2	_	_	_	_	_	_	_	_	_	3
CO5. **Combine** various AI techniques to solve intelligent systems' problems. (HOTS: Level 6: Create)	3	3	3	3	2	2	_	_	_	_	_	3	_	3
Level of Attainments PC/AIML/34-T														

DATA STRUCTURES AND ALGORITHMS USING C/C++LAB.(PC/AIML/31-P)

General Course Information

Course Code: PC/AIML/31-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4 hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Programming in C language.

About the Course:

This lab.Course involves implementation of basic and advance data structures and various operations on these data structures. The objective of the lab course is to train the students to solve the problems related to data structures and choose the appropriate data structure for solvingcomputational problem efficiently.

Course Outcomes: By the end of the lab course a student would be able to:

CO1. **Implement**various data structuresand the related operations. (LOTS: Levels 3: Apply)
CO2. **Analyse**space and time complexity of algorithms. (HOTS: Level 4: Analyse)
CO3. **Compare** solutions on the basis of the appropriateness of data structure used and the efficiency of the operations implemented. (HOTS: Level 5: Evaluate)
CO4. **Integrate** knowledge of data structures to solve real world problems related to data structure and algorithms. (HOTS: Level 6: Create)
CO5. **Create**written records for the given assignments with problem definition, design of solution and conclusions. (HOTS: Level 6: Create)
CO6. **Demonstrate** ethical practices while solving problems individually or in groups (LOTS: Level 3: Apply).

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List of experiments/assignments

1. Two assignments related to creating and manipulating matrices and linear lists.
2. Two assignments associated with linked list, operations on linked lists and their applications.
3. Two assignments on array and linked implementation of stacks and queues.
4. Two assignments on trees and their applications.
5. Two assignments on graphs and their applications.
6. Two assignments on different searching and sorting methodsalong with their complexity analysis.
7. One assignment on challenging problems on data structuresto be given in groups.

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix: Data Structures and Algorithms using C/C++Lab. (PC/AIML/31-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Implement** various data structures and the related operations. (LOTS: Levels 3: Apply)	2	-	-	-	2	-	-	-	2	-	-	-	3	-
CO2. **Analyse** space and time complexity of algorithms. (HOTS: Level 4: Analyse)	2	2	-	-	2	-	-	-	1	-	-	-	3	-
CO3. **Compare** solutions on the basis of the appropriateness of data structure used and the efficiency of the operations implemented. (HOTS: Level 5: Evaluate)	2	2	-	-	3	-	-	-	1	-	-	-	3	-
CO4. **Integrate** knowledge of data structures to solve real world problems related to data structure and algorithms. (HOTS: Level 6: Create)	3	2	3	-	3	-	-	-	3	-	-	-	3	-
CO5. **Create** written records for the given assignments with problem definition, design of solution and conclusions. (HOTS: Level 6: Create)	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO6. **Demonstrate** ethical practices while solving problems individually or in groups (LOTS: Level 3: Apply).	-	-	-	-	-	-	-	3	-	-	-	3	-	-
Level of Attainments:PC/AIML/31-P														

OBJECT ORIENTED PROGRAMMING USING C++ LAB.(PC/AIML/32-P)

General Course Information

Course Code: PC/AIML/32-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Problem solving using C Lab.

About the course:

The lab course provides the opportunity to students to solve problems using Object Oriented Framework in C++ language. This includes implementing the concepts of data abstraction, data hiding, and encapsulation, reuse of code and, compile and runtime polymorphism.

Course Outcomes: By the end of the course studentswill be able to:

CO1. **Implement**problems with object oriented framework. (LOTS: Level 3: Apply)
CO2. **Analyse** the structure of programs for modular design. (HOTS: Level 4: Analyse)
CO3. **Evaluate** robustness of a program by testing it on test/use cases. (HOTS: Level 5: Evaluate)
CO4. **Design** class hierarchies for implementing inheritance/polymorphism. (HOTS: Level 6: Create)
CO5. **Create** a lab record of assignments including problem definitions, design of solutions and conclusions. (HOTS: Level 6: Create)
CO6. **Demonstrate** ethical practices and solve problems individually or in a group. (LOTS: Level 3: Apply)

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List of experiments

1. Create two classes **DM** and **DB** which store the value of distances. **DM** stores distances in meters and centimeters and **DB** in feet and inches. Write a program that can read values for the class objects and add one object of **DM** with another object of **DB**. Use a friend function to carry out the addition operation. The object that stores the results maybe a **DM** object or **DB** objects, depending on the units in which the result is required. The display should be in the format of feet and inches or meters and centimeters depending on the object on display.
2. Create a class rational which represents a numerical value by two double values-NUMERATOR & DENOMINATOR. Include the following public member Functions:
   - Constructor with no arguments (default).
   - Constructor with two arguments.
   - void reduce () that reduces the rational number by eliminating the highest common factor between
   - The numerator and denominator.
   - Overload + operator to add two rational number.
   - Overload >> operator to enable input through cin.
   - Overload << operator to enable output through cout.

   Write the main () function to test all the functions in the class.
3. A hospital wants to create a database regarding its indoor patients. The information to be stored includes
   a) Name of the patient b) Date of admission c) Disease d) Date of discharge
   Create a structure to store the date (year, month and day as its members). Create a base class to store the above information. The member function should include functions to enter information and display a list of all the patients in the database. Create a derived class to store the age of the patients. List the information about all the pediatric patients (less than twelve years in age).

4. Make a class **Employee** with a name and salary. Make a class **Manager** inherited from **Employee**. Add an instance variable named department of type string. Supply a method to **toString**that prints the manager's name, department and salary. Make a class **Executive** inherited from **Manager**. Supply a method **toString**that prints the string **"Executive"** followed by the information stored in the **Manager** superclass object. Supply a test program that tests these classes and methods.

5. Imagine a tollbooth with a class called 'tollBooth'. The two data items are of type unsigned int to hold the total number of cars, and a type double to hold the total amount of money collected. A constructor initializes both to 0. A member function called 'payingCar()' increments the car total and adds 0.50 to the cash total. Another function, called 'nopayCar ()', increments the car total but adds nothing to the cash total. Finally, a member function called displays the two totals. Include a program to test this class. This program should allow the user to push one key to count a paying car, and another to count a nonpaying car. Pushing the ESC key should cause the program to print out the total cars and total cash and then exit.

6. Write a function called 'revers_it()' that reverses a string (an array of char). Use a for loop that swaps the first and last characters, then the second and next to last characters and so on. The string should be passed to 'revers_it ()' as an argument. Write a program to exercise 'revers_it ()'. The program should get a string from the usercallof'revers_it () function and print out the result. Use an input method that allows embedded blanks. Test

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the program with phrase, "*Guru Jambheshwar University of Science & Technology, Hisar*".

7. Write a program related to file handling with all the exception handling provisions.
8. C++ program to write and read time in/from binary file using fstream. Use exception handling wherever possible.
9. Write a program to implement string classusing STL.
10. Write a program to implement run time polymorphism.

Note:

The experiments/assignments may vary from session to session and will be designed by the course coordinator. The assignments must meet the objective of the course and the levels of the given course outcomes. The course coordinator will provide the schedule for submission of the assignment.

CO-PO Articulation Matrix:Object Oriented Programming using C++ Lab. (PC/AIML/32-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Implement** problems with object oriented framework. (LOTS: Level 3: Apply)	2	2	-	-	1	-	-		2	-	-	2	3	-
CO2. **Analyse** the structure of programs for modular design. (HOTS: Level 4: Analyse)	2	2	-	-	2	-	-	-	-	-	-	-	3	-
CO3. **Evaluate** robustness of a program by testing it on test/use cases. (HOTS: Level 5: Evaluate)	2	2	-	-	2	-	-	-	-	-	-	-	3	-
CO4. **Design** class hierarchies for implementing inheritance/polymorphism. (HOTS: Level 6: Create)	3	-	1	-	2	-	-	-	-	-	-	2	3	-
CO5. **Create** a lab record of assignments including problem definitions, design of solutions and conclusions. (HOTS: Level 6: Create)	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO6. **Demonstrate** ethical practices and solve problems individually or in a group. (LOTS: Level 3: Apply)	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Level of Attainments: PC/AIML/32-P														

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DATA ANALYTICS USING R LAB (PC/AIML/33-P)

General Course Information

Course Code: PC/AIML/33-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4 hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Basic programming skills.

About the Course:
The objective of this lab is to enable students to apply advanced data analytics tools for manipulating data, applying statistics, regression and classification.

Course Outcomes: By the end of the course students will be able to:

CO1. **Apply** pre-processing techniques to real world data. (LOTS: Level 3: Apply)
CO2. **Solve**problemsof predictive analytics. (LOTS: Level 3: Apply)
CO3. **Evaluate**the performance ofpredictive models. (LOTS: Level 5: Evaluate)
CO4. **Design**completedata analytics experiments. (LOTS: Level 6: Create)
CO5. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create).
CO6. **Demonstrate**ethical practices, self-learning and team spirit.

List of experiments/assignments using R:

1. Four Assignments on descriptive statistics
2. Four Assignment on visualizing data
3. Four Assignments on Pre-processing Data
4. Two assignments to solve linear and non-linear regression problems.
5. Two assignments on classification problems.
6. Two assignments on different sampling techniques.

Note:
The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

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CO-PO Articulation Matrix:Data Analytics using R Lab. (PC/AIML/33-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Apply** pre-processing techniques to real world data. (LOTS: Level 3: Apply)	2	1	_	_	2	_	_	_	_	_	_	_	_	3
CO2. **Solve** problemsof predictive analytics. (LOTS: Level 3: Apply)	3	2	_	_	3	_	_	_	_	_	_	_	_	3
CO3. **Evaluate** the performance ofpredictive models. (LOTS: Level 5: Evaluate)	3	2	1	_	3	_	_	_	_	_	_	_	_	3
CO4. **Design**completedata analytics experiments. (HOTS: Level 6: Create)	3	2	2	3	3	_	_	_	_	_	_	_	_	3
CO5. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	3
CO6. **Demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments PC/AIML/33-P														

Detailed Syllabus of

IV

Semester

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COMPUTER ORGANISATION AND ARCHITECTURE(PC/AIML/41-T)

General Course Information

Course Code: PC/AIML/41-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Fundamental of Computer Systems.

About the Course:

Computer Architecture and organization describes the role of instruction set architecture in digital computer, main memory, and input/output devices. It illustrates the simple data path and control design for processors. It helps to understand the different operations and concept of instructions. It would enable the students to learn the basic function and architecture of modern computer systems.

Course Outcomes: By the end of the course students will be able to:

CO1. **Outline** the general concepts of digital electronics and computer organisation and architecture. (LOTS: Level 1: Remember)
CO2. **discuss** the basic components and their interfacing.(LOTS: Level 2: Understand)
CO3. **Apply**instructions for performing different operations. (LOTS: Level 3: Apply)
CO4. **analyse** the effect of addressing modes on the execution time of a program.(HOTS: Level 4: Analyse)
CO5. **Contrast**different types of memory, their architecture and access methods. (HOTS: Level 5: Evaluate)
CO6. **Design of** simple computer with different instruction sets. (HOTS: Level 6: Create)

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Course Content

UNIT I

Basic Principles: Boolean algebra and Logic gates, Combinational logic blocks (Adders, Subtractors, Multiplexers, Encoders, decoders, demultiplexers, KMaps), Sequential logic blocks (Flip-Flops, Registers, Counters); Flynn's classification of computers (SISD, MISD, MIMD); Performance metrics: MIPS, MFLOPS; CPU Architecture types: computer register, (accumulator, register, stack, memory/ register) detailed data path of a typical register based CPU.

UNIT II

Computer Organization: Store program control concept, Instruction codes, timing and control, instruction cycle; type of instructions: memory reference, register reference, I/O reference; Basics of Logic Design, accumulator logic, Control memory; Micro Programmed Control: address sequencing, micro-instruction formats, micro-program sequencer, Implementation of control unit.

UNIT III

Instruction Set Architecture & Parallelism: Instruction set based classification of processors (RISC, CISC, and their comparison); Stack Organization, Instruction Formats; addressing modes: register, immediate, direct, indirect, indexed; Operations in the instruction set: Arithmetic and Logical, Data Transfer, Control Flow; Types of interrupts; Introduction to Parallelism: Goals of parallelism (Exploitation of concurrency, throughput enhancement); Amdahl's law; Instruction level parallelism (pipelining, super scaling –basic features); Processor level parallelism (Multiprocessor systems overview).

UNIT IV

Memory Hierarchy & I/O Techniques: The need for a memory hierarchy (Locality of reference principle, Memory hierarchy in practice: Cache, main memory and secondary memory, Memory parameters: access/ cycle time, cost per bit); Main memory (Semiconductor RAM & ROM organization, memory expansion, Static & dynamic memory types); Cache memory (Associative & direct mapped cache organizations; input-output interface, mode of transfer, DMA (Direct memory transfer).

Text and Reference Books:

1. Mano, M. Morris, *Digital Logic and Computer Design*, Prentice Hall of India Pvt. Ltd., 1981.
2. M. Morris Mano, *Computer System Architecture*, Prentice Hall of India Pvt. Ltd., 1993.
3. Milles J. Murdocca, Vincent P. Heuring, *Computer Architecture and Organization, An Integrated Approach*, JohnWiley& Sons Inc., 2007.
4. William Stallings, 10th edition, *Computer Organization and Architecture*, Prentice Hall, 2016.

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5. Heuring, V.P., Jordan, H.F., *Computer Systems Design and Architecture*, Addison Wesley,1997.
6. R.P Jain, *Modern Digital Electronics*, 3rd Edition , Tata McGraw Hill,, 2003.

CO-PO Articulation Matrix:Computer Organisation and Architecture (PC/AIML/41-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **outline** the general concepts of digital electronics and computer organisation and architecture. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2. **discuss** the basic components and their interfacing. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Apply** instructions for performing different operations. (LOTS: Level 3: Apply)	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO4. **Analyse** the effect of addressing modes on the execution time of a program. (HOTS: Level 4: Analyse)	2	2	-	1	-	-	-	-	-	-	-	1	3	-
CO5. **Contrast** different types of memory, their architecture and access methods. (HOTS: Level 5: Evaluate)	2	2	-	1	-	-	-	-	-	-	-	1	3	-
CO6. **Design** of simple computer with different instruction sets. (HOTS: Level 6: Create)	3	2	-	-	2	-	-	-	-	-	-	-	3	-
Level of Attainments PC/AIML/41-T														

DATA MINING TECHNIQUES(PC/AIML/42-T)

General Course Information

Course Code: PC/AIML/42-T Course Credits: 3 Type: Contact Hours: Mode: Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Knowledge of database systems, elementary knowledge of statistics and probability.

About the Course:

Today's era is the era of information. Data is growing exponentially day by day. There is a need to process and analyse the data to extract knowledge from it, so that one can use that knowledge for decision making. This course provides introductory concepts of data mining and data warehousing. The course will be taught with a database as well as machine learning perspectives. The objective of the course is to provide a comprehensive understanding of data mining tasks and evaluation of results obtained out of data mining processes.

Course Outcomes: By the end of the course students will be able to:

CO1. **Outline** various types of data mining and data warehouse concepts and techniques. (LOTS: Level 1: Remember)

CO2. **Explain** association of patterns, data mining functionalities, tasks of data mining, (LOTS: Level 2: Understand)

CO3. **Apply** various classifications, clustering correlation and association mining for extracting valuable information from data. (LOTS: Level 3: Apply)

CO4. **Evaluate** the descriptive and predictive data mining models. (HOTS: Level 5: Evaluate)

CO5. **Plan** a data mining process for discovering knowledge from real-world databases. (HOTS: Level 6: Create)

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Course Content

UNIT I

Introduction to Data Mining: Kind of data to be mined, Data Mining Functionalities, Technologies used in Data Mining, Applications of data Mining, Major Issues in Data Mining.
Data Warehouse: Introduction, Data Warehouse and Database Systems, Data Warehouse Architecture, Data Warehouse Models, Data Cube and OLAP, Multidimensional data Model, Concept Hierarchies, OLAP operations
Pattern Mining:Mining Frequent Patterns, Associations and Correlations, Frequent Itemset Mining using Apriori Algorithm, Generating Association Rules from Frequent Itemsets. Pattern Growth Approach for Mining Frequent Itemsets, Pattern evaluation Methods

UNIT II

Classification: Introduction, Classification using Decision Tree Induction, Bayesian Classification Methods, Rule Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy.
Introduction to advanced classifiers: k-Nearest Neighbor, Support Vector Machine, Artificial Neural Network.

UNIT III

Cluster Analysis: Introduction, overview of Basic Clustering Methods, **Partitioning Methods**: k-mean, k-medoids, **Hierarchical Methods:**Agglomerative versus Divisive Hierarchical Clustering,Distance Measures in Algorithmic Methods,Balanced Iterative Reducing and Clustering using Hierarchies (BIRCH), Chameleon: Multiphase Hierarchical ClusteringUsing Dynamic Modelling, Probabilistic Hierarchical Clustering, **Density-based methods:** DBSCAN, OPTICS, DENCLUE,**Grid-based Methods:** STING, CLIQUE, **Evaluation of Clustering.**

UNIT IV

Outlier Detection: Introduction, types of outliers, challenges of outlier detection.Outlier detection methods: statistical approaches, proximity-based approaches, clustering based approaches, classification-based approaches, Outlier detection in high dimensional data.

Text and Reference Books:

1. Jiawei Han, MichelineKamber and Jian Pei, *Data Mining Concepts and Techniques*, Morgan Kaufmann Publishers,Third Edition, July 2011.
2. Alex Berson, Stephen J. Smith, *Data Warehousing, Data Mining & OLAP*, Tata McGraw Hill, 2004.
3. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, *Introduction to Data Mining*, Pearson Education, 2014.
4. K. P. Soman, ShyamDiwakar and V. Ajay, *Insight into Data Mining Theory and Practice*, Easter Economy Edition, Prentice Hall of India, 2009.

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5. G. K. Gupta, *Introduction to Data Mining with Case Studies*, Prentice Hall of India, 2006.
6. Daniel T. Larose, *Data Mining Methods and Models*, Wiley, 2006.
7. W. H. Inman, *Building the Data Warehouse*, Wiley India, 2005

CO-PO Articulation Matrix:Data Mining Techniques (PC/AIML/42-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Outline** various types of data mining and data warehouse concepts and techniques. (LOTS: Level 1: Remember)	1	_	_	_	2	_	_	_	_	_	_	_	_	1
CO2. **Explain** characteristics, architecture of a data warehouse, OLAP operations and data mining tasks. (LOTS: Level 2: Understand)	1	_	_	_	3	_	_	_	_	_	_	_	_	2
CO3. **Apply** various pre-processing and data mining techniques for extracting valuable information from data. (LOTS: Level 3: Apply)	2	1	_	_	3	_	_	_	_	_	_	_	_	3
CO4. **Evaluate** the descriptive and predictive data mining models. (HOTS: Level 5: Evaluate)	3	2	2	3	3	_	_	_	_	_	_	_	_	3
CO5. **Plan** a data mining process for discovering knowledge from real-world databases. (HOTS: Level 6: Create)	3	3	3	3	3	_	_	_	_	_	_	_	_	3
Level of Attainments PC/AIML/42-T														

OPERATING SYSTEMS(PC/AIML/43-T)

General Course Information

Course Code: PC/AIML/43-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Programming in C and knowledge of computer fundamentals.

About the Course:

The objective of this course is to help students become familiar with the fundamental concepts of operating systems and provide them with enough understanding of operating system design.

Course Outcomes: By the end of the course studentswill be able to:

CO1. **list** various functions and design characteristics of operating systems (LOTS: Level 1: Remember)

CO2. **Explain** fundamental concepts of operating systems. (LOTS: Level 2: Understand)

CO3. **apply** operating system design concepts for solving problems regarding scheduling, memory management, disk management and deadlocks etc.(LOTS: Level 3: Apply)

CO4. **Analyze** the issues related to various operating systems. (HOTS: Level 4: Analyze)

CO5. **Design** solutions for the memory and process management problems. (HOTS: Level 6: Create)

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Course Content

UNIT I

Introductory Concepts: Operating systems functions and characteristics, operating system services and systems calls, system programs, operating system structure. operating systems generation, operating system services and systems calls. Types of Operating systems: Batch operating system, Time-sharing OS, Distributed operating system, Realtime systems.

File Systems: Types of Files and their access methods, File allocation methods, Directory Systems: StructuredOrganizations, directory and file protection mechanisms, disk scheduling and its associated algorithms.

UNIT II

Processes: Process concept, Process Control Block, Operations on processes, cooperating processes.CPU scheduling: Levels of Scheduling, scheduling criteria, Comparative study of scheduling algorithms, Algorithmevaluation, multiple processor scheduling. Critical-section problem, Semaphores.

UNIT III

Storage Management: Storage allocation methods: Single contiguous allocation, non-contiguous memory allocation,Paging and Segmentation techniques, segmentation with paging, Virtual memory concepts, Demand Paging, PagereplacementAlgorithms, Thrashing.

UNIT IV

Deadlock: System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention,Deadlock avoidance, Deadlock detection, Recovery from deadlock

Case Studies: Comparative study of WINDOW, UNIX & LINUX system.

Text and Reference Books:

1. Silberschatz, Peter B. Galvin and Greg Gagne, *Operating System Concepts*, 8th Edition, WileyIndian Edition, 2010.
2. Andrew S Tanenbaum, *Modern Operating Systems*, Third Edition,Prentice Hall India, 2008.
3. NareshChauhan, *Principles of Operating Systems*, Oxford Press, 2014.
4. D.M. Dhamdhere, *Operating Systems*, 2nd edition, Tata McGraw Hill, 2010.
5. William Stallings, *Operating Systems– Internals and Design Principles*, 5th Edition,Prentice Hall India, 2000.

CO-PO Articulation Matrix:Operating Systems (PC/AIML/43-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **List** various functions and design characteristics of operating systems (LOTS: Level 1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	3	_
CO2. **Explain** fundamental concepts of operating systems. (LOTS: Level 2: Understand)	1	_	_	_	_	_	_	_	_	_	_	_	3	_
CO3. **Apply** operating system design concepts for solving problems regarding scheduling, memory management, disk management and deadlocks etc. (LOTS: Level 3: Apply)	3	1	_	_	2	_	_	_	_	_	_	1	3	_
CO4. **Analyze** the issues related to various operating systems. (HOTS: Level 4: Analyse)	3	2	3		2	_	_	_	_	_	_	1	3	_
CO5. **Design** solutions for the memory and process management problems. (HOTS: Level 6: Create)	3	2	3	2	2	_	_	_	_	_	_	_	3	_
Level of Attainments PC/AIML/43-T														

DATABASE MANAGEMENT SYSTEM(PC/AIML/44-T)

General Course Information

Course Code: PC/AIML/44-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Exam Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Prerequisite: Knowledge of UNIX/ Windows, programming language and data structures

About the Course:

This course includes a detailed coverage of principles of database design and models. Students learn querying a database using SQL, normalization techniques, transaction processing etc.

Course Outcomes: By the end of the course students will be able to:

CO1. **Describe** fundamental elements of Database Management System. (LOTS: Level 1: Remember)
CO2. **Discuss** principles of relational Database modelling. (LOTS: Level 2: Understanding)
CO3. **Apply** SQL for designing queries for Relational Databases. (LOTS: Level 3: Apply)
CO4. **Contrast** various concurrency control and recovery techniques with concurrent transactions in DBMS. (HOTS: Level 5: Evaluate)
CO5. **design** models of databases using ER modelling and normalization for real life applications.(HOTS: Level 6: Create)

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Course Content

UNIT I

Overview: Overview of File Systems and Database Systems, Characteristics of the Data Base Approach, Database users, Advantages and Disadvantages of a DBMS, Responsibility of Database Administrator.

Data Base Systems Concepts and Architecture: DBMS architecture and various views of Data, Data Independence, Database languages, Data Models: Relational Database Model, Hierarchical Data Model, Network Data Model, Schemas and Instances.

UNIT II

E-R Model: Entity Types, Attributes & Keys, Relationships, Roles and Structural Constraints, E-R Diagrams, Reduction of an E-R Diagram to Tables. Relational Model and Query Language: Overview of Relational Database, Key Integrity Constraints, Relational Algebra, Relational Calculus, SQL fundamentals, Basic Operators, Missing information and NULL values, Advanced SQL features

UNIT III

Relational Database Design: Overview of normalization, Database Anomalies, Candidate and Super Key, Functional Dependencies, Integrity Constraints, Decomposition, Normal forms: First, Second, Third Normal, Boyce Codd, Normal Form, Multi-valued Functional Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Denormalization.

UNIT IV

Concurrency Control Techniques: Overview of database Transactions, Transaction states, ACID properties of a Transaction, Transaction Recovery, Concurrency Control, Locking Techniques, Time-stamp ordering, Multi-version Techniques, Deadlock, Recovery Techniques in centralized DBMS.

DDBMS Design: Replication and Fragmentation Techniques.

Text and Reference Books:

1. Elmasri, R., and Navathe,S. B., *Fundamentals of Database Systems*, 3rd Edition, Addison Wesley, 2002.
2. Silberschatz, A., Korth, H. F., and Sudarshan, S., Database *System Concepts*, McGraw Hill, 2011.
3. Pannerselvam R., *Database Management Systems*, 2ndEdition, PHI Learning, 2011.
4. Desai, B. C., *An Introduction to Database System*,Galgotia Publication, 2010.
5. Leon, A., and Leon, M.,*Database Management Systems*,I stEdition,Vikas Publishing, 2009.

6.Mata-Toledo, R., Cushman, P., Sahoo, D., *Database Management Systems*, Schaums'Outline series, TMH, 2007.

CO-PO Articulation Matrix:Database Management System (PC/AIML/44-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Describe** fundamental elements of Database Management System. (LOTS: Level 1: Remember)	1	--	--	--	--	--	--	--	--	--	--	--	3	--
CO2. **discuss** principles of relational Database modeling. (LOTS: Level 2: Understanding)	1	--	--	--	--	--	--	--	--	--	--	--	3	--
CO3. **Apply** SQL for designing queries for Relational Databases. (LOTS: Level 3: Apply)	1	--	--	_	2	--	--	--	--	--	--	--	3	--
CO4. **Contrast** various concurrency control and recovery techniques with concurrent transactions in DBMS. (HOTS: Level 5: Evaluate)	1	2	--	--	--	--	--	--	--	--	--	--	3	--
CO5. **Design** models of databases using ER modelling and normalization for real life applications.(HOTS: Level 6: Create)	3	2	3	1	2	--	--	--	--	--	--	--	3	--
Level of Attainments PC/AIML/44-T														

DISCRETE MATHEMATICS(PC/AIML/45-T)

General Course Information

Course Code: PC/AIML/45-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic knowledge of Number Theory, Calculus and Algebra

About the Course:

Discrete Mathematics is a core and an essential course for every graduate in Computer Science and Engineering. This branch of mathematics mainly deals with discrete objects (as computer runs on discrete steps). It provides a mathematical language for computer science to resolve many realworld problems by incorporating different methods applicable tovarious discrete structures.This course introduces set theory, propositional calculus, algebraic structures, recurrence relations and graph theory.

Course Outcomes: By the end of the course a student would be able to:

CO1. **Outline** various discrete structures and the related operations. (LOTS: Level 1: Remember)

CO2. **Illustrate** different discrete structures with the help of examples. (LOTS: Level 2: Understand)

CO3. **apply** appropriate techniques to solve problems related to discrete structures.(LOTS: Level 3: Apply)

CO4. **Justify** the solutions with the help of proofs. (HOTS: Level 5: Evaluate)

CO5. **Combine** techniques related to discrete structuresfor solving real world problems. (HOTS: Level 6: Create)

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Course Content

UNIT I

Set Theory: Introduction to Set Theory, Venn Diagrams, Set Operations, Algebra of Sets, Duality, Finite, Infinite Sets and Counting Principle, Classes of Sets, Power Sets, Partitions, Multi Sets, Relations: Cartesian Product, Representation of Relations, Types of Relation, Equivalence Relations and Partitions, Partial Ordering Relations, Functions:Definition, Types of Functions, Composition of Functions, Inverse Function, Recursively Defined Functions.

UNIT II

Logic and Propositional Calculus: Introduction, Propositions and Compound Propositions, Basic Logical Operations, Propositions and Truth Tables, Tautologies and Contradictions, Logical Equivalence, Algebra of Propositions, Conditional and Bi-conditional Statements, Algebraic Structures:Group Axioms, Monoid, Semi-Groups, Subgroups, Abelian Group, Cosets, Normal Subgroup, Cyclic Group, Permutation Group, Lagrange's Theorem, Homomorphism, Isomorphism, Automorphism, Rings, Integral Domains and Fields (Also, some basic and standard results related to Groups, Rings, ID and Fields).

UNIT III

Recursion and Recurrence Relation: Polynomials and their evaluation, Sequences, Introduction to AP, GP and AG Series, Partial Fractions, Recurrence Relation,Linear Recurrence Relations with Constant Coefficients, Linear Homogeneous Recurrence Relations with Constant Coefficients, Particular Solution- Homogeneous Linear Difference Equations, Non-Homogeneous Linear Difference Equations, Total Solution, Generating Functions.

UNIT IV

Graphs Theory:Introduction to Graphs, Multi Graph, Directed and Undirected Graphs, Subgraphs, Bipartite Graphs, Regular Graphs, Connected Graphs,Homomorphic and Isomorphic Graphs,Cut points and Bridges, Paths and Circuits, Euler Graph, Hamiltonian Graph, Planar Graph, Euler Formula, Weighted Graphs,Dijkstra's ShortestPath Algorithm forWeighted Graphs, Trees, Spanning Trees, Minimum Spanning Tree (Prim's and Kruskal's Algorithm).

Text and Reference Books:

1. J.P. Trembley and R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*, Tata McGraw Hill – 13th reprint, 2012.
2. Kenneth H. Rosen, *Discrete Mathematics and its applications*, 6th Edition, Tata McGraw Hill, 2011.
3. Richard Johnsonbaugh, *Discrete Mathematics*, 6th Edition, Pearson Education Asia, 2011.
4. S. Lipschutz and M. Lipson, *Discrete Mathematics*, Tata McGraw Hill, 3rd Edition, 2010.
5. B. Kolman, R. C. Busby and S. C. Ross, *Discrete Mathematical structures*, 6th Edition, PHI, 2010.
6. C. L. Liu, *Elements of Discrete Mathematics*, Tata McGraw Hill, 3rd Edition, 2008.

CO-PO Articulation Matrix:Discrete Mathematics (PC/AIML/45-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Outline** various discrete structures and the related operations. (LOTS: Level 1: Remember)	1	--	--	--	--	--	--	--	--	--	--	--	1	--
CO2. **Illustrate** different discrete structures with the help of examples. (LOTS: Level 2: Understand)	1	--	--	--	--	--	--	--	--	--	--	--	2	--
CO3. **Apply** appropriate techniques to solve problems related to discrete structures. (LOTS: Level 3: Apply)	2	--	--	--	1	--	--	--	--	--	--	--	3	2
CO4. **Justify** the solutions with the help of proofs. (HOTS: Level 5: Evaluate)	3	1	--	--	2	--	--	--	--	--	--	--	3	--
CO5. **Combine** techniques related to discrete structures for solving real world problems. (HOTS: Level 6: Create)	3	2	--	--	2	--	--	--	1	--	--	1	3	2
Level of Attainments: PC/AIML/45-T														

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PYTHON PROGRAMMING (PC/AIML/46-T)

General Course Information

Course Code:PC/AIML/46-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Exposure to programming languages.

About the Course:

Python is a popular open source programming language used for both standalone programs and scripting applications in a wide variety of domains. It is free, portable, and powerful and is both relatively easy and remarkably fun to use. In today's era Python has found great applicability in machine learning, data analytics and many other data science application. This is introductory course and covers most of the basic concepts required for basic python programming. Some of the contents are advanced may be useful for data analytics purpose.

Course Outcomes: By the end of the course students will be able to:

CO1. **Outline**various basic programming constructs including operators, character sets, basic data types and control statements. (LOTS: level 1: Understand)

CO2. **Explain**Python packages and their functionalities for data analysis. (LOTS: level 2: Understand)

CO3. **Solve**problems using python programming. (LOTS: level 3: Apply)

CO4. **Analyze**the results of data analysis or machine learning programs (HOTS: level 4: Analyze)

CO5. **Evaluate**solutions according to the problem definition. (HOTS: level 5: Evaluate)

CO6. **Develop**database applications in Python. (HOTS: level 6: Create)

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Course Content

UNIT I

Introduction to Python, History of Python, Features of Python, Python Identifiers, Python Character Set, Keywords and Indentation, Comments, Command Line Arguments, Assignment Operator, Operators and Expressions, *print()* Function, *input()* Function, *eval()* Function, Python Data Types: *int, float, complex*, Variables, Mutable vs Immutable variables, Namespaces, Decision Statements: Boolean Type, Boolean Operators, *if* statement, *else* statement, Nested Conditionals Statements, Multi-way Decision Statements (*elif*statement).

UNIT II

Loop Control Statements: *While* loop, *range()* Function, *For* Loop, Nested Loops, Infinite Loop, *Break* Statement, *Continue* Statement, *Pass* Statement, Introduction to Strings, String Operations: Indexing and Slicing, Lists: Operations on List: Slicing, Inbuilt Functions for Lists, List Processing: Searching and Sorting, Dictionaries: Need of Dictionary, Operations on Directories: Creation, Addition, Retrieving Values, Deletion; Tuples, operations on Tuples, Inbuilt Functions for Tuples, Introduction to Sets, operations on sets.

Python Functions, Inbuilt functions, *Main* function, User Defined functions, Defining and Calling Function, Parameter Passing, Actual and Formal Parameters, Default Parameters, Global and Local Variables, Recursion, Passing Functions as Data, *Lamda*Function, Modules, Importing Own Module, Packages.

UNIT III

Operations on File: Reading text files, read functions, *read(), readline()* and *readlines(),* writing Text Files, write functions, *write()* and *writelines()*,Manipulating file pointer using seek, Appending to Files.

Python Object Oriented: Overview of OOP, Classes and objects, Accessing attributes, Built-In Class Attributes, Methods, Class and Instance Variables, Destroying Objects, Polymorphism, Overlapping and Overloading of Operators, Class Inheritance: *super(),* Method Overriding, Exception Handling, *Try-except-else* clause, Python Standard Exceptions, User-Defined Exceptions

UNIT IV

Databases in Python: Create Database Connection, *create, insert, read, update* and *delete* Operation, DML and DDL Operation with Databases.

Python for Data Analysis: *numpy*: Creating arrays, Using arrays and Scalars, Indexing Arrays, Array Transposition, Universal Array Function, Array Processing, Array Input and Output

Pandas: Series, Data Frame, Panel, Index objects, Re-indexing, Iteration, Sorting. *Matplotlib*: Python for Data Visualization, Visualization Section, *Sklearn*: loading of dataset, learning and predicting, Model Persistence.

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Text and Reference Books:

1. Ashok NamdevKamthane, *Programming and Problem Solving with Python*, McGraw Hill Education Publication, 2018.

2. John Guttag, *Introduction to Computation and Programming using Python*, Springer, Revised and Expanded version (Referred by MIT), 2013.

3. Lutz, M., *Learning Python: Powerful Object-Oriented Programming*. O'Reilly Media, Inc., 2013.

4. Michael T Goodrich and Robertto. Thamassia, Micheal S Goldwasser, *Data Structures and Algorithms in Python*, Wiley, 2016.

5. Y. Daniel Liang, *Introduction to Programming Using Python*, Pearson, 2013.

6. ReemaThareja, *Python Programming Using Problem Solving Approach* , Oxford Publications, 2017.

7. Dr. R. NageswaraRao, Allen B. Downey, *Core Python Programming , Think Python*, O'Reilly Media, 2012.

8. Kenneth A. Lambert, *The Fundamentals of Python: First Programs*, Cengage Learning, 2011.

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Python Programming Course (PC/AIML/46-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Outline** various basic programming constructs including operators, character sets, basic data types and control statements. (LOTS: level 1: Understand)	1	_	_	_	_	_	_	_	_	_	_	_	_	_
CO 2.Explain Python packages and their functionalities for data analysis. (LOTS: level 2: Understand)	1	_	_	_	_	3	_	_	_	_	_	_	_	_
CO 3. **Solve** problems using python programming. (LOTS: level 3: Apply)	3	2	-	2	-	_	_	_	_	_	_	_	_	-
CO 4. **Analyse**the results of data analysis or machine learning programs (HOTS: level 4: Analyse)	2	3	2	2	_	_	_	_	_	_	_	_	–	-
CO 5.**Evaluate** solutions according to the problem definition. (HOTS: level 5: Evaluate)	2	3	2	2	-	3	_	_	_	_	_	-	–	-
CO 6.**Develop** database applications in Python. (HOTS: level 6: Create	3	3	2	3	-	-	-	-	-	-	-	-	3	-
Level of Attainments PC/AIML/46-T														

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DATA MINING USING R/PYTHON/WEKA LAB.(PC/AIML/42-P)

General Course Information

Course Code: PC/AIML/42-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4 hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department..

Pre-requisites: Basic Programming skills.

About the Course:
The objective of this lab is to enable students to use tools for applying advanced data reduction, classification and clustering techniques.

Course Outcomes: By the end of the course students will be able to:

CO1. **Apply** advanced data mining algorithms. (LOTS: Level 3: Apply)
CO2. **Usages**of modern data mining tools such as WEKA, R/Python packages. (LOTS: Level 3: Apply)
CO3. **Evaluate**the performance ofdata mining models. (LOTS: Level 5: Evaluate)
CO4. **Design**advanced data mining experiments. (LOTS: Level 6: Create)
CO5. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create).
CO6. **Demonstrate**ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)

List of experiments/assignments: (WEKA/R/Python packages etc.)

1. Five assignments on advanced classification algorithms (Advanced Classifiers).
2. Five assignment on clustering problems
3. Four assignment on data reduction and attribute selection
4. Two assignments on discovering association rules.

Note:
The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

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CO-PO Articulation Matrix:Data Mining using R/Python/WEKA Lab. (PC/AIML/42-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Apply** advanced data mining algorithms. (LOTS: Level 3: Apply).	2	3	3	_	3	_	_	_	_	_	_	_	_	3
CO2. **Usages** of modern data mining tools such as WEKA, R/Python packages. (LOTS: Level 3: Apply)	1	-	_	_	3	_	_	_	_	_	_	_	_	3
CO3. **Evaluate** the performance ofdata mining models (LOTS: Level 5: Evaluate)	3	2	_	_	3	_	_	_	_	_	_	_	_	3
CO4. **Design** advanced data mining experiments. (LOTS: Level 6: Create)	3	3	_	3	3	_	_	_	_	_	_	_	_	3
CO5. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create)	–	–	–	–	–	–	–	–	–	3	–	–	–	3
CO6. **Demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	–	–	–	–	–	–	–	3	3	–	–	3	–	–
Level of Attainments PC/AIML/42-P														

DATABASE MANAGEMENT SYSTEM LAB.(PC/AIML/44-P)

General Course Information

Course Code: PC/AIML/44-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 2 hours/week Mode: Lab practice and assignments.	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Exposure to programming language, MS Access.

About the Course:

This lab.course on DBMS involves a rigorous training on Oracle programming. It provides a strong formal foundation in database concepts, technology and practice to the students to groom them into well-informed database application developers. The objective of the lab course is to develop proficiency in the execution of commands of the database design and query using Oracle.

Course Outcomes: By the end of the course students will be able to:

CO1. **Implement**database problems using Oracle DML/DDL commands. (LOTS: Level 3: Apply)
CO2. **Enforce** integrity constraints on a database using a state-of-the-art RDBMS. (LOTS: Level 3: Apply)
CO3. **Analyse** the design of a relational database. (HOTS: Level 4: Analyse)
CO4. **Design** a relational database for a given schema. (HOTS: Level 6: Create)
CO5. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create)
CO6. **Demonstrate**ethical practices, self-learning and team spirit.

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List of experiments/assignments:

1. Use oracle software and login with valid user id and password. Explore its GUI and practice some basic commands of it.
2. Three assignments related to creation of database with tables having different fields and datatypes.
3. Two assignments on the creation of table with different types of constraints.
4. Two assignments on insert, delete and modify records from the tables.
5. Two assignments on modifying the table using the alter command.
6. Two assignments on exploring select statement using various clauses like where, order by, group by, having and aggregate functions.
7. Two assignments on the use of set operations to query the tables.
8. Two assignments on creating joins and views on the tables.
9. One assignment on generating sub-queries.

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation: Matrix Database Management System Lab. (PC/AIML/44-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Implement** database problems using Oracle DML/DDL commands. (LOTS: Level 3: Apply)	2	1		_	2	_	_	_	_	_	_	_	3	_
CO2. **enforce** integrity constraints on a database using a state-of-the-art RDBMS. (LOTS: Level 3: Apply)	2	2	_	_	2	_	_	_	_	_	_	_	3	_
CO3. **Analyse** the design of a relational database. (HOTS: Level 4: Analyse)	3	3	1	_	2	_	_	_	_	_	_	_	3	_
CO4. **Design** a relational database for a given schema. (HOTS: Level 6: Create)	3	3	2	3	3	_	_	_	_	_	_	_	3	_
CO5. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	_
CO6. **Demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments PC/AIML/44-P														

PYTHON PROGRAMMING LAB.(PC/AIML/46-P)

General Course Information

Course Code: PC/AIML/46-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 3 hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. File and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Basic programming skills

About the Course:

Python is a scripting programming language known for both its simplicity and wide breadth of applications. For this reason it is considered one of the best languages for beginners. Used for everything from web development to scientific computing Python is referred to as a general purpose language by the greater programming community. The major objective of Python language is to make the students solve real word problem efficiently using python library.

Course Outcomes: By the end of the coursestudentswill be able to:

CO1. **Implement** solutions to the given assignments in Python. (LOTS: Level 3: Apply)
CO2. **use** various Python packages for solving different programming problems. (LOTS: Level 3: Apply)
CO3. **Devise** solutions for complex problems of data analysis and machine learning. (HOTS: Level 6: Create)
CO4. **Evaluate** the output of data analysis and machine learning models. (HOTS: Level 5: Evaluate)
CO5. **Create** lab records of the solutions for the given assignments. (HOTS: Level 6: Create)
CO6. **Demonstrate** use of ethical practices, self-learning and team spirit.. (LOTS: Level 3: Apply)

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List of experiments/assignments

List of experiments/assignments

1. Install Python and explore various popular IDE like IDLE, PyCharm, and Anaconda.
2. Assignments to perform various number operations like
a. Find maximum from a list of numbers
b. GCD of two numbers
c. Square root of a number
d. Check number is prime or not.
e. Print first N prime numbers
f. Remove duplicate numbers from list
g. Print the Fibonacci series.
3. Assignments to perform various operations on Strings like creation, deletion, concatenation.
4. Create a List L = [10, 20, 30]. Write programs to perform following operations:
a. Insert new numbers to list L. b. Delete numbers from list L.
c. Sum all numbers in list L. d. Sum all prime numbers in list L.
e. Delete the list L.
5. Create a Dictionary D= {'Name': 'Allen', 'Age': 27, 5:123456}. Write programs to perform following operations:
a. Insert new entry in D. b. Delete an entry from D.
c. Check whether a key present in D. d. Update the value of a key.
e. Clear dictionary D.
6. Two assignments on Sets to perform various operation like union, intersection, difference etc.
7. Two assignments related to searching operation like linear search, binary search.
8. Three assignments related to sorting like selection sort, bubble sort, insertion sort.
9. Demonstrate the use of dictionary for measuring student marks in five subjects and you have to find the student having maximum and minimum average marks.
10. Two assignment on usage of different available packages like random package to perform
a. Print N random numbers ranging from 100 to 500.
b. Print 10 random strings whose length between 3 and 5.
11. Two assignments on usage of package such as Numpy, Pandas.
12. Implement and demonstrate the functions of a simple calculator.
13. One assignment on implementing object oriented concept such as classes, inheritance, and polymorphism.
14. One assignment on file handling that how data is read and written to a file.

Reference Books:

1. Allen B. Downey , " Think Python: How to Think Like a Computer Scientist", Second Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
2. Shroff "Learning Python: Powerful Object-Oriented Programming; Fifth edition, 2013.
3. David M.Baezly "Python Essential Reference". Addison-Wesley Professional; Fourth edition, 2009.
4. David M. Baezly "Python Cookbook" O'Reilly Media; Third edition (June 1, 2013) by.
5. http://www.edx.org

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Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix:Python Programming Lab. (PC/AIML/46-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Implement** solutions to the given assignments in Python. (LOTS: Level 3: Apply)	2	1	_	_	3	_	_	_	_	_	_	_	_	3
CO2. **Use** various Python packages for solving different programming problems. (LOTS: Level 3: Apply)	2	3	_	3	3	_	_	_	_	_	_	_	_	3
CO3. **Devise** solutions for complex problems of data analysis and machine learning. (HOTS: Level 6: Create)	3	3	1	3	3	_	_	_	_	_	_	_	_	3
CO4. **Evaluate** the output of data analysis and machine learning models. (HOTS: Level 5: Evaluate)	3	3		3	3	_	_	_	_	_	_	_	_	3
CO5. **Create** lab records of the solutions for the given assignments. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	_
CO6. **Demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments PC/AIML/46-P														

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INDUSTRIAL TRAINING/INTERNSHIP

General Course Information

Course Code: EEC/AIML/51-P Course Credits: 2 Mode: Industrial Training / Internship	**Course Assessment Methods (100 Marks)** An internal evaluation is done by a faculty member appointed by the Chairperson of the Department. Significance and originality of the problem addressed and the solution provided: 20 Knowledge of the problem domain and tool used (VIVA-VOCE):25 Report Writing: 20 Judgement of the skill learnt and system developed: 20 Level of ethics followed: 15

About the Industrial training:
Students do an Industrial Training of 6 to 8 weeks after fourth semester. They are expected to learn novel skills and develop some software application during the training period.

After doing training students will be able to:

CO1. **Address** novel problems in an original manner using latest skills. (HOTS: Level 6: Create)
CO2. **Select and apply** modern engineering tools. (LOTS: Level 3: Apply)
CO3. **Prepare** training report by organising ideas in an effective manner. (HOTS: Level 6: Create)
CO4. **Engage** in lifelong learning. (HOTS: Level 6: Create)
CO5. **Apply** ethical practices while doing the training and writing report. (LOTS: Level 3: Apply)

CO-PO Articulation Matrix:Industrial Training (EEC/AIML/51-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Address** novel problems in an original manner using latest skills (HOTS: Level 6: Create)	_	3	3	2		1	_	_	2	_	1	_	3	3
CO2. **Select and apply** modern engineering tools. (LOTS: Level 3: Apply)	2	–	–	–	3	_	_	_	3	_	_	_	3	2
CO3. **Prepare** training report by organising ideas in an effective manner. (HOTS: Level 6: Create)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CO4. **Engage** in lifelong learning. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	_	_	3	_	_
CO5. **Apply** ethical practices while doing the training and writing report. (LOTS: Level 3: Apply	_	_	_	_	_	_	_	3	_	3	_	_	_	_
Level of Attainments EEC/AIML/51-P														

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Scheme of Examination &Detailed Syllabusof BTech (AI&ML) 3rd Year

(V&VI Semester)

B.Tech. AI & ML V& VI Semester

Semester	Basic Sciences' Courses BSC		Engineering Sciences'/Programme Core/Programme Elective/Open Elective Courses ESC/PC/PE/OE		Humanities, Social Sciences, Management Courses HSMC		Mandatory Courses MC		IndustrialTrainimng(EEC/AIML-)		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
V	00	0	07	18	01	02	00	00	01	02	22
VI	00	00	07	18	01	02	01	00	01	02	22

Courses' codes, titles, and credits (Semester- V)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/51-T	Machine Learning	3/3	-/-	-	3/3
2	PC/AIML/52-T	Computer Networks	3/3	-/-	-	3/3
3	PC/AIML/53-T	Formal Language and Automata Theory	3/3	-/-	-	3/3
4	PC/AIML/54-T	Evolutionary and Swarm Intelligence for Optimization	3/-	-/-	-	3/3
5	OE-I	Open Elective Course be opted by students from another branch	3/-	-/-	-	3/3
6	HSMC/4-T	Economics for Engineers	2/2	-/-	-	2/2
7	MC/4-T	*Essence of Indian Traditional Knowledge	3/-	-/-	-	3/-
8	PC/AIML/51-P	Machine Learning Lab.	-/-	-/-	4/2	4/2
9	PC/AIML/52-P	Computer Networks Lab			2/1	2/1
10	**EEC/AIML/51-P	Industrial Training/ Internship-I	-/-	-/-	4/2	4/2
					Total Credit	30/22

*******The students will have to prepare and submit a Micro Project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of IV semester under the supervision of faculty duringVsemester.

Courses' codes, titles, and credits (Semester- VI)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/61-T	Neural Networks	3/3	-/-	-	3/3
2	PC/AIML/62-T	Cloud Computing	3/3	-/-	-	3/3
3	PC/AIML/63-T	Analysis and Design of Algorithms	3/3	-/-	-	3/3
4	PE/AIML/61-T To PE/AIML/65-T	Programme Elective Course to be opted by students **(Electives I)**	3/-	-/-	-	3/3

5	HSMC/3-T	Fundamentals of Management for Engineers	2/2	-/-	-	2/2
6	OE-II	Open Elective Course be opted by students from another branch	3/3	-/-	-	3/3
7	PC/AIML/61-P	Neural Networks Lab.	-/-	-/-	3/1.5	3/1.5
8	PC/AIML/62-P	Cloud Computing Lab.			3/1.5	3/1.5
9	EEC/AIML/61-P	Minor Project I			4/2	4/2
					Total Credit	27/ 22
***AMini-Project/Trainingbasedonopen-source tools						

***The students will have to undergo Industrial Training/Internship for 6-8 weeks during **summer** vacations after the examination of VI semester which will be evaluated in VII semester.

List of Programme Electives I

6. PE/AIML/61-T: Computer Graphics
7. PE/AIML/62-T/ PEC-CSE409-T/PEC-IT409-T: Internet of Things
8. PE/AIML/63-T/ PEC-CSE304-T/ PEC-IT304-T: Bio-informatics
9. PE/AIML/64-T: Information Retrieval Systems
10. PE/AIML/65-T: Microprocessor and Embedded Systems

Detailed Syllabus of V Semester

Machine Learning(PC/AIML/51-T)

General Course Information

Course Code: PC/AIML/51-T Course Credits:3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basics of Linear Algebra and Statistics, Basics of Probability Theory, Data Structures and Computer Algorithms.

About the Course:

Machine learning is the study of computer algorithms that improve their performance through experience. Machine learning draws its conceptual foundation from the fields like artificial intelligence, probability and statistics, computational complexity, cognitive science, biology and information theory etc. The course introduces some of the key machine learning algorithms and the theory that form the backbone of these algorithms. The examples of such algorithms are classification algorithms for learning patterns from data, clustering algorithms for grouping objects based on similarity, neural network algorithms for pattern recognition, genetic algorithms for searching large and complex search spaces etc.

Course Outcomes: By the end of the course students will be able to:

CO1. **outline** the concepts and working of different machine learning algorithms. (LOTS: Level 1: Remember)
CO2. **interpret** the results of machine learning algorithms. (LOTS: Level 2: Understand)
CO3. **apply** machine learning concepts and algorithms to given problems. (LOTS: Level 3: Apply)
CO4. **analyse** the performance of machine learning algorithms. ((HOTS: Level 4: Analyse)
CO5. **compare** different machine learning algorithms. (HOTS: Level 5: Evaluate)
CO6. **design** machine learning algorithms for optimization, pattern recognition and search problems. (HOTS: Level 6: Create)

Course content

UNIT I

Introduction: Well-Posed Learning Problems, Designing a Learning System, Perspectives and Issues in Machine Learning, Examples of Machine Learning Applications

Concept Learning and General-to-Specific Ordering: the concept learning task, Concept learning as search, Finding a maximally specific hypothesis, Version spaces and candidate elimination algorithm, Remarks on version spaces and candidate-eliminations, Inductive bias.

UNIT II

Bayesian Learning: Bayes Theorem, Bayes Theorem and Concept learning, Maximum likelihood and least-squared error hypotheses, Maximum likelihood and least square hypothesis, Maximum likelihood hypothesis for Predicting Probabilities, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Bayesian Belief Network.

UNIT III

Artificial Neural Network: Introduction, Neural Network Representation, Perceptron: Representational Power of Perceptrons, Perceptron Training Rule, Gradient Descent Algorithm.

Kernel Machines: Introduction, Optimal Separating Hyperplane, Support Vector Machine (SVM), The Non-separable Case: Soft Margin Hyperplane, Kernel Trick, Vectorial Kernels, Defining Kernels, Multiclass Kernel Machines. Kernel Machines for Regression,

UNIT IV

Dimensional Reduction: Introduction, Subset selection, Principal Component analysis, Feature Embedding, Factor analysis, Probabilistic PCA, Singular Value Decomposition and Matrix Factorization, Linear Discriminant analysis.

Reinforcement Learning: Introduction, Elements of Reinforcement Learning, the Learning Task, Q Learning, Deterministic Rewards and Actions, Non-Deterministic Rewards and Actions, Temporal Difference Learning

Text and Reference Books:

1. Tom M. *Mitchell, Machine Learning*, McGraw-Hill, 1997.
2. Ethem Apaydin, *Introduction to Machine Learning*, 3rd Edition, MIT Press, 2014.
3. Bishop Christopher, *Pattern Recognition and Machine Learning*, Springer Verlag, 2006.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning: Data Mining, Inference and Prediction*, Springer, 2nd edition, 2009.
5. J. Han and M. Kamber, *Data Mining Concepts and Techniques*, 3rd Edition, Elsevier, 2012

CO-PO Articulation Matrix: Machine Learning (PC/AIML/51-T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1. **Outline** the concepts and working of different machine learning algorithms. (LOTS: Level 1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	_	1
CO2. **Interpret** the results of machine learning algorithms. (LOTS: Level 2: Understand)	1	1	_	_	_	_	_	_	_	_	_	_	_	2
CO3. **Apply** machine learning concepts and algorithms to given problems. (LOTS: Level 3: Apply)	2	2	_	_	1	_	_	_	_	_	_	_	_	2
CO4. **Analyse** the performance of machine learning algorithms. ((HOTS: Level 4: Analyse)	2	3	_	1	2	_	_	_	_	_	_	_	_	3
CO5. **Compare** different machine learning algorithms. (HOTS: Level 5: Evaluate)	3	3	_	2	2	_	_	_	_	_	_	_	_	3
CO6. **Design** machine learning algorithms for optimization, pattern recognition and search problems. (HOTS: Level 6: Create)	3	3	_	3	3	_	_	_	_	_	_	_	_	3
Level of Attainments PC/AIML/51-T														

Computer Networks(PC/AIML/52-T)

General Course Information

Course Code: PC/AIML/52-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic knowledge of Digital and Analog Communication.

About the Course:

This course has been designed with an aim to provide students with an overview of the concepts and fundamentals of data communication and computer networks. The learner is given an opportunity to grasp various algorithms for routing of data, forwarding data and switching the data from hop to hop. Layered Architecture adds value to the subject contents.

Course Outcomes: By the end of the course students will be able to:

CO1. **outline** various models, topologies and devices of Computer Networks. (LOTS: Level 1: Remember)

CO2. **explain** the functions of various layers in Network Reference Model. (LOTS: Level 2: Understand)

CO3. **apply** different network concepts in various network communication protocols. (LOTS: Level 3: Apply)

CO4. **analyse** performance of various protocols in different scenarios. (HOTS: Level 4: Analyse)

CO5. **design** network for an organisation. (HOTS: Level 6: Create)

Course content

UNIT I

Data communication: Components, Data representation and Data flow; Network: Uses, Topologies, Network Services, OSI and TCP/IP Reference Models; Network categories: LAN, MAN, WAN; Guided Transmission Media, Wireless Transmission Media, Switching Techniques: Circuit Switching, Packet Switching, Message Switching, Networking Devices**:** Hubs, Repeaters, Bridges, Modems, Switches, Routers, and Gateways.

UNIT II

Data Link Layer-design issues, Framing & Error Handling: Framing Protocols, Error detection and correction mechanisms; Flow Control Protocols: Stop-and-wait, Sliding Window protocols: Go-back-N and Selective Repeat; Medium Access sub layer: Channel allocation methods, Multiple Access Communication: Random Access-ALOHA, Slotted-ALOHA, CSMA, CSMA-CD, LAN Standards: Ethernet, Fast Ethernet & Gigabit Ethernet.

UNIT III

Network Layer-Design issues, store and forward packet switching connection less and connection-oriented networks, Routing algorithms: optimality principle, shortest path, flooding, Distance Vector Routing, Count to Infinity Problem, Link State Routing, Hierarchical Routing, Congestion control algorithms, admission control.

Internetworking: IPV4 and IPV6, IP Addressing (Classful Addressing, Private IP Addresses, Classless Addressing, Sub-netting), ARP, RARP, ICMP, Internet Routing Protocol.

UNIT IV

Transport Layer: Transport layer Services: Addressing, Multiplexing, Flow control, Buffering and Error control. Internet Transport Protocols: UDP, TCP, TCP Segment, TCP Connection.

Application Layer: Introduction to DNS, FTP, TELNET, HTTP, SMTP, Electronic Mail, WWW and Multimedia.

Text and Reference Books:

1. Andrew S Tanenbaum, *Computer Networks,* 5th Edition, Pearson publications, 2010.
2. Forouzan, *Data Communication and networking* ,5th Edition, Tata McGraw Hill, 2012.
3. William Stalling, *Data & Computer Communication* 6th edition, LPE Pearson Education, 2013.
4. Todd Lammle, *CCNA Study Guide*,6th Edition, 2013.
5. RFCs and Internet Drafts available from Internet Engineering Task Force.

CO-PO Articulation Matrix: Computer Networks (PC/AIML/52-T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1. **Outline** various models, topologies and devices of Computer Networks. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2. **Explain** the functions of various layers in Network Reference Model. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Apply** different network concepts in various network communication protocols. (LOTS: Level 3: Apply)	2	1	-	-	2	-	-	-	-	-	-	-	3	-
CO4. **Analyse** performance of various protocols in different scenarios. (HOTS: Level 4: Analyse)	2	2	2	1	2	-	-	-	-	-	-	-	3	-
CO5. **Design** network for an organisation. (HOTS: Level 6: Create)	3	2	2	-	2	-	-	-	-	-	-	-	3	-
Level of Attainments PC/AIML/52-T														

Formal Language and Automata Theory(PC/AIML/53-T)

General Course Information

Course Code: PC/AIML/53-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: The students are expected to have a strong background in the fundamentals of discrete mathematics like in the areas of symbolic logic, set, induction, number theory, summation, series, combinatorics, graph, recursion, basic proof techniques.

About the Course:

Formal Languages and Automata theory presents the theoretical aspects of computer science, which lay the foundation for students of Computer Science. The course introduces some fundamental concepts in automata theory and formal languages including grammar, finite automaton, regular expression, formal language, pushdown automaton, and Turing machine.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** terminology related to theory of computation. (LOTS: Level1: Remember)

CO2. **explain** the basic concepts and applications of Theory of Computation. (LOTS: Level 2: Understand)

CO3. **apply** the principles of Theory of Computation to solve computational problems. (LOTS: Level3: Apply)

CO4. **contrast** the hierarchy of grammars (HOTS: Level 5: Evaluate).

CO5. **design** various types of automata for given problems. (HOTS: Level6: Create)

Course Content

UNIT I

Finite Automata and Regular Expressions: Finite State Systems, Basic Definitions Non-Deterministic finite automata (NDFA), Deterministic finite automata (DFA), Equivalence of DFA and NDFA Finite automata with E-moves, Regular Expressions, Equivalence of finite automata and Regular Expressions, Regular expression conversion and vice versa, Conversion of NFA to DFA by Arden's Method.

UNIT II

Introduction to Machines: Concept of basic Machine, Properties and limitations of FSM. Moore and mealy Machines, Equivalence of Moore and Mealy machines.

Properties of Regular Sets: The Pumping Lemma for Regular Sets, Applications of the pumping lemma, Closure properties of regular sets, Myhill-Nerode Theorem and minimization of finite Automata, Minimization Algorithm.

UNIT III

Grammars: Definition, Context free and Context sensitive grammar, Ambiguity regular grammar, Reduced forms, Removal of useless Symbols and unit production, Chomsky Normal Form (CNF), Griebach Normal Form (GNF).

Pushdown Automata: Introduction to Pushdown Machines, Application of Pushdown Machines

UNIT IV

Turing Machines: Deterministic and Non-Deterministic Turing Machines, Design of T.M, Halting problem of T.M., PCP Problem.

Chomsky Hierarchies: Chomsky hierarchies of grammars, Unrestricted grammars, Context sensitive languages, Relation between languages of classes.

Computability: Basic concepts, Primitive Recursive Functions.

Text and Reference Books:

1. Hopcroaft & O. D. Ullman, R Mothwani, *Introduction to automata theory, language &computations*, AW, 2001.
2. K. L. P. Mishra & N. Chandrasekaran, *Theory of Computer Sc. (Automata, Languages and computation)*, PHI, 2000.
3. PeterLinz, *Introduction to formal Languages & Automata*, Narosa, Publication,2001.
4. Ramond Greenlaw and H. James Hoover, *Fundamentals of the Theory of Computation-Principles and Practice*, Harcourt India Pvt. Ltd.,1998.

5. H.R. Lewis & C.H. Papaditriou, *Elements of theory of Computation*, PHC, 1998.
6. John C. Martin, *Introduction to Languages and the Theory of Computation*, T.M.H.,2003.

CO-PO Articulation Matrix: Formal Language and Automata Theory (PC/AIML/53-T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1. **Define** terminology related to theory of computation. (LOTS: Level1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	3	_
CO2. **Explain** the basic concepts and applications of Theory of Computation. (LOTS: Level 2: Understand)	1	_	_	_	_	_	_	_	_	_	_	_	3	_
CO3. A**pply** the principles of Theory of Computation to solve computational problems. (LOTS: Level3: Apply)	2	1	2	_	2	_	_	_	_	_	_	_	3	_
CO4. **Contrast** the hierarchy of grammars (HOTS: Level 5: Evaluate).	3	2	2	2	2	_	_	_	_	_	_	_	3	_
CO5. **Design** various types of automata for given problems. (HOTS: Level6: Create)	3	3	2	2	2	_	_	_	_	_	_	_	3	_
Level of Attainments PC/AIML/53-T														

Evolutionary and Swarm Intelligence for Optimization(PC/AIML/54-T)

General Course Information

Course Code: PC/AIML/54-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic understanding of computer algorithms, familiarity with basic optimization methods

About the Course:

This course provides the introduction to the concepts, principles and applications of evolutionary and swarm optimization techniques. It covers evolutionary computing, particle swarm optimization, ant colony optimization algorithms. It offers an opportunity to understand and apply these nature inspired algorithms to solve complex optimization problems which otherwise cannot be solved within reasonable time due to their high complexity.

Course Outcomes: By the end of the course students will be able to:

CO6. **outline** the terminology and concepts in evolutionary and swarm optimization (LOTS: Level 1: Remember)
CO7. **explain** the working of evolutionary and swarm optimization algorithms. (LOTS: Level 2: Understand)
CO8. **solve** optimization problems by using evolutionary and optimization algorithms. (LOTS: Level 3: Apply)
CO9. **compare** evolutionary and swarm intelligence algorithms. (HOTS: Level 4: Analyse)
CO10. **judge** the performance of evolutionary and swarm intelligence algorithms on diverse optimization problems (HOTS: Level 5: Evaluate)
CO11. **design** novel evolutionary and swarm intelligence algorithm for optimization problems. (HOTS: Level 6: Create)

Course content

UNIT I

History and need for nature inspired algorithm. Basics of Genetic Algorithm (GA) and its working: Encoding, Fitness evaluation, Selection, Crossover and Mutation operators. Parameters of GA. Different Encoding Schemes, Selection and Sampling mechanisms and GA Operators, Designing GAs for solving problems regarding function optimization.

UNIT II

Local and Global Convergence, Linear Scaling, Multi-objective optimization, MultiObjective GAs, Working of NSGA-II. Solving function optimization, knapsack, numeric optimization, routing and scheduling problems using GA, parallel genetic algorithms.

UNIT III

Swarm Intelligence, Basic of Particle Swarm Optimization (PSO): Definitions and Concepts of PSO, Working of PSO, swarm size, information links, initialization, Equations of motion, interval confinement, proximity distributions, distribution bias, explosion and maximum velocity, parameters of PSO, Local best and global best PSO, Solving function optimization, knapsack, numeric optimization, routing and scheduling problems using PSO.

UNIT IV

Ants' foraging behaviour and optimization, Artificial Ants, Artificial Ants and minimum cost paths, combinatorial optimization, Ant Colony Optimization (ACO) Metaheuristic, Applying ACO, Theoretical considerations on ACO, Convergence Proof, ACO and Model based search, solving travelling sales person and other similar problems using ACO, Ant Systems and its successors, ACO plus local search.

Text and Reference Books:

1. Zbigniew Michalewicz, *Genetic algorithms +Data Structures = Evolution Programs*, Springers-Verlag, 1999.
2. David.E. Goldberg, *Genetic Algorithms in Search, Optimization and machine learning*, Addison Wesley, 1999.
3. Marco Dorigo, Thomas, Stutzle, *Ant Colony Optimization*, MIT Press, 2004.
4. Helio J.C. Barbosa, "*Ant Colony Optimization - Techniques and Applications*", Intech 2013
5. Maurice Clerc, *Particle Swarm Optimization*, ISTE, Ltd., London, UK, 2006.

CO-PO Articulation Matrix: Evolutionary and Swarm Intelligence for Optimization
(PC/AIML/54-T**)**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Outline** the terminology and concepts in evolutionary and swarm optimization (LOTS: Level 1: Remember)	1	–	–	–	–	–	–	–	–	–	–	–	–	–
CO2. **Explain** the working of evolutionary and swarm optimization algorithms. (LOTS: Level 2: Understand)	1	–	–	–	–	3	–	–	–	–	–	–	–	–
CO3. **Solve** optimization problems by using evolutionary and optimization algorithms. (LOTS: Level 3: Apply)	3	2	-	2	-	–	–	–	–	–	–	–	–	-
CO4. **Compare** evolutionary and swarm intelligence algorithms. (HOTS: Level 4: Analyse)	2	3	2	2	–	–	–	–	–	–	–	–	–	-
CO5. **Judge** the performance of evolutionary and swarm intelligence algorithms on diverse optimization problems. (HOTS: Level 5: Evaluate)	2	3	2	2	-	3	–	–	–	–	–	-	–	-
CO6. **Design** novel evolutionary and swarm intelligence algorithm for optimization problems. (HOTS: Level 6: Create)	3	3	2	3	-	-	-	-	-	-	-	-	3	-
Level of Attainments PC/AIML/54-T														

Economics for Engineers(HSMC/4-T)

General Course Information

Course Code: HSMC/4-T Course Credits: 2 Type: Humanities and Social Sciences including Management courses Contact Hours: 2 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: None

About the Course:

This course is designed to provide the elementary and essential knowledge of economics relevant to their profession as engineers. The graduating engineers will learn about the basic principles of economics and cost benefit analysis for various economic alternatives. The course also gives an initial exposure to issues and challenges for sustainable development.

Course Outcomes: By the end of the course students will be able to:

- CO1. **outline** the principles of economics in general and economics in Indian context. (LOTS: Level 1: Remember)
- CO2. **discuss** concepts related to economics in general and particularly relevant to Indian scenario. (LOTS: Level 2: Understand)
- CO3. **apply** the principles of economics for solving problems related to Engineering sector. (LOTS: Level 3: Apply)
- CO4. **carry** out cost/benefit/, life cycle and breakeven analyses on one or more economic alternatives. (HOTS: Level 4: Analyse)
- CO5. **judge** the issues and challenges of sustainable development. (HOTS: Level 5: Evaluate)

Course content

UNIT I

Definition of Economics- various definitions, Nature of economic problem, Production possibility curve, Economics laws and their nature. Relation between Science, Engineering, Technology and Economics. Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility - its practical applications and importance.

UNIT II

Meaning of Demand, Individual and Market demand schedules, Law of demand, shape of demand curve, Elasticity of Demand, measurement of elasticity of demand, factors affecting elasticity of demand, practical importance and applications of the concept of elasticity of demand.

Meaning of production and factors of production; Law of variable proportions, Returns to scale, Internal and External economics and diseconomies of scale.

UNIT III

Various concepts of cost- Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost. Shape of average cost, marginal cost, total cost etc. in short run and long run both.

Meaning of Market, Types of Market - Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets)

Issues, Strategies and challenges for sustainable development for developing economies

UNIT IV

Elements of Business/Managerial Economics and forms of organizations, Cost &Cost Control Techniques, Types of Costs, Lifecycle Costs, Budgets, Break Even Analysis, Capital Budgeting, Application of linear Programming. Investment Analysis- NPV, ROI, IRR, Payback Period, Depreciation, Time Value of Money (present and future worth of cash flows).

Business Forecasting- Elementary techniques. Statements- Cash Flows, Financial. Case Study Method. Nature and Characteristics of Indian Economy (brief and elementary introduction). Privatization - meaning, merits, and demerits. Globalisation of Indian economy- merits and demerits.

WTO and TRIPs agreements.

T**ext and Reference Books:**

1. Alfred William Stonier, D. C. Hague, *A textbook of Economic Theory*, 5th edition, Longman Higher Education, 1980.
2. K. K. Dewett, M. H. Navalur, *Modem Econornic Theory*, S. Chand, 2006.
3. H. L. Ahuja, *Modern Microeconomic: Theory and Applications*, S. Chand, 2017.
4. N. Gregory Mankiw, *Principles of Economics*, 7th edition, South-Western College Publishing, 2013.

5. Ruddar Dutt & K.P.M. Sundhram, *Indian Economy*, S. Chand, 2004.
6. V. Mote, S. Paul, G. Gupta, *Managerial, Economics*, McGraw Hill Education, 2017.
7. Saroj Pareek, *Textbook of Business Economics*, Neha Publishers and Distributors, 2013.
8. William McDonough and Michael Braungart, *Cradle to Cradle Remaking the Way We Make Things*, North Point Press, New York, 2002.
9. Sustainable Development Challenges, *World Economic and Social Survey*, United Nations Publication, 2013.

CO-PO Articulation Matrix: Economics for Engineers (HSMC/4-T)

List of Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1. **Outline** the principles of economics in general and economics in Indian context particularly for public sector agencies and private sector businesses. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2. **Discuss** concepts related to economics in general and particularly relevant to Indian scenario. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3. **Apply** the principles of economics for solving problems related to Engineering sector. (LOTS: Level 3: Apply)	2	2	2	2	2	-	-	-	-	-	-	-	-	-
CO4. **Carry** out benefit/cost, life cycle and breakeven analyses on one or more economic alternatives. (HOTS: Level 4: Analyse)	3	2	2	3	3	-	-	-	2	-	-	3	-	-
CO5. **Judge** the issues and challenges of sustainable development. (HOTS: Level 4: Evaluate)	3	_	3	3	_	_	3	-		3	3	3	-	-
Level of Attainments HSMC/4-T														

Essence of Indian Traditional Knowledge (MC/4-T)

General Course Information

Course Code: MC/4-T Course Credits: 0 Type: Mandatory course Contact Hours: 3 hours/week Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: None

About the Course:

This course is designed to acquaint students with Indian knowledge traditions It introduces students to Vedic period, Post Vedic period, Sufi and Bhakti Movement in India, the ancient scientists of India and social reform movements of 19^{th} century.

Course Outcomes: By the end of the course students will be able to:

CO1. **recognise** the forms and sources of Indian traditional knowledge. (LOTS: Level 1: Remember)

CO2. **identify** the contribution of the great ancient Indian scientists and spiritual leaders to the world of knowledge. (LOTS: Level 2: Understand)

CO3. **apply** the reasoning based on objectivity and contextual knowledge to address the social and cultural issues prevalent in Indian society. (LOTS: Level 3: Apply)

CO4. **differentiate** the myths, superstitions from reality in context of traditional knowledge to protect the physical and social environment. (LOTS: Level 4: Evaluate)

CO5. **suggest** means of creating a just and fair social environment that is free from any prejudices and intolerance for different opinions and cultures. (LOTS: Level 6: Create)

Course Content

UNIT I

Introduction to Indian Tradition Knowledge: Defining traditional knowledge, forms, sources and dissemination of traditional knowledge.

Vedic Period: Vedas and Upanishads, Yogsutras of Patanjali

Post Vedic Period: Budhism, Janism and Indian Materialism: Charvak School of Thought

UNIT II

Sufi and Bhakti Movement (14th to 17th century): सगुण-निर्गुणभक्ति, Sufism and Sufi saints, Kabir, Nanak and Guru Jambheshwar ji Maharaj etc., Composite Culture of Indian sub-continent.

UNIT III

Jyotirao Phuleand Savitri Bai Phule and other 19th Century Social Reform Movements;

India's cultural heritage.

UNIT IV

India's Contribution to the world of knowledge: प्राचीन भारत के महान वैज्ञानिक: बौधायन, चरक, कौमारभृत्यजीवन, सुश्रुत, आर्यभट, बराहमिहिर, ब्रह्मगुप्त, नागार्जुन, वाग्भट; Astrology and Astronomy, Myths and Reality

Text and Reference Books:

1. A. L. Bhansam, The *Wonder That was India, A Survey of the Culture of the, Indian Sub-Continent before, the Coming of the Muslims*, Vol 1, Groove Press, New York, 1959.
2. S. A. A. Rizvi, *Wonder That was India, A Survey of the History and Culture of the Indian Sub-Continent from the Coming of the Muslims to the British Conquest 1*200-1700, Vol 2, Rupa and Co. 2001.
3. *प्रतियोगितादर्पणअतिरिक्तांकसीरीज–5*भारतीयकलाएवंसंस्कृति,
4. गुणाकरमूले,*प्राचीनभारतकेमहानवैज्ञानिक,*ज्ञानविज्ञानप्रकाशन,नईदिल्ली,1990.
5. B. V. Subbarayappa, *A Historical Perspective of Science in India*, Rupa Publications, New Delhi, 2013.
6. Thich Nhat Hanh, Nguyen Thi Hop, Mobi Ho , *Old Path White Clouds: Walking in the Footsteps of the Buddha*, Parallax Press, 1991.
7. Hermann Hesse, *Siddhartha*, Simon & Brown, 2017.
8. सावित्रीचंद्रशोभा, *हिन्दीभक्तिसाहित्यमेंसामाजिकमूल्यएवंसहिष्णुतावाद,* नेशनलबुकट्रस्ट, इंडिया, 2007.
9. Rosalind O' Hanlon, *Caste Conflict and Ideology, Mahatma Jyotirao Phule and low caste protest in nineteen century*, Western India, Camridge University Press, 2009.
10. Melanie P. Kumar, Savitribai Phule: *Forgotten liberator*, Infochange, 2009.
11. Leah Verghese, Ranjna, and Medha Sundar, *Savitribai, Journey of a Trailblazer*, Azim Prem Ji University, 2014.

CO-PO Articulation Matrix: Essence of Indian Traditional Knowledge (MC/4-T)

List of Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1. **Recognise** the forms and sources of Indian traditional knowledge. (LOTS: Level 1: Remember)	-	1		-	-		-	-	-	-	-	1	-	-
CO2. **Identify** the contribution of the great ancient Indian scientists and spiritual leaders to the world of knowledge. (LOTS: Level 2: Understand)	-	2	1	-	-	3	-	-	-	-	-	1	-	-
CO3. **Apply** the reasoning based on objectivity and contextual knowledge to address the social and cultural issues prevalent in Indian society. (LOTS: Level 3: Apply)	-	3	3	2	-	3	-	-	-	-	-	3	-	-
CO4. **Differentiate** the myths, superstitions from reality in context of traditional knowledge to protect the physical and social environment. (LOTS: Level 4: Evaluate)	-	2	3	3	-	3	1	-	-	-	-	3	-	-
CO5. **Suggest** means of creating a just and fair social environment that is free from any prejudices and intolerance for different opinions and cultures. (LOTS: Level 6: Create)	-	3	3	3	-	3	-	-	-	-		3	-	-
Level of Attainments MC/4-T														

Machine Learning Lab.(PC/AIML/51-P)

General Course Information

Course Code: PC/AIML/51-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4 hours / week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Programming in Java, Python, R and Octave/MATLAB.

About the Course:

In this lab course, students learn to solve optimization, supervised, unsupervised and reinforcement learning problems using machine learning tools. Students will use machine learning tools available in Java, R, Python and MATLAB etc. The lab experiments involve downloading datasets and applying machine learning techniques on these datasets. The course has a special focus on interpreting and visualizing results of machine learning algorithms.

Course Outcomes: By the end of the course students will be able to:

CO1. **implement** machine learning algorithms using modern machine learning tools. (LOTS: Level 3: Apply)
CO2. **analyse** the trends in datasets using descriptive statistics. (HOTS: Level 4: Analyse)
CO3. **apply** descriptive and predictive modelling. (LOTS: Level 3: Apply)
CO4. **compare** machine learning algorithms for a given problem. (HOTS: Level 5: Evaluate)
CO5. **create** lab records of assignment by incorporating problem definitions, design of solutions, results, and interpretations. (HOTS: Level 6: Create)
CO6. **demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)

List of experiments/assignments

List of Experiments:

1. Install R/Python/Matlab and learn to use these software packages.
2. Implement perceptron learning with step function. Also show the decision boundary for classification.
3. Two assignments related to clustering algorithms and interpreting the results of these algorithms.
4. Two assignments on ranking or selecting relevant features.
5. Implement feature scaling/normalization.
6. Implement gradient descent algorithm to optimize linear regression and logistic regression algorithm.
7. Apply various evaluation metrics on breast cancer data set after classification using:
    a. ANN (a multilayer perceptron)
    b. SVM
8. In exercise-7 plot decision boundary using *matplotlib*
9. Implement PCA on breast cancer dataset.
10. Draw two-dimensional scatter plot of the breast cancer dataset using the first two principal components as done in exercise 7.
11. Implement SVM with different kernels. The program must classify the “Orange and Apple” dataset with Accuracy as a performance measure.
12. Implement Bayesian theorem and classifier.
13. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
14. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm. Output a description of the set of all hypotheses consistent with the training examples.
15. 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.
16. Implementation of Q-learning (Reinforcement learning)

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix: Machine Learning Lab. (PC/AIML/51-P**)**

List of Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1. **Implement** machine learning algorithms using modern machine learning tools. (LOTS: Level 3: Apply)	2	3	_	_	3	_	_	_	_	_	_	_	_	3
CO2. **Analyse** the trends in datasets using descriptive statistics. (HOTS: Level 4: Analyse)	2	-	_	2	3	_	_	_	_	_	_	_	_	3
CO3. **Apply** descriptive and predictive modelling. (LOTS: Level 3: Apply)	3	2	_	3	3	_	_	_	_	_	_	_	_	3
CO4. **Compare and contrast** machine learning algorithms for a given problem. (HOTS: Level 5: Evaluate)	3	3	_	3	3	_	_	_	_	_	_	_	_	3
CO5.**Create** lab records of assignment by incorporating problem definitions, design of solutions, results and interpretations. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	_
CO6. **Demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments PC/AIML/51-P														

Computer Networks Lab.(PC/AIML/52-P)

General Course Information

CourseCode:PC/AIML/52-P Course Credits: 1 Type: Professional Core Lab. Course Contact Hours: 2 hours/week Mode: Lab. practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department

Pre-requisites: knowledge of programming, digital and analog communication.

About the Course:

This course has been designed with an aim to provide students with an overview of the concepts and fundamentals of data communication and computer networks. Students learn about various topologies, network devices, routing protocols, firewall amongst other features and devices of Computer Networks.

Course Outcomes: By the end of the course students will be able to:

CO1. **demonstrate** various network topologies and networking devices. (LOTS: Level: 3: Apply)

CO2. **justify** a particular routing protocol for any implemented data communication networks. (HOTS: Level: 5: Evaluate)

CO3. **construct** a network and implement various network protocols. (HOTS: Level: 6: Create)

CO4. **devise** solutions for various routing and switching problems in Computer Networks. (HOTS: Level: 6: Create)

CO5. **create** lab records for the solutions of the assignments. (HOTS: Level: 6: Create)

CO6. **demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level: 3: Apply)

List of Experiments/assignments:

1.
   a) Familiarization with networking components and devices: LAN Adapters - Hubs - Switches - Routers etc.
   b) Familiarization with transmission media and Tools: Co-axial cable - UTP Cable - Crimping Tool - Connectors etc.
2. Installation and introduction of simulation tools PacketTracer/ GNS3.
3. Preparing the UTP cable for cross and direct connections using crimpingtool.
4. Introduction to various interior and exterior routing protocols.
5. Configuration of RIP protocol on routers to configure a network topology.
6. Implementation EIGRP protocol on router.
7. Implementation OSPF protocol on a larger network.
8. Configuration of ARP protocol in network.
9. Configuration of a wireless device in simulated environment.
10. Implementation BGP protocol between two different networks.
11. Implementation of static routing in simulation environment.
12. Configuration of TELNET protocol on router for remote access.
13. Configuration of access lists on network to stop unwanted traffic on network.
14. Configuration of zone-based firewall in network.

Note:
The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix Computer Networks Lab. (PC/AIML/52-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	
CO1. **Demonstrate** various network topologies and networking devices. (LOTS: Level: 3: Apply)	1	1	_	_	_	_	_	_	_	_	_	_	_	3	
CO2. **Justify** a particular routing protocol for any implemented data communication networks. (HOTS: Level: 5: Evaluate)	2	2	2	_	_	_	_	_	_	_	_	_	_	3	
CO3. **Construct** a network and implement various network protocols. (HOTS: Level: 6: Create)	2	3	3	_	2	_	_	_	_	_	_	_	_	3	
CO4. **Devise** solutions for various routing and switching problems in Computer Networks. (HOTS: Level: 6: Create)	3	3	3	3	3	_	_	_	_	_	_	_	_	3	
CO5. **Create** lab records for the solutions of the assignments. (HOTS: Level: 6:	_	_	_	_	_	_	_	_	_	3	--	--	_	_	

Create)															
CO6. **Demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level: 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_	
Level of AttainmentPC/AIML/52-P															

Industrial Training I (EEC/AIML/51-P)

General Course Information

Course Code: (**EEC/AIML/51-P) Course Credits: 2 Mode: Industrial Training	**Course Assessment Methods (100 Marks)** An internal evaluation is done by internal examiner/(s) appointed by the Chairperson. Significance and originality of the problem addressed, and the solution provided: 20 Knowledge of the problem domain and tool used (VIVA-VOCE):25 Report Writing: 20 Judgement of the skill learnt, and system developed: 20 Level of ethics followed: 15

About the Industrial training:

Students will do an Industrial Training of 4 to 6 weeks after fourth semester. They are expected to learn novel skills and develop some software application during the training period.The training will be evaluated in the fifth semester.

After doing training students will be able to:

CO6. **review** the existing systems for their strengths and weaknesses. (HOTS: Level 4: Analyse)
CO7. **address** novel problems in an original and innovative manner (HOTS: Level 6: Create)
CO8. **select and apply** modern engineering tools. (LOTS: Level 3: Apply)
CO9. **evaluate** the system developed critically with respect to the requirement analysis and other similar systems. (HOTS: Level 5: Evaluate)
CO10. **prepare** training report by organising ideas in an effective manner.
CO11. **follow** ethical practices while doing the training and writing report. (LOTS: Level 3: Apply)

CO-PO Articulation Matrix: Industrial Training I (**EEC/AIML/51-P)

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
CO6. **Address** novel problems in an original manner using latest skills (HOTS: Level 6: Create)	3	3	3	2		1	_	_	2	_	1	_	_	_
CO7. **Select and apply** modern engineering tools. (LOTS: Level 3: Apply)	2	_	_	_	3	_	_	_	3	_	_	_	_	_
CO8. **Prepare** training report by organising ideas in an effective manner.	_	_	_	_	_	_	_	_	_	_	_	_	_	_
CO9. **Engage** in lifelong learning. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	_	_	3	_	_
CO10.**Apply** ethical practices while doing the training and writing report. (LOTS: Level 3: Apply	_	_	_	_	_	_	_	3	_	3	_	_	_	_
Level of Attainments (**EEC/AIML/51-P)														

Detailed Syllabus of VI Semester

Neural Networks(PC/AIML/61-T)

General Course Information

Course Code: PC/AIML/61-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic understanding of Mathematics and Machine Learning.

About the Course:

Neural Networks are important component of Machine Learning. These have ability to discover patterns from input data with or without a teacher. Neural Networks have a very wide spectrum of applications starting from simple pattern recognition to advanced image processing tasks. This course provides a comprehensive foundation of Neural Networks.

Course Outcomes: By the end of the course students will be able to:

CO1. **recognize** the basic vocabulary and functioning of Neural Networks. (LOTS: Level 1: Remember)
CO2. **describe** various kinds of Neural Networks and their learning mechanisms. (LOTS: Level 2: Understand)
CO3. **use** Neural Networks to solve pattern recognition problems. (LOTS: Level 3: Apply)
CO4. **compare** different Neural Networks and their suitability for diverse machine learning tasks. (HOTS: Level 4: Analyse)
CO5. **justify** the use of different Neural Networks in particular situations. (HOTS: Level 5: Evaluate)
CO6. **design** Neural Networks for machine learning problems. (HOTS: Level 6: Create)

Course content

UNIT I

Introduction to neural networks: what is a neural network, human brain, feedback, neural network as directed graph, feedback, network architectures, knowledge representations, artificial intelligence and neural networks.

Learning Process: Error Correction learning, memory-based learning, Hebbian learning, competitive learning, Boltzmann learning, credit assignment problem, learning with a teacher, learning without a teacher, learning tasks, memory, adaptation, statistical nature of learning process, statistical learning theory, probability approximately correct model of learning

UNIT II

Single Layer Perceptron: Adaptive filtering process, Unconstrained optimization techniques, linear least square filters, least mean square algorithm, learning curves, learning rate annealing technique, perceptron, perceptron convergence theorem.

Multilayer Perceptron: Back Propagation algorithm, XOR Problem, Output representation and decision rule, feature detection, Hessian matrix, generalization, approximation of function, cross validation, network pruning techniques, virtues and limitations of back propagation learning, convolutional networks

UNIT III

Radial basis function networks: Cover's theorem on separability of patterns, interpolation problem, regularization theory and networks, generalized Radial basis function networks, approximation properties of RBF networks, comparison of RBF networks and multilayer perceptron.

Self-Organizing Maps: two basic feature mapping models, Self-Organizing Map, SOM algorithm, Properties of feature map, learning vector quantization, hierarchical vector quantization, contextual maps.

UNIT IV

Associative Memories: Linear Associator, Basic Concepts of Recurrent Auto associative Memory Retrieval Algorithm, Storage Algorithm, Energy Function Reduction, Capacity of Auto Associative Recurrent Memory, Memory Convergence versus Corruption, Fixed Point Concept, Modified Memory Convergent Toward Fixed Points, Bidirectional Associative Memory, Memory Architecture, Association Encoding and Decoding, Stability Considerations, Multidirectional Associative Memory.

Applications of Neural Networks: Character Recognition Networks, Connectionist Expert Systems for Medical Diagnosis

Text and Reference Books:

1. Simon S Haykin, *Neural Networks, A Comprehensive Foundations,* PHI, Second Edition, 2009.
2. Jacek M. Zurada, *Introduction to Artificial Neural Systems*, JAICO Publishing House Ed. 2006.
3. Bose N.K., Liang, P., *Neural Network Fundamentals*, T.M.H 2002.
4. Kosko, *Neural Network & Fuzzy System*, Prentice Hall, 1992.

CO-PO Articulation Matrix: Neural Networks (PC/AIML/61-T**)**

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1. **Recognize** the basic vocabulary and functioning of Neural Networks. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-		1
CO2. **Describe** various kinds of Neural Networks and their learning mechanisms. (LOTS: Level 2: Understand)	2	-	-	-	1	-	-	-	-	-	-	-		2
CO3. **Use** Neural Networks to solve pattern recognition problems. (LOTS: Level 3: Apply)	2	1	-	1	2	-	-	-	-	-	-	-		3
CO4. **Compare** different Neural Networks and their suitability for diverse machine learning tasks. (HOTS: Level 4: Analyse)	2	2	-	2	2	-	-		-	-	-	-		3
CO5. **Justify** the use of different Neural Networks in particular situations. (HOTS: Level 5: Evaluate)	3	3	-	3	2	-	-	-	-	-	-	-		3
CO6. **Design** Neural Networks for machine learning problems. (HOTS: Level 6: Create)	3	3	-		2									3
Level of AttainmentsPC/AIML/61-T														

Cloud Computing(PC/AIML/62-T)

General Course Information

Course Code: PC/AIML/62-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basics of Computer Network, Distributed System, Operating System

About the Course:

The objective of the course is to give students a comprehensive view of storage and networking infrastructures for highly virtualized cloud ready deployments. The course discusses the concepts and features related to Virtualized data-centre and cloud, information storage and design of applications.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** concepts related to cloud computing. (LOTS: Level 1: Remember)
CO2. **express** deployment models for clouds. (LOTS: Level 2: Understand)
CO3. **apply** cloud computing techniques for various applications. (LOTS: Level 3: Apply)
CO4. **analyse** cloud computing services used at various levels. (HOTS: Level 4: Analyse)
CO5. **compare** different cloud management platform. (HOTS: Level 5: Evaluate)
CO6. **assess** real time cloud services. (HOTS: Level 5: Evaluate)

Course content

UNIT I

Overview of Cloud Computing- Cloud at a Glance: The Vision of Cloud Computing, Defining a Cloud, Cloud Computing Reference Model, Characteristics and Benefits, Historical Developments: Distributed Systems, Cluster Computing, Grid Computing, Virtualization, Web 2.0, Service-Oriented Computing, Building Cloud Computing Environment: Application Development, Infrastructure and System Development, Computing Platforms and Technologies: Amazon Web Services, Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com

UNIT II

Virtualization & Cloud Computing Architecture – Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques: Execution Virtualization, Other Types of Virtualization, Virtualization and Cloud Computing: Pros and Cons of Virtualization, Technology Examples: Xen: Paravirtualization, VMware: Full Virtualization, Microsoft Hyper – V, Cloud Architecture: Introduction, Cloud Reference Model Architecture, Infrastructure as a Service, Platform as a Service, Software as a Service, Types of Clouds: Public, Private, Hybrid, Community,

Cloud management Platform: CloudStack, Eucalyptus, vCloud Director and OpenStack

UNIT III

Cloud in Industry and Its Applications – Amazon Web Services: Compute Services, Storage Services, Communication Services, Additional Services, Google AppEngine: Architecture and Core Concepts, Application Life-Cycle, Microsoft Azure: Core Concepts, SQL Azure, Windows Azure Platform Appliance, Cloud Applications: Scientific Applications: Healthcare: ECG, Biology: Protein Structure Prediction, Gene Expression Data Analysis for Cancer Diagnosis, Geo-Science Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Media Applications, Multiplayer Online Gaming.

UNIT IV

Security in Cloud – Cloud Information Security Fundamentals, Cloud Security Services, Design Principles, Secure Cloud Software Requirements, Policy Implementation, Cloud Computing Security Challenges, Virtualization Security Management, Cloud Computing Security Architecture.

Text and Reference Books and Links:

1. Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, *Mastering Cloud Computing*, McGraw Hill Publication (India) Private Limited, 2013.
2. Krutz, Vines, *Cloud Security*, Wiley Publication, 2010.
3. Bloor R., Kanfman M., Halper F. Judith Hurwitz, *Cloud Computing for Dummies*, (Wiley India Edition), 2010.

4. John Rittinghouse & James Ransome, *Cloud Computing Implementation Management and Strategy*, CRC Press, 2010.
5. Antohy T Velte , *Cloud Computing : A Practical Approach*, McGraw Hill, 2009.
6. Rajkumar Buyya, James Broberg and Andrez Gosscinski, *Cloud Computing: Principles and Paradigm*, John Wiley and Sons, Inc. 2011.
7. Kai Hwang, Geofferyu C. Fox and Jack J.Dongarra, *Distributed and Cloud Computing*, Elsevier, 2012.

CO-PO Articulation Matrix: Cloud Computing (PC/AIML/62-T**)**

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** concepts related to cloud computing. (LOTS: Level 1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	1	_
CO2. **Express** deployment models for clouds. (LOTS: Level 2: Understand)	1	1	1	1	1	_	_	_	_	_	_	_	2	_
CO3. **Apply** cloud computing techniques for various applications. (LOTS: Level 3: Apply)	2	2	2	2	2	_	_	_	_	_	_	_	3	_
CO4. **Analyse** cloud computing services used at various levels. (HOTS: Level 4: Analyse)	3	3	2	3	2	_	_	_	_	_	_	_	3	_
CO5. **Compare** different cloud management platform and cloud platforms. (HOTS: Level 5: Evaluate)														
CO6. **Assess** real time cloud services. (HOTS: Level 5: Evaluate)	3	3	3	3	3	2	_	_	_	_	_	2	3	_
Level of Attainments PC/AIML/62-T														

Analysis and Design of Algorithms(PC/AIML/63-T)

General Course Information

Course Code: PC/AIML/63-T Course Credits:3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Knowledge of Data Structure and a Programming Language

About the Course:

This Course focus on effective and efficient design of algorithms. In this course various algorithm design techniques and their analysis is to be studied. After studying this course, a student is expected to apply better techniques for solving computational problems efficiently and prove it analytically.

Course Outcomes: By the end of the course students will be able to:

CO1. **state** terminology and concepts algorithmic techniques. (LOTS: Level 1: Remember)

CO2. **discuss** various algorithmic techniques. (LOTS: Level 2: Understand)

CO3. **apply** appropriate algorithmic techniques to solve computational problems. (LOTS: Level 3: Apply)

CO4. **analyse** algorithms for their efficiency by determining their complexity. (HOTS: Level 4: Analyse)

CO5. **compare** the pros and cons of applying the different algorithmic techniques to solve problems. (HOTS: Level 5: Evaluate)

CO6. **formulate** efficient and effective algorithmic solutions for different real-world problems. (HOTS: Level: 6 Create)

Course content

UNIT I

Algorithms, Algorithms as a technology, Insertion sort, analyzing algorithms, asymptotic notations, Divide and Conquer: General method, binary search, merge sort, quick sort, Strassen‟s matrix multiplication algorithms and analysis of algorithms for these problems.

UNIT II

Sorting and Data Structures: Heapsort, Hash Tables, Red and Black Trees, Greedy Method: General method, knapsack problem, minimum spanning trees, single source paths and analysis of these problems.

UNIT III

Dynamic Programming: General method, matrix chain multiplication, longest common subsequence, optimal binary search trees,

Back Tracking: General method, 8 queen's problem, graph colouring, Hamiltonian cycles, Analysis of these problems.

Unit IV

Branch and Bound: Method, O/I knapsack and traveling salesperson problem,NP Completeness: Polynomial time, NP-completeness and reducibility, NP-complete problems.

Text and Reference Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronalde L. Rivest, Clifford Stein, *Introduction to Algorithms*, MIT press, 3rd Edition, 2009.
2. Ellis Horowitz, Satraj Sahni, Sanguthevar Rajasekaran, *Fundamental of Computer Algorithms*, Galgotia Publication Pvt. Ltd., 1999.
3. S. Dasgupta, C. Papadimitriou, and U. Vazirani, *Algorithms*, McGraw-Hill Higher Education, 2006.

CO-PO Articulation Matrix: Analysis and Design of Algorithms (PC/AIML/63-T**)**

List of Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1. **State** terminology and concepts algorithmic techniques. (LOTS: Level 1: Remember)	1	--	--	--	--	--	--	--	--	--	--	--	2	--
CO2. **Discuss** various algorithmic techniques. (LOTS: Level 2: Understand)	1	--	--	--	--	--	--	--	--	--	--	--	3	--
CO3. **Apply** appropriate algorithmic techniques to solve computational problems. (LOTS: Level 3: Apply)	2	1	1	--	1	--	--	--	--	--	--	--	3	1
CO4. **Analyse** algorithms for their efficiency by determining their complexity. (HOTS: Level 4: Analyse)	3	2	1	--	2	--	--	--	--	--	--	--	3	2
CO5. **Compare** the pros and cons of applying the different algorithmic techniques to solve problems. (HOTS: Level 5: Evaluate)	3	2	1	--	--	--	--	--	--	--	--	--	3	2
CO6. **Formulate** efficient and effective algorithmic solutions for different real- world problems. (HOTS: Level: 6 Create)	3	3	2	2	--	--	--	--	--	--	--	--	3	2
Level of Attainments PC/AIML/63-T														

Fundamentals of Management for Engineers(HSMC/3-T)

General Course Information

Course Code: HSMC/3-T Course Credits: 2 Type: Humanities and Social Sciences including Management Contact Hours: 2 hours/week Mode: Lecture (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: None

About the Course:

Fundamentals of Management for Engineers is a necessary course for B. Tech. (CSE) graduates wishing to work with organizations in their near future. It helps them acquiring managerial, planning and decision-making skills. This course makes students ready to work in teams as well as play leadership roles.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** fundamental concepts of management (LOTS: Level 1: Remember)
CO2. **explain** the basic principles of management related to planning and decision making, HRM and motivation, and leadership. (LOTS: Level 2: Understand)
CO3. **apply** the managerial skills to solve real world management problems. (LOTS: Level 3: Apply)
CO4. **identify** leadership roles in various scenarios. (HOTS: Level 4: Analyse)
CO5. **evaluate** a business model based on principles of management. (HOTS: Level 5: Evaluate)
CO6. **prepare** a plan for a start up in IT sector. (HOTS: Level 6: Create)

Course Content

Unit I

Management Definition: Scope and process of management, Managerial Roles, Levels of

Management, Managerial Skills, Challenges of Management, Evolution of Management, Scientific and Administrative Management, The Behavioural approach, The Quantitative approach, The Systems Approach, Contingency Approach, IT Approach.

Unit II

Planning and Decision Making: General Framework for Planning, Planning Process, Types of plans, Management by objectives, Development of business strategy.

Decision making and Problem Solving: Programmed and Non-Programmed Decisions, Steps in Problem Solving and Decision Making, Bounded Rationality and Influences on Decision Making, Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

Unit III

Organization HRM and Controls: Organizational Design & Organizational Structures, Delegation, Empowerment, Centralization, Decentralization, Organizational culture, Organizational climate and Organizational change, Talent management, Talent management Models and strategic human Resource planning; Recruitment and selection; Training and development, Performance Appraisal. Types of controls and controlling Techniques.

Unit IV

Leading and Motivation: Leadership, Power and authority, Leadership styles; Behavioural leadership, Situational leadership, Leadership skills, Leader as mentor and coach, Leadership during adversity and crisis; Handling employee and customer complaints, Team leadership. Motivation: Types of motivation, Relationship between motivation, performance and engagement, Content motivational theories.

T**ext and Reference Books:**

1. Robert N Lussier, *Management Fundamentals*, 5th edition, Cengage Learning, 2013.
2. Stephen P. Robbins, *Fundamentals of Management*, Pearson Education, 2009.
3. Weihrich Koontz, *Essentials of Management*, fifth edition, Tata Mc Graw Hill, 1990.
4. Dubrin Andrew, *Management Essentials*, 9th edition, Cengage Learning, 2012.

CO-PO Articulation Matrix: Fundamentals of Management for Engineers (HSMC/3-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** fundamental concepts of management (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2. **Explain** the basic principles of management related to planning and decision making, HRM and motivation, and leadership. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3. **Apply** the managerial skills to solve real world management problems. (LOTS: Level 3: Apply)	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO4. **Identify** leadership roles in various scenarios. (HOTS: Level 4: Analyse).	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO5. **Evaluate** business model based on principles of management. (HOTS: Level 5: Evaluate)	2	3	2	-	-	-	-	-	-	-	-	2	-	-
CO6. **Prepare** a plan for start-up in IT sector. (HOTS: Level 5: Create)	3	3	3	2	-	3	-	-	-	3	3	-	-	-
Level of Attainments HSMC/3-T														

Neural Networks Lab.(PC/AIML/61-P)

General Course Information

Course Code: PC/AIML/61-P Course Credits: 1.5 Type: Professional Core Lab. Course Contact Hours: 3 hours / week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/ assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: MATLAB / Python

About the Course:

This course will serve as a comprehensive introduction to various tools used in neural network. This course would help the students to understand the different issues involved in designing and implementing of a Neural Networks.

Course Outcomes: By the end of the course students will be able to:

CO1. **apply** perceptron-based algorithms to solve simple learning problems. (LOTS: Level 3: Apply)

CO2. **solve** binary as well as multi-class classification problems using back propagation neural networks. (LOTS: Level 3: Apply)

CO3. **compare** various neural network solutions for given problems. (LOTS: Level 4: Analyse)

CO4. **judge** the performance of neural network models. (LOTS: Level 5: Evaluate)

CO5. **create** lab record for assignments that includes problem definitions, design of solutions and conclusions. (LOTS: Level 6: Create)

CO6. **demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply).

List of experiments/assignments

List of experiments:

1. Write a program to generate following logic functions using McCulloch-Pitts neuron and appropriate values for weights, bias and threshold.

a. AND logic function

b. OR logic function

c. NOT logic function

d. NOR logic function

e. XOR logic function

2. Write a program to build a logistic regression classifier with a Neural Network.

   Consider the following guidelines.

   a. Consider any convenient dataset (Cats dataset etc.) and pre-process the dataset.

   b. Define the appropriate model structure.

   c. Analyse the obtained results.

   d. Evaluate the model's performance.

3. Design a neural network (NN) model with one hidden layer for classification problems. Use any suitable datasets.

   a. Implement a 2-class classification neural network with a single hidden layer.

   b. Use units with a non-linear activation function, such as tanh.

   c. Compute the cross-entropy loss.

   d. Implement forward and backward propagation.

   e. Evaluate the model's performance.

   f. Analyse the results.

4. Implement a multilayer perceptron (MLP) model for prediction such as house prices.

   a. Perform Exploratory Data Analysis

   b. Prepare datasets.

   c. Build MLP models.

   d. Evaluate Models' performance.

   e. Make predictions for test data.

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix: Neural Networks Lab. (PC/AIML/61-P**)**

List of Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1. **Apply** perceptron-based algorithms to solve simple learning problems. (LOTS: Level 3: Apply)	1	1	_	2	3	_	_	_	_	_	_	_	_	3
CO2. **Solve** binary as well as multi-class classification problems using back propagation neural networks. (LOTS: Level 3: Apply)	2	2	_	2	3	_	_	_	_	_	_	_	_	3
CO3. **Compare** various neural network solutions for given problems. (LOTS: Level 4: Analyse)	3	2	_	2	3	_	_	_	_	_	_	_	_	3
CO4. **Judge** the performance of neural network models. (LOTS: Level 5: Evaluate)	3	3	_	3	3	_	_	_	_	_	_	_	_	3
CO5. **Create** lab record for assignments that includes problem definitions, design of solutions and conclusions. (LOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	_
CO6. **Demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply).	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments PC/AIML/61-P														

Cloud Computing Lab.(PC/AIML/62-P)

General Course Information

Course Code: PC/AIML/62-P Course Credits: 1.5 Type: Professional Core Lab. Course Contact Hours: 3 hours / week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/ assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Basic programming skills and knowledge of Operating System.

About the Course:

This lab course on Cloud Computing helps students to learn how to use cloud services, implement virtualization and task scheduling. The main objective of this course is to help the students to learn the design and development process involved in creating a cloud based application. In addition to this, students also learn how to use the different services provided by cloud platform AWS.

Course Outcomes: By the end of the course students will be able to:

CO1. **outline** the cloud computing with its applications using different architectures. (LOTS: Level 1: Remember)
CO2. **identify** and propose applications which advance the cloud computing. (LOTS: Level 4: Analyse)
CO3. **implement** different workflows according to requirements, apply GAE and CloudSim programming model. (LOTS: Level 3: Apply)
CO4. **develop** applications which advance the cloud computing (AWS). (LOTS: Level 4: Develop)
CO5. **create** lab record for assignments that includes problem definitions, design of solutions and conclusions. (LOTS: Level 6: Create)
CO6. **demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)

List of experiments/assignments

List of Experiments:

1. Install Virtualbox/VMware Workstation with different flavours of linux or windows OS on top of windows.

2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs
3. Install Google App Engine (GAE). Create hello world app and other simple web applications using python.
4. Use GAE launcher to launch the web applications.
5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm.
6. Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version)
7. Create a free tier account in Amazon Web Services (AWS), and run / demonstrate the following services of AWS
    a. Compute
    b. Database
    c. Networking
    d. Machine Learning
    e. Security
    f. Storage
    g. Auto-Scaling
    h. Load Balancing

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix: Cloud Computing Lab. (PC/AIML/62-P**)**

List of Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
CO1. **Outline** the cloud computing with its applications using different architectures. (LOTS: Level 1: Remember)	1	1	_	2	3	_	_	_	_	_	_	_	_	3
CO2. **Identify** and propose applications which advance the cloud computing. (LOTS: Level 4: Analyse)	2	2	_	2	3	_	_	_	_	_	_	_	_	3
CO3. **Implement** different workflows according to requirements and apply GAE and CloudSim programming model. (LOTS: Level 3: Apply)	3	2	_	2	3	_	_	_	_	_	_	_	_	3
CO4. **Develop** applications which advance the cloud computing (AWS). (LOTS: Level 4: Develop)	3	3	_	3	3	_	_	_	_	_	_	_	_	3
CO5. **Create** lab record for assignments that includes problem definitions, design of solutions and conclusions. (LOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	_
CO6. **Demonstrate** use of ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments PC/AIML/62-P														

Minor Project I(EEC/AIML/2)

General Course Information

Course Code: EEC/AIML/2 Course Credits: 2 Mode: Design and development of minor project in lab. No. of hours per week: -04	**Course Assessment Methods (Internal evaluation: 50 marks; External Evaluation marks: 50)** Evaluation is done by the internal examiner, preferably project guide and external examiner appointed by the Chairperson and COE respectively. The criteria for evaluation are given below. 1. Review of literature related to problem domain: 10(In +10(Ex.) 2. Significance and originality of the solution presente 15(In.) +15(Ex.) 3. Significance and Scope of results: 10(In.) +10(Ex.) 4. Organisation and presentation of minor project repo 10(In.) +10(Ex.) 5. Level of Ethics followed: 5(In.) +5(Ex.)

About the minor project:

Students do a minor project using artificial intelligence and machine learning techniques in sixth semester. They are expected to learn any open artificial intelligence and machine learning specific tool/software and develop project that can be completed within sixth semester.

After doing minor project students will be able to

CO1. **identify** a suitable problem from the environment around. (HOTS: Level 4: Analyse)
CO2. **survey** the design of similar problems (HOTS: Level 5: Evaluate)
CO3. **select** suitable engineering specialisation and artificial intelligence and machine learning specific tools. (LOTS: Level 3: Apply)
CO4. **address** the problem in an original and innovative manner. (HOTS: Level 6: Create)
CO5. **communicate** orally as well as in written (minor project report) about the application developed. (HOTS: Level 6: Create)
CO6. **engage** in ethical practices, individual and teamwork, and lifelong learning. (LOTS: Level 3: Apply)

CO-PO Articulation Matrix: Minor Project (EEC/AIML/2**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1. **Identify** a suitable problem from the environment around. (HOTS: Level 4: Analyse)	2	3	_	2	_	3	2	_	_	_	_	_	_	_
CO2. **Survey** the design of similar problems (HOTS: Level 5: Evaluate)	_	3	2	3	_	_	_	_	_	_	_	_	_	_
CO3. **Select** suitable engineering specialisation and artificial intelligence and machine learning specific tools. (LOTS: Level 3: Apply)	_	_	_	_	3	_	_	_	_	_	_	_	_	_
CO4. **Address** the problem in an original and innovative manner. (HOTS: Level 6: Create)	3	3	3	3	_	2	_	_	_	_	_	_	_	_
CO5. **Communicate** orally as well as in written (minor project report) about the application developed. (HOTS: Level 6: Create)	_	_	_	_	_	_	_	_	_	3	_	_	_	_
CO6. **Engage** in ethical practices and lifelong learning. (LOTS: Level 3: Apply)	_	_	_	_	_	_	_	3	3	_	_	3	_	_
Level of Attainments EEC/AIML/2														

Computer Graphics(PE/AIML/61-T)

General Course Information

1. Course Code: PE/AIML/61 -T Course Credits: 3 Type: Professional Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Vector Mathematics, Matrices, Linear Algebra, Programming skills in C/C++ and Data Structures.

About the Course:

This course involves studying graphic techniques, algorithms and imaging models. Moreover, students learn about the techniques for clipping, cropping, representing 2-D and 3-D objects.

Course Outcomes: By the end of the course students will be able to:

CO1. **state** basic concepts related to graphics. (LOTS: Level 1: Remember)
CO2. **describe** the principles of creating graphical objects and graphical user interface applications. (LOTS: Level 2: Understand)
CO3. **apply** 2-D and 3-D transformations (rotation, scaling, translation, shearing) on geometric objects. (LOTS: Level 3: Apply)
CO4. **use** different techniques for clipping and filling geometric objects. (LOTS: Level 3: Apply)
CO5. **compare** different graphics algorithms for different geometric objects. (HOTS: Level 4: Analyse)
CO6. **create** user-friendly interfaces for computer applications. (HOTS: Level 6: Create)

Course Content

Unit I

Introduction to Computer Graphics: What is Computer Graphics, Computer Graphics Applications, Computer Graphics Hardware and software, Two dimensional Graphics Primitives: Points and Lines, Line drawing algorithms: DDA, Bresenham's; Circle drawing algorithms: Using polar coordinates, Bresenham's circle drawing, mid-point circle drawing algorithm; Filled area algorithms: Scan-line: Polygon filling algorithm, boundary filled algorithm.

Unit II

Two/Three Dimensional Viewing: The 2-D viewing pipeline, windows, viewports, window to view port mapping; Clipping: point, clipping line (algorithms): 4 bit code algorithm, Sutherland-cohen algorithm, parametric line clipping algorithm (Cyrus Beck). Polygon clipping algorithm: Sutherland-Hodgeman polygon clipping algorithm.

Two dimensional transformations: transformations, translation, scaling, rotation, reflection, composite transformation.

Three dimensional transformations: Three-dimensional graphics concept, Matrix representation of 3-D Transformations, Composition of 3-D transformation.

Unit III

Viewing in 3D: Projections, types of projections, the mathematics of planner geometric projections, coordinate systems.

Hidden surface removal: Introduction to hidden surface removal, Z- buffer algorithm, scanline algorithm, area sub-division algorithm.

Unit IV

Representing Curves and Surfaces: Parametric representation of curves: Bezier curves, B-Spline curves. Parametric representation of surfaces; Interpolation method.

Illumination, shading, image manipulation: Illumination models, shading models for polygons, shadows, transparency. What is an image? Filtering, image processing, geometric transformation of images.

Text and reference books:

1. James D. Foley, Andeies van Dam, Stevan K. Feiner and Johb F. Hughes, *Computer Graphics Principles and Practices*, second edition, Addision Wesley, 2000.
2. Pradeep K Bhatia, *Computer Graphics*, 3rd edition, I K International Pub, New Delhi, 2013.
3. Donald Hearn and M. Pauline Baker, *Computer Graphics* 2nd Edition, PHI, 1999.
4. David F. Rogers, *Procedural Elements for Computer Graphics* Second Edition, T.M.H, 2001.

5. Alan Watt, *Fundamentals of 3Dimensional Computer Graphics*, Addision Wesley, 1999.
6. Corrign John, *Computer Graphics: Secrets and Solutions*, BPB, 1994.
7. Pilania & Mahendra, *Graphics, GUI, Games & Multimedia Projects in C*, Standard Pub., 2002.
8. N. Krishanmurthy, *Introduction to Computer Graphics*, T.M.H, 2002.

CO-PO Articulation Matrix: Computer Graphics (PE/AIML/61 -T**)**

List of Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1. **State** basic concepts related to graphics. (LOTS: Level 1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	2	_
CO2. **Describe** the principles of creating graphical objects and graphical user interface applications. (LOTS: Level 2: Understand)	1	_	_	_	_	_	_	_	_	_	_	_	3	_
CO3. **Apply** 2-D and 3-D transformations (rotation, scaling, translation, shearing) on geometric objects. (LOTS: Level 3: Apply)	2	1	_	_	2	_	_	_	_	_	_	_	3	_
CO4. **Use** different techniques for clipping and filling geometric objects. (LOTS: Level 3: Apply)	2	1	_	_	2	_	_	_	_	_	_	_	3	_
CO5. **Compare** different graphics algorithms for different geometric objects. (HOTS: Level 4: Analyse)	-	2	2	2	1	_	_	_	_	_	_	_	3	_
CO6. **Create** user-friendly interfaces for computer applications. (HOTS: Level 6: Create)	1	2	2	_	3	_	_	_	_	_	-	_	3	_
1. Level of Attainments PE/AIML/61 -T			**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**

Internet of Things(PE/AIML/62-T)

General Course Information

1. Course Code:PE/AIML/62 -T Course Credits: 3 Type: Professional Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Fundamentals of Computer Networks

About the Course:

The field of Internet of Things is growing very fast. The purpose of this course is to impart the knowledge on basic concepts of IoT, its Architecture, various protocols and applications in real world scenarios.

Course Outcomes: By the end of the course students will be able to:

CO1. **state** the basic concepts and key technologies of IoT. (LOTS: Level 1: Remember)
CO2. **discuss** the pros and cons of various protocols for IoT. (LOTS: Level 2: Understand)
CO3. **apply** the IOT models for business applications. (LOTS: Level 3: Apply)
CO4. **analyse** applications of IoT in real time scenario. (HOTS: Level 4: Analyse)
CO5. **design** business model scenarios (HOTS: Level 6: Create)

Course content

Unit I

What is the Internet of Things: History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks : IoT Definitions, IoT Architecture, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities, Basics Of Microcontroller, Microprocessor Vs Microcontroller, Types of Sensor, Actuators and their Applications.

Unit II

Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture, Key IoT Technologies, Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology-Introduction, Principle of RFID, Components of an RFID system, Issues, Satellite Technology.

Unit III

IoT Access Technologies: Physical and MAC layers, Topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT.

Unit IV

Business Models and Business Model Innovation, Value Creation in the Internet of Things, Business Model Scenarios for the Internet of Things. Internet of Things Applications: Smart Metering Advanced Metering Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Smart Transportation and Smart Shopping.

T**ext and Reference Books:**

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, *IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*, Cisco Press, 1st Edition, 2017.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, *The Internet of Things – Key applications and Protocols*, Wiley, 2nd Edition, 2012.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), *Architecting the Internet of Things*, 1st Edition, Springer, 2011.
4. Michael Margolis, Arduino Cookbook, "*Recipes to Begin, Expand, and Enhance Your Projects*", 2nd Edition, O'Reilly Media, 2011.
5. Arshdeep Bahga, Vijay Madisetti, *Internet of Things – A hands-on approach*, 1st Edition, Universities Press, 2015.

CO-PO Articulation Matrix: Internet of Things (PE/AIML/62 -T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO1**	**PSO2**
CO1. **State** the basic concepts and key technologies of IoT. (LOTS: Level 1: Remember)	1	_	_	2	_	_	_	_	_	_	_	_	_	2
CO2. **Discuss** the pros and cons of various protocols for IoT. (LOTS: Level 2: Understand)	1	_	_	3	_	_	_	_	_	_	_	_	_	3
CO3. **Apply** the IOT models for business applications. (LOTS: Level 3: Apply)	2	2	2	3	3	_	_	_	_	_	_	_	2	3
CO4. **Analyse** applications of IoT in real time scenario. (HOTS: Level 4: Analyse)	3	3	2	_	3	_	_	_	_	_	_	_	2	3
CO5. **Design** business model scenarios (HOTS: Level 6: Create)	3	3	2	_	3	_	_	_	_	_	_	_	_3	3
Level of Attainments PE/AIML/62 -T														

Bio-informatics(PE/AIML/63-T)

General Course Information:

Course Code: PE/AIML/63 -T Course Credits: 3 Type:Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: None

About the Course:

The scope of Bio-informatics is growing rapidly. Analysing data related to bio-informatics is not possible without computational skills. This course is designed to impart fundamental knowledge of bio-informatic which would enable students to understand the intricacies of Bioinformatics. The students will learn about the characteristic of bio-informatic data and the tools for analysis of such data.

Course Outcomes: By the end of the course students will be able to:

CO1. **list** the applications of bioinformatics and biological databases. (LOTS: Level 1: Remember)
CO2. **explain** storage and retrieval of biological data from various biological databases. (LOTS: Level 2: Understand)
CO3. **apply** the knowledge of bioinformatics concepts. (LOTS: Level 3: Apply)
CO4. **identify** challenges in bioinformatics and computational biology. (HOTS: Level 4: Analyse)
CO5. **compare and contrast** various algorithms for sequence alignment and scoring algorithms. (HOTS: Level 5: Evaluate)
CO6. **devise** schemes for addressing bioinformatics problems. (LOTS: Level 6: Create)

Course content

Unit I

Bioinformatics: Introduction to Bioinformatics, Scope, Overview of molecular biology & genetics, Nucleic acid; structure & function, Protein structure & function; DNA Replication, Transcription, Translations, Genetic code, Codon Bias, Molecular Biology Techniques used in Bioinformatics.

Computer applications in molecular biology, Protein domains and human genome analysis program (BLAST, FASTA etc.). Search and retrieval of biological information and databases sequence, databank (NCBI)

Unit II

Sequence Alignment

Pairwise Sequence Alignment: Evolutionary Basis, Sequence Homology versus Sequence Similarity, Sequence Similarity versus Sequence Identity, Methods, Scoring Matrices, Statistical Significance of Sequence Alignment

Database Similarity Searching: Unique Requirements of Database Searching, Heuristic Database Searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with the Smith–Waterman Method.

Unit III

Multiple Sequence Alignment: Scoring Function, Exhaustive Algorithms, Heuristic Algorithms, Practical Issues.

Profiles and Hidden Markov Models: Position-Specific Scoring Matrices, Profiles, Markov Model and Hidden Markov Model.

Protein Motifs and Domain Prediction: Identification of Motifs and Domains in Multiple Sequence Alignment, Motif and Domain Databases Using Regular Expressions, Motif and Domain Databases Using Statistical Models, Protein Family Databases, Motif Discovery in Unaligned Sequences, Sequence Logos**.**

Unit IV

Molecular Phylogenetics

Phylogenetics Basics: Molecular Evolution and Molecular Phylogenetics, Terminology, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation, Procedure.

Phylogenetic Tree Construction Methods and Programs: Distance-Based Methods, Character-Based Methods, Phylogenetic Tree Evaluation, Phylogenetic Programs

Text and References Books:

1. T K Attwood and D J Parry Smith, *Introduction to Bioinformatics*, Pearson Education Asia, Singapore, 2001.
2. Sensen, C.W., *Essentials of Genomics and Bioinformatics*, John Wiley and Sons, 2002

3. Attwood, T. and Pary-Smith, D., *Introduction to Bioinformatics*, Prentice Hall, 1999
4. Baxevanis, A.D. and Ouellette, B.F.F., *Bioinformatics: A Practical Guide to the Analysis of genes and Protein*, Wiley- Interscience, 2001
5. Stuart M. Brown, *Bioinformatics: A Biologists Guide to Computing and the Internet*, NKU MedicalCentre, NY USA, 2000.

CO-PO Articulation Matrix: Bio-informatics (PE/AIML/63 -T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1. **List** the applications of bioinformatics and biological databases. (LOTS: Level 1: Remember)	1	_	_	_	_	_	_	_	_	_	_	_	_	2
CO2. **Explain** storage and retrieval of biological data from various biological databases. (LOTS: Level 2: Understand)	1	_	_	_	_	_	_	_	_	_	_	_	_	3
CO3. **Apply** the knowledge of bioinformatics concepts. (LOTS: Level 3: Apply)	2	_	_	_	_	_	_	_	_	_	_	_	_	3
CO4. **Identify** challenges in bioinformatics and computational biology. (HOTS: Level 4: Analyse)	_	2	_	_	_	_	_	_	_	_	_	_	_	3
CO5. **Compare and contrast** various algorithms for sequence alignment and scoring algorithms. (HOTS: Level 5: Evaluate)	2	3	2	_	2	_	_	_	_	_	_	_	_	3
CO6. **Devise** schemes for addressing bioinformatics problems. (LOTS: Level 6: Create)	3	3	2	3	2	_	_	_	_	_	_	_	_	3
Level of Attainments PE/AIML/63 -T														

Information Retrieval Systems(PE/AIML/64-T)

General Course Information:

Course Code: PE/AIML/64 -T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Data Structures, Data Base Management Systems

About the Course:

This course would enable the students to understand the various aspects of an information retrieval system and its evaluation and to be able to design. The main aim of this course is to give students an understanding about data/file structures that are necessary to design, and implement information retrieval (IR) systems, IR principles to locate relevant information large collections of data, different document clustering algorithms, information retrieval systems for web search tasks etc.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** the information retrieval system and its objectives along with various capabilities. (LOTS: Level 1: Remember)
CO2. **understand** to apply IR principles to locate relevant information from large collections of data using various indexing process and data structures. [Understand] (LOTS: Level 2: Understand)
CO3. **implement** to design different document clustering algorithms. (LOTS: Level 3: Apply)
CO4. **analyze** different retrieval systems for text search. (HOTS: Level 4: Analyse)
CO5. **compare** various algorithms and systems for information retrieval. (HOTS: Level 5: Evaluate)
CO6. **investigate** various information retrieval systems which falls under Multimedia retrieval systems. (LOTS: Level 6: Create)

Course content

Unit I

Introduction to Information Retrieval Systems: Definition of Information Retrieval System, Objectives of Information Retrieval Systems, Functional Overview, Relationship to Database Management Systems, Digital Libraries and Data Warehouses. Information Retrieval System Capabilities: Search Capabilities, Browse Capabilities, Miscellaneous Capabilities.

Unit II

Cataloging and Indexing: History and Objectives of Indexing, Indexing Process, Automatic Indexing, Information Extraction. Data Structure: Introduction to Data Structure, Stemming Algorithms, Inverted File Structure, N-Gram Data Structures, PAT Data Structure, Signature File Structure, Hypertext and XML Data Structures, Hidden Markov Models.

Unit III

Automatic Indexing: Classes of Automatic Indexing, Statistical Indexing, Natural Language, Concept Indexing, Hypertext Linkages. Document and Term Clustering: Introduction to Clustering, Thesaurus Generation, Item Clustering, Hierarchy of Clusters.

User Search Techniques: Search Statements and Binding, Similarity Measures and Ranking, Relevance Feedback, Selective Dissemination of Information Search, Weighted Searches of Boolean Systems, Searching the INTERNET and Hypertext.

Unit IV

Information Visualization: Introduction to Information Visualization, Cognition and Perception, Information Visualization Technologies.

Text Search Algorithms: Introduction to Text Search Techniques, Software Text Search Algorithms, Hardware Text Search Systems. Multimedia Information Retrieval: Spoken Language Audio Retrieval, Non-Speech Audio Retrieval, Graph Retrieval, Imagery Retrieval, Video Retrieval.

Text and References Books:

1. Kowalski & Maybury, *Information storage and retrieval systems: theory and implementation* (Vol. 8). Springer Science & Business Media, 2002.
2. Frakes & Baeza-Yates (Eds)., Information *retrieval: data structures and algorithms*. Prentice-Hall, Inc., 1992.
3. Korfhage, *Information Retrieval and Storage*, John Wiley & Sons, 1997
4. Baeza-Yates & Ribeiro-Neto (1999), *Modern information retrieval* (Vol. 463), New York: ACM press, 1999.

CO-PO Articulation Matrix: Information Retrieval Systems (PE/AIML/64 -T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1. **Define** the Information retrieval system and its objectives along with various capabilities. (LOTS: Level 1: Remember)	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2. **Understand** to apply IR principles to locate relevant information from large collections of data using various indexing process and data structures. (LOTS: Level 2: Understand)	1	-	-	1	-	-	-	-	-	-	-	-	-	3
CO3. **Implement** to design different document clustering algorithms. (LOTS: Level 3: Apply)	2	-	1	2	-	-	-	-	-	-	-	-	-	3
CO4. **Analyze** different retrieval systems for text search. (HOTS: Level 4: Analyse)	3	1	2	2	-	-	-	-	-	-	-	-	-	3
CO5. **Compare** various algorithms and systems for information retrieval. (HOTS: Level 5: Evaluate)	3	2	2	3	-	-	-	-	-	-	-	-	-	3
CO6. **Investigate** various information retrieval systems which falls under Multimedia retrieval systems. (LOTS: Level 6: Create)	3	3	3	3	-	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/64 –T														

Microprocessor and Embedded Systems(PE/AIML/65-T)

General Course Information:

Course Code: PE/AIML/65 -T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Computer Architecture and Organization

About the Course:

A microprocessor incorporates the functions of a central processing unit (CPU) on a single integrated circuit. The advent of microprocessors and their increased capacity made them to be used in everything be it a smallest embedded system or handheld device, or the largest mainframe and supercomputer. It is being used in variety of applications such as process control systems, security systems, household appliances, and mobile phone technologies. An embedded system is a self-contained unit that have a dedicated purpose within a device. This course aims to provide a strong foundation about the principles, programming and various applications of different microprocessors and microcontrollers. This course also helps the students to build new-age technological solutions with the embedded systems.

Course Outcomes: By the end of the course students will be able to:

CO1. **outline** the architecture of 8085 and 8086 Microprocessor. (LOTS: Level 1: Remember)
CO2. **discuss** the principles of embedded systems and their applications. (LOTS: Level 2: Understand)
CO3. **describe** the general procedure of IO and memory interfacing (LOTS: Level 2: Understand)
CO4. **apply** the principles of embedded design for problem solving. (LOTS: Level 3: Apply)
CO5. **compare** and contrast the working of 8085 and 8086 microprocessors. (HOTS: Level 5: Evaluate)
CO6. **develop** new-age technological solutions with the embedded systems. (HOTS: Level 6: Create)

Course content

Unit - I

Internal architecture of 8085 microprocessor –Instruction set - Addressing modes – Classification of instructions. Assembly language programming –standard programs in assembly language – code conversion, sorting – binary and BCD arithmetic

16-bit microprocessor- 8086 architecture, registers, memory segmentation and addressing, 32-bit/64-bit microprocessor families (Only architecture)

Unit - II

Stack and Subroutines – CALL and RETURN instructions – Delay subroutines. Timing and control – Machine cycles, instruction cycle and T states – fetch and execute cycles – Timing diagram for instructions.

IO and memory interfacing – Address decoding– interrupt structure of 8085. I/O ports-Programmable peripheral interface PPI 8255 - Modes of operation. Interfacing of LEDs, ADC and DAC with 8085.

Unit - III

Introduction to Embedded Systems-Application domain of embedded systems, features and characteristics, System model, Microprocessor Vs Microcontroller, current trends and challenges, hard and soft real time systems, Embedded product development, Life Cycle Management (water fall model), Tool Chain System,

Introduction to Real-time operating systems (RTOS) -RTOS and Scheduling, Operating basics, types, RTOS, tasks, process and threads, multiprocessing and multitasking, types of multitasking, non-preemptive, preemptive scheduling.

Unit - IV

8051- Microcontrollers Hardware: Microcontroller Architecture: IO Port structure, Register organization, general purpose RAM, Bit Addressable RAM, Special Function Registers (SFRs). Instruction Set, addressing modes Instruction Types.

Interfacing – LCD, ADC, Stepper motor, and DAC.

Text and References Books:

1. Gaonkar R., *Microprocessor, Architecture, Programming and Applications*, Penram International Publishing; Sixth edition, 2014.
2. Mathur A., *Introduction to Microprocessors*, Tata McGraw Hill, New Delhi, 1992.
3. Brey B. B., *The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit Extensions*, 8th Edition, Pearson Education, 2008
4. Hall D.V., *Microprocessors and Interfacing*, Tata McGraw Hill, Education, New Delhi, Third Edition.

5. Rafiquzzaman, *Microprocessor Theory and Application*, PHI Learning, First Edition.
6. Ajoy R. and Burchandi, *Advanced Microprocessor & Peripherals*, Tata McGraw Hill, Education, New Delhi, Second Edition.
7. Mazidi M. A. and Mazidi J. G., *The 8051 microcontroller and embedded systems using Assembly and C*,second edition, Pearson education /Prentice Hall of India, 2004
8. MacKenzie S., and Raphael C W Phan, The *8051 Microcontroller*, Fourth Edition, Pearson education
9. Daniele Lacamera, *Embedded Systems Architecture*, Packt Publishing, May 2018, ISBN: 9781788832502.
10. Raj Kamal, *Embedded Systems*, TMH, 2004.
11. Wayne Wolf, *Computers as components: Principles of Embedded Computing System Design*, Morgan Kaufman Publication, 2000.
12. Tim Wilmshurst, *The Design of Small-Scale embedded systems*, Palgrave, 2003.
13. Marwedel, Peter, *Embedded System Design*, Kluwer Publishers, 2004.

CO-PO Articulation Matrix: Microprocessor and Embedded Systems (PE/AIML/65 -T**)**

List of Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1. **Outline** the architecture of 8085 and 8086 Microprocessor. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2. **Discuss** the principles of embedded systems and their applications. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Describe** the general procedure of IO and memory interfacing (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO4. **Apply** the principles of embedded design for problem solving. (LOTS: Level 3: Apply)	2	1	1	1	-	-	-	-	-	-	-	-	3	-
CO5. **Compare** and contrast the working of 8085 and 8086 microprocessors. (HOTS: Level 5: Evaluate)	3	2	2	2	-	-	-	-	-	-	-	-	3	-
CO6. **Develop** the programs in assembly language and in C language for embedded applications. (HOTS: Level 6: Create)	3	3	3	2	-	-	-	-	-	-	-	-	3	-
Level of Attainments PE/AIML/65 –T														

B.Tech. AI & ML VII & VIII Semester

Semester	Basic Sciences' Courses BSC		Engineering Sciences'/Programme Core/Programme Elective/Open Elective Courses ESC/PC/PE/OE		Humanities, Social Sciences, Management Courses HSMC		Mandatory Courses MC		IndustrialTrainimng(EEC/AIML-)		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
5th	00	0	06	17	00	00	00	00	02	06	23
6th	00	00	04	11	00	00	00	00	01	06	17

Courses' codes, titles, and credits (Semester- VII)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/71-T	Deep Learning	3/3	-/-	-/-	3/3
2	PC/AIML/72-T	Cryptography and Network Security	3/3	-/-	-/-	3/3
3	PE/AIML/71-T to PE/AIML/74-T	Programm Elective Course to be opted by students **Elective II**	3/3	-/-	-/-	3/3
4	PE/AIML/75-T to PE/AIML/79-T	Programm Elective Course to be opted by students **Elective III**	3/3	-/-	-/-	3/3
5	OE-III	Open Elective Course be opted by students from another department	3/3	-/-	-/-	3/3
6	PC/AIML/71-P	Deep Learning Tools Lab. (Python Packages, Tensor Flow, Keras, Google Colab etc.)	-/-	-/-	4/2	4/2
7	EEC/AIML/71-P	*Major Project Part I	-/-	-/-	8/4	8/4
8	EEC/AIML/72-P	**A mini project /Training based on open source tool	-/-	-/-	4/2	4/2
					Total Credit	31/23

*******The students will have to prepare and submit a mini project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty duringVIIsemester.

List of Programme Electives II

5. PE/AIML/71-T: Wireless and Mobile Communication
6. PE/AIML/72-T: Compiler Design
7. PE/AIML/73-T:Data Visualization Techniques
8. PE/AIML/74-T: Software Defined Networks

List of Programme Elective III

6. PE/AIML/75-T: Digital Image Processing
7. PE/AIML/76-T: Reinforcement Learning
8. PE/AIML/77-T: Edge and Fog Computing
9. PE/AIML/78-T: Natural Language Processing
10. PE/AIML/79-T: Cognitive Systems

Courses' codes, titles, and credits (Semester- VIII)

#	Course Code	Course Title	Workload/Credit			
			Theory	Tutorial	Practical	Total
1	PC/AIML/ 81-T	Big Data Analytics	3/3	-/-	-/-	3/3
2	PE/AIML/81-T to PE/AIML/84-T	Programm Elective Course to be opted by students **Elective IV**	3/3	-/-	-/-	3/3
3	PE/AIML/85-T to PE/AIML/89-T	Programm Elective Course to be opted by students **Elective V**	3/3	-/-	-/-	3/3
4	PC/AIML/ 81-P	Big Data Analytics Lab	-/-	-/-	4/2	4/2
5	EEC/AIML/81-P	*Major Project Part II	-/-	-/-	12/6	12/6
					Total Credit	25/17

*Major Project Part II will be evaluated by internal examiner and external examiner appointed by Chairperson and COE respectively.

List of Programm Elective I

5. PE/AIML/81-T:Digital Forensics
6. PE/AIML/82-T: Social Network Analysis
7. PE/AIML/83-T: Computer Vision
8. PE/AIML/84-T: Pattern Recognition

List of Programm Elective V

6. PE/AIML/85-T: Quantum Computing
7. PE/AIML/86-T : Optimization Methods
8. PE/AIML/87-T: Blockchain Technology
9. PE/AIML/88-T: Introduction to Augmented and Virtual Reality
10. PE/AIML/89-T: Federated Learning

Policy Document for providing exemptions in attendance to the B.Tech. students of the University for undertaking various internships/trainings during their final/penultimate semester

1. Background:

It has been realized that the students pursuing B. Tech.programmes offered by the University/affiliated Institutes/Colleges are facing challenges as under:

1. Students selected in industry during their programme are asked to join the industry for internship/training of duration upto one semester.
2. The provision is not there in these programmes to allow the students to join the internship by way of getting the required attendance of semester from internship/training.
3. So, students are not able to join such internship/training consequential to two-fold loss:
   (a) Job opportunity.
   (b) Skill development in industry environment.

But, presently, in the B. Tech. Programmes run by the University, there is no provision for the students to join the industry for such internship/training of/for more than 6–8-week duration. To facilitate the students for joining longer duration internships/trainings, a need for framing a policydocument was felt.

Keeping in view the above challenges/statutory position and to avoid hardship to students and to improve the employability of the students, Ch. Devi Lal University, Sirsa has framed a policy to accord exemptions in attendance to students undertaking various internships/trainings during their final/penultimate semester of the B. Tech. Programmes.

2. Applicability of the policy with following Provisions:

The policy is applicable to the students studying in the final semester/ penultimate semester of B. Tech.programmes.

2.1 Provisions:

Student covered as per section title 'Applicability of the Policy' will be governed by the following provisions:

1. The student will be allowed to join the organization for internship/training in the final semester/ penultimate semester of the course for a period of up to one semester only if he/she must be passed/ cleared in all courses/subjects in all the semester examination whose results have been declared.
2. The student will earn his attendance from the organization during the period of internship.
3. Attendance will be certified by the organization, failing which student will be debarred from appearing in the University examinations of that semester.
4. The student will have to give an undertaking that he/she will appear in all the internal/external examination/practical as per requirements of the Programme and as per Schedule of the University examination for that programme. For this he/she will have to do the necessary preparation by himself/herself and Institute/department will not be responsible for the same.
5. If the student is selected in a company/industry/organization etc., and is asked to join the organization in the finalsemester/ penultimate semester for a period of upto one semester; then formally constituted Internship Facilitation Committee (IFC) will examine and give its recommendation as deemed fit.

2.2 Composition of Internship Facilitation Committee (IFC):

The composition of IFC will be as under:

1. Dean,Faculty of Engg. & Tech./Director/ Principal (or Nominee)(Chairperson)
2. Chairperson/Head/ In-charge of the concerned Department/Branch(Member)
3. In-Charge Academic Branch/Academic In-charge of Institute (Member)
4. Senior most faculty of the department other than Chairperson/ Director/Head of the Department/Branch (Member)
5. Training and Placement officer/ In-Charge TPO of the Institute /College/Department (Member Secretary)

Any offer by the organisations providing internship on demanding charges from a student will be discouraged by the Internship Facilitation Committee (IFC). Member Secretary of the IFC will schedule the meeting and maintain all the records.

3. Conclusion:

The students can only be allowed to join the internship/training incompany/industry/organizationetc. with exemptions in attendance on the final recommendation of Internship Facilitation Committee (IFC) of the Institute /Department and permission given by the Department/Institute/College authority.

DETAILED SYLLABUS OF VII SEMESTER

Deep Learning

General Course Information

Course Code: PC/AIML/71-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Linear Algebra, probability and information theory and machine learning

About the Course:

Deep learning has revolutionised the field of machine learning. Deep learning emphasises on learning complex, hierarchical feature representation from raw data. Deep learning algorithms have found tremendous amount of applications in machine learning applications. The course covers fundamental principles of deep learning and elaborates on building and optimizing these highly parameterized models. It involves learning about convolutional neural networks, recurrent and generative adaptive neural network models.

Course Outcomes: By the end of the course students will be able to:

CO1. **state** the basic and fundamental terms and concepts in deep learning.(LOTS: Level 1: Remember)

CO2. **demonstrate** the understanding of deep learning principals involving architecture, regularization and optimization, of neural nets, CNN, RNN and autoencoders (LOTS: Level 2: Understand)

CO3. **solve** problemspertaining machine learning involving deep learning solutions. (LOTS: Level 3: Apply)

CO4. **compare** various neural network architectures. (HOTS: Level 4: Analyse)

CO5. **evaluate** the performance and challenges for deep learning algorithms. (HOTS: Level 5: Evaluated)

CO6. **devise** new deep learning architectures, optimization techniques and algorithms. (HOTS: Level 6: Create)

Course contents

Unit I

Review of Machine Learning: Learning algorithms, Overfitting and Underfitting, Hyperparameters and validation set, Estimating bias and variance, Maximum likelihood estimation, Bayesian Statistics, Stochastic gradient descent, Building a machine learning algorithm, Challenges and motivation for deep learning.

Deep Feedforward Networks: Learning XOR, Gradient-based learning, Hidden units, Backpropagation and other differentiation algorithms.

Unit II

Regularization for Deep Learning: Parameter norm Penalties, Norm penalties as constrained Optimization, Regularization and under-constrained problems, Dataset augmentation, Noise robustness, Semi-supervised learning, Multi-task learning, Early stopping, Adversarial training.

Optimization for Training Deep Models: How learning differs from pure optimization, Challenges in neural network optimization, Basic algorithms for neural network optimization, Parameter initialization strategies, Algorithm with Adaptive Learning Rule, Optimization Strategies and Meta-algorithms.

Unit III

Convolutional Networks: The convolution operation, Motivation, Pooling, Convolution and pooling as an infinitely strong prior, Variants of basic convolution functions, Structured outputs and Data types, Efficient convolution algorithms.

Recurrent Networks: Recurrent neural networks, Bidirectional RNNs, Encoder-Decoder sequence to sequence architectures, Deep recurrent networks, Recursive Neural Networks, The challenge of long term dependencies, The Long Short-Term Memory RNNs.

Unit IV

Autoencoders: Undercomplete autoencoders, Regularized autoencoders, Representational power, layer size and depth, stochastic encoders and decoders, Denoising autoencoders, Applications of autoencoders.

Deep Generative Models: Boltzmann Machines, Restricted Boltzmann machines, Deep belief networks, Deep Boltzmann machines, Boltzmann machine for real-valued data, Convolutional Boltzmann machine.

Text and References Books

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, *Deep Learning*, MIT press, 2017.
2. Charu C Aggarwal, *Neural Networks and Deep Learning: A text book*, Springer, 2018.
3. John D. Kelleher, Deep Learning, MIT press, 2019.
4. NithinBuduma, Nikhil Buduma and Joe Papa, Fundamentals of Deep Learning: Designing Next-Generation Machine Learning Algorithms, Second Edition, O'reilly, 2022.
5. Francois Chollet, Deep Learning with Python, Manning Publications, 2018.

CO-PO Articulation Matrix: Deep Learning (Course Code: PC/AIML/71-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **State** the basic and fundamental terms and concepts in deep learning. (LOTS: Level 1: Remember)	1	1	-	-	-	-	-	-	-	-	-	-	-	3
CO2. **Demonstrate** the understanding of deep learning principals involving architecture, regularization and optimization, of neural nets, CNN, RNN and autoencoders. (LOTS: Level 2: Understand)	2	2	-	1	-	-	-	-	-	-	-	-	-	3
CO3. **Solve problems** pertaining machine learning involving deep learning solutions. (LOTS: Level 3: Apply)	3	3	-	2	1	-	-	-	-	-	-	-	1	3
CO4. **Compare** various neural network architectures. (HOTS: Level 4: Analyse)	3	3	-	3	2	-	-	-	-	-	-	-	2	3
CO5. **Evaluate** the performance and challenges for deep learning algorithms. (HOTS: Level 5: Evaluated)	3	3	-	3	3	-	-	-	-	-	-	-	2	3
CO6. **Devise** new deep learning architectures, optimization techniques and algorithms. (HOTS: Level 6: Create)	3	3	-	3	3	-	-	-	-	-	-	-	2	3
Level of Attainments Course Code: PC/AIML/71-T														

Cryptography and Network Security

General Course Information

Course Code: Course Code: PC/AIML/72-T Course Credits: 3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic knowledge of Number systems, Complexity Theory, Computer Networks.

About the Course:

The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis. This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms.

Course Outcomes: By the end of the course students will be able to:

CO1. **describe** various cryptography terminology and cryptographic Algorithms.(LOTS: Level 1: Remember)

CO2. **represent** security in terms of various techniques and algorithms. (LOTS: Level2: Understand)

CO3. **apply** mathematical techniques to cryptography for solving problems related to security issue. (LOTS: Level 3: Apply)

CO4. **identify** various types of attacks for their mitigation/proactive and reactive treatment. (HOTS: Level 4: Analyze)

CO5. **judge** the security of an organization/institute by means of network security devices/models/controls. (HOTS: Level 5: Evaluate)

CO6. **integrate** different types of securities under one environment and evaluate its performance.(HOTS: Level 6: Create)

Course Contents

Unit I

Computer & Network Security Concepts: Overview; Security Goals; Threats, Attacks, & Assets; Vulnerabilities; Security Functional Requirements; Security Services; Security Mechanism; Secure Communications; Model for Network Security; The OSI Security Architecture.

Cryptographic Tools: Symmetric and Asymmetric Key Ciphers; Classical Encryption Techniques; Symmetric Ciphers: Confidentiality with Symmetric Encryption; One-Time Pads; User Authentication Methods; Block Cipher and Data Encryption Standard; Advanced Encryption Standard; RC2, RC4, RC5 & RC6; Block Cipher Operation; Random and Pseudo Random Numbers.

Unit II

Asymmetric Ciphers: Public Key Cryptography and RSA; Diffie-Hellman Key Exchange; Elliptic Curve Cryptography.

Cryptographic Data integrity: Cryptographic Hash Functions and Applications; Message Authentication Codes; Digital signatures & Schemes; Hashing & Signing; Message Digests; Digital Signature Standard; Birthday attacks on Signatures.

Key Management and Distribution: Symmetric Key Distribution using Symmetric Encryption & Asymmetric Encryption; Distribution of Public Keys; X.509 Certificates; Public Key Infrastructure.

Unit III

User Authentication Protocols: Remote User Authentication Principles; Remote User Authentication using Symmetric & Asymmetric Encryption; Kerberos.

Network Security: Threats & Attacks; Denial-of Service; Distributed Denial-of-Service; Cryptography in Network Security: Network & Browser Encryption, Onion Routing, IP Security protocol Suite (IPSec), Virtual Private Networks; Firewalls: Design & Types, Personal Firewalls, Network Address Translation (NAT); Intrusion Detection and Prevention Systems.

IP Security: Overview; IP Security Policy; Encapsulating Security Payload; Combining Security Associations; Internet Key Exchange.

Unit IV

Transport-Level Security: Web Security: Issues & Threats; Secure Naming; Secure Socket layer (SSL); Transport Layer Security (TLS); HTTPS; Secure Shell(SSH).

Wireless Network Security: Vulnerabilities in Wireless Networks; IEEE 802.11 Wireless LAN Securities; Wireless Application Protocol Overview; Wireless Transport Layer Security; WEP & WPA.

Electronic-mail Security: E-Mail Attacks; Pretty Good Privacy (PGP); Privacy Enhanced Mail (PEM); S/MIME; DomainKeys Identified Mail (DKIM).

Text and Reference Books and Links:

1. William Stallings, *Cryptography and Network security-Principles and Practices*, Pearson Education, Ninth Indian Reprint 2005.
2. Charlie Kaufman , *Network Security : Private communication in Public World*, Prentice-Hall International, Inc. April 2008.
3. Roberta Bragg, Mark Rhodes-Ousley, Keith Strassberg, *The Complete Reference Network Security*, McGraw hill Education, 2004.
4. Charles P. Fleeger, *Security in Computing*, 2nd Edition, Prentice Hall International Inc., 1996.
5. Atul Kahate, *Cryptography and Network Security*, McGraw Hill Education; Third edition, 2017

CO-PO Articulation Matrix:Cryptography and Network SecurityCourse (Course Code: PC/AIML/72-T)														
List of Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1. **Describe** cryptography terminology and cryptographic Algorithms.(LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2. **Represent** security in terms of various techniques and algorithms. (LOTS: Level2: Understand)	2	1	-	-	-	-	-	-	-	-	-	-	1	2
CO3. **Apply** mathematical techniques to cryptography for solving problems related to security issue. (LOTS: Level 3: Apply)	3	2	1	1	-	-	-	-	-	-	-	-	2	3
CO4. **Identify** various types of attacks for their mitigation/proactive and reactive treatment. (HOTS: Level 4: Analyze)	3	2	2	2	-	-	-	-	-	-	-	-	2	3
CO5. **Judge** the security of an organization/institute by means of network security devices/models/controls. (HOTS: Level 5: Evaluate)	3	2	2	2	-	-	-	-	-	-	-	-	2	3
CO6. **Integrate** different types of securities under one environment and evaluate its performance.(HOTS: Level 6: Create)	3	3	3	3	-	-	-	-	-	-	-	-	2	3
Level of Attainments PCC-CSEAI402-T					-	-	-	-	-	-	-	-		

Wireless and Mobile Communication

General Course Information

Course Code: PE/AIML71-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites:

Basic knowledge of computer networks, Network Architecture and reference model, High Speed Network technologies, Ethernet, TCP/IP architecture.

About the course:

This course attunes the students with mobile and wireless communication using the Networking infrastructure of organizations/institutes. Students learn to analyse Networks' Architecture for wireless communication and the protocols for various layers in the Wireless Networks, technologies used and application arena of Wireless Networks.

Course Outcomes: At the end of this course studentswill be able to:

CO1. **recall** different mobile and wireless communication concepts. (LOTS: Level 1: Remember)

CO2. **explain**working of different Mobile Communication Technologies used now a days. (LOTS: Level 2: Understand)

CO3. **demonstrate**application of different mobile protocols for different Mobile and Wireless Communication Technologies. (LOTS: Level 2: Understand)

CO4. **analyze**the performance of different Mobile Communication technologies in different scenarios / situations. (HOTS: Level 4: Analyse)

CO5. **design** a mobile network for any city/state/country using combination of different Mobile Technologies. (HOTS: L evel 6: Create)

Course Contents

Unit I

Mobile Communication**:** Wireless Transmission--- Frequencies, signals, antennas, signal propagation, multiplexing, modulation, spread spectrum, cellular system. Specialized MAC, SDMA, FDMA, TDMA- fixed TDM, classical ALOHA, slotted ALOHA, CSMA, DAMA, PRMA, reservation TDMA. Collision avoidance, polling inhibit sense multiple access. CDMA, GSM- mobile services, architecture, radio interface, protocol, localization, calling, handover, security, new data services, Introduction to WLL.

Unit II

Wireless LAN IEEE 802.11-System and protocol architecture, physical layer. Frame format.

Bluetooth--- Protocol architecture, Frame format.

WiMAX – Layered Protocol architecture, frame types, format, Applications

Introduction to LTE, LTE advanced, VoLTE

Unit III

Mobile network Layer: Mobile IP- goals, assumption, requirement, entities, terminology, IP packet delivery, Agent advertisement and discovery, registration, tunneling, encapsulation, optimization , reverse tunneling, IPV6. DHCP. Adhoc Networks—routing , Destination Sequence Distance Vector, dynamic source routing, hierarchical algorithm, alternative metric.

Unit IV

Mobile Transport Layer: Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP fast retransmission/ recovery, transmission/time out freezing, selective retransmission, Transaction oriented TCP.

T**ext and Reference Books:**

1. Jochen Schiller, *Mobile Communication*, 2nd Edition, Pearson,2009.
2. Andrew S Tanenbaum, *Computer Networks*, 5th Edition, Pearson 2013.
3. William C Y Lee, *Mobile Communication Engineering*: *Theory and Applications*, 2nd Edition, McGraw Hill, 1997.

CO-PO Articulation Matrix: Wireless and Mobile Communication Course (PE/AIML71-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Recall** different mobile and wireless communication concepts. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2. **Explain** working of different Mobile Communication Technologies used now a days. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3. **Demonstrate** application of different mobile protocols for different Mobile and Wireless Communication Technologies. (LOTS: Level 2: Understand)	1	1	-	-	-	-	-	-	-	-	-	-	-	3
CO4. **Analyze** the performance of different Mobile Communication technologies in different scenarios / situations. (HOTS: Level 4: Analyse)	2	2	2	2	2	-	-	-	-	-	-	-	-	3
CO5. **Design** a mobile network for any city/state/country using combination of different Mobile Technologies. (HOTS: Level 6: Create)	3	3	3	3	3	-	-	-	-	-	2	2	-	3
Level of Attainments PE/AIML71-T														

Compiler Design

General Course Information

Course Code: PE/AIML/ 72-T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Brief knowledge of programming languages, Data Structure, and Algorithm Design.

About the Course:

Compilers have become part and parcel of today's computer systems. These are responsible for making the user's computing requirements, specified as a piece of program, understandable to the underlying machine. There tools work as interface between the entities of two different domains – the human being and the machine. The actual process involved in this transformation is quite complex. Compiler design covers basic translation mechanism and, error detection and recovery. It includes lexical, syntax, and semantic analysis as front end, and code generation and optimization as back-end.

Course Outcomes: By the end of the course studentswill be able to:

CO1. **state** principles of compiler design. (LOTS: Level 1: Remember)
CO2. **illustrate** the essential phases for automatically converting source code into object code. (LOTS: Level 2: Understand)
CO3. **apply** lexical analysis, syntax analysis and code optimization techniques for solving problems. (LOTS: Level 3: Apply)
CO4. **analyse** a parse tree and a givenBNF grammar. (LOTS: Level 4: Analyse)
CO5. **compare and contrast** syntax-oriented translation schemes (HOTS: Level 5: Evaluate)
CO6. **design** a lexical analyser from the specification of alanguage's lexical rules.(HOTS: Level 6: Create)

Course Contents

Unit I

Introduction To Compilers: Compilers and translators, need of translators, structure of compiler its different phases, Compiler construction tools.

Lexical Analysis: Role of lexical analyzer, design of lexical analyzer, regular expressions, Specification and recognition of tokens, input buffering, A language specifying lexical analyzer. Finite automata, conversion from regular expression to finite automata, and vice versa, minimizing number of states of DFA, Implementation of lexical analyzer.

Unit II

Syntax Analysis: Role of parsers, context free grammars, definition of parsing. Parsing Technique: Shift- reduce parsing, operator precedence parsing, top-down parsing, predictive parsing.

Unit III

LR parsers, SLR, LALR and Canonical LR parser. Syntax Directed Translations: Syntax directed definition, construction of syntax trees, syntax directed translation scheme, implementation of syntax directed translation, three address code, quadruples and triples.

Unit IV

Symbol Table & Error Detection and Recovery: Symbol tables, its contents and data structure for symbol tables; trees, arrays, linked lists, hash tables. Errors, lexical phase error, syntactic phase error, semantic error.

Code Optimization & Code Generation: Code generation, forms of objects code, machine dependent code, optimization, register allocation for temporary and user defined variables.

Text and Reference Books:

1. Alfread V. AHO, Ravi Sethiand J.D. Ullman, *Compilers Principle, Techniques and Tools*, Addison Wesley, 2007.
2. Tremblay and Sorenson, *Theory and practice of compiler writing*, Mc. Graw Hill, 1985.
3. Dhamdare, *System software*, MGH, 1986.
4. Alfred V. Aho, Jeffrey D. Ullman, *Principles of Compiler Design*, Narosa Publication, 2002.

CO-PO Articulation Matrix: Compiler Design Course (PE/AIML/72-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **State** principles of compiler design. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2. **Illustrate** the essential phases for automatically converting source code into object code. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Apply** lexical analysis, syntax analysis and code optimization techniques for solving problems. (LOTS: Level 3: Apply)	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO4. **Analyse** a parse tree and a given BNF grammar. (LOTS: Level 4: Analyse)	3	2	1	-	2	-	-	-	-	-	-	-	3	-
CO5. **Compare and contrast** syntax-oriented translation schemes (HOTS: Level 5: Evaluate)	2	2	1	-	2	-	-	-	-	-	-	-	3	-
CO6. **Design** a lexical analyser from the specification of a language's lexical rules. (HOTS: Level 6: Create)	3	3	2	2	3	-	-	-	-	-	-	-	3	-
Level of Attainments PE/AIML/72-T														

Data Visualization Techniques

General Course Information

Course Code: PE/AIML/73-T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basics ofdata handling techniques, graphs and plots.

About the Course:

This course focuses on building creative and technical skills to transform data into visual reports for engendering a shared understanding. Students will learn to use software to organize, and visualize data, with an emphasis on applying design principles ofproducing clear, elegant graphs and dashboards that capture the essence of an insight, message, or recommendation distilled from the data.

Course Outcomes: By the end of the course students will be able to:

CO7. **define**the key concepts and terms behind data visualization.(LOTS: Level 1: Remember)
CO8. **explain** the methods for visualizing data using various tools. (LOTS: Level 2: Understand)
CO9. **apply** visualization methods for different data domains. (LOTS: Level 3: Apply)
CO10. **suggest** appropriate data visualization tools for domain specific applications. (HOTS: Level 4: Analyze)
CO11. **evaluate** information visualization systems and other forms of visual presentation for their effectiveness. (HOTS: Level 5: Evaluate)
CO12. **design** and build data visualization systems**.** (HOTS: Level 6: Create)

Course Contents

Unit I

Introduction to Data Visualization: Definition, methodology, sevenstages of data visualization, Data visualizationtools, Visualizing Data: Mapping data onto aesthetics, Visualizing amounts,Visualizing Distributions: Histograms and density Plots, Visualizing Propositions:

Visualizing associations among two or more quantitative variables, Visualizing Time Series and otherFunctions of an independent variable, trends, Visualizing geospatial data.

Unit II

Interactive Data Visualization: Introduction to D3, Fundamental Technology: The Web, HTML, DOM, CSS, JavaScript, SVG. D3 setup, generatingpage elements, Bindingdata, Drawing with data, Scales: Domains andranges,Normalization, Creating a scale, Scaling the scatter plot, other methods and other scales; Axes, Modernizing the chart,Update the data, Transition, Updates, Interactivity.

Unit III

D3 Based Reusable Chart Library: Setup and deployment, Generate Chart, Customize Chart: Additional axis, Show axis labels,Change chart type, Format values, size, color, padding, tooltip; Use APIs: Load and unload, Show and hide, Focus, Transform, Groups, Grid, regions, Flow,Revert, Toggle, Legend, Sub chart, Zoom, Resize; Customize Style, Building Real time and live updating animated graphs withC3.

Unit IV

Introduction to Tableau: Environment Setup, Navigation, File & Data Types; TA SOURCE: Custom data view, ExtractingData, Fields operations, editingmeta data, Data joining, Data blending; Worksheets.

Basic and Advanced Charts in Tableau: Bar chart, Line chart, Pie chart, Scatter plot, Bubble chart, Gantt chart, Histograms,Waterfall charts. Dashboard, Formatting, Forecasting, Trend Lines.

Text and Reference Books and Links:

8. Ben Fry, *Visualizing Data: Exploring and Explaining Data with the Processing Environment*, O'Reilly, 1st Edition, 2008.
9. Scott Murray, *Interactive data visualization for the web: An Introduction to Designing with D3*, O'Reilly, 2nd Edition, 2017.
10. Joshua N. Milligan, *Learning Tableau 2019: Tools for Business Intelligence, data prep, and visual analytics*, Packt Publishing Limited, 2019.
11. Claus O. Wilke, *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*, O.Reilly, 2019.
12. Ritchie S. King, *Visual Storytelling with D3: An Introduction to Data Visualization in JavaScript, Addison-wesley Data and Analytics*, 2014.
13. Elijah Meeks, *D3.js in Action: Data visualization with JavaScript*, Second Edition, Manning Publications, 2017.
14. Lindy Ryan, *Visual Data Storytelling with Tableau*, 1st Edition, Pearson, 2018.
15. Cole NussbaumerKnaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, Wiley, 2015.

CO-PO Articulation Matrix: Data Visualization (PE/AIML/73-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** the key concepts and terms behind data visualization. (LOTS: Level 1: Remember)	1	-	-	-	1	-	-	-	-	-	-	-	-	1
CO2. **Explain** the methods for visualizing data using various tools. (LOTS: Level 2: Understand)	1	-	-	-	2	-	-	-	-	-	-	-	-	2
CO3. **Apply** visualization methods/tools for different data domains. (LOTS: Level 3: Apply)	2	1	-	1	3	-	-	-	-	-	-	-	-	3
CO4. **Suggest** appropriate data visualization tools for domain specific applications. (HOTS: Level 4: Analyze)	2	2	1	2	3	-	-	-	-	-	-	-	-	3
CO5. **Evaluate** information visualization systems and other forms of visual presentation for their effectiveness. (HOTS: Level 5: Evaluate)	2	2	1	2	3	-	-	-	-	-	-	-	-	3
CO6. **Design** and build data visualization systems**.** (HOTS: Level 6: Create)	3	3	2	3	3	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/73-T														

Software Defined Networks

General Course Information

Course Code: PE/AIML/74-T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Programming in C/C++/Java

About the Course:

Software Defined Networks is a result of improvement of flexibility of Network Control. To make the Networks Programmable it was deemed necessary to separate the Control Plane from the Data Plane. SDN Controllers are inserted into the Network to realize Network Virtualization. OpenFlow protocol and Mininet framework are used to design SDN. This Course is considered as a necessary addition in the Curriculum of B. Tech. (CSE/IT) from professional point of view.

Course Outcomes: By the end of the course students will be able to:

CO1. **outline** Software Defined Networks and its various components. (LOTS: Level 1: Remember)
CO2. **explain** techniques to make the Network Programmable for better flexibility. (LOTS: Level 2: Understand)
CO3. **use** modern tools to implement SDN Controllers in a Network scenario. (LOTS: Level 3: Apply)
CO4. **breakdown** Virtual Networks into its components for controlling of networks. (HOTS: Level 4: Analyse)

CO5. **compare** and **contrast** the working of SDN through various protocols. (HOTS: Level 5: Evaluate)

CO6. **generate** SDN using Application Programming Interface and compute its performance for a given scenario. (HOTS: Level 6: Create)

Course Contents

Unit I

Introduction: The need for Programmable Networks, Evolution of Software Defined Networks, Software Defined Networks' Architecture and Design, Traditional Switch Architecture, Centralized and decentralized Control Plane and Data Plane, IETF SDN framework, Scalability (Service provider Networks, ISP Automation), Reliability (QoS and Service Availability), Consistency (Configuration management and Access Control violations).

Unit II

Openflow and Software Defined Networks Controllers: Control and Data Plane Separation, Evolution of Openflow, SDN Controllers(POX, floodlight, openDayLight), Applicability of Openflow protocols in SDN Controllers, scalable Programming for SDN Controllers.

Unit III

Network Virtualization: Virtual Network, Abstraction of physical Network, Components of Virtual Network (Virtual Switch, Bridge, Host-virtual adapter, NAT device, DHCP server, Network Adapter), Network as a Service (NaaS), Network Virtual Machine.

Unit IV

Software Defined Networks Programming: Programming Software Defined Networks, Northbound Application Programming Interface, Current Languages and tools, Network Functions Virtualization, Software Defined Networks implementation and Applications, Bandwidth Calendaring- Data Center Orchestration, Mininet. Use-cases(Network Access Control, Virtual Customer Edge, Data center Optimization), Latest trends in SDN.

T**ext and Reference Books:**

1. Paul Goransson and Chuck Black, *Software Defined Networks: A Comprehensive Approach*, First Edition, Morgan Kaufmann, 2014.
2. Thomas D.Nadeau, Ken Gray, *Software Defined Networks*, O'Reilly Media, 2013.
3. SiamakAzodolmolky, *Software Defined Networking with Openflow, Packt Publishing*, 2013.
4. Kingston Smiler, *Openflow Cookbook*, Packt Publishing, 2015.

5. Doug Marschke, Jeff Doyle, PeteMoyer, *Software Defined Networking: Anatomy of Openflow*, Volume-I, Lulu Publishing Services, 2015.

CO-PO Articulation Matrix: Software Defined Networks Course (PE/AIML/74-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Outline** Software Defined Networks and its various components. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2. **Explain** techniques to make the Network Programmable for better flexibility. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3. **Use** of modern tools to implement SDN Controllers in a Network scenario. (LOTS: Level 3: Apply)	2	2	2	2	3	-	-	-	-	-	-	-	-	3
CO4. **Breakdown** Virtual Networks into its components for controlling of networks. (HOTS: Level 4: Analyse)	3	2	2	3	3	-	-	-	-	-	-	-	-	3
CO5. **Compare** and **contrast** the working of SDN through various protocols. (HOTS: Level 5: Evaluate)	3	3	2	3	3	-	-	-	-	-	-	-	-	3
CO6. **Generate** SDN using Application Programming Interface and compute its performance for a given scenario. (HOTS: Level 6: Create)	3	3	2	2	3	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/74-T														

Digital Image Processing

General Course Information

Course Code: PE/AIML/75-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: knowledge of basic linear algebra, basic probability theory, basic programming techniques, and Fourier Transforms.

About the Course:

Digital Image Processing is a Professional Elective course that provides a theoretical foundation of digital image processing concepts. This course provides a mathematical foundation for digital manipulation of images, image acquisition, pre-processing, enhancement, segmentation and compression. Students learn algorithms that perform basic image processing operations (e.g., histogram processing, noise removal and image enhancement and restoration).Algorithms for image analysis (e.g., image compression, image segmentation and image representation) are explained.

Course Outcomes: By the end of the course students will be able to:

CO1. **State** concepts related to image acquisition and processing. (LOTS: Level 1: Remember)

CO2. **illustrate** the principles and methods in image processing. (LOTS: Level 2: Understand)

CO3. **apply** mathematical functions for digital manipulation of images such as image acquisition, pre-processing, segmentation, compression and representation. (LOTS: Level 3: Apply)

CO4. **compare** various image processing techniques. (HOTS: Level 4: Analyse)

CO5. **assess** the various image processing techniques for a given problem. (HOTS: Level 5: Evaluate)

CO6. **design** and implement algorithms for digital image processing operations such as histogram equalization, filtering, enhancement, restoration and denoising, segmentation, compression. (HOTS: Level 6: Create)

Course contents

Unit I

Introduction and fundamental to digital image processing: What is digital image processing, Origin of digitalimage processing, Examples that use digital image processing, Fundamental steps in digital image processing, Components of digital image processing system, Image sensing and acquisition, Image sampling, Quantization and representation, Basic relationship between pixels. Image enhancement in spatial domain and frequency domain: Background, Basic gray level transformation,

Histogram processing, Basics of spatial filtering, Smoothing and sharpening spatial and the frequency domain filters.

Unit II

Image Restoration: Image degradation/restoration Process, Noise models, Restoration in presence of noise, Inverse filtering, Minimum mean square filtering, Geometric mean filter, Geometric transformations.Color Image Processing: Color fundamentals, Color models, Basics of full color image processing, Colortransformations.

Unit III

Image Compression: Fundamentals, Image compression models, Error free compression, Lossy compression.

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region

based segmentation.

Unit IV

Representation, Description and Recognition: Representation-chain codes, polygonal approximation and

skeletons, Boundary descriptors-simple descriptors, shape numbers, Regional descriptors-simple, topological

descriptors.

Recognition: Pattern and Pattern classes.

T**ext and Reference Books:**

1. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, Pearson Education,Ed, 2001.
2. Anil K. Jain, *Fundamentals of Digital Image Processing*, Pearson Education, PHI, 2001.
3. Tinku Acharya and Ajoy K. Ray, *Image Processing-Principles and Applications*, John Wiley & Sons,
4. Inc., 2005.
5. Chanda and D. Dutta Majumdar, *Digital Image Processing and Analysis*, PHI, 2003.
6. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, 2nd edition, PWS Publishing Company, Thomson Learning, 1999.

CO-PO Articulation Matrix: Digital Image Processing Course (PE/AIML/75-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **State** concepts related to image acquisition and processing. (LOTS: Level 1: Remember)	1	3	-	-	-	-	-	-	-	-	-	-	-	1
CO2. **Illustrate** the principles and methods in image processing. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3. **Apply** mathematical functions for digital manipulation of images such as image acquisition, pre-processing, segmentation, compression and representation. (LOTS: Level 3: Apply)	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO4. **Compare** various image processing techniques. (HOTS: Level 4: Analyse)	2	3	2	2	-	-	-	-	-	-	-	-	-	3
CO5. **Assess** the various image processing techniques for a given problem. (HOTS: Level 5: Evaluate)	3	3	2	2	-	-	-	-	-	-	-	-	-	3
CO6. **Design** and implement algorithms for digital image processing operations such as histogram equalization, filtering, enhancement, restoration and denoising, segmentation, compression. (HOTS: Level 6: Create)	3	3	2	3	3	-	-	-	-	-	-	2	-	3
Level of Attainments PE/AIML/75-T														

Reinforcement Learning

General Course Information

Course Code: PE/AIML/76-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Pre-requisites: Probability and linear algebra, python programming, data structures and algorithms, artificial intelligence, machine learning.

About the Course:

Reinforcement learning is a paradigm that aims to model the trial-and-error learning process that is needed in many problem situations where explicit instructive signals are not available. The goal of the course is to introduce the basic foundations of reinforcement learning, model-based learning, temporal difference learning and ensemble learning.

Course Outcomes: By the end of the course students will be able to:

CO1. **describe** the relevance of reinforcement learning and how does it complement other ML techniques.(LOTS: Level 1: Remember)
CO2. **discuss**the challenges in learning from dynamic environment with minimal data and how reinforcement learning overcome these challenges. (LOTS: Level 2: Understand)
CO3. **apply** various reinforcement and ensemble learning algorithms. (LOTS: Level 3: Apply)
CO4. **analyze** the performance of various reinforcement and ensemble learning methods. (HOTS: Level 4: Analyze)
CO5. **Interpret** the results of reinforcement and ensemble learning algorithms. (HOTS: Level 5: Evaluate)
CO6. **design** reinforcement learning algorithms for addressing novel problems. (HOTS: Level 6: Create)

Course Contents

Unit I

Introduction: Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope, relationship to dynamic programming.

Multi-armed Bandits: A k-armed Bandit Problem, Action-value Methods, The 10-armed Testbed,Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandit Algorithms

Unit II

Finite Markov Decision Processes: The Agent–Environment Interface, Goals and Rewards, Reward models (infinite discounted, total, finite horizon, and average), Returns and Episodes, Policies and Value Functions, Optimal Policies and Optimal Value Functions

Dynamic Programming: Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration

Monte Carlo Methods: Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control

Unit III

Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD (0), Sarsa, Q-learning, Expected Sarsa , Maximization Bias and Double Learning

n-step Bootstrapping: n-step TD Prediction, n-step Sarsa, n-step Off Policy Learning, The n-step Tree Backup Algorithm, A Unifying Algorithm: n-step Q(σ)

Unit IV

Policy Gradient Methods: Policy Approximation and Advantages, Policy Gradient Theorem, Monte Carlo Policy Gradient, Reinforce with Baseline,Actor–Critic Methods, Policy Gradient for Continuing Problems

Applications and case studies: TD-Gammon, Samuel‘s Checkers Player, Watson‘s Daily-Double Wagering, Optimizing Memory Control, Mastering the Game of Go, Personalized Web Services, Reinforcement learning in robotics

Text and Reference Books and Links:

1. Sutton and Barto, *Reinforcement Learning: An Introduction*, The MIT Press Cambridge, Massachusetts London, England, 2015.
2. Zhou andZhi-Hua,*Ensemble Methods: Foundations and Algorithms*, Chapman & Hall/CRC, 2012
3. CsabaSzepesvari, *Algorithms for Reinforcement Learning*, Morgan & Claypool, UnitedStates,2010.
4. Tesauro, *Temporal Difference Learning and TD-Gammon*, Communications of the Association for Computing Machinery, 1995.
5. Dimitri P. Bertsekas, Reinforcement *Learning and Optimal Control*, 1st Edition, Athena Scientific, 2019.

CO-PO Articulation Matrix: Reinforcement Learning (PE/AIML/76-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Describe** the relevance of reinforcement learning and how does it complement other ML techniques. (LOTS: Level 1: Remember)	1	1	1	1	-	-	-	-	-	-	-	-	-	1
CO2. **Discuss** the challenges in learning from dynamic environment with minimal data and how reinforcement learning overcome these challenges. (LOTS: Level 2: Understand)	2	2	2	1	-	-	-	-	-	-	-	-	-	2
CO3. **Apply** various reinforcement and ensemble learning algorithms. (LOTS: Level 3: Apply)	3	3	2	2	-	-	-	-	-	-	-	-	-	3
CO4. **Analyze** the performance of various reinforcement and ensemble learning methods.(HOTS: Level 4: Analyze)	3	3	2	3	-	-	-	-	-	-	-	-	-	3
CO5. **Interpret** the results of reinforcement and ensemble learning algorithms. (HOTS: Level 5: Evaluate)	3	3	2	3	-	-	-	-	-	-	-	-	-	3
CO6. **Design** reinforcement learning algorithms for addressing novel problems. (HOTS: Level 6: Create)	3	3	2	3	-	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/76-T														

Edge and Fog Computing

General Course Information

Course Code: PE/AIML/77-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basics of Cloud Computing and Internet of Things.

About the Course:

Responding to the ever-increasing bandwidth demands of the IoT, Fog and Edge computing concepts have been developed to collect, analyze, and process data more efficiently than traditional cloud architecture. This course will provide the design concepts, frameworks, and applications in Fog and Edge computing.

Course Outcomes: By the end of the course students will be able to:

CO13. **recall**the basic principles, architectures of edge and fog computing.(LOTS: Level 1: Remember)

CO14. **discuss** the storage and computation in edge and fog computing paradigm. (LOTS: Level 2: Understand)

CO15. **realize** the improved performance of Internet of things by exploring the edge and fog computing paradigm. (LOTS: Level 3: Apply)

CO16. **analyze** the performance of the applications developed using fog architecture.(HOTS: Level 4: Analyze)

CO17. **design** and implement Internet of Everything (IoE) applications through fog computing architecture. (HOTS: Level 6: Create)

Course Contents

Unit I

Introduction of Edge and Fog Computing: Internet of Things (IoT) and New computing paradigms, Emergence of edge computing, Fog computing: A platform for Internet of Things and analytics, Legal aspects of operating IoT applications in the fog.

Edge Architecture: Multi-Tier cloud computing framework; Data services with clouds at home; Leveraging mobile devices to provide cloud service at the edge; Fast, scalable and secure onloading of edge functions.

Unit II

Integrating IoT + Fog + Cloud Infrastructures: System modeling and research Challenges, Management and Orchestration of network slices in 5G, Fog, Edge, and Clouds.
System Design: Optimization problems in fog and edge computing; Middleware for fog and edge Computing: Design issues, A Lightweight container middleware for edge cloud architectures.

Unit III

Data Processing: Data management in fog computing, Predictive analysis to support fog application deployment, using machine learning for protecting the security and privacy of Internet of Things (IoT) systems, fog Computing realization for Big data analytics.

Unit IV

Applications and Case Studies: Fog computing realization for big data analytics, exploiting fog computing in health monitoring, Smart surveillance video stream processing at the edge for real-time human objects tracking, Fog computing model for evolving smart transportation applications.

Text and Reference Books and Links:

1. R. Buyya and S.N. Srirama,*Fogand Edge Computing: Principles and Paradigms*, Wiley-Blackwell, 2019.
2. Ajit Singh, *Edge Computing: Simply in Depth*, Amazon LLC, 2019.
3. Cao,Jie, Zhang, Quan, Shi, and Weisong,*Edge Computing: A Primer, Pearson Education*, Springer, 2018.
4. Assad Abbas, Samee U. Khan, Albert Y. Zomaya,*Fog Computing – Theory and Practice*, John Wiley & Sons, 2020.
5. Zaigham Mahmood, *Fog Computing: Concepts, Frameworks and Technologies*,Springer, 2018.
6. Amir M. Rahmani, PasiLiljeberg, Preden, and Axel Jantsch, *Fog Computing in the Internet of Things - Intelligence at the Edge*, Springer International Publishing, 2018.

CO-PO Articulation Matrix: Edge and Fog Computing (PE/AIML/77-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Recall** the basic principles, architectures of edge and fog computing. (LOTS: Level 1: Remember)	1	1	-	-	-	-	-	-	-	-	-	-	-	1
CO2. **Discuss** the storage and computation in edge and fog computing paradigm. (LOTS: Level 2: Understand)	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO3. **Realize** the improved performance of Internet of things by exploring the edge and fog computing paradigm. (LOTS: Level 3: Apply)	3	2	1	1	-	-	-	-	-	-	-	-	-	2
CO4. **Analyze** the performance of the applications developed using fog architecture. (HOTS: Level 4: Analyze)	3	2	2	2	-	-	-	-	-	-	-	-	-	3
CO5. **Design** and implement Internet of Everything (IoE) applications through fog computing architecture. (HOTS: Level 6: Create)	3	3	3	3	-	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/77-T														

Natural Language Processing

General Course Information

Course Code: PE/AIML/78-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basic of machine learning and data mining

About the Course:

Natural Language processing (NLP) has a wide scope of application sentiment analysis, opinion mining, chatbots, summarization and question answering. This objective of course is to give exposure to students about basic tasks and principles in natural language processing. The course covers pre-processing of text, language models and sentiment analysis using Bayesian and Logistic regression frameworks.

Course Outcomes: By the end of the course students will be able to:

CO1. **define**the basic vocabulary and terminology used in NLP. (LOTS: Level 1: Remember)

CO2. **describe** regular expressions, text processing, N-grams, sentiment analysis, NLP applications and challenges. (LOTS: Level 2: Understand)

CO3. **solve** problems pertaining to NLP tasks. (LOTS: Level 3: Apply)

CO4. **compare** the various language models and NLP algorithms. (LOTS: Level 4: Analyse)

CO5. **evaluate** language models andNLP algorithms. (HOTS: Level 5: Evaluate)

Course Contents

Unit I

Introduction to NLP, Ambiguity, Models and Algorithms, Language thought and understanding, Historical perspective and Latest developments in NLP.
Regular expressions: Basic regular expression patterns, Disjunction, grouping and precedence,

Examples, Advanced operators, Regular expression substitution, Finite state automata, Formal languages, Non-deterministic FSAs, Using NFSAs to accept strings, Regular languages and FSAs.
Text Processing and Tokenisation: English morphology, Finite-state morphological parsing, Building a finite state lexicon, Finite state transducers, FSTs for morphological parsing, Combining FST lexicon and rules, Lexicon-free FSTs.

Unit II
Words and sentence tokenization, detecting and correcting spelling errors, Words, Corpora, Text normalization, Minimum edit distance.
N-Grams: Counting words in corpora, Simple N-grams, Training and test sets, Evaluating language models, Smoothing, advanced topics in language modelling.
Vector Semantics and Embeddings: Lexical semantics, Vector semantics, Words and vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in vector, Pointwise mutual information, Applications of TF-IDF, Word2vec, Visualizing embeddings, Semantic properties of embeddings, Bias and embeddings, Evaluating vector models.

Unit III
Naïve Bayesian and Sentiment Classification: Training the Naïve Bayes classifier, Optimizing for sentiment analysis, Naïve Bayes as a language model, Evaluation, test set and cross-validation, Statistical significance testing.
Classification with logistic regression, Multinomial logistic regression, Learning in logistic regression, The cross-entropy loss function, Regularization, Learning in multimodal logistic regression, Interpreting models.

Unit IV
NLP Applications: Machine Translation: Machine translation using Encoder-Decoder, Details of Encoder-Decoder model, Machine Translation evaluation, Biases and ethical issues, Text classification for sentiment analysis.
Question answering and Information Retrieval: Information retrieval, IR-based factoid question answering, Entity linking, Knowledge based question answering, Using language models to do question answering, Classic QA models, Evaluation of Factoid answers.

Text and Reference Books:

1. Daniel Jurafsky and James H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*, 2nd Edition, Prentice Hall, Second Edition, 2009.
2. Dan Jurafsky and James Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*, 3rd Edition, 2023.
3. Yoav Goldberg, *Neural Network Methods for Natural Language Processing*, Morgan and Claypool, 2017.
4. Chris Manning and Hinrich Schütze,*Foundations of Statistical Natural Language Processing*, MIT Press, Cambridge, MA, 1999.
5. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit, O'Reilly, 2009,http://www.nltk.org/book/.
6. Dipanjan Sarkar, Text Analytics with Python, Springer, 2016,

   https://link-springer-com.proxy.uchicago.edu/book/10.1007%2F978-1-4842-2388-8.

CO-PO Articulation Matrix: Natural Language Processing (PE/AIML/78-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** the basic vocabulary and terminology used in NLP. (LOTS: Level 1: Remember)	1	1	-	-	-	-	-	-	-	-	-	-	-	3
CO2. **Describe** regular expressions, text processing, N-grams, sentiment analysis, NLP applications and challenges. (LOTS: Level 2: Understand)	2	2	1	1	-	-	-	-	-	-	-	-	1	3
CO3. **Solve** problems pertaining to NLP tasks. (LOTS: Level 3: Apply)	3	2	2	2	-	-	-	-	-	-	-	-	2	3
CO4. **Compare** the various language models and NLP algorithms. (LOTS: Level 4: Analyse)	3	3	2	2	-	-	-	-	-	-	-	-	2	3
CO5. **Evaluate** language models andNLP algorithms. (HOTS: Level 5: Evaluate)	3	3-	2	2	-	-	-	-	-	-	-	-	3	3
Level of Attainments PE/AIML/78-T														

Cognitive Systems

General Course Information

Course Code: PE/AIML/79-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Background in basic computer science, programming and artificial intelligence.

About the Course

This course covers introduction to the basic concepts of cognitive science and systems, hypotheses, models, methods, issues and debates in cognitive science. The course encompasses the historical perspective and current debates on cognitive systems and ethical issues involved in the domain. Since the course is multi-disciplinary and situated at the cross-section of Artificial Intelligence, Machine learning, Psychology, Philosophy, and Linguistics, it involve quite a few readings to understand the issues around cognitive science. Overall, it needs an open and inquisitive mind.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** the basic vocabulary and terms of cognitive science and systems. (LOTS: Level 1: Remember)

CO2. **describe** the fundamentals of cognitive concepts such as perception, knowledge representation, reasoning, decision making, cognitive architectures, natural language processing etc. (LOTS: Level 2: Understanding)

CO3. **apply** techniques of knowledge representation and reasoning to model and solveproblems in cognitive systems(LOTS: Level 3: Apply)

CO4. **identify** emerging trends and future directions in cognitive systems for staying informed about advancements and potential opportunities in the field.(LOTS: Level 3: Apply)

CO5. **analyze** the historical perspectives and advancements in cognitive systems, recognizing their impact on various fields and applications. (HOTS: Level 4: Analyse).

CO6. **review** criticallythe current debates on cognitive science and on applying cognitive systems. (HOTS: Level 5: Evaluate).

Course Contents

Unit I

Overview of Cognitive Systems, Historical perspective on cognitive systems, Perception and sensing, Knowledge Representation and reasoning: Logic, rules, concepts,analogies, images, connections, Cognitive architectures.

UnitII

The interdisciplinary nature of cognitive science, cognitive science and integration challenge, Information processing models of the mind- Physical symbols systems and language of thought, Applying symbolic paradigm, Neural Networks and distributed information processing, neural network model of cognitive process, Challenges and applications of cognitive systems.

Unit III

Language and Communication in Cognitive Systems: Introduction to natural language processing, Syntax and semantics in NLP, Language understanding and generation, Dialog systems, Sentiment analysis and opinion mining.

UnitIV

Cognitive Systems in Practice: Cognitive systems in health care, Intelligent Virtual Assistants, Cognitive systems in robotics and autonomous systems, Ethical and social implications of cognitive systems, Future trends and applications.

T**ext and Reference Books:**

1. Paul Thagard, *MIND, An Introduction to Cognitive Science*, MIT Press, Second edition, 2005.
2. José Luis Bermúdez, *cognitive science: An Introduction to the Science of the Mind*, Second Ed., Cambridge University Press, 2014.
3. RichardG.M. Morris, Lionel Tarassenko and Michael Kenward, *Cognitive Systems - Information Processing Meets Brain Science*, Elsevier, 2006.
4. Frank C. Keil, (Eds.), *The MIT Encyclopaedia of the Cognitive Sciences*, MIT Press, 1999.
5. Jay Friedenberg, Gordon Silverman, Cognitive Science: *An Introduction to the Study of Mind*, Sage Publications, 2006.

CO-PO Articulation Matrix: Cognitive Systems (PE/AIML/79-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO6. **Define** the basic vocabulary and terms of cognitive science and systems. (LOTS: Level 1: Remember)	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO7. **Describe** the fundamentals of cognitive concepts such as perception, knowledge representation, reasoning, decision making, cognitive architectures, natural language processing etc. (LOTS: Level 2: Understanding)	1	2	-	-	-	1	-	-	-	-	-	-	-	1	2
CO3. **Apply** techniques of knowledge representation and reasoning to model and solve problems in cognitive systems. (LOTS: Level 3: Apply)	1	2	1	-	-	2	-	-	-	-	-	-	-	2	3
CO4.**Identify** emerging trends and future directions in cognitive systems for staying informed about advancements and potential opportunities in the field. (LOTS: Level 3: Apply)	2	2	2	-	-	2	-	-	-	-	-	-	-	2	3
CO5.**Analyze** the historical perspectives and advancements in cognitive systems, recognizing their social and cultural impact on various fields and applications. (HOTS: Level 4: Analyse)	2	3	3	-	-	3	-	-	-	-	-	-	1	-	3
CO6. **Review** critically the current debates on cognitive science and on applying cognitive systems.	2	3	-	-	-	-	-	-	-	-	-	-	1	-	3

(HOTS: Level 5: Evaluate)															
Level of Attainments PE/AIML/79-T															

Deep Learning Tools Lab.

General Course Information

Course Code: PC/AIML/71-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4 hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/ assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Introduction to deep learning concepts and techniques

About the Course:
This is a lab course for hands on practice of deep learning techniques such as simple neural network, CNN, RNN, Transfer Learning using Keras, TensorFlow and PyTorch. The students will solve and compare various techniques for classification problems.

Course Outcomes: By the end of the course students will be able to:

CO1. **implement** deep learning algorithms for solving simple and medium size classification problems using modern deep learning tools such as Keras, TensorFlow, PyTorch etc. (LOTS: Level 3: Apply)
CO2. **analyse** the impact of parameter setting/tuning and activation functions on the resulting solutions. (LOTS: Level 4: Analyse)
CO3. **evaluate** the performance deep learning algorithms on various problems. (LOTS: Level 5: Evaluate)
CO4. **create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create).
CO5. **demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)

List ofexperiments/assignments:

1. Install deep learning frameworks like Keras, TensorFlow and PyTorch.
2. Build a feedforward NN to classify Iris dataset using Keras. Experiment with different activation functions and compare the impact on the performance of the NN.
3. Implement a feedforward neural network from scratch using NumPy. Train the NN on any synthetic/real world dataset to perform binary classification. Experiment with different activation functions and compare the performance of the NN.

4. Create a neural network to classify handwritten digits using MNIST handwritten digits dataset.
5. Implement a CNN architecture to classify handwritten digits from MNIST dataset. Visualize filters and feature maps from different layers to understand learnt features.
6. Implement a CNN architecture for image classification on the CIFAR-10 dataset or any other dataset. Analyse the effect of varying hyperparameters such as filter size, stride and, pooling method. Visualise the intermediate layer outputs and discuss the feature learned by different layers.
7. Build an RNN model to perform sentiment analysis on Movie reviews (e.g., IMDB dataset)
8. Implement a character-level RNN to generate text sequences.
9. Fine-tune a pre-trained CNN (e.g., VGG16, ResNet) on any image dataset of your choice for classification. Compare the performance of fine-tuned model with training a CNN from scratch.
10. Implement the YOLO object detection algorithm to detect objects in images.
11. Choose a suitable problem from domain such as healthcare, finance, robotics, surveillance etc. and design deep learning solution using appropriate frameworks and tools.

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

CO-PO Articulation Matrix: Deep Learning Tools Lab. (PC/AIML/71-P)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO7. **Implement** deep learning algorithms for solving simple and medium size classification problems using modern deep learning tools such as Keras, TensorFlow, PyTorch etc. (LOTS: Level 3: Apply)	2	3	2	2	3	-	-	-	-	-	-	-	-	3
CO8. **Analyse** the impact of parameter setting/tuning and activation functions on the resulting solutions. (LOTS: Level 4: Analyse)	3	3	-	2	3	-	-	-	-	-	-	-	-	3
CO9. **Evaluate** the performance deep learning algorithms on various problems. (LOTS: Level 5: Evaluate)	3	3	-	3	3	-	-	-	-	-	-	-	-	3
CO10. **Create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create).	3	3	-	3	3	-	-	-	-	3	-	-	-	3
CO11. **Demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Level of Attainments: PC/AIML/71-P														

Major Project Part I

General Course Information

Course Code: EEC/AIML/71-P Course Credits: 4 Mode: Self learning under the guidance of faculty members. Contact hours: 8 hours/week	**Course Assessment Method (100)** An internal evaluation is done by a committee of two teachers constituted by the Chairperson of the Department. The criteria for evaluation are given below. 1. Literature review: 20 2. Problem formulation: 20 3. Basic knowledge of the tools:20 4. Organisation and presentation of synopsis: 20 5. Level of Ethics followed: 20

About the major project Part I:

Students start working on their project work in seventh semester. Students do the background research for identifying appropriate problems, methodology and tools for their respective project works to be culminated in eighth semester. They prepare a synopsis of the project work to be carried out. At the end of seventh semester, each student is required to prepare a synopsis in the format provided and present it in front of a committee constituted by the Chairperson of the Department. Students can carry out projects in groups of two. In case of group project, the size of the problem should be significant, and members of the group must specify their individual contribution.

Course Outcomes: After doing Major Project Part 1 students will be able to:

CO1. **evaluate** criticallythe existing solutions and methodologies through reviewing literature. (HOTS: Level 5: Evaluate)
CO2. **formulate** suitable AI and ML problems to be addressed. (HOTS: Level 6: Create)
CO3. **identify** tentative modern AI and ML tools to solve the problem. (HOTS: Level 4: Analyse)
CO4. **organise** and communicate (written and oral) ideas effectively. (HOTS: Level 6: Create)
CO5. **develop** methodologies that meet ethical, societal and legal considerations. (HOTS: Level 6: Create)

Note: The project for the students of B.Tech. CSE (AIML) must involve components of Artificial Intelligence and Machine Learning. A simple website development or simple

database applications will not be accepted toward the project work. Therefore, the students are advised to select appropriate topic for their projects in consultation with their guides.

CO-PO Articulation Matrix:Major Project Part 1(EEC/AIML/71-P)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO1	PSO2
CO1. **Evaluate** critically the existing solutions and methodologies through reviewing literature. (HOTS: Level 5: Evaluate)	2	3	3	3	-	-	-	-	-	-	-	3	-	-	3
CO2. **Formulate** suitable AI and ML problems to be addressed. (HOTS: Level 6: Create)	2	3	3	3	-	-	-	-	-	-	-	-	-	-	3
CO3. **Identify** tentative AI and ML modern tools to solve the problem. (HOTS: Level 4: Analyse)	2	_	2	_	3	-	-	-	-	-	-	2	-	-	3
CO4. **Organise** and communicate (written and oral) ideas effectively. (HOTS: Level 6: Create)	-	-	-	-	-	-	-	-	-	3	3	-	-	-	3
CO5. **Develop** methodologies that meet ethical, societal and legal considerations. (HOTS: Level 6: Create)	-	-	-	-	-	3	-	3	3	-	-	3	-	-	3
Level of Attainments EEC/AIML/71-P															

A mini Project/Training based on open source Tool

General Course Information

Course Code: EEC/AIML/72-P Course Credits: 2 Mode: Industrial Training /Internship	**Course Assessment Methods (100 Marks)** An internal evaluation is done by a faculty member appointed by the Chairperson of the Department. Significance and originality of the problem addressed and the solution provided: 20 Knowledge of the problem domain and tool used (VIVA-VOCE):25 Report Writing: 20 Judgement of the skill learnt and system developed: 20 Level of ethics followed: 15

About the Industrial training:

Students do an Industrial Training of 6-8 weeks after fourth semester. They are expected to learn novel skills and develop some software application during the training period.

After doing training students will be able to:

CO12. **review** the existing systems for their strengths and weaknesses. (HOTS: Level 4: Analyse)
CO13. **address** novel problems in an original and innovative manner (HOTS: Level 6: Create)
CO14. **select and apply** modern engineering tools. (LOTS: Level 3: Apply)
CO15. **evaluate** the system developed critically with respect to the requirement analysis and other similar systems. (HOTS: Level 5: Evaluate)
CO16. **prepare** training report by organising ideas in an effective manner.
CO17. **follow** ethical practices while doing the training and writing report. (LOTS: Level 3: Apply)

Note: The Industrial training/Internship must be carried out preferably in the domain of AI and ML.

CO-PO Articulation Matrix: A mini Project/Training based on open source Tool (EEC/AIML/72-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO1	PSO2
CO11.**Address** novel problems in an original manner using latest skills (HOTS: Level 6: Create)	3	3	3	2	-	1	-	-	2	-	1	-	-	-	-
CO12.**Select and apply** modern engineering tools. (LOTS: Level 3: Apply)	2	-	-	-	3	-	-	-	3	-	-	-	-	-	-
CO13.**Prepare** training report by organising ideas in an effective manner.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO14.**Engage** in lifelong learning. (HOTS: Level 6: Create)	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO15.**Apply** ethical practices while doing the training and writing report. (LOTS: Level 3: Apply	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-
Level of Attainments EEC/AIML/4															

DETAILED SYLLABUS
OF VIII SEMESTER

Big Data Analytics

General Course Information

Course Code: PC/AIML/ 81-T Course Credits: 3 Type: Professional Core Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Statistics, Data Analytics and data mining

About the course:

This course aims to equip the student with emerging field of big data analytics. Students achieve this through developing understanding of Big data analytics techniques and principles in typical real world scenarios. The course teaches students to understand as well as apply data analytics to big data projects.

After doing training students will be able to:

CO1. **outline** the basic terminology of big data analytics. (LOTS: Level 1: Remember)
CO2. **describe**big data analytics techniques,MapReduce, Hadoop environment, processing data in distributed file systems, applications of big data analytics etc. (LOTS: Level 2: Understanding)
CO3. **apply**big data techniques and tools to address the problems in big data domain. (LOTS: Level 3: Apply)
CO4. **analyze** the big data techniques and tools for different scenarios. (HOTS: Level 4: Analyse).
CO5. **interpret** the outcomes/results of big data algorithms. (HOTS: Level 5: Evaluate).
CO6. **design complete** frameworkto address big data problems. (HOTS: Level 6: Create).

Course Contents

Unit-I

Introduction: Overview of Big data, Characteristics of big data.

MapReduce: Distributed File System, MapReduce, and Algorithm using MapReduce.

MapReduce using Hadoop: A weather dataset example, Analyzing data with UNIX tool, Analysing data with Hadoop, Scaling out, Hadoop streaming and Hadoop pipes.

Unit-II

Hadoop distributed file system: The Design of HDFS, HDFS Concepts, The Command-Line

Interface, Hadoop File systems, The Java Interface, Data Flow, Parallel Copying with distcp, Hadoop Archives.

Unit-III

The stream data model, sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting ones in a window, decaying windows.

Unit-IV

Pig: Installing and Running Pig: execution type, running pig programs, grunt, Pig Latin editors, An example in Pig Latin, generating examples, Comparing with databases, Pig Latin structure, statement, expression, types, schemas, function and macros.

Hive: Installing Hive, Hive shell, Hive example illustrating use of hive, running hive, hive services, the metastore, Comparing Hive with traditional databases.

Hbase: Hbasics, Concepts: Whirlwind Tour of Data Model, Implementation; Installation, Hbase versus RDBMS

Text and Reference Books:

1. Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O"reilly, 2012
2. Anand Rajaraman and Jefrey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015
4. Zikopoulos, Paul, and Chris Eaton. Understanding big data: Analytics for enterprise class hadoop and streaming data. McGraw-Hill Osborne Media, 2011.
5. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, DT Editorial Services
6. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
7. Fundamentals of Business Analytics by R.N. Prasad, Seema Acharya, Wiley.
8. Buyya, Rajkumar, Rodrigo N. Calheiros, and Amir Vahid Dastjerdi, eds. Big data: principles and paradigms. Morgan Kaufmann, 2016.

CO-PO Articulation Matrix: Big Analytics (PC/AIML/ 81-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14
CO1. **outline** the basic terminology of big data analytics. (LOTS: Level 1: Remember)	1	1	1	-	-	-	-	-	-	-	-	-	-	3
CO2. **describe** big data analytics techniques, MapReduce, Hadoop environment, processing data in distributed file systems, applications of big data analytics etc. (LOTS: Level 2: Understanding)	2	2	2	-	1	-	-	-	-	-	-	-	-	3
CO3. **apply** big data techniques and tools to address the problems in big data domain. (LOTS: Level 3: Apply)	2	2	2	-	-	-	-	-	-	-	-	-	1	3
CO4. **analyze** the big data techniques and tools for different scenarios. (HOTS: Level 4: Analyse).	3	3	3	1	2	-	-	-	-	-	-	-	2	3
CO5. **interpret** the outcomes/results of big data algorithms. (HOTS: Level 5: Evaluate).	3	3	3	2	-	-	-	-	-	-	-	-	2	3
CO6. **design complete** frameworkto address big data problems. (HOTS: Level 6: Create).	3	3	3	3	3	-	-	-	-	-	-	-	3	3
Level of Attainments PC/AIML/ 81-T														

Digital Forensics

General Course Information

Course Code: PE/AIML/81-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: working knowledge of Windows/Macintosh/Linux, Network security.

About the Course:
The course on Digital Forensics is an inevitable study in this information era. Computer crimes are on a hike by the hackers and cyber criminals. The need to recover the deleted, hidden and corrupted files on Windows/Macintosh/Linux platforms give an opportunity to offer digital forensics automating features. This will give students a chance to study laws of court against computer crimes committed intentionally or inadvertently.

Course outcomes: By the end of the course studentswill be able to:

CO1. **determine** the hardware and operating system requirements for digital forensics.(LOTS: Level 1: Remember)
CO2. **represent** digital forensics by organization of data and metadata in computer systems.(LOTS: Level 2: Understand)
CO3. **analyze** file recovery and hidden file extraction techniques. (HOTS: Level 4: Analyze)
CO4. **identify** various types of forensics in the arena of information technology. (HOTS: Level 4:Analyze)
CO5. **critic** the computer crimes by studying the security Laws and legal Landscape around the world.(HOTS: Level 5: Evaluate)
CO6. **integrate** security of computer systems with digital forensics and evaluate its performance. (HOTS: Level 6: create)

Course content

Unit I

Introduction to Digital Forensics: digital crimes, digital investigation, evidence, extraction, preservation etc.; overview of hardware and operating systems: structure of storage media/devices, Windows/Macintosh/Linux- registry, boot process; disk and file system analysis, data acquisition of physical storage devices.

Unit II

Data recovery: identifying hidden data, recovering deleted files; digital evidence controls: uncovering attacks that evade detection by event viewer, task manager and other windows GUI tools; disk imaging, recovering swap files, temporary and cache files; automating analysis and extending capabilities.

Unit III

Network Forensics: collecting and analyzing network-based evidence, reconstructing web browsing, email activity, intrusion detection, tracking offenders, windows registry changes, etc.; Mobile Network forensics: introduction, investigations, collecting evidences, where to seek digital data for further investigations; Email and database forensics; memory acquisition.

Unit IV

Computer crime and legal issues: intellectual property, privacy issues, criminal justice system for forensic, audit/investigative situations and digital crime scene, investigative procedure/standards for extraction, preservation and deposition of legal evidence in a court of law.

T**ext and Reference Books:**

1. Thomas J Holt , Adam M Bossler, Kathryn C Seigfried-Spellar, *Cybercrime and Digital Forensics: An Introduction*, Routledge, 2015.
2. Cory Altheide and Harlan Carvey,*Digital Forensics with Open Source Tools,* Elsevier publication, April 2011.
3. B. Nelson, A. Phillips, F. Enfinger, C. Steuart, *Guide to Computer Forensics and Investigations* 4th edition, Thomson, 2009.
4. Michael Hale Ligh, Andrew Case, Jamie Levy, AAron Walters, *The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory*,july 2014.

CO-PO Articulation Matrix Digital Forensics Course (PE/AIML/81-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1. **Determine** the hardware and operating system requirements for digital forensics. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2. **Represent** digital forensics by organization of data and metadata in computer systems. (LOTS: Level 2: Understand)	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3. **Analyze** file recovery and hidden file extraction techniques. (HOTS: Level 4: Analyze)	2	2	-	-	3	-	-	-	-	-	-	-	-	3	-
CO4. **Identify** various types of forensics in the arena of information technology. (HOTS: Level 4:Analyze)	2	2	2	2	3	-	-	-	-	-	-	-	-	3	2
CO5. **Critic** the computer crimes by studying the security Laws and legal Landscape around the world. .(HOTS: Level 5: Evaluate)	3	3	3	3	-	3	-	3	-	3	-	-	-	3	-
CO6. **Integrate** security of computer systems with digital forensics and evaluate its performance. (HOTS: Level 6: create)	3	3	2	3	3	-	-	-	-	-	-	-	-	3	-
Level of Attainments PE/AIML/81-T															

Social Network Analysis

General Course Information

Course Code: PE/AIML/82-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Background knowledge of statistics, data analysis techniques and scripting tools are useful.

About the Course:
This course introduces concepts and theories of social network analyses. Application areas include human behavior, community and trend detection, sentiment analysis, and development and visualize social network results.

Course outcomes: By the end of the course studentswill be able to:

CO1. **recall** the terminology associated with network science and analysis. (LOTS: Level 1: Remember)
CO2. **describe**concepts and algorithms of social network analysis. (LOTS: Level 2: Understand)
CO3. **apply**social network techniques to address the issues in the domain. (HOTS: Level 4: Apply)
CO4. **analyze** the challenges forsocial network algorithms and privacy issues. (HOTS: Level 4:Analyze)
CO5. **judge** the performance of various social network algorithms.(HOTS: Level 5: Evaluate)
CO6. **create** novel techniques for social network analysis. (HOTS: Level 6: create)

Course content

Unit I

Introduction to network science, Descriptive network analysis, mathematical models of networks, Introduction to semantic web and limitations, Development of semantic web, Emergence of the Social Web, Social network analysis,Expansion of social network analysis, Key concepts and measures in network analysis, E-sources for network analysis,E-discussion

networks, Blogs and online communities, Web-based networks, Applications of Social Network Analysis.

Unit II

Extracting process of web community from a series of web archive,detecting communities in social networks, Definition of community,evaluating communities, Methods for community detection and mining, Applications of community in mining algorithms, Tools for detecting communities, social network infrastructures, Decentralized online social networks,Multi-Relational characterization of dynamic social network communities.

Unit III

Understanding and predicting human behaviour for social communities, User data management, Inference and Distribution,enabling new human experiences, Reality mining,Concept of context, Awareness and Privacy in online social networks, Trust in online environment, Trust models based on subjective logic, Trust network analysis, Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and countermeasures.

Unit IV

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

Text Books and References:

1. J. Golbeck, *Analyzing the social web*, First edition.Morgan Kaufmann, Elsevier, 2013.
2. B. Furht, Ed., *Handbook of Social Network Technologies and Applications*. New York,Springer US, 2010.
3. P. J. Carrington, J. Scott, and S. Wasserman, “Models and Methods in Social: Network Analysis,” 2005.
4. M. Tsvetovat and A. Kouznetsov, “Social Network Analysis for Startups”.
5. S. Wasserman and K. Faust, *Social network analysis: methods and applications*. in Structural analysis in the social sciences, Cambridge, New York: Cambridge University Press, 1994.
6. J. G. Breslin, A. Passant, and S. Decker, *The Social Semantic Web*. Berlin, Heidelberg: 2009.
7. G. Xu, Y. Zhang, and L. Li, *Web Mining and Social Networking: Techniques and Applications*. Boston, MA: Springer US, 2011.

CO-PO Articulation Matrix: Social Network Analysis (PE/AIML/82-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Recall** the terminology associated with network science and analysis. (LOTS: Level 1: Remember)	1	-	-	1	-	-	-	-	-	-	-	-	-	1
CO2. **Describe** concepts and algorithms of social network analysis. (LOTS: Level 2: Understand)	2	1	1	1	-	-	-	-	-	-	-	-	1	2
CO3. **Apply** social network techniques to address the issues in the domain. (HOTS: Level 3: Apply)	3	2	2	2	-	-	-	-	-	-	-	-	2	2
CO4. **Analyze** the challenges for social network algorithms and privacy issues. (HOTS: Level 4:Analyze)	3	2	3	2	-	-	-	-	-	-	-	-	1	3
CO5. **Judge** the performance of various social network algorithms. (HOTS: Level 5: Evaluate)	3	2	2	2	-	-	-	-	-	-	-	-	2	3
CO6. **Create** novel techniques for social network analysis. (HOTS: Level 6: create)	3	3	3	3	-	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/82-T														

ComputerVision

General Course Information

Course Code: PE/AIML/83-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Linear algebra, Calculus, and. Basics of programming using python.

About the Course

Computer Vision includes methods of acquiring, processing, analysing and understanding digital images and gaining insights from them. This course includes introduction to computer vision as a new advancement in technology. We start from understanding the concepts of images, colors, 2D-3D images. Then we understand about image formation, image processing, technologies used for image classification and application of computer vision.

Course Outcomes: By the end of the course students will be able to:

CO1. **outline** the basicsof computer vision and image processing domain. (LOTS: Level 1: Remember)
CO2. **describe** the fundamental concepts of image processing, sampling, image smoothing, filtering and transformations etc.(LOTS: Level 2: Understanding)
CO3. **Solveproblems** usingimageprocessing and computer vision techniques. (LOTS: Level 3: Apply)
CO4. **analyze**computer vision, image processing and deep learning algorithms for diverse applications. (HOTS: Level 4: Analyse).
CO5. **Design** complete solutions by synthesising your knowledge from computer vision, machine learning and image processing.

Course Contents

Unit-1

Introduction to Computer Vision: Basics of computer vision, its history and applications, Imaging and Image representation: sensing light, reflection and shading, optics, Imaging devices(Digital Camera), Image Formation: 2D transformations, 3D transformations, 3D rotations, 3D to 2D projections.

Unit-II

Image Processing: Need of image processing, pixel transforms, color transforms, histogram equalization, Linear filtering: separable filtering, examples of linear filtering, band pass and steerable filters, Non-linear filtering, binary image classification, Fourier transformation, 2D Fourier transformation and applications, Wavelets transformation, Geometric Transformation. Sampling and Aliasing, image smoothing.

Unit III

Edge detection: Edges and gradient based edge detectors, Differentiation and noise, Feature extractions: finding patterns, normalized correlation, human vision, the visual pathway and a model for early spatial vision.

Textures: analysis of textures, shape for textures and applications.

Unit IV

Introduction to Deep Learning: Supervised Learning, Unsupervised learning, Neural networks: Convolutional Neural networks, network architecture, visualizing weights and activation function, applications of convolutional neural network, 3D NN, recurrent NN, generative models.

Applications of Computer Vision: Image classification: Feature based methods, Face recognition, Object detection: face detection, general object detection, Image segmentation: instance segmentation, medical image diagnosis, retail and e-commerce, autonomous driving and augmented reality.

Text and Reference Books:

1. Richard Szeliski, Computer vision: Algorithms and applications, springer 2nd edition, 2022.
2. Forsyth and Pounce, Computer Vision: A modern approach, Pearson 2nd edition, 2011.
3. Shaprio, Linda G., Stockman, George C., Computer Vision, Pearson 1st edition, 2001.

CO-PO Articulation Matrix: Computer Vision (PE/AIML/83-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14
CO1. **outline** the basics of computer vision and image processing domain. (LOTS: Level 1: Remember)	1	1	1	-	-	-	-	-	-	-	-	-	1	3
CO2. **describe** the fundamental concepts of image processing, sampling, image smoothing, filtering and transformations etc.(LOTS: Level 2: Understanding)	2	2	2	-	-	-	-	-	-	-	-	-	2	3
CO3. **Solve problems** usingimageprocessing and computer vision techniques. (LOTS: Level 3: Apply)	3	2	2	1	-	-	-	-	-	-	-	-	2	3
CO4. **analyze**computer vision, image processing and deep learning algorithms for diverse applications. (HOTS: Level 4: Analyse).	3	3	3	2	-	-	-	-	-	-	-	-	2	3
CO5. **Design** complete solutions by synthesising your knowledge from computer vision, machine learning and image processing	3	3	3	3	-	-	-	-	-	-	-	-	3	3
Level of Attainments PE/AIML/83-T														

Pattern Recognition

General Course Information

Course Code: PE/AIML/84-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Data mining, data analytics.

About the Course:

Course Outcomes: By the end of the course studentswill be able to:

CO7. **State** the introductory fundamentals of pattern recognition, Maximum Likelihood and Bayesian Parameter estimation, Linear discriminant functions. (LOTS: Level 1: Remember)

CO8. **Describe** various types of pattern recognition concepts and techniques. (LOTS: Level 2: Understand)

CO9. **Find** solutions for pattern recognition problems. (LOTS: Level 3: Apply)

CO10. **Analyze**classification problems probabilistically and estimate classifier performance. (HOTS: Level 4: Analyse)

CO11. **Evaluate**the performance of pattern recognition algorithms. (HOTS: Level 5: Evaluate)

CO12. **Design** algorithms and pattern recognition systems. (HOTS: Level 6: Design)

Course Content

Unit I

Introduction - Basic concepts, Applications, Fundamental problems in pattern Recognition system design, Design concepts and methodologies, The Design Cycle, Learning and Adaptation., Examples of Automatic Pattern recognition systems, Simple pattern recognition model, Decision and Distance Functions - Linear and generalized decision functions, Pattern space and weight space, Geometrical properties, implementations of decision functions, Minimum-distance pattern classifications. Bayes Decision Theory: Bayes Decision Theory, Minimum Error rate Classification.

Unit II

Maximum Likelihood and Bayesian Parameter Estimation: Maximum Likelihood Estimation, Bayesian Estimation, Bayesian Parameter Estimation, Gaussian Case and General Theory. Hidden Markov models; Non Parametric Techniques: Density Estimation, Parzen Windows, K-Nearest Neighbor Estimation, Nearest Neighbour rule, Metrics and Nearest Neighbour Classification, Fuzzy Classification, k-Means Clustering, Self-Organizing Maps.

Non Parametric Decision Making - Introduction, histogram, kernel and window estimation,. Adaptive decision boundaries, adaptive discriminate functions, Minimum squared error Discriminate functions.

Unit III

Linear Discriminant Functions: Linear Discriminant Functions and Decision Surfaces, Generalized Discriminant Functions, The two-category linearly separable case, Minimizing the perceptron criterion function, relaxation procedures, non- separable behaviour, Minimum Squared- Error procedures. Support vector machines, Algorithm-independent machine learning-Bias and Variance, Bootstrapping-Adaboost Algorithm, Boosting, Bagging

Unit IV

Syntactic Pattern Recognition & Application of Pattern Recognition: Introduction, concepts from formal language theory, formulation of syntactic pattern recognition problem, syntactic pattern description, recognition grammars, automata as pattern recognizers, Application of pattern recognition techniques in bio-metric, facial recognition, IRIS scan, Finger prints, etc..

T**ext and Reference Books:**

5. R. O. Duda, P. E. Hart and D. G. Stork, Pattern classification, John Wiley & Sons, 2002.
6. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.
7. V. N. Vapnik, The Nature of Statistical Learning Theory, Springer, 2000.
8. N. Cristianini and J. Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.

CO-PO Articulation Matrix: Pattern Recognition (PE/AIML/84-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14
CO1. **State** the introductory fundamentals of pattern recognition, Maximum Likelihood and Bayesian Parameter estimation, Linear discriminant functions. (LOTS: Level 1: Remember)	1	1	1	-	-	-	-	-	-	-	-	-	1	3
CO2. **Describe** various types of pattern recognition concepts and techniques. (LOTS: Level 2: Understand)	2	2	2	-	-	-	-	-	-	-	-	-	2	3
CO3. **Find** solutions for pattern recognition problems. (LOTS: Level 3: Apply)	2	2	2	1	-	-	-	-	-	-	-	-	2	3
CO4. **Analyze**classification problems probabilistically and estimate classifier performance. (HOTS: Level 4: Analyse)	3	3	3	2	-	-	-	-	-	-	-	-	2	3
CO5. **Evaluate** the performance of pattern recognition algorithms. (HOTS: Level 5: Evaluate)	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO6. **Design** algorithms and pattern recognition systems. (HOTS: Level 6: Design)	3	3	3	3									3	3
Level of Attainments PE/AIML/84-T														

Quantum Computing

General Course Information

Course Code: PE/AIML/85-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Linear algebra and preferably basics of quantum mechanics.

About the Course

Quantum computing can be used to compute the answers to certain problems much faster than any classical system or computer can. This course provides a concise introduction to quantum computing from a computer science perspective. Initially we delve into the basics of linear algebra, complex vector space and quantum mechanics required for the course. Subsequently, we take up on quantum gates, circuits and algorithms, error correcting codes etc.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** the basic principles of linear algebra, quantum mechanics quantum gates, quantum circuits and the related quantum computing concepts. (LOTS: Level 1: Remember)

CO2. **describe** the fundamental concepts of qubits, quantum gates, and quantum circuits, quantum entanglement, quantum search algorithms and quantum error correction codes etc.(LOTS: Level 2: Understanding)

CO3. **apply**the principles of quantum computing to solve problemsthat cannot be solved by classical computing. (LOTS: Level 3: Apply)

CO4. **illustrate** the importance of quantum error correction techniques in building reliable quantum computing systems. (LOTS: Level 3: Apply

CO5. **analyze**quantum algorithms, including their applications and advantages over classical algorithms. (HOTS: Level 4: Analyse).

Course Contents

Unit-1

Review of Linear Algebra:

Bases and linear independence, Linear operators and matrices, The Pauli matrices, Inner product, Eigenvectors and eigen values, Adjoint and Hermitian operators, Tensor products, Operator functions, The polar and singular value decomposition.

Introductory Quantum Mechanics:

Basic principles of quantum mechanics, State space, quantum measurements, distinguishing quantum states, projective measurements, POVM measurements, phase, composite systems, Superdense coding, The density operator, The Schmidt decomposition and purifications, EPR and Bell inequality.

Unit-II

Quantum Computing Fundamentals:

Qubits, Single qubit gates, Multiple qubitgates, quantum circuits, qubit copying circuit, quantum measurement and quantum state collapse, Bell states, quantum parallelism and superposition, quantum teleportation. classical computation on a quantum computer, The Deutch-Jozsa algorithm.

Unit –III

Quantum Circuits:

Quantum algorithms, Single qubit operations, Controlled operations, Measurements, universal quantum gates, two level unitary gates, single qubit and CNOT gates, A discrete set of universal operations, The quantum simulation illustrative example, quantum fourier transform, quantum search algorithms: Grover's Algorithm, Quantum Factoring: Shor's Algorithm.

Unit– IV

Quantum Information and Quantum Error Correction:

Quantum Entanglement, Classical noise and Markov process, quantum operations, examples of quantum noise and quantum operations, quantum teleportation and superdense coding.

Quantum Error Correction: The three-qubit flip code, three qubit phase flip code, The Shor code, theory of quantum error correction,fault-tolerant quantum computing,quantum cryptography.

Text and Reference Books:

1. Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum, Information*, Cambridge University Press, 2000.
2. Noson S. Yanofsky and Mirco A. Mannucci, *Quantum Computing for Computer Scientists*, Cambridge University Press, 2008.
3. Eleanor Rieffel and Wolfgang Polak, *Quantum computing: A gentle introduction*, MIT Press, 2014.
4. N. David Mermin, Quantum computer science: An introduction, Cambridge Univ. Press, 2007.

CO-PO Articulation Matrix: Quantum Computing (PE/AIML/85-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1. **Define** the basic principles of linear algebra, quantum mechanics quantum gates, quantum circuits and the related quantum computing concepts.(LOTS: Level 1: Remember)	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2. **Describe** the fundamental concepts of qubits, quantum gates, and quantum circuits, quantum entanglement, quantum search algorithms and quantum error correction codes etc. (LOTS: Level 2: Understanding)	2	2	-	-	-	-	-	-	-	-	-	-	-	1	2
CO3. **Apply**the principles of quantum computing to solve problemsthat cannot be solved by classical computing. (LOTS: Level 3: Apply)	3	3	1	1	-	-	-	-	-	-	-	-	-	2	2
CO4.**Illustrate** the importance of quantum error correction techniques in building reliable quantum computing systems. (LOTS: Level 3: Apply)	3	3	2	2	-	-	-	-	-	-	-	-	-	2	2
CO5.**Analyze**quantum algorithms, including their applications and advantages over classical algorithms. (HOTS: Level 4: Analyse).	3	3	3	3	-	-	-	-	-	-	-	-	1	3	3
Level of Attainments PE/AIML/85-T															

Optimization Methods

General Course Information:

Course Code: PE/AIML/86-T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Exam Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Prerequisite: Background in differential calculus and basic maths.

About the Course

This course introduces the basic concepts of optimization methods as an important segment of Operation Research. These methods use the concepts of maximization or minimization of parameters to find the solution of problem. The course focuses on the mathematical modelling of real-life problems using optimization methods. The course encompasses on linear programming problems, Integer linear programming problems, Transportation problems, Assignment problems. Moreover, this course also covers the project management techniques, resource allocation and queueing theory concepts.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** the basic terms related to linear programming problems, integer programming problems, transportation and assignment problems, project management techniques and queueing systems. (LOTS: Level 1: Remember)

CO2. **formulate** linear programming problems, integer programming problems, transportation and assignment problems. (LOTS: Level 2: Understanding)

CO3. **apply** techniques of linear programming problems, integer programming problems, transportation and assignment problems to obtain optimal solutions. (LOTS: Level 3: Apply)

CO4. **select**an appropriate method to solve optimizationand queuing theory problems. (LOTS: Level 4: Analyse)

CO5. **Optimize** the allocation of resources using project management techniques like PERT/CPM.(HOTS: Level 5: Evaluate)

CO6. **model** real-world problems using various concepts of optimization methods. (LOTS: Level 6: Create)

Course Contents

Unit-1

Introduction to linear and non-linear programming problems, formulation of LPP, Graphical solution, Standard and matrix form of LPP, Assumptions in LPP, Limitations, application and advantages of LPP, solution of LPP by Simplex method, Two phase method, Big-M method, disadvantages of Big-M method over Two phase method, Degeneracy problem, Special cases: Alternative solutions, Unbounded solutions, Non-existing solutions.

Unit-II

Revised simplex method, Duality in linear programming: concept of duality, Primal-Dual problems, general rules for converting any primal to its dual, Dual simplex method, advantages of Dual simplex method over Simplex method, difference between simplex and Dual simplex method, Integer linear programming: Importance of Integer programming problems, Gomory's cutting plane method, Branch and bound method.

Unit-III

Transportation problems: Finding an initial basic feasible solution by Northwest corner rule, Least cost rule, Vogel's approximation method, degeneracy, optimality test, MODI method, stepping stone method, Assignment problems: Hungarian method for assignment problem, unbalanced assignment problems.

Unit-IV

Project management by PERT-CPM: Applications of PERT/CPM techniques, basic steps in PERT/CPM techniques, Network diagram representation, rules for drawing network diagram, Time estimates and critical path in network analysis, Project evaluation and review technique, resource allocation, Queueing theory: Queueing system, queueing problem, transient and steady states, traffic intensity, probability distributions in queueing systems, Kendall's notation for queueing models, $(M \mid M \mid 1) : (\infty \mid FCFS)$: Birth and death model, General erlang queueing model (birth-death process), $(M \mid M \mid 1) : (\infty \mid SIRO)$ model, $(M \mid M \mid 1) : (N \mid FCFS)$ model.

T**ext and Reference Books:**

1. Hamdy A. Taha, *Operations Research: An Introduction*, Pearson, Tenth edition, 2017.
2. S. D. Sharma, *Operations Research: Theory*,Methods and Applications,2020th edition., Kedar Nath Ram Nath & Co., 2014.
3. Wayne L. Winston, *Operations Research: Applications and Algorithms*, Thomson, Fourth edition, 2004.
4. P. K. Gupta and D. S. Hira, *Operations Research*, 2017th edition, S. Chand & Co Ltd., 2017.

CO-PO Articulation Matrix: Optimization Methods(PE/AIML/86-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** the basic terms related to linear programming problems, integer programmingproblems, transportation and assignment problems, project management techniques and queueing systems. (LOTS: Level 1: Remember)	1	1	-	1	-	-	-	-	-	-	-	-	1	1
CO2. **Formulate** linear programming problems, integer programming problems, transportation and assignment problems. (LOTS: Level 2: Understanding)	2	2	-	2	-	-	-	-	-	-	-	-	2	2
CO3. **Apply** techniques of linear programming problems, integer programming problems, transportation and assignment problems to obtain optimal solutions. (LOTS: Level 3: Apply)	3	3	-	3	-	-	-	-	-	-	-	-	2	3
CO4. **Select** an appropriate method to solve optimization and queuing theory problems. (LOTS: Level 4: Analyse)	3	3	-	3	-	-	-	-	-	-	-	-	3	3
CO5. **Optimize** the allocation of resources using project management techniques like PERT/CPM.(HOTS: Level 5: Evaluate)	3	3	-	3	-	-	-	-	-	-	-	-	3	3
CO6. **Model** real-world problems using various concepts of optimization methods. (LOTS: Level 6: Create)	3	3	-	3	-	-	-	-	-	-	-	-	3	3
Level of Attainments PE/AIML/86-T														

Blockchain Technology

General Course Information

Course Code: PE/AIML/87-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Basics of Cryptographic Hash Functions

About the Course:

This course provides a broad overview of the essential concepts of blockchain technology by initially exploring the Bitcoin protocol followed by the Ethereum protocol to lay the foundation necessary for developing applications.

Course Outcomes: By the end of the course students will be able to:

CO1. **describe** the basic concepts and technology used for blockchain.(LOTS: Level 1: Remember)
CO2. **explain** the primitives of the distributed computing and cryptography related to blockchain. (LOTS: Level 2: Understand)
CO3. **illustrate** the concepts of Bitcoin and their usage. (LOTS: Level 2: Understand)
CO4. **apply** security features in blockchain technologies. (LOTS: Level 3: Apply)
CO5. **identify** challenges in smart contract in real world applications.(HOTS: Level 4: Analyse)
CO6. **devise**Ethereum block chain contract. (HOTS: Level 6: Create)

Course Contents

Unit I

Overview of Blockchain Technology: Defining Blockchain and Distributed Ledger, Blockchain properties decentralized, transparent, immutable and secure. Blockchain applications. Types of blockchain: Public, private, and consortium based blockchain, when to use, and when not to use blockchain, History of blockchain.

Introduction to computing models and P2P networking: Centralized, Decentralized and Distributed Systems, Decentralization vs distributed, P2P systems, propertied of P2P systems, P2P communication architecture. P2P network applications: File sharing, P2P network for

Blockchain

Unit II

Foundational Concepts in Blockchain Data Structure: Cryptographic Hash Functions, Digital Signatures, Public Keys as Identities, Hash Pointers and Hash chain and Merkel tree, Consensus mechanisms

Blockchain Characteristics: Decentralized Identity management, Transactions, incentivizing and mining. Distributed Consensus (PoW), Cryptocurrency as the first blockchain application. Mechanics of Bitcoin, Bitcoin Scripts, Storing and Using Bitcoins, Mining in Bitcoin.

Unit III

Consensus Mechanisms: Proof of storage, proof of stake, proof of deposit, proof of burn, proof of activity. algorithms for adjusting difficulty and retargeting. Limitations of Bitcoin, alternative cryptocurrencies.

Smart Contracts and Ethereum: Purpose and types of smart contracts, Introduction to Ethereum, bitcoin vs Ethereum stack. P2P network in Ethereum, consensus in Ethereum, scripts in Ethereum, Smart contracts (Ethereum Virtual Machine). Developing and executing smart contracts in Ethereum. State and data structure in Ethereum.

Unit IV

Private and Consortium based BlockchainHyperledger: Need for the consortium. Hyperledger stack, Multichainblockchain, Innovation in Hyperledger, smart contracts, and distributed applications in Hyperledger.

Case studies/ Enabling Technologies and applications: Application of blockchain in privacy and security, IoT and smart cities, Business and Industry, Data management, e-Governance.

Text and Reference Books and Links:

1. Imran Bashir, *Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained*, Packt Publishing, 2018.
2. Daniel Drescher, *Block Chain Basics*, Apress; 1stedition, 2017.
3. Josh Thompsons, *Block Chain: The Block Chain for Beginners- Guide to Blockchain Technology and Leveraging Blockchain Programming*, Createspace Independent Pub, 2017.
4. Pethuru Raj, Kavita Saini, ChellammalSurianarayanan, *Blockchain Technology and Applications*, CRC Press, 2021.
5. Raj K., *Foundation of Blockchain: The pathway to cryptocurrency and decentralized blockchain application*, 1st ed. Packt Publishing Ltd, 2019.
6. S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, *Blockchain Technology: Cryptocurrency and Applications*, Oxford University Press, 2019
7. Melanie Swan, *Blockchain: Blueprint for a New Economy*, O'Reilly, 2015.
8. Amit Dua, *Blockchain Technology and Applications: A systematic and Practical approach*, Amazon LLC, 2022

CO-PO Articulation Matrix: Block chain Technology(PE/AIML/87-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Describe** the basic concepts and technology used for blockchain. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2. **Explain** the primitives of the distributed computing and cryptography related to blockchain. (LOTS: Level 2: Understand)	2	1	-	-	-	-	-	-	-	-	-	-	-	2
CO3. **Illustrate** the concepts of Bitcoin and their usage. (LOTS: Level 2: Understand)	2	1	-	-	-	-	-	-	-	-	-	-	-	2
CO4. **Apply** security features in blockchain technologies. (LOTS: Level 3: Apply)	2	2	-	1	-	-	-	-	-	-	-	-	-	3
CO5. **Identify** challenges in smart contract in real world applications. (HOTS: Level 4: Analyse)	3	3	1	2	-	-	-	-	-	-	-	-	-	3
CO6. **Devise** Ethereum block chain contract. (HOTS: Level 6: Create)	3	3	2	2	-	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/87-T														

Introduction to Augmented and Virtual Reality

General Course Information

Course Code: PE/AIML/88-T Course Credits: 3 Type: Programme Elective Contact Hours: 3hours/week Mode: Lectures (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Augmented and Virtual reality basic.

About the Course

The objective of this course is to provide a foundation to the fast growing field of Augmented Reality and Virtual Reality. This course provides brief introduction to Augmented Reality and Virtual Reality, AR and VR software development. In this course, students will learn about VR modelling, 3D interactions, 3D user interfaces, Strategies for Designing and Developing 3D UIs etc.

Course Outcomes: By the end of the course students will be able to:

CO1. **define** the concepts pertaining to augmented reality and virtual reality, AR and VR techniques etc. (LOTS: Level 1: Remember)

CO2. **describe** the fundamental principles applications and challenges of augmented and visual reality, VR modelling, 3D interaction UIs etc. (LOTS: Level 2: Understand)

CO3. **find** solutions to real world problems involving the use of augmented and virtual reality. (LOTS: Level 3: Apply)

CO4. **analyse** the techniques available in the domain of augmented and virtual reality. (LOTS: Level 4: Analyse)

CO5. **comment** on the outcomes of the augmented and virtual reality solutions. (LOTS: Level 5: Evaluate)

Course Contents

Unit-I

Introduction to Augmented Reality (AR):Definition and Scope of AR, History of Augmented Reality, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays), Merits and demerits of AR. Applications of AR, Challenges in AR

Unit-II

Introduction to Virtual Reality (VR):

Definition and Scope of VR, Types of VR, Characteristics of VR, Components of VR system, Designing & Building VR Systems,Benefits of VR, Limitations of VR environments, Key hardware requirements for VR, Difference between VR and AR

Unit-III

AR software development :AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit.

VR software development : Challenges in VR software development, Master/slave and Client/server architectures, Cluster rendering, Game Engines and available sdk to develop VR applications for different hardware (HTC VIVE, Oculus, Google VR).

Unit-IV

VR Modeling:

Geometric modeling, Kinematic, Physical and Behavior modeling, Selection and Manipulation during 3D Interaction, Travel and Wayfinding in Virtual Environments, Strategies for Designing and Developing 3D UIs, Evaluation of 3D User Interfaces, Traditional and Emerging VR/AR applications

Text and Reference Books:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition.Wiley-IEEE Pr ess, 2003/2006.
2. *D.A. Bowman* et al., "3D User Interfaces: Theory and Practice", Addison Wesley.
3. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan K aufmann, 2013.
4. GJ Kim, "Designing VR Systems: The Structured Approach", Springer, 2005.

CO-PO Articulation Matrix: Introduction to Augmented and Virtual Reality (PE/AIML/88-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1. **Define** the concepts pertaining to augmented reality and virtual reality, AR and VR techniques etc. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2. **Describe** the fundamental principles applications and challenges of augmented and visual reality, VR modelling, 3D interaction UIs etc. (LOTS: Level 2: Understand)	2	-	1	-	-	-	-	-	-	-	-	-	-	2
CO3. **Find** solutions to real world problems involving the use of augmented and virtual reality. (LOTS: Level 3: Apply)	2	1	2	1	-	-	-	-	-	-	-	-	-	3
CO4. **Analyse** the techniques available in the domain of augmented and virtual reality. (LOTS: Level 4: Analyse)	3	2	2	2	-	-	-	-	-	-	-	-	-	3
CO5. **Comment** on the outcomes of the augmented and virtual reality solutions. (LOTS: Level 5: Evaluate)	3	3	2	3	-	-	-	-	-	-	-	-	-	3
Level of Attainments PE/AIML/88-T														

Federated Learning

General Course Information:

Course Code: PE/AIML/89-T Course Credits: 3 Type: Programme Elective Contact Hours: 3 hours/week Mode: Lectures (L) Exam Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Prerequisite: Machine Learning and proficiency in Python

About the Course

The machine learning applications are spread around many fields such as health care, financial, marketing agriculture, and space organisations. The machine learning algorithms, specifically, deep learning techniques require millions of data tuples to achieve a reasonable acceptable performance. Very often the data required is not located at one place rather it is distributed across several locations or edge devices. One approach could be to gather all the data at cloud server, integrate it and then run machine learning algorithms. This approach is time consuming and not feasible due to data privacy issues. The solution is federated learning. The models are learnt with smaller size training data at the side of edge devices. These models are encrypted and sent to the cloud server for constructing the aggregated model. The aggregated model can be downloaded by the edge devices. This course aims to introduces the students with principles and algorithms for federated learning, relatively a novel area of research.

Course Outcomes: By the end of the course students will be able to:

CO1. **define**the related terms and concepts of federated learning. (LOTS: Level 1: Remember)

CO2. **describe**the federated learning's principles, significance, potential benefits, challenges, security, communication efficiency and optimizations issues. (LOTS: Level 2: Understanding)

CO3. **apply**the federated learning algorithms and respective optimization techniques. (LOTS: Level 3: Apply)

CO4. **analyze**issues regarding applications of federated learning, in domains such as healthcare, IoT, financeetc. and adapt federated learning to cater to domain-specific challenges. (HOTS: Level 4: Analyse).

CO5. **evaluate** ongoing research and ethical issues for federated learning environments.(HOTS: Level 5: Evaluate)

Course Contents

Unit1

Overview of federated learning and its significance, comparing traditional centralized machine learning with federated learning, Privacy and security challenges in distributed learning.

Decentralized data sources: Types of decentralized data sources, Data heterogeneity and distribution challenges, Federated datasets and data representation.

Ethical and legal considerations: Fairness, bias and accountability in federated learning, regulatory compliance and data protection laws, ethical implications of decentralized machine learning.

UnitII

Privacy and Security in Federated Learning: Privacy preserving techniques (differential privacy, secure aggregation), Federated learning framework for privacy protection, Threat models and security models, adversary security models, Privacy preservation techniques.

Federated learning algorithms: Federated averaging and weighted averaging, communication-efficient optimization methods, model aggregation techniques, Privacy preserving decision trees, Privacy preserving DML schemes. Architecture of horizontal and vertical federated learning, Secure federated linear regression and tree boosting algorithms.

Unit III

Optimization techniques for federated learning: Federated stochastic gradient descent, federated meta-learning, Adaptive learning rate techniques.

Communication and bandwidth optimization: Model compression and quantization method, Bandwidth efficient communication protocols.

UnitIV

Applications of federated learning: Finance, Healthcare and medical applications, Internet of thing and edge computing.

Research trends and future directions: Current research challenges in federated learning, federated transfer learning (FTL), Federated transfer learning framework, The FTL training process, The FTL prediction process, Federated reinforcement learning: Policy, reward, value function, model of environment, RL example. reinforcement learning algorithms.

Text and Reference Books:

Yang Liu, Tianjian Chen, and Qiang Yang, Federated Learning: Theory and Practice, 2023.

Research papers:

1. Q. yang, et al., Federated Machine Learning: Concept and Applications, *ACM Trans. Intell. Syst. Technology*, Vol. 10, No. 2, 2019.

2. Li. Tian et al., Federated Learning: Challenges, Methods, and Future Directions, *IEEE Signal Processing Magazine*, Vol. 37, No. 3, 2020.
3. Jakub Konecnyet al., Federated Learning: Strategies for Improving Communication Efficiency, NIPS Workshop on Private Multi-Party Machine Learning, 2016.
4. H. Brendan McMahan et al., Communication-Efficient Learning of Deep Networks from Decentralized Data, *Proceedings of the 20th International Conference on Artificial Intelligence and Statistics*, Florida, USA, 2017.
5. Daniel Ramage et al., Federated Learning for Mobile Keyboard Prediction, *Google LLC*, Mountain View, CA, U.S.A., 2018.
6. M. Joshi et al., Federated Learning for Healthcare Domain - Pipeline, Applications and Challenges, *ACM Transactions on Computing for Healthcare*, Vol. 3, No. 4, 2022.
7. Li, Hao et al. Review on security of federated learning and its application in healthcare, *Future Generation Computer Systems*, Vol. 144, 2023.

CO-PO Articulation Matrix: Federated Learning(PE/AIML/89-T)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1. **Define**the related terms and concepts of federated learning. (LOTS: Level 1: Remember)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2. **Describe**the federated learning's principles, significance, potential benefits, challenges, security, communication efficiency and optimizations issues. (LOTS: Level 2: Understanding)	2	1	-	-	-	1	-	1	-	-	-	-	-	-	2
CO3. **Apply**the federated learning algorithms and respective optimization techniques. (LOTS: Level 3: Apply)	3	2	-	1	-	-	-	-	-	-	-	-	-	-	3
CO4.**Analyze**issues regarding applications of federated learning, in domains such as healthcare, IoT, finance etc. and adapt federated learning to cater to domain-specific challenges. (HOTS: Level 4: Analyse).	3	3	-	2	-	2	-	2	-	-	-	-	-	-	3
CO5.**Evaluate** ongoing research and ethical issues for federated learning environments.(HOTS: Level 5: Evaluate).	3	3	3	3	-	3	-	3	-	-	-	-	-	-	3
Level of Attainments PE/AIML/89-T															

Big Data Analytics Lab.

General Course Information

Course Code: PC/AIML/81-P Course Credits: 2 Type: Professional Core Lab. Course Contact Hours: 4 hours/week Mode: Lab practice and assignments	**Course Assessment Methods (internal: 50; external: 50)** The internal and external assessment is based on the level of participation in lab. Sessions and the timely submission of lab experiments/ assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department.

Pre-requisites: Data Analytics, Big Data Analytics

About the Course:

The course familiarizes students with Hadoop distributions, configuring Hadoop and performing File management tasks. It also includes implementation of storage of big data using MongoDB,MapReduce programs for processing big data for various applications, andProcessing Large datasets using programming tools like PIG & HIVE in Hadoop ecosystem.

Course Outcomes: By the end of the lab course a student would be able to:

CO 1. **configure** and install HDFS and apply big data analytics technique for solving big data problems. (LOTS: Level 3: Apply)

CO 2. **select and compare** big data analytics algorithms and tools for address diverse big data problems. (HOTS: Level 4: Analyse)

CO 3. **Interpret** the results of applying big data analytics techniques. (HOTS: Level 5: Interpret)

CO 4. **create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create).

CO 5. **demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)

List of Experiments:

1. Install, configure and run Hadoop and Hadoop Distributed file System (HDFS).
2. Develop a MapReduce program to calculate the frequency of a given word in a given file.

3. Develop a MapReduce program to find the maximum temperature in each year.
4. Develop a MapReduce program to implement Matrix Multiplication.
5. Develop a MapReduce to analyze weather data set and print whether the day is shiny or cool day.
6. Develop a program to calculate the maximum recorded temperature yearwise for the weather dataset in Pig Latin.
7. Write queries to sort and aggregate the data in a table using HiveQL.
8. Develop a Java application to find the maximum temperature using Spark.
9. Implement NoSQL Database Operations: CRUD operations, Arrays using MongoDB.
10. Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB.
11. Implement clustering techniques using SPARK
12. Implement an application that stores big data in MongoDB / Pig using Hadoop / R

Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course and the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester

CO-PO Articulation Matrix: Big Data Analytics Lab. (PC/AIML/81-P)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14
CO1. **configure** and install HDFS and apply big data analytics technique for solving big data problems. (LOTS: Level 3: Apply)	2	3	2	2	3	-	-	-	-	-	-	-	-	3
CO2. **select and compare** big data analytics algorithms and tools for address diverse big data problems. (HOTS: Level 4: Analyse)	3	3	-	2	3	-	-	-	-	-	-	-	-	3
CO3. **Interpret** the results of applying big data analytics techniques. (HOTS: Level 5: Interpret)	3	3	-	3	3	-	-	-	-	-	-	-	-	3
CO4. **create** lab assignment record that includes problem definitions, solutions, results and conclusions. (HOTS: Level 6: Create).	3	3	-	3	3	-	-	-	-	3	-	-	-	3
CO5. **demonstrate** ethical practices, self-learning and team spirit. (LOTS: Level 3: Apply)	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Level of Attainments: PC/AIML/81-P														

Major Project Part II

General Project Information

Course Code: EEC/AIML/81-P Course Credits: 6 Mode: Self learning under the guidance of a faculty member.	**Course Assessment Methods (Internal evaluation: 30 marks; External Evaluation marks: 70)** Evaluation is done by the internal examiner (project guide) and external examiner appointed by the Controller of Examination. The criteria for evaluation are given below. 1. Review of literature related to problem domain: 15 2. Significance and originality of the solution presented: 15 3. Application of software engineering principles and project management: 15 4. Significance and scope of results: 20 5. Organisation and presentation of major project report: 20 6. Level of Ethics and societal issues covered: 15

About the major project part II:

Students continue working on their project work and they are required to complete it by the end of 8th semester. Students carry out implementation of their respective projects based on the problem identified, methodology and tools suggested in the synopsis prepared during seventh semester. They prepare the final project reports according to the format provided. At the end of eighth semester, each student is required to present his/her project work in front of internal project guide and external examiner appointed by the Controller of Examination.

Course Outcomes: After doing major Project students will be able to:

CO1. **review** information critically for solving complex engineering problems. (HOTS: Level 4: Analyse)

CO2. **plan** the project according to principles of project management. (HOTS: Level 6: Create)

CO3. **devise** original solutions to complex engineering problems using modern engineering tools. (HOTS: Level 6: Create)

CO4. **justify** the outcomes of the project work. (HOTS: Level 5: Evaluate)

CO5. **organise** and communicate (written and oral) ideas effectively. (HOTS: Level 6: Create)

CO6. **develop** solutions that meet ethical, societal and legal considerations. (HOTS: Level 6: Create)

CO-PO Articulation Matrix Course (EEC/AIML/5**)**														
List of Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1. **Review** information critically for solving complex engineering problems. (HOTS: Level 4: Analyse)	2	2	2	3	-	-	-	-	-	-	-	-	-	3
CO2. **Plan** the project according to principles of project management. (HOTS: Level 6: Create)	1	1	1	-	3	-	-	-	-	-	3	3	-	3
CO3. **Devise** original solutions to complex engineering problems using modern engineering tools. (HOTS: Level 6: Create)	3	2	3	3	3	2	-	-	-	-	-	-	-	3
CO4. **Justify** the outcomes of the project work. (HOTS: Level 5: Evaluate)	3	3	3	3	-	2	-	-	-	-	-	-	-	3
CO5. **Organise** and communicate (written and oral) ideas effectively. (HOTS: Level 6: Create)	-	-	-	-	-	-	-	-	-	3	3	-	-	3
CO6. **Develop** solutions that meet ethical, societal and legal considerations. (HOTS: Level 6: Create)	-	-	-	-	-	-	-	3	3	-	-	3	-	3
Level of Attainments EEC/AIML/5														

(LISTOFOPEN ELECTIVES COURSES TO BE OFFERED BY CSE BRANCH TO THE STUDENTS OF OTHER BRANCH/ DEPARTMENT)

List of Open electives (For V semester):

OE/AIML/51-T: Internet&Application
OE/ AIML /52-T: Introduction to Software Engineering
OE/ AIML /53-T: Fundamental of Computer Networks
OE/ AIML /54-T: Fundamentals of PythonProgramming

List of Open electives (For VI semester):

OE/ AIML/61-T: Basics of Digital Marketing
OE/ AIML/62-T: Cyber Laws and IPR
OE/ AIML/63-T: Fundamentals of Information Security
OE/ AIML/64-T: Big Data
OE/ AIML/65-T: Introduction to Data Science

List of Open electives (For VII semester):

OE/ AIML/71-T: Basics of Cloud computing
OE/ AIML/72-T: Introduction to Software Project Management
OE/ AIML/73-T: Cyber security
OE/ AIML/74-T: IntelligentSystems
OE/ AIML/75-T: Basics of Machine Learning

Internet&Application

GeneralCourseInformation

Course Code: OE/ AIML /51-T Course Credits:3 Type:OpenElective ContactHours:3hours/wee k Mode: Lectures(L)Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: MathematicsandProgramming language.

Aboutthe Course:

This is an introductory course for students covering the clear idea of using the Internet, audio andvideoconferencingconceptseasily,associatetheprinciplesofwebbrowserandWebapplicationsandlearnconceptsofISDN,ADSLandIntranet.

CourseOutcomes:Bythe endofthe course studentswillbe able to:

CO1.**Understand**theconceptrelatingtoInternetand Web.(LOTS:Level1:Remember)**CO2**:Comparedifferenthigh speedconnectivedevice.(LOTS:Level 4:Analyze)**CO3**: Analyzethe connectionofLAN tointernet.(LOTS:Level3:Apply)
CO4:Constructanenvironmentfor chat,channelandWebConference.(LOTS:Level4:Create)
CO5:DescribeallconceptrelatedtoEmail.(LOTS:Level2:Understand)

CourseContent

Unit I

Overview: Computer Security Concepts, Security Attacks, Security Services, SecurityMechanism, A Model for Network Security, Symmetric Ciphers: Symmetric Cipher Model,SubstitutionTechniques, TranspositionTechniques, Steganography,BlockCiphersandtheDataEncryption, Euclid's Algorithm, Placement of Encryption Function, Traffic Confidentiality, keydistribution

UnitII

Public Key CryptoSystem and RSA:Prime Numbers,Fermat's and Euler's heorems,PrinciplesofPublic-KeyCryptography,theRSAAlgorithm,KeyManagement,DiffieHellmanKeyExchange,CryptographicHashFunction:Applications,Requirements&Security,SHA3,AuthenticationRequirements,AuthenticationFunctions

UnitIII

DigitalSignatures, DigitalSignatureStandards, Authentication Application & ElectronicMailSecurity: Kerberos,X.509AuthenticationService,PrettyGoodPrivacy,S/MIME.

UnitIV

IPSecurityandWebSecurity: IPSecurityoverview, IPSecurityPolicy,Encapsulating SecurityPayload,TransporTLevelSecurity,WirelessNetworkSecurity

TextandReferencebooks:

- Cryptographyand NetworkSecurity:Principals&Practice: byWilliamStallings
- CryptographyandNetworkSecurity:Atul kahate

CO-POArticulationMatrix Software Engineering Course (OE/ AIML /51-T):

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	1	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	_	2	2	_	_	_	2	_	3	_	_	_	_	_	_
CO4	_	2	2	_	_	_	2	_	_	2	_	_	2	_	_
CO5	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
3-High 2-Medium 1-Low															

Introduction to Software Engineering

GeneralCourseInformation

Course Code: OE/ AIML /52-T Course Credits:3 Type:OpenElective Contact Hours: 3 hours/weekMode:Lectures(L) Examination Duration: 3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Fundamentalofcomputerandprogramminglanguage

Aboutthe Course:

This is an introductory course for students specify software requirements, design thesoftware using tools, different testing techniques, planning and scheduling techniquesandapplicationofcomputing-basedsolutions.

CourseOutcomes:Bythe endofthe course studentswillbe able to:

CO1.**Understand**theconceptrelatingtoSoftwareandSoftwaretool.(LOTS:Level1:Remember)
CO2:Comparedifferenttestingtechniques.(LOTS:Level4:Analyze)
CO3:Analyzetheplanningandschedulingtechniques.(LOTS:Level3:Apply)
CO4:Constructanapplicationofcomputing-basedsolutions.(LOTS:Level4:Create)
CO5:Describeallconceptrelatedtostructuredandobjectorientedanalysis&design..
(LOTS:Level2:Understand)

CourseContent

UnitI

TheProduct-TheProcess-Project ManagementConcepts-SoftwareProjectsandProject Metrics-SoftwareProjectPlanning-RiskAnalysisAndManagement.

UnitII

ProjectSchedulingAndTracking-SoftwareQualityAssurance-SoftwareConfigurationManagement-SystemEngineering-AnalysisConceptsAndPrinciples-

AnalysisModeling.

UnitIII

DesignConceptsAndPrinciples–ArchitecturalDesigns-User InterfaceDesign.

UnitIV

Component level Design-Software Testing Techniques-Software Testing Strategies-TechnicalMetricsForSoftware.

Textandreferencebooks:

- RogerS.Pressman-SoftwareEngineeringAPractitioner'sapproach–5th edition-McGrawHill.
- IanSommerville–SoftwareEngineering-5thEdition–AddisonWesley

CO-POArticulationMatrix Software Engineering Course (OE/ AIML /52-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	1	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	_	2	2	_	_	_	2	_	3	_	_	_	_	_	_
CO4	_	2	2	_	_	_	2	_	_	2	_	_	2	_	_
CO5	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
3-High 2-Medium 1-Low															

FundamentalofComputerNetworks

GeneralCourseInformation

Course Code: OE/ AIML/ 53-T Course Credits:3 Type:OpenElective ContactHours:3hours/weekMode :Lectures(L)ExaminationDuratio n:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..

Pre-requisites: FundamentalofInternet

Aboutthe Course:

This is an introductory course for students to understand the concept of Computer network,knowledgeaboutnetworkingandinternetworkingdevices,topologiesandprotocols,moderntechnologiesandtheirapplication,OSImodelandTCP/IP.

CourseOutcomes:Bythe endofthe course studentswillbe able to:

CO1.**Understand**theconcept relatingtoComputerNetworks.(LOTS:Level1:Remember)**CO2**: Compare different networking protocols and their hierarchical relationship in theconceptualmodel(LOTS:Level4:Analyze)

CO3:Analyzethedifferent networkmodels.(LOTS:Level3:Apply)

CO4:Construct aclasslessaddressingscheme.(LOTS:Level4:Create)

CO5:Describehowcomputer networksareorganizedwiththeconceptoflayeredapproach.(LOTS:Level2:Understand)

CourseContent

Unit1

Introduction – Network Hardware - Software - Reference Models - OSI and TCP/IPModels-Example Networks: Internet, ATM, Ethernet and Wireless LANs -PhysicalLayer - TheoreticalBasis forDataCommunication-GuidedTransmissionMedia.

UnitII

Wireless Transmission - Communication Satellites - Telephone System: Structure,LocalLoop,TrunksandMultiplexingandSwitching.DataLinkLayer:DesignIssues-ErrorDetectionandCorrection.

UnitIII

Elementary Data Link Protocols- SlidingWindow Protocols - Data LinkLayerinthe Internet-MediumAccess Layer-ChannelAllocation Problem –Multiple AccessProtocols -Bluetooth.

UnitIV

Network Layer - Design Issues - Routing Algorithms - Congestion Control Algorithms - IPProtocol-IPAddresses-InternetControlProtocols.TransportLayer-Services -Connection Management - Addressing, Establishing and Releasing a Connection-SimpleTransportProtocol-InternetTransportProtocols(ITP)- NetworkSecurity:Cryptography.

Textandreferencebooks:

- A.S.Tanenbaum,"ComputerNetworks",Prentice-HallofIndia2008,4th Edition.
- Stallings,"DataandComputerCommunications",PearsonEducation2012,7th Edition.
- B.A.Forouzan, "DataCommunicationsandNetworking", TataMcGrawHill2007,4th Edition.
- F.Halsall,"DataCommunications, ComputerNetworksandOpenSystemPearsonEducation2008

CO-POArticulation Matrix of Fundamental of Computer NetworksCourse (OE/ AIML /53-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	1	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	_	2	2	_	_	_	2	_	3	_	_	_	_	_	_
CO4	_	2	2	_	_	_	2	_	_	2	_	_	2	_	_
CO5	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
3-High 2-Medium 1-Low															

Fundamentals of PythonProgramming

GeneralCourseInformation

Course Code: OE/ AIML /54-T Course Credits:3 Type:ProfessionalCore ContactHours:3 hours/week Mode:Lectures(L) ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisite: Exposuretoprogramminglanguages

AbouttheCourse:
Python is a popular open-source programming language used for both standalone programs andscripting applications in a wide variety of domains. It is free, portable, and powerful and is bothrelatively easy and remarkably fun to use.In today's era Python has found great applicability inmachine learning, data analytics and many other data science applications. This is introductorycourse and covers most of the basic concepts required for basic python programming. Some ofthe contents areadvancedmaybe usefulfordataanalyticspurpose.

CourseOutcomes: Bytheendofthecourse studentswillbeable to:
CO1. **outline** various basic programming constructs including operators, character sets, basicdatatypes andcontrolstatements.(LOTS:level1:Understand)
CO2.**explain** Python packages andtheirfunctionalitiesfor data analysis. (LOTS:level 2:Understand)
CO3.**solve**problems using pythonprogramming.(LOTS:level3:Apply)
CO4.**analyse**theresultsofdataanalysisormachinelearningprograms(LOTS:level4:Analyse)
CO5. **evaluate** solutions according to the problem definition. (LOTS: level 5: Evaluate)
CO6.**develop**databaseapplicationsinPython.(LOTS:level6:Create)

CourseContent

UnitI
IntroductiontoPython, History of Python,Featuresof Python,Python Identifiers, PythonCharacter Set, Keywords and Indentation, Comments, Command Line Arguments, AssignmentOperator, Operators and Expressions, *print()* Function, *input()* Function, *eval()* Function, PythonDataTypes:*int*,*float*,*complex*,Variables,MutablevsImmutablevariables,Decision Statements: Boolean Type, Boolean Operators, *if* statement, *else* statement, NestedConditionalsStatements,Multi-wayDecisionStatements(*elif*statement).

UnitII
LoopControlStatements:*While*loop,*range ()*Function,*For*Loop,NestedLoops,Infinite

Loop, *Break* Statement, *Continue* Statement, *Pass* Statement, Introduction to Strings, StringOperations: Indexing and Slicing, Lists: Operations on List: Slicing, Inbuilt Functions for
Lists,ListProcessing:SearchingandSorting,Dictionaries:NeedofDictionary,OperationsonDirectories:Creation,Addition,RetrievingValues,Deletion;Tuples,operationson
Tuples,InbuiltFunctions forTuples,IntroductiontoSets,operationsonsets.

UnitIII

OperationsonFile: Readingtextfiles,readfunctions,*read ()*,*readline()*and*readlines()*,writing Text Files, write functions, *write()* and *writelines()*,Manipulating file pointer using seek,AppendingtoFiles.

Python Object Oriented: Overview of OOP, Classes and objects, accessing attributes, Built-InClass Attributes, Methods, ClassInheritance:*super ()*,MethodOverriding,ExceptionHandling,*Try-except-else*clause,PythonStandardExceptions,User-DefinedExceptions

UnitIV

DatabasesinPython: CreateDatabaseConnection,*create*,*insert*,*read*,*update*and*delete* Operation,DMLandDDLOperationwithDatabases.

PythonforDataAnalysis:*numpy*:Creatingarrays,UsingarraysandScalars,IndexingArrays,Array Transposition,UniversalArrayFunction,ArrayProcessing,Array InputandOutput

TextandReferenceBooks:

- AshokNamdevKamthane,*ProgrammingandProblemSolvingwithPython*,McGrawHill EducationPublication,2018.
- JohnGuttag,*IntroductiontoComputationandProgrammingusingPython*,Springer,Revise dandExpandedversion(ReferredbyMIT),2013.
- Lutz,M.,*LearningPython: PowerfulObject-OrientedProgramming*.O'ReillyMedia,Inc.,2013.
- MichaelTGoodrichandRobertto.Thamassia,MichealS Goldwasser,*DataStructuresandAlgorithmsinPython*, Wiley,2016.
- Y.DanielLiang,*IntroductiontoProgrammingUsingPython*,Pearson,2013.
- ReemaThareja,*PythonProgrammingUsingProblemSolvingApproach*,OxfordPu blications,2017.
- Dr.R. NageswaraRao,AllenB.Downey,*CorePythonProgramming*,*ThinkPython*,O'ReillyM edia,2012.
- KennethA.Lambert,*TheFundamentalsofPython:FirstPrograms*,CengageLearning,201 1.

CO-POArticulationMatrixPythonProgrammingCourse(OE/AIML/54-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	2
CO2	1	_	_	_	_	_	_	_	_	_	_	_	_	_	3
CO3	3	2		2	_	3	_	_	_	_	_	_	_	_	3
CO4	2	3	2	2	_	_	_	_	_	_	_	_	_	_	3
CO5	2	3	2	2	_	_	_	_	_	_	_	_	_	_	3
CO6	3	3	2	3		3	_	_	_	_	_	_	3		3
3-High 2-Medium 1-Low															

Basics of DigitalMarketing

GeneralCourseInformation

CourseCode:OE/ AIML /61-T Course Credits:3 Type: OpenElective Contact Hours: 3 hours/weekMode:Lectures (L)ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: Computer Fundamental

Aboutthe Course:
To understand digital marketing, important conceptual insights and perspectives to demonstratethe use of tools required for effective digital marketing and analyze the market impact fromdigitalmarketing,and applythe toolsofdigital marketing toget bestvisibilityinmarket.
CourseOutcomes: Bythe endofthecoursestudentswillbeable to:

CO1. understanding digital marketing along with technical acumen will be an added toolasaproblemsolverandsolutionprovider.(LOTS:Level1:Remember)
CO2.demonstrate the use of search engine optimization keyword planner Tools.(LOTS:Level2:Understand)
CO3.assistandadvicethemarketertotakerightdecision.(LOTS:Level3:Apply)
CO4.apply various social media platform for marketing such as Facebook,Twitter,LinkedIn etc.(LOTS:Level4:Analyse).
CO5. **assess**realtimedigital marketingservices.(LOTS:Level5:Evaluate)

CourseContent

UnitI

Introduction toDigital Marketingandits Significance Traditional Marketing Vs DigitalMarketing Digital Marketing Process. Website Planning and Development: Types of websitesWebsitePlanningandDevelopment,UnderstandingDomainandWebhostingBuilding**Website/**Blog using CMS Word Press, Using Word Press Plug-ins

Unit II

Introduction to Search Engine Optimization Keyword Planner Tools on Page SEO Techniques- Indexing and Key Word Placement, On Page SEO Techniques- Content Optimization on Page SEO: Yoast, SEO Plug-in, Off –Page SEO Techniques, Email Marketing- Introduction and Significance, Designing e-mail marketing campaigns using Mail Chimp

Unit III

Building E-mail List and Signup Forms, Email Marketing Strategy and Monitoring Email – Atomization. Pay Per Click Advertising: Introduction Pay Per Click Advertising: Google Ad word, Types of Bidding strategies, Designing and Monitoring search campaigns, Designing and Monitoring Display campaigns

Unit IV

Designing and Monitoring Video campaigns Designing and Monitoring Universal App Campaigns. Google Analytics: Introduction and Significance Google Analytics Interface and Setup Understanding Goals and Conversions. Monitoring Traffic Behavior and preparing Reports Social Media Marketing: Introduction and Significance Facebook Marketing, Types of Various Ad Formats

TextandReferenceBooks:

- TheArtofDigitalMarketing:TheDefinitiveGuidetoCreatingStrategic,Targeted,andMeasurable OnlineCampaignsbyIanDodson,Wiley;1stedition(2016)
- DigitalMarketingforDummiesbyRyanDeissandRussHenneberry,ForDummies.
- UnderstandingDigitalMarketing:MarketingStrategiesforEngagingtheDigitalGenerationby DamianRyan,KoganPagePublisher.
- DigitalMarketingbySeemaGupta,McGrawHillEducation.

CO-POArticulation DigitalMarketingMatrixCourse (OE/AIML/61-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	_	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	_	_	_	1	_	1	_	_	1	_	_	_	_	_	_
CO4	1	_	2	_	2	_	3	_	_	2	_	_	_	_	_
CO5	_	3	2	_	2	_	1	_	_	2	_	_	2	_	_
3-High 2-Medium 1-Low															

CyberLawsandIPR

GeneralCourseInformation

Course Code: OE/ AIML /62-T Course Credits:3 Type:OpenElective Contact Hours: 3 hours/weekMode:Lectures(L)Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: BasicComputerNetwork

Aboutthe Course:
ThiscourseinvolvesstudyingcyberInvestigationthatisadmissiblebytheCourtroom,aclearidea on International Law and Regulation of Cyberspace, concept of Intellectual PropertyRightsandCopyright.

Course Outcomes:Bythe endofthe coursestudentswillbe able to:

CO1. **Understand** the concept relating to E-Governance and E- Commerce. (LOTS: Level1:Remember)
CO2.**Describe** legalissuerelatingtocourtroompractices.(LOTS:Level2:Understand)
CO3. **Apply** the laws dealing with the cyber crimes related to Patents and TradeMark..(LOTS:Level3:Apply)
CO4. **Use**theconceptofTrademark, copyrightandIPR.(LOTS:Level3:Apply)
CO5.**Compare**internationalLawsandRegulationofCyberspace. (LOTS:Level4:Analyze)

CourseContent

Unit1

Fundamentals of Cyber Law Introduction on cyber space - Jurisprudence of Cyber Law -ScopeofCyber Law - CyberlawinIndiawithspecialreferencetoInformationTechnologyAct,2000(asamended)andInformationTechnologyAct,2008

UnitII

E- Governance and E – Commerce Electronic Governance - Procedures in India - Essentials& System of Digital Signatures - The Role and Function of Certifying Authorities - Digitalcontracts - UNCITRAL Model law on Electronic Commerce - Cryptography – Encryptionanddecryption

UnitIII

Cyber Crimes Investigation Investigation related issues - Issues relating to Jurisdiction - Relevant provisions under Information Technology Act, Evidence Act - Indian PenalCode - Cyberforensics-Casestudies

UnitIV

Trademark, IPR and Patent laws Definitions and concepts Trademark: Introduction toTrademarks, Functions and types of Trademarks, Madrid Agreements, Trademarks LawTreaty (Geneva), Indian Trademark Act, Registration of Trademarks, IPR infringements - Secrecy and Confidentiality in IPR - Civil and Criminalliabilities in IPR - International Applications and its advantages - Geneva convention onPatentLaw-SoftwareandBusinessMethod Patents-IndianPatentAct-Infringement-Defenses

Textandreferencebooks:

- Raman Mittal.(2004).Legal Dimension on Cyber Space, Indian Law Institute, NewDelhi
- AnupaPKumar.(2009).CyberLaw,Volume1.CreatespaceIndependentPublishers
- VakulSharma.(2017).InformationTechnology-LawandPractice.5thEdition,UniversalLawPublishing,NewDelhi
- LawsonCyber Crime:P.K.Singh(2007),BookEnclaveJaipur, Page131
- Dr.Gupta&Agrawal.(2016).CyberLaws.PremierPublishingCompany
- SethKamika.(2013).ComputersInternetand NewTechnologyLaw
- CyberlawbyNandankamath,FifthEdition,UniversallawPublication,01Jan2012
- intellectualpropertybyRobertPMerges,3rdEdition,AspenPublication,2003

CO-POArticulation MappingwithProgrammeOutcomes (OE/AIML/62-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	_	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	2	2	_	_	_	_	_	_	_	_	_	_	_	_	_
CO4	_	_	_	1	_	1	_	_	1	_	_	_	_	_	_
CO5	_	_	2	_	2	_	_	_	_	2	2	2	2	_	_
3-High 2-Medium 1-Low															

Fundamentals of Information Security

GeneralCourseInformation

Course Code:OE/ AIML/ 63-T Course Credits:3 Type:OpenElective Contact Hours: 3 hours/week Mode:Lectures(L)Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end-semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Pre-requisites: FundamentalofcomputerandSoftwareengineering

Aboutthe Course:

Thiscourseinvolvesstudyinginformationsecurity,assetclassificationintheorganization,riskmanagementprocess,knowledgeaboutemergingtechnology.

CourseOutcomes:Bythe endofthe course studentswillbe able to:

CO1.**Understand**theconceptrelatingtobasicinformationsecurityconcepts.(LOTS:Level1:Remember)
CO2.**Describe** assetclassification.(LOTS:Level2:Understand)
CO3.**apply**riskanalysisandmanagement process.(LOTS:Level3:Apply)
CO4.**use** the concept of critically assess in access control and privilegemanagement.(LOTS:Level3:Apply)
CO5.**Compare**emergingtechnologies.(LOTS:Level4:Analyze)

CourseContent

UnitI

Overview of Information Security What is Information and why should be protect it? - Information Security: Threats, Frauds, Thefts, Malicious Hackers, Malicious Code, Denial ofServices Attacks, Social Engineering - Vulnerability – Risk: Risk definition, Types Risk – anintroduction Business Requirements Information Security - Definitions Security Policies:Tier1 (Origination Level), Tier2 (Function Level), Tier3 (Application/Device Level),Procedures,Standards,Guidelines

UnitII

Information Asset Classification Why should we classify information? - Information Asset:Owner, Custodian, User - Information Classification: Secret, Confidential, Private, Public,Declassification, Reclassification, Retention and Disposal of Information Assets, ProvideAuthorizationforAccess-OwnerCustodianUser

UnitIII

Risk Analysis & Risk Management Risk Analysis Process - Asset Definition - ThreatIdentification - Determine Probability of Occurrence - Determine the Impact of the Threat -Controls Recommended Risk Mitigation - Control Types – Categories - Cost/BenefitAnalysis

UnitIV

Emerging Technologies Introduction to Cloud Computing: Concepts - Fundamentals ofCloud Computing - Types of clouds - Security Design and Architecture -Concerns Internet of Things: Overview of IoT - Key Features of IoT - IoT Architecture -Impact of IoT on Business - Examples of IoT - Advantages and Disadvantages of IoT - IoTHardware:IoTSensors,WearableElectronics,Standard Devices-IoTSoftware-IoTtechnology and Protocols - IoT Common Issues - IoT applications Domains - IoT Liability - IoTSecurityandThreats:Mitigation

Textandreferencebooks:

- CISSPAll-in-OneExamGuidebyShonHarrisandFernandoMaymi, 7thEdition,McGrawHillEducation,1June2016
- InformationSecurityManagementhandbook,6thEdition, HaroldFTipton,MickiKrause,AuerbachPublications,5April2012
- TheCISSPPrepGuide:GoldEditionbyRonaldL.Krutz,RusselDeanVines,GoldEdition WileyPublication,31Oct2002
- CertifiedInformationSystemsSecurityProfessional,StudyGuidebyEdTittel,MikeCh appleJamesMichaelStewart,6thEdition,SybexPublication,06 July2012

CO-POArticulation MappingwithProgrammeOutcomes (OE/AIML/63-T)

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	_	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO4	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO5	_	2	2	_	_	_	2	_	_	_	_	_	2	_	_
3-High 2-Medium 1-Low															

Big Data

GeneralCourseInformation

Course Code: OE/ AIML/64-T Course Credits:3 Type:OpenElective Contact Hours: 3 hours/weekMode:Lectures(L)ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..

Pre-requisites:

FundamentalofDatabaseandMobileComputingAbouttheCourse:

This course involves studying basic technologies related to BigData, cloud computing with aviewtorapidprototypingofcomplexapplications,bigdataapplication,andbigdataanalytics.

Course Outcomes: Bythe endofthe course studentswillbe ableto:

CO1. **Understand** the concept of Big data and challenges in processing Big data. (LOTS:Level1:Remember)
CO2. **Describe**Hadooparchitectureandeco-system.(LOTS:Level2:Understand)
CO3.**apply** research trends related to Hadoop File System, Map Reduce and Google File Systemetc.(LOTS:Level3:Apply)
CO4.**use**theconceptofcriticallyassessinaccesscontroland privilegemanagement.(LOTS:Level3:Apply)
CO5.**Compare**appropriatetechniquesandtoolstosolveactualBigDataproblems.(LOTS:Level4: Analyze)

CourseContent
UnitI

IntroductiontoBigDataandHadoop:WhatisBigData,WhatareChallengesinprocessingBigdata? What is hadoop, Data Storage and Analysis, Comparison with Other Systems: RDBMS,Grid Computing, Volunteer Computing; A Brief History of Hadoop, Apache Hadoop and theHadoopEcosystem.

UnitII

HDFS:HadoopDistributedFileSystem:SignificanceofHDFSinHadoop,FeaturesofHDFS,The Design of HDFS, HDFS Concepts: Blocks, Data replication, Namenodes and Datanodes;AccessingHDFS

UnitIII

Map Reduce: Map ReduceArchitecture,Howmapreduce works:JobSubmission,JobInitialization,TaskAssignment,TaskExecution,ProgressandStatusUpdates,JobCompletion.Failures,JobScheduling.

UnitIV

Pig: Introduction to Apache Pig, Map-Reduce vs Pig, Pig Latin, Data Processing Operators.Hive:Hiveintroduction,Architecture,ComparisonwithTraditionalDatabases,HiveQL,Tables. HBase:HBasics, Concepts, HBase Versus RDBMS. ZooKeeper: The ZooKeeper Service. CaseStudies:HadoopandHive atFacebook,LogProcessingatRackspace.

Textandreferencebooks:

- BigDataAnalyticsinCyberSecurity,EditedbyOnurSavasandJuliaDeng.
- Tom White, “Hadoop: The Definitive Guide”, Second Edition, O’Reilly Yahoo Press.
- RobertD.Schneider,“HadoopforDummies”, Wiley. 3.
- VigneshPrajapati,“BigData Analyticswith RandHadoop”,PacktPublishing.

CO-POArticulation MappingwithProgrammeOutcomes (OE/AIML/64-T)

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	2	2	_	_	_	_	_	_	1	_	_	_	_	_	_
CO2	_	2	2	_	_	_	2	_	_	_	_	_	_	_	_
CO3	_	2	2	_	_	_	2	_	3	_	_	_	_	_	_
CO4	_	2	2	_	_	_	2	_	_	2	_	_	_	_	_
CO5	_	2	2	_	_	_	2	_	_	_	_	_	2	_	_
3-High 2-Medium 1-Low															

Introduction to Data Science

GeneralCourseInformation

Course Code:OE/ AIML /65-T Course Credits:3 Type: Professional Core Contact Hours: 3 hours/week Mode: Lectures (L) ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..

Pre-requisites: Student should have a fundamental understanding of Fundamentals of Programming Languages (C, C++, and Java & Python) and a strong mathematical foundation.

AbouttheCourse:

Thiscourseinvolvesstudyingthe concept of data science and data science life cycle.Moreover,studentslearn aboutthe techniquesforgenerating quality data inputs.

CourseOutcomes: Bytheendofthecoursestudentswillbeableto:

CO1.To understand the concept of data science and data science life cycle (LOTS:Level1:Remember)
CO2.To apply the pre-processing techniques for generating quality data inputs (LOTS:Level 2:Understand)
CO3.To analyse the concept and parameters of exploratory data analytics (LOTS:Level 3:Apply)
CO4.To develop the regression models using data science and analytics process (LOTS:Level3:Apply)
CO5.To analyse various tools and techniques of data visualization (LOTS: Level 4: Analyse)
CO6.handling data, encoding, tools apply, and types of data visualization (LOTS:Level6:Create)

CourseContent

UnitI

Evolution of Data Science, Introduction to Data Science – Types of Data, Data Science Vs Big Data, Concept of Big Data, Concept of Data Warehousing, Introduction to Data Mining, Role of Data Scientist, Data Science Life Cycle, Data Science Roles – Data Science Project Stages – Data Science Applications in Various Fields – Data Security Issues, thinking in a structured way to solve data science problem statements.

UnitII

Need of Data Pre-processing,Pre-processing of data and data collection, Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization, Data Storage, and management,Data preparation with Sandbox foranalytics.

Unit III

Simple and Linear Regression – Visual Model Evaluation – Residual Plot – Distribution Plot – Polynomial Regression and Pipelines – Residual Plot – Distribution Plot – Polynomial Regression and Pipelines – In- sample Evaluation Measures – Prediction and Decision Making

UnitIV

Metrics for Out-of-Sample Evaluation Error – Cross Validation – Overfitting – Under fitting and Model Selection – Ridge Regression Prediction – Grid Search Testing Multiple Parameters
Data handling /Data wrangling using Python Definition.

Textandreferencebooks:

1.G. Strang . Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth edition, USA, 2016.
2. Bendat, J. S. and A. G. Piersol. Random Data: Analysis and Measurement Procedures. 4th Edition. John Wiley & Sons, Inc., NY, USA, 2010
3. Montgomery, D. C. and G. C. Runger. Applied Statistics and Probability for Engineers. 5th Edition. John Wiley & Sons, Inc., NY, USA, 2011.
4. David G. Luenberger . Optimization by Vector Space Methods, John Wiley & Sons (NY), 1969.
5. Cathy O'Neil and Rachel Schutt . Doing Data Science, O'Reilly Media, 2013.
6.Jojo Moolayil, "Smarter Decisions : The Intersection of IoT and Data Science", PACKT, 2016.
7.Cathy O'Neil and Rachel Schutt , "Doing Data Science", O'Reilly, 2015.
8. David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big data Analytics", EMC 2013

CO-POArticulationMatrixFoundations of Data Science Course(OE/AIML/65-T)

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1.	1	1	2	1	_	_	_	_	_	_	_	_	_	_	_
CO2	1	2	_	2	_	_	_	_	_	_	_	_	_	_	_
CO3.	2	1	2	1	_	_	_	_	_	_	_	_	_	_	_
CO4.	1	2	_	2	_	_	_	_	_	_	_	_	_	_	_
CO5.	_	_	2	_	_	_	_	_	_	_	_	_	_	_	_
CO6.	_	2	1	2	_	_	_	_	_	_	-	-	_	_	_
3 –High, 2-Medium, 1-Low															

Basics of CloudComputing

GeneralCourseInformation

CourseCode:OE/ AIML /71-T Course Credits:3 Type: OpenElective Contact Hours: 3 hours/weekMode:Lectures (L)ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). **For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..**

Pre-requisites:BasicsofComputerNetwork,DistributedSystem.

AbouttheCourse:
Theobjectiveofthecourseistogivestudentsacomprehensiveviewofstorageandnetworking infrastructures for highly virtualized cloud ready deployments. To familiarize thestudentswithbasics ofCloudComputinganditsApplications.

CourseOutcomes:Bythe endofthe course studentswillbe able to:
CO1.defineconceptsrelatedtocloudcomputing. (LOTS:Level1: Remember)CO2.expressdeploymentmodelsfor clouds.(LOTS: Level2:Understand) CO3.applycloudcomputingtechniquesforvariousapplications.(LOTS:Level3:Apply)CO4. analyse cloud computing services used at various levels. (LOTS: Level 4: Analyse)CO5.assess realtime cloudservices.(LOTS:Level5:Evaluate)

CourseContent
UnitI
CloudComputing:Introductiontoclientservercomputing,PeertoPeercomputing,Distributed computing, collaborative computing and cloud computing, Importance of cloudcomputingincurrentera, Characteristics, advantagesanddisadvantagesofcloudcomputing.
UnitII
CloudServices:Functioningof cloudcomputing,Classification of cloudon thebasis ofservices: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as aService (Iaas):Definition,characteristicsandtheirbenefits.
UnitIII
Cloud Architecture: CloudcomputingLogical and service architecture, Types of clouds:Private cloud, Public cloud and Hybrid cloud, Comparison of a Private, public and hybridclouds,migratingtoacloud,sevenstepmodeltomigrate.
Unit IV
Applications: Business opportunities using cloud, Managing Desktop and devices in cloud,cloud as a

type of distributed infrastructure, Application of cloud computing for centralizing.Email communication, collaboration on schedules, calendars. Overview of major cloud serviceproviders - AmazonEc2,GoogleAppEngine.

TextandReferenceBooks:

Srinivasan,A.CloudComputing:APracticalApproachforLearningandImplementation.PearsonEducationIndia,2014.
CloudComputing, APracticalApproach-McGraw-HillOsborneMediaby“TobyVelte,AnthonyVelte,RobertElsenpeter-(2009)”.
CloudComputingBible,Author:“BarrieSosinsky”,Publisher:“Wiley”(2011)
RajkumarBuyya,ChristianVecchiolaandSThamaraiSelvi,*MasteringCloudComputing*,TataMcGrawHill EducationPvt.Ltd.,2013.

CO-POArticulationMatrixCloud ComputingCourse(OE/AIML/71-T)

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	1	_	_	_	_	_	_	_	_	_	_	_	_	2	_
CO2	1	_	_	_	_	_	_	_	_	_	_	_	_	3	_
CO3	2	2	2	_	2	_	_	_	_	_	_	_	_	3	_
CO4	3	3	2	3	2	_	_	_	_	_	_	_	_	3	_
CO5	3	3	3	3	3	2	_	_	_	_	_	2	_	3	_
3-High 2-Medium 1-Low															

Introduction to SoftwareProjectManagement

GeneralCourseInformation

CourseCode:OE/ AIML /72-T Course Credits:3 Type: OpenElective Contact Hours: 3 hours/weekMode:Lectures (L)ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). **For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..**

Pre-requisites:PreliminaryknowledgeofSoftwareEngineering.

AbouttheCourse:
Thecourserecognizesbasicconceptsandissuesofsoftwareprojectmanagement; Emphasizesuccessfulsoftwareprojectsthatsupportorganization'sstrategicgoals, Comprehendsoftwarequalityissues, and Comprehendsoftwareriskissues.
CourseOutcomes: Bytheendofthecoursestudentswillbeable to:

CO1.maintain software projects and monitor software project. (LOTS: Level 1: Remember)
CO2. demonstratethedesignanddevelopprojectmodulesandassignresources(LOTS:Level2: Understand)
CO3.illustrateComprehend,assess,
andcalculatethecostofriskinvolvedinaprojectmanagement.(LOTS:Level2:Understand)
CO4. apply tools and methods for identifying risk management. (LOTS: Level 3: Apply)
CO5.analyse thetoolsforriskmanagement.(LOTS:Level4:Analyse)
CO6.plana CasestudyusingSPMtools.(LOTS:Level6:Create)

CourseContent

UnitI
SPM Concepts Definition: components of SPM - challenges and opportunities - tools andtechniques - managing human resource and technical resource - costing and pricing of projects -traininganddevelopment-projectmanagementtechniques.
Unit II
SoftwareMeasurements:Monitoring&measurementofSWdevelopment-cost-sizeandtimemetrics-methodsandtoolsfor metrics-issuesofmetricsinmultipleprojects.
UnitIII
Software Quality: Quality in SW development- quality assurance - quality standards andcertifications - the process and issues in obtaining certifications - the benefits and implicationsfortheorganizationandits customers-changemanagement.
UnitIV
RiskIssuesandSPMToolsTheriskissuesinSWdevelopmentandimplementation-identification of risks - resolving and avoiding risks - tools and methods for identifying riskmanagement. Tools Software project management using Primavera & Redmine - case study onSPMtools.

Text&ReferenceBooks
RichardH.Thayer,“SoftwareEngineeringProjectManagement”,SecondEdition,JohnWiley&Sons,2001.
Royce,Walker,“SoftwareProject Management”,PearsonEducation,2002.
KelkerS.A.,“SoftwareProject Management”, PrenticeHall,2003.
Kan,StephenH., “MetricsandModels inSoftwareQualityEngineering”,Addison-WesleyLongmanPublishingCo.Inc.,2002.
Galin,Daniel,“SoftwareQualityAssurance:FromTheorytoImplementation”,PearsonEducationIndia,2004.
Charette,RobertN.,“SoftwareEngineeringRiskAnalysisandManagement”,NewYork:McGraw Hill,1989.

CO-POArticulationMatrixSoftwareProject ManagementCourse(OE/ AIML /72-T)

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	_	_	_	_	3	_	_	_	_	_	_	_	_	_	_
CO2		_	_	_	3	_	_	_	_	_	_	_	_	_	_
CO3	2	_	_	_	1	_	_	_	_	_	_	_	3	_	_
CO4	_	2	_	_	2	_	_	2	_	_	_	_	2	_	_
CO5	_	_	3	2	_	3	_	2	_		2	_	2	_	_
CO6	3	3	_	3	3	_	_	_	_	2	3	2	3	_	_
3-High 2-Medium 1-Low															

CyberSecurity

GeneralCourseInformation

CourseCode:OE/ AIML /73-T Course Credits:3 Type: OpenElective Contact Hours: 3 hours/weekMode:Lectures (L)ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..

Pre-requisites: Computer Networks

AbouttheCourse:

Thecoursehasbeendesignedtogivestudentsanextensiveoverviewofcybersecurityissues,toolsand techniquesthatare criticalin solvingproblemsincybersecuritydomains.

CourseOutcomes: Bytheendofthecoursestudentswillbeable to:

CO1.**define**thevariouschallengesandconstraintsincyber security.(LOTS:Level1:Remember)
CO2.**discuss**ITACT(Cyberlaw) to thegivencase/problemandanalyseit.(LOTS:Level2:Understand)
CO3.**understand**theneedforComputerCyberforensics.(LOTS:Level3:Apply)
CO4.**Analyse**thedesignofIntellectualPropertyLaw.(LOTS:Level4:Analyse)
CO5.**demonstrate**thenetworkdefencetoolstoprovidesecurityofinformation.(LOTS:Level5:Evaluate)

CourseContent

Unit-I

IntroductiontoCyberSecurity:OverviewofCyberSecurity,InternetGovernance:Challenges and Constraints, Cyber Threats, Cyber Warfare, Cyber Crime, Cyber terrorism,CyberEspionage,needforaComprehensiveCyberSecurityPolicy,NeedforaNodalAuthority,InternationalconventiononCyberspace.

Unit–II

IntroductiontoCybercrimeandLaws: OriginsofCybercrime,ClassificationsofCybercrimes, information Security, Cybercriminals, Criminals Plan for Attacks, Cybercafe,Botnets,AttackVector,TheIndianITACT2000andamendments.

ToolsandMethodsusedinCybercrime: Introduction,Proxy ServerandAnonymizers,Password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, DOSandDDOSattack,SQLinjection.

Unit–III

PhishingandIdentityTheft: IntroductiontoPhishing,MethodsofPhishing,PhishingTechniques, Phishing Toolkits and Spy Phishing. Identity Theft: PII, Types of Identity Theft,Techniques of ID Theft. Digital Forensics Science, Need for Computer Cyber forensics andDigitalEvidence,DigitalForensicsLifeCycle.

IntroductiontoIntellectual PropertyLaw–TheEvolutionaryPast-TheIPRToolKit-Para -LegalTasksinIntellectualPropertyLaw– EthicalobligationsinParaLegalTasksinIntellectualPropertyLaw–types of intellectualpropertyrights.

Unit–IV

NetworkDefencetools: FirewallsandPacketFilters:FirewallBasics,PacketFilterVs.Firewall, PacketCharacteristic to Filter, Stateless Vs. Stateful Firewalls, Network AddressTranslation (NAT) and Port Forwarding, Virtual Private Networks, SnortDetectionSystem, Introductiontoblockchaintechnologyanditsapplications.

TextandReferenceBooks:

1. MikeShema,Anti-HackerToolKit(IndianEdition),McGrawHill.
2. NinaGodboleandSunit Belpure,CyberSecurity:UnderstandingCyberCrimes,ComputerForensicsand LegalPerspectives,Wiley.
3. MarjieT.Britz,ComputerForensicsandCyberCrime:AnIntroduction,PearsonEducation
4. Chwan-Hwa(John)Wu,J.DavidIrwin,Introductionto ComputerNetworksandCybersecurity,CRC Press
5. BillNelson,AmeliaPhillips,ChristopherSteuart,GuidetoComputerForensicsandI nvestigations,CengageLearning
6. DebiragE.Bouchoux,IntellectualProperty, CengageLearning.

CO-POArticulationMatrixCyberSecurity Course(OE/ AIML /73-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12	PSO13	PSO14	PSO15
CO1	1	_	_	_	_	_	_	_	_	_	_	_	_	2	_
CO2	1	_	_	_	_	_	_	_	_	_	_	_	_	3	_
CO3	2	2	2	_	2	_	_	_	_	_	_	_	_	3	_
CO4	3	3	2	3	2	_	_	_	_	_	_	_	_	3	_
CO5	3	3	3	3	3	2	_	_	_	_	_	2	_	3	_

IntelligentSystems

GeneralCourseInformation

CourseCode:OE/ AIML /74-T Course Credits:3 Type: OpenElective Contact Hours: 3 hours/weekMode:Lectures (L)ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..

Pre-requisites: BasicknowledgeofAlgorithmsandprobability.

AbouttheCourse:

To introduce to the field of Artificial Intelligence (AI) with emphasis on its use to solve realworld problems for which solutions are difficult to express using the traditional algorithmicapproach and to explore the essential theory behind methodologies for developing systems thatdemonstrate intelligent behaviour including dealing with uncertainty, learning from experienceandfollowingproblemsolvingstrategiesfoundinnature.

CourseOutcomes: Bytheendofthecoursestudentswillbeableto:

CO1. **outline** the concepts of neural networks and fuzzy logic. (LOTS: Level 1: Remember)
CO2.**illustrate**theconceptsofartificialintelligenceinstatespacesearch.(LOTS:Level2: Understand)
CO3.**apply**searchandknowledgerepresentationtechniquestosolveAIproblems.(LOTS:Level3:Apply)
CO4.**compare**strengthsandweaknessesofAIalgorithms(LOTS: Level4:Analyse).
CO5.**understand**andusetheconceptsofreasoninginartificialintelligence.(LOTS:Level6:Create)

CourseContent

Unit–I

Biological foundations to intelligent systems: Artificial neural networks, Back-Propagationnetworks, Radial basis function networks, and recurrent networks.Fuzzy logic, knowledgeRepresentationandinferencemechanism,geneticalgorithm,andfuzzyneuralnetworks.

Unit–II

Search Methods: Basic concepts of graph and tree search. Three simple search methods:breadth-first search, depth-first search, iterative deepening search. Heuristic search methods:best-first search, admissible evaluation functions, hill-climbing search. Optimization and searchsuchas stochasticannealingandgeneticalgorithm.

Unit–III

Knowledge representation and logical inference Issues in knowledge representation. Structuredrepresentation, such as frames, and scripts, semantic networks and conceptual graphs. Formallogic and logical inference. Knowledge-based systems structures, its basic components. Ideas ofBlackboardarchitectures.

Unit–IV

ReasoningunderuncertaintyandLearningTechniquesonuncertaintyreasoningsuchasBayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning, Astudyofdifferentlearningandevolutionaryalgorithms,suchasstatisticallearningandinduction learning.RecenttrendsinFuzzylogic,Knowledge Representation

TextandReferenceBooks:

1. LugerG.F.andStubblefieldW.A.,ArtificialIntelligence:StructuresandstrategiesforComplexProblemSolving.AddisonWesley.
2. RussellS. andNorvigP., ArtificialIntelligence:AModernApproach. Prentice-Hall

CO-POArticulationIntelligentSystemsMatrixCourse(OE/AIML/74-T)

CourseOutcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12	PSO13	PSO14	PSO15
CO1	1	3	3	1	3	1	3	2	3	3	1	2	_	_	_
CO2	2	3	2	1	3	1	3	2	3	3	1	2	_	_	_
CO3	3	3	3	1	3	3	3	2	3	3	1	3	_	_	_
CO4	2	2	2	2	_	_	_	_	_	_	_	_	_	_	3
CO5	4	3	2	1	3	3	3	2	3	3	1	3	_	_	_

Basics of MachineLearning

GeneralCourseInformation

Course Code: OE/ AIML /75-T CourseCredits:3 Type: Professional Elective Contact Hours: 3 Mode: Lectures (L) ExaminationDuration:3hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor examinations (20 marks), Class Performance measured through percentage of lectures attended (4 marks), assignments (6 marks), and the end- semester examination (70 marks). For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units..

Pre-requisites: Basics of Linear Algebra and Statistics, Basics of Probability Theory, Data Structures andComputerAlgorithms.

About the Course:

Thecourseintroduces some of the key machine learning algorithmsandthe theory that form the backbone of thesealgorithms. The examples of such algorithms are classification algorithms for learning patterns from data,clusteringalgorithmsforgroupingobjectsbasedonsimilarity,neuralnetworkalgorithmsforpattern recognition,geneticalgorithmsforsearchinglargeandcomplexsearchspacesetc.

Course Outcomes: By the end of the course students will be able to:
CO1. **outline** the concepts and working of different machine learning algorithms. (LOTS: Level1: Remember)
CO2. **Interpret** the results of machine learning algorithms. (LOTS: Level 2: Understand)
CO3. **Apply** machine learning concepts and algorithms to given problems. (LOTS: Level 3: Apply)
CO4. **Analyse** the performance of machine learning algorithms. ((LOTS: Level 4: Analyze)
CO5. **Compare and contrast** different machine learning algorithms. (LOTS: Level5: Evaluate)
CO6. **Design** machine learning algorithms for optimization, pattern recognition and search problems. (LOTS: Level 6: Create)

Course Content

Unit-I
Introduction: Well posed learning problems, designing a learning system, Issues in machine learning, theconcept learning task, Concept learning as search, Version spaces andcandidateeliminationalgorithm,Remarksonversionspaces and candidate-eliminations,Inductivebias.

Unit- II

Supervised Learning: Introduction to linear regression, estimating the coefficients, Accessing the accuracy ofthe coefficient estimates, Accessing the accuracy of the regression model, Multiple linear regression, Logisticregression, basic decision tree learning (ID3) algorithm, Inductivebiasindecisiontreelearning,Issuesindecisiontreelearning.

Unit-III

UnsupervisedLearning:Aboutclustering,typeofdatainclusteringanalysis,DBSCANdensity-based clusteringmethod,Performanceanalysisofclusteringalgorithms,ArtificialNeuralnetworks:NeuralNetworkrepresentations,Appropriateproblemsforneuralnetworklearning, Perceptron, perceptron training rule, Multilayer Networks andbackpropagationalgorithm.

Unit-IV

Bayesian Learning: Bayes theorem, Bayes theorem and concept learning, Maximum likelihood and least-squared error hypotheses.

Text and Reference Books:

TomM.Mitchell,MachineLearning, McGraw-Hill,1997.
BishopChristopher,PatternRecognitionandMachineLearning,SpringerVerlag,2006.
Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning:DataMining, Inference and Prediction, Springer, 2nd edition, 2009.
J.HanandM.Kamber, Data Mining Concepts and Techniques, 3rdEdition, Elsevier, 2012.
S.Rajeshkaran, G.A.VijayalakshmiPai, NeuralNetworks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI, 2003.

CO-PO Articulation Matrix Machine Learning Course(OE/ AIML /75-T)

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	1	_	_	1	_	_	_	_	_	_	_	_	_	_	3
CO2	2	2	2	3	_	_	_	_	_	_	_	_	_	_	3
CO3	2	2	2	2	_	_	_	_	_	_	_	_	_	_	3
CO4	3	3	2	3	_	_	_	_	_	_	_	_	_	_	3
CO5	3	3	2	3	_	_	_	_	_	_	_	_	_	_	3
CO6	3	3	2	3	_	_	_	_	_	_	_	_	_	_	3
3-High 2-Medium 1-Low															