G H Raisoni College of Engineering and Management

(An Autonomous Institute affiliated to RTM Nagpur University Nagpur)

Department of Artificial Intelligence
B. Tech. in Artificial Intelligence with Multidisciplinary Minor
UG Scheme& Curriculum - 2023
(NEP 2020)

G H Raisoni College of Engineering & Management
(Formerly Known as G H Raisoni Institute of Engineering &Technology, Nagpur)
An Autonomous Institute Affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
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UG Scheme-2023 (NEP-2020)
B. Tech.(Artificial Intelligence)
Scheme Summary

Semester	Credits	Hours	Marks	Theory Heads	Practical Heads	Total Heads
I	20	27	525	6	6	12
II	20	26	625	7	5	12
III	20	23	550	6	2	8
IV	20	23	600	8	3	11
V	20	23	550	6	3	9
VI	20	24	550	6	4	10
VII	22	24	550	5	3	8
VIII	20	32	450	2	1	3
Total	**162**	**210**	**4400**	**46**	**27**	**73**

Course Category Credits Summary

Semester Basket		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	6	8	--	--	--	--	--	--	14
Engineering Science Course		8	4	--	--	--	--	--	--	12
Program Core Course (PCC)	Program Courses	--	2	8	8	10	8	10	--	46
Program Elective Course (PEC)		--	--	--	--	4	8	4	4	20
Multidisciplinary Minor (MD M)	Multidisciplinary courses	--	--	2	2	4	2	4	--	14
Open Elective (OE) Other than a particular program		--	--	4	2	2	--	--	--	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2	--	2	--	2	--	--	8
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	2	--	--	2	--	--	--	--	4
Entrepreneurship/Economics/ Management Courses		--	--	2	2	--	--	--	--	4
Indian Knowledge System (IKS)		--	2	--	--	--	--	--	--	2
Value Education Course (VEC)		--	--	2	2	--	--	--	--	4
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--	--	4	4
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	2	--	--	--	--	--	2
Project		--	--	--	--	--	--	4	--	4
Internship/ OJT		--	---	--	--	--	--	--	12	12

Co-curricular Courses (CC)	Liberal Learning Courses	2	2	--	--	--	--	--	--	4
Total Credits (Major)		**20**	**20**	**20**	**20**	**20**	**20**	**22**	**20**	**162**

UG Scheme-2023 (NEP-2020)
B. Tech. (Artificial Intelligence)

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-I													
23BTSHL101AI 23BTSHP101AI	Engineering Physics	BSC2	1	1	2	4	3	10	15	50	25	-	100
23BTSHL103AI	Matrices and Differential Calculus	BSC1	2	1	-	3	3	10	15	50	-	-	75
23BTSHL108AI 23BTSHP108AI	Communication Skills	AEC1	1	-	2	3	2	10	15		25	-	50
23BTSHL10XAI	Elective : Indian Knowledge System	IKS	2	-	-	2	2	10	15	50			75
23BTSHP112AI	Liberal Learning Courses-I	CC1	-	-	4	4	2	-	-	-	25	25	50
23BTAIL101 23BTAIP101	Introduction to Artificial Intelligence and Machine Learning.	PCC1	1	-	2	3	2	10	15	50	25	-	100
23BTAIL10X 23BTAIP10X	Elective -I : Vocational and Skill Enhancement	VSEC1	1	-	2	3	2	10	15		25	-	50
23BTITL102AI 23BTITP102AI	Programming for Problem Solving	ESC3	3	-	2	5	4	10	15	50	25	-	100
TOTAL			**11**	**2**	**14**	**27**	**20**	**70**	**105**	**250**	**150**	**25**	**600**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-II													
23BTSHL102AI 23BTSHP102AI	Environmental Chemistry	BSC5	1	-	2	3	2	10	15	50	25	-	100
23BTSHL104AI	Integral Calculus and Differential Equations	BSC3	2	1	-	3	3	10	15	50	-	-	75
23BTSHL105AI	Linear Algebra and Statistics	BSC4	2	1	-	3	3	10	15	50	-	-	75

23BTSHP113AI	Liberal Learning Courses-II	CC2	-	-	4	4	2	-	-	-	25	25	50
23BTEEL101AI 23BTEEP101AI	Basic Electrical Engineering	ESC1	3	-	2	5	4	10	15	50	25	-	100
23BTECL101AI 23BTECP101AI	Digital Logic Design	ESC2	3	-	2	5	4	10	15	50	25	-	100
23BTAIL10X 23BTAIP10X	Elective –II: Vocational and Skill Enhancement	VSEC2	1	-	2	3	2	10	15		25	-	50
TOTAL			**12**	**2**	**12**	**26**	**20**	**60**	**90**	**250**	**125**	**25**	**550**

ELECTIVES

23BTSHL10XAI -Elective : Indian Knowledge System -

Course	Course Code (L)	Course Code(P)
Elective: IKS-1- Concepts and Applications inEngineering	23BTSHL109AI	Not Applicable
Elective: IKS-2- Social History of Medicine In Colonial India	23BTSHL110AI	Not Applicable
Elective: IKS-3- Modern Indian Architecture	23BTSHL111AI	Not Applicable

AI Board

Course	Course Code (L)	Course Code(P)
Elective -I : Vocational and Skill Enhancement -Data Visualization	23BTAIL102	23BTAIP102
Elective -I : Vocational and Skill Enhancement	23BTAIL103	23BTAIP103
Elective -I : Vocational and Skill Enhancement-	23BTAIL104	23BTAIP104
Elective –II: Vocational and Skill Enhancement-Artificial Intelligence with Python	23BTAIL105	23BTAIP105
Elective –II: Vocational and Skill Enhancement	23BTAIL106	23BTAIP106
Elective –II: Vocational and Skill Enhancement	23BTAIL107	23BTAIP107

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-III													
23BTSHL201AI	Discrete Mathematics and Graph Theory	PCC2	3	1		4	4	10	15	50			75
23BTCSL201AI 23BTCSP201AI	Data Structure and Algorithms	PCC3	3	-	2	5	4	10	15	50	25	25	125
23BTCSL202AI	Multidisciplinary Minor I	MDM1	2			2	2	10	15	50			75
23BTISL2XXAI	Open Elective I	OE1	4			4	4	10	15	50			75
23BTMBL201AI	Engineering Economics and Industrial Management	EEMC 1	2	-	-	2	2	10	15	50	-	-	75
23BTHUL20XAI	Humanities Elective	VEC1	2	-	-	2	2	10	15	50	-	-	75
23BTAIP210	Minor Project	P			4	4	2				50		50
TOTAL			**16**	**1**	**6**	**23**	**20**	**60**	**90**	**300**	**75**	**25**	**550**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-IV													
23BTSHL202AI	Transform and Numerical Method	PCC4	3	1		4	4	10	15	50			75
23BTAIL202 / 23BTAIP202	Machine Learning Algorithms	PCC5	3		2	5	4	10	15	50	25	25	125
23BTITL204AI	Multidisciplinary Minor II-	MDM2	2			2	2	10	15	50			75
23BTXXLXXAI	Open Elective II	OE2	2			2	2	10	15	50			75
23BTXXL1XXAI 23BTXXP1XXAI	Vocational and Skill Enhancement Elective III	VSEC3	1		2	3	2	10	15		25		50
23BTHUL202AI 23BTHUP202AI	Aptitude and Employability skill	AEC2	1		2	3	2	10	15		25		50
23BTHUL203AI	Entrepreneurship Development Practices	EEMC2	2			2	2	10	15	50			75
23BTHUL204AI	Universal Human Values 2: Understanding Harmony	VEC2	2			2	2	10	15	50			75
TOTAL			**16**	**1**	**6**	**23**	**20**	**80**	**120**	**300**	**75**	**25**	**600**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-V													
23BTAIL301/ 23BTAIP301	Soft Computing	PCC6	3		2	5	4	10	15	50	25	25	125
23BTAIL302	Formal Language and Automata	PCC7	3			3	3	10	15	50			75
23BTAIL303	Operating System	PCC8	3			3	3	10	15	50			75
23BTAIL202	Program Elective I-	PEC1	3		2	5	4	10	15	50	25		100
23BTXXLXXXAI	Multidisciplinary Minor - III	MDM3	3		2	5	4	10	15	50	25		100
23BTSLXXXAI	Open Elective III	OE3	2			2	2	10	15	50			75
TOTAL			**17**		**6**	**23**	**20**	**60**	**90**	**300**	**75**	**25**	**550**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-VI													
23BTAIL304/ 23BTAIP304	Natural Language Processing	PCC9	3		2	5	4	10	15	50	25	25	125
23BTAIL305/ 23BTAIP305	Computer Vision and Deep Learning	PCC10	3		2	5	4	10	15	50	25	25	125
23BTXXLXXAI 23BTXXLXXAI	Program Elective II	PEC2	3		2	5	4	10	15	50	25		100
23BTXXLXXAI 23BTXXLXXAI	Program Elective III	PEC3	4			4	4	10	15	50			75
23BTXXLXXAI 23BTXXLXXAI	Multidisciplinary Minor - IV	MDM4	2			2	2	10	15	50			75
23BTXXL1XXAI 23BTXXP1XXAI	Vocational and Skill Enhancement Elective III	VSEC4	1		2	3	2	10	15		25		50
TOTAL			**16**		**8**	**24**	**20**	**60**	**90**	**250**	**100**	**50**	**550**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-VII													
23BTAIL401	Data Networks	PCC11	3			3	3	10	15	50			75
23BTAIL402/ 23BTAIP402	Responsible AI	PCC12	2		2	4	3	10	15	50	25		100
23BTAIL403/ 23BTAIP403	Design and Analysis of Algorithms	PCC13	3		2	5	4	10	15	50	25	25	125
23BTXXLXXAI 23BTXXLXXAI	Program Elective IV	PEC4	4			4	4	10	15	50			75
23BTXXLXX 23BTXXLXX	Multidisciplinary Minor	MDM5	4				4	10	15	50			75
23BTAIP460	Project	P			8	8	4				50	50	100
TOTAL			**16**		**12**	**24**	**22**	**50**	**75**	**250**	**100**	**75**	**550**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-VIII													
23BTXXLXX	Program Elective VI Moocs Based	PEC4	4			4	4	10	15	50			75
23BTISP401	Research Methodology	RM	4			4	4				75		75
23BTAIP461	Internship	I			24	24	12				200	100	300
TOTAL			**8**		**24**	**32**	**20**	**10**	**15**	**50**	**275**	**100**	**450**

Multidisciplinary Minor from Other Department

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-III													
23BTCSL202AI	Computer Architecture	MDM1	2	-	-	2	2	10	15	50	-	-	75
SEMESTER-IV													
	3D Printing	MDM2	2	-	-	2	2	10	15	50	-	-	75
SEMESTER-V													
	Software Engineering and Project Management	MDM3	3	-	2	5	4	10	15	50	25	-	100

Multidisciplinary Minor offer to Other Department

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-III													
23BTAIL203	Fundamentals of Artificial Intelligence	MDM1	2	-	-	2	2	10	15	50	-	-	75
SEMESTER-IV													
23BTAIL204	Introduction to Machine Learning Algorithms	MDM2	2	-	-	2	2	10	15	50	-	-	75

Vocational and Skill Enhancement Courses

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-I													
UNCSL101 /UNCSP101	Computer Programming	VSEC1	1	-	2	3	2	10	15	-	25	-	50
UNITL103/ UNITP103	Introduction to Linux	VSEC1	1	-	2	3	2	10	15	-	25	-	50
UNDIL104/UNDIP104	Data Science Tools	VSEC1	1	-	2	3	2	10	15	-	25	-	50
23BTAIL102/ 23BTAIP102	Data Visualization	VSEC1	1	-	2	3	2	10	15	-	25	-	50
SEMESTER-II													
UNCSL102/ UNCSP102	Foundation of Data Analytics	VSEC2	1	-	2	3	2	10	15	-	25	-	50
UNITL106/ UNITP106	Fundamentals of Ethical Hacking	VSEC2	1	-	2	3	2	10	15	-	25	-	50
23BTAIL105/23BTAIP105	Artificial Intelligence with Python	VSEC2	1	-	2	3	2	10	15	-	25	-	50
UNDIL106/UNDIP106	R programming	VSEC2	1	-	2	3	2	10	15	-	25	-	50
SEMESTER-IV													
UNITL203/ UNITP203	Web Development	VSEC3	1	-	2	3	2	10	15	-	25	-	50
23BTAIL205/ 23BTAIP205	Data Preprocessing	VSEC3	1	-	2	3	2	10	15	-	25	-	50
UNITL204 /UNITP204	Principles of Object Oriented Programming	VSEC3	1	-	2	3	2	10	15	-	25	-	50
UNDIL203/UNDIP203	Security in IoT	VSEC3	1	-	2	3	2	10	15	-	25	-	50
SEMESTER-VI													
23BTAIL307/UNAIP307	Introduction to Salesforce	VSEC4	1	-	2	3	2	10	15	-	25	-	50
UNITL308 /UNITP308	Information Coding Technique	VSEC4	1	-	2	3	2	10	15	-	25	-	50
UNAIL308/UNAIP308	R Programming for Statistics and Data Science	VSEC4	1	-	2	3	2	10	15	-	25	-	50

Syllabus of III SEMESTER

Course Title: **Discrete Mathematics and Graph Theory**										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	BS	3	1	--	4	10	15	50	--	--
Course Code	23BTSHL201AI									
Teaching Mode	Offline	4			Total	75			--	
Duration of ESE	2.5 hrs					75				

Course Objectives	This course introduces concepts of set theory and graph theory and its application to computer science.
	It also skills to analyze various kinds of sets and groups of objects meeting the criteria.
	It also introduces combinatorial structures and applies algebraic techniques to combinatorial problems.
Course Outcomes	**CO1**: Know grouping of objects and operation, relation, ordering of objects, concepts of Groups.
	CO2: Classify the algebraic structure for a given mathematical problem.
	CO3: Apply the concept of Boolean algebra in computer science engineering.
	CO4: Solve problems using basic graph theory.
	CO5: Develop algebraic technique to solve combinatorial problems using combinatorial structure.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PSO 1	PSO 2
CO1	**3**	**3**										**3**		
CO2	**3**	**3**										**3**		
CO3	**3**	**3**										**3**		
CO4	**3**	**3**										**3**		
CO5	**3**	**3**										**3**		

Course Contents:

Unit	Contents	Hours
I	**Set Theory** Operations on sets, Laws of algebra of sets, Representation of sets on computer in terms of 0's & 1's. Partition & covering of a set, ordered pair, Product set, Relation– Different types of relations, Graph of relation, Matrix of relation, Transitive closure of relation, Properties of relations, Compatible relation. Functions, Partial ordering & partially ordered set, Hasse diagram of Poset, Totally ordered set, Peano axioms & Mathematical Induction.	10
II	**Group** Algebra or Algebraic systems like semigroup, monoid and examples. Homomorphism, Isomorphism of semigroup & monoid. Groups, properties of algebraic groups. Permutations groups, Subgroups, Cosets, Lagrange's theorem, properties of cyclic groups, generator of group, kernel of Homorphism, quotient group, Rings, types of rings, Fields, subring, Integral domain.	8
III	**Lattices and Boolean algebra** Lattice as Poset & as algebraic system, Types of lattices, Hasse diagrams, Sublattice, direct product of Lattices, Lattice Homomorphism, complement of elements of lattices, Various lattices, composition tables, Lattice, Boolean algebra; Boolean Expressions, Equivalence of Boolean Expression by tables, Simplification of circuit & equivalent circuit by truth tables.	8
IV	**Graph Theory** Graphs and its types, Sub graph, Quotient graph, Euler path, complete path, indegree, outdegree, reachability, cycle, matrix representation of graph. Transitive closure of graph, Adjacency matrix, Trees, Venn diagram, Representation of trees, binary trees, spanning trees, Prim's algorithm.	8
V	**Combinatorics** Counting Theorem and application, multiplication principle of counting, Permutation & Combination with examples, Definition of generating functions and it's examples, proof of simple combinatorial identities. Recursive relations: definitions & examples, explicitly formula for sequence, back tracking to find explicit formula of sequence, Solving recurrence relations. The pigeon hole principle & extended pigeon hole principle and application of pigeon hole principle in solving simple problems.	8

Text Books	1.	Discrete Mathematical structure with application to computer science by Trembley & Manohar (Mc. Graw Hill)
	2.	Discrete Mathematical Structure by Kolmann , Busby & Ross (PHI)
	3.	Discrete mathematics by Lipschutz & Lipson , Schaum's outline, TMH
Reference Books	1.	Discrete Mathematics by Liu
	2.	Discrete Mathematics by John Truss (Addison Wesley, 2000)
	3.	Foundations of Discrete Mathematical by K. D. Joshi (Willey Eastern).

Course Title: **Data Structure and Algorithms**										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	C	3	--	2	4	10	15	50	25	25
Course Code	23BTCSL201AI/ 23BTCSP201AI									
Teaching Mode	Offline	5			Total	75			50	
Duration of ESE						125				

Course Objectives	This course introduces basic idea of data structure while making aware of methods and structure used to organize large amount of data.
	It's also aimed at developing skill to implement methods to solve specific problems using basic data structures.
	The course also provides career opportunities in design of data, implementation of data, technique to sort and searching the data.
Course Outcomes	CO1: Analyze various techniques for searching, Sorting and Hashing.
	CO2: Illustrate linear arrays and linked lists, including operations such as insertion, deletion, traversal, sorting, and searching.
	CO3: Demonstrate the array and linked representations of stacks and queues and their applications.
	CO4: Apply trees as non-linear data structure to find solution for given engineering applications.
	CO5: Understand the basics of Graphs as non-linear data structures.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific 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	PSO 1	PSO 2
CO1		3	2	3									1	
CO2		2	3	3									2	
CO3		3	3	3									2	1
CO4		3	3	3									3	2
CO5		3	3	2									3	1

Course Contents:

Unit	Contents	Hours
I	Introduction to Algorithms, Searching and Sorting Introduction to Algorithms, Common operations on data structures, Types of data structures, Abstract Data Type Time and Space Complexity, Step Count Method, Asymptotic Notations. Searching: Linear Search, Binary Search Sorting: Bubble sort, Selection Sort, Merge-Sort, Shell Sort, Radix Sort, Introduction to Hashing	9
II	Arrays and Linked Lists Arrays: Introduction, Linear Arrays, Arrays as ADT, Representation of Linear array in Memory, Traversing Linear Arrays, Insertion and deletion in arrays. Linked List: Introduction, Representation of Linked Lists in Memory, Traversing a Linked List, Searching a Linked List, Memory Allocation; Garbage Collection, Types of linked lists, Insertion and Deletion in Singly Linked List, Insertion and Deletion in Doubly Linked List, Insertion and Deletion in Circular Linked List	9
III	Stacks, Queue and Recursion Stacks-Introduction to Stacks ,Array Representation of Stacks ,Linked Representation of Stacks, Stack as ADT, Various operations on stacks using arrays and linked lists, Application of Stacks : Polish Notations, Recursion, Towers of Hanoi Queue: Introduction to Queues, Array Representation of Queues, Linked Representation of Queues, Queues as ADT, Circular Queues, Deques, Priority Queues, Applications of Queues	9
IV	Trees and Binary Trees General and Binary Trees, Representation of binary tree in memory, Operations on Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees ,various operations in Binary Search Trees, AVL Search Trees, Insertion in an AVL Search Tree, Deletion in an AVL Search Tree, m-way Search Trees, B-Trees-Insertion and deletion in B-Tree, B+Trees-Insertion and deletion in B+Tree	10
V	Graphs and their Applications: Introduction, Graph Theory Terminology, Representation of Graphs, Operations on Graphs, Traversing a Graph, Posets , Topological Sorting, Spanning Trees, Minimum Spanning Trees	8

Text Books	1.	AVAho, J Hopcroft, JD Ullman, Data Structures and Algorithms, Addison-Wesley, 1983.
	2.	THCormen, CF Leiserson, RL Rivest, C Stein, Introduction to Algorithms, 3rd Ed., MIT Press, 2009.
	3.	Sahni, S., "Data Structures, Algorithms, and Applications in C++", WCB/McGraw-Hill.
E--Books	1.	https://apps2.mdp.ac.id/perpustakaan/ebook/Karya%20Umum/Dsa.pdf
Reference Books	1.	Data Structures & Algorithms, 1e, Alfred V.Aho, Jeffery D. Ullman , Person.
	2.	MT Goodrich, R Tamassia, DM Mount, Data Structures and Algorithms in Java, 5th Ed., Wiley, 2010. (Equivalent book in C also exists.)
	3.	Wirth, N., "Algorithms and Data Structures", Prentice-Hall of India.
On-line TL Material	1.	https://nptel.ac.in/courses/106/102/106102064/
	2.	http://cse01-iiith.vlabs.ac.in/
	3.	https://ds2-iiith.vlabs.ac.in/data-structures-2/

Course Title: **Computer Architecture MD-I**										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM1	2	--		2	10	15	50	-	-
Course Code	23BTCSL208AI									
Teaching Mode	Offline	2			Total	75				
Duration of ESE										

Course Objectives	To understand the design principles of digital computing systems
	To provide essential understanding of different subsystems of modern computer system and design aspects these subsystems3
	To provide overview on performance enhancement methods in instruction execution
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: To describe the basic components and design of a computer system
	CO2: To examine the issues involved in the instruction execution and various stages of instruction life stage
	CO3: To apply the concept of various memories and interfacing technologies
	CO4: To analyze the different parallel processing technique
	CO5: To design different high performance computing architecture

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO0	PO1	PO2	PSO1	PSO2
CO1	1	--	--	--	--	--	--	--	--	--	--	--	3	--
CO2	--	2	--	--	--	--	--	--	--	--	--	--	2	--
CO3	--	3	--	--	--	--	--	--	--	--	--	--	2	--
CO4	--	--	3	--	--	--	--	--	--	--	--	--	3	--
CO5	--	--	3	--	--	--	--	--	--	--	--	--	--	3

Course Contents:

Unit	Contents	Hours
I	**Introduction:** Overview and history of computer architecture, CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU:–registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, Instruction set architecture CISC, RISC. **Case study:** –instruction sets of common CPUs, performance matrices for calculation of processingin Computer	5
II	**Computer Arithmetic:** Fixed point Addition, Subtraction, Multiplication and Division. Floating Point Arithmetic, High-performance arithmetic, Booth's algorithm: Division and Multiplication, Data representation methods. **IEEE standard:** single and double precision format and examples, ALU	5
III	**Memory Architecture:** Memory hierarchy, Memory Chip Organization, Cache memory, Virtual memory, Parallel Bus Architectures, Internal Communication Methodologies, Serial Bus Architectures, Mass storage, Input and Output Devices, Segmentation, TLB, DMA	5
IV	**An Overview of Pipelining:** Basic concepts of Pipelining, Pipelined Datapath, and Control. **Data Hazards:** Forwarding versus Stalling, Control Hazards, Exceptions, Arithmetic and Instruction Pipeline, throughput and speedup, pipeline hazards.	5
V	**Processor Architecture:** hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU. Multicore processors architecture, Introduction toGraphics Processing Units, Clusters and Warehouse scale computers, Advanced topics & its application.	5

Text Books	1.	Computer Organization and Architecture by Carl Hamacher 4th Edition
	2.	Advance computer Architecture by Kai Hwang under Tata McGraw Hill Publications
	3.	Introduction to Parallel Processing: Algorithms & Architectures, Behrooz Parhami in Springer Shop
EBooks	1.	Computer Architecture and Organization by William Stalling http://home.ustc.edu.cn/~leedsong/reference_books_tools/Computer%20Organization%20and%20Architecture%2010th%20-%20William%20Stallings.pdf
Reference Books	1.	Introduction to Parallel Processing by P. Ravi Prakash, M. Sasikumar, Dinesh Shikhare By PHI Publications
	2.	Fundamentals of Parallel Processing by Jordan Harry, Alaghband Gita, PHI Publication
	3	Parallel Computers – Architecture and Programming by V. Rajaraman And C. Siva Ram Murthy.
	4.	Introduction to Parallel Programming by Steven Brawer
On-line TL Material	1.	NPTL https://nptel.ac.in/courses/106/105/106105163/

Course Title: Applied life skills for Progressive Excellence										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	H	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTSHL227									
Teaching Mode	Offline	2 Hrs.			Total	75			--	
Duration of ESE	2 Hrs.					75				

Course Objectives	To develop understanding of the fundamentals of life skills in students.
	To improve self-awareness and develop ways to face demands and challenges of life.
	To provide social-psychological and emotional foundations for the understanding of life skills.
	To foster social responsibility in students and enhance their positive and healthy behaviour.
	To carve the students with the opportunity to become active members of their community and has a lasting, positive impact on society at large.
Course Outcomes	**After the completion of the course, students shall be equipped with**
	CO1: The basic life skills towards self and Community as a whole and its varied approaches.
	CO2: The exposure to Self-awareness and face challenges based on life situations.
	CO3: A better understanding of life skills with social-psychological and emotional foundations.
	CO4: Social responsibility and exhibit enhancement in their positive and healthy behaviour.
	CO5: A deep sense of active membership of their community and a lasting, positive impact on

Mapping of Course Outcomes with Program Outcomes:

Course Outcome	Program Outcomes and Program Specific 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	PSO 3
CO1						**2**	**1**								
CO2								**1**	**2**			**2**			
CO3						**2**			**1**						
CO4						**1**	**1**	**2**		**1**					
CO5						**2**	**1**			**1**		**1**			

Course Contents:

Unit	Contents	Hours
1	**Life skills for Individuals:** Self- Realization and managing self in different social context- Self- Direction -Introspection- Attitudes & Behavior- Expectation Management and capability Approach- Justifications Vs. Reasons-Learn to Struggle and Bounce Back	**8**
2	**Life skills for Relationships:** Pro-social Behavior and Aggression- Handling Parenting- Jealousy Negotiation and Refusal Skills - Networking with a purpose-Balancing Negative Human Traits – Confess and Confront-Developing Positive relationships- Conflict Management	**8**
3	**Life Skills for Youth** Peer Pressure- Substance abuse and Alcoholism- Depression and consequence handling- Suicide and skills to avoid ideation-Preparedness for life disasters- Thinking Skills- Approach towards Practical Living	**7**
4	**Deconstructing Life skills as a whole:** Emotion and Coping: Identifying and Managing Emotions/ Techniques to deal with Emotions – Risk and Resilience- Perspective & Challenges- Stress Management- Decision Making- Accepting Criticism	**7**
5	**Life skills for Society:** Community Service Volunteering- Evading Social Exclusion-Human Trafficking- Women and Social inclusion-Service Learning- Responsible Citizenship	**5**

Text Books	1.	Life skills by Dr. Usha Jain and Dr. Rajiv Kumar Jain Publisher: Vayu Education of India in 2014
	2.	Life skills for Teenagers by Dr. Rinita Jain Publisher: Notion Press in 2014
Reference Books	1.	The first book of Life Skills by Larry James Publisher: Embassy Books in 2006
	2.	Fundamentals of Management and Life Skills by Sunil B Rao, Manjunatha M K , Buela D, Sheema Shaheen by Vision Book House in 2020
E-Learning	1.	Conover Resources- Life Skills

Sr. No.	Name of Activities
1	Group Discussions
2	Role Plays
3	Case Studies
4	Group Presentations

Course Title: Content Designing and Media Fundamentals										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	H	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTSHL228									
Teaching Mode	Offline	2 Hrs.			Total	75				
Duration of ESE	2 Hrs.					75				

Course Objectives	To introduce students to the basics of Content Writing, the writing styles with relevant techniques
	To nourish their creative content writing with appropriate methods and practices
	To develop an overall understanding of digital marketing / online marketing platforms
	To demonstrate the emerging trends in digital marketing & the use of digital marketing tools.
	To introduce students to the Social Media related content writing and also to critically assess the choice of visual aids
Course Outcomes	**After the completion of the course, students shall be equipped with**
	CO1: The skills to implement the concepts of Content Writing in their writing styles
	CO2: The knowledge of various styles and techniques of writing and editing
	CO3: The understanding of various online platforms and exploring the digital marketing strategies
	CO4: The evolving styles in digital marketing and its associated tools
	CO5: The prime choice of visual aids and the in par content writing via Social Media

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcome	Program Outcomes and Program Specific 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	PSO 3
CO1									**1**	**2**					
CO2									**1**	**3**					
CO3										**2**	**1**				
CO4										**2**	**1**				
CO5									**1**	**2**	**1**				

Course Contents:

Unit	Contents	Hours
1	**The Fundamentals of Content Writing:** The concept of content writing and its significance- Types of Content Writing- Principles and Process of Content Writing- Traits of a content writer- Print and Web content Writing	**8**
2	**The Content Writing Theory:** The Method: Brief/ Conceive/Research/Structure/Format – Editing & Proof reading- Writing styles- Corporate Communication: B2B/B2C/Press Release/Newsletters-Formal & Informal Language	**9**
3	**Basics of Digital Marketing:** Introduction to Digital Marketing- Website planning and Creation- Search Engine Optimisation- Social Media Marketing- Web Analytics- Web Marketing and Remarketing- Design Essentials	**8**
4	**Social Media and Visual Aids:** Basics of Social Media and its related content writing- Public relations- Infographics- Importance and relevance- Images and Screenshots- Videos, Memes, Gifs- Product demonstration	**5**
5	**Plagiarism in Content Writing:** What is Plagiarism- Importance of plagiarism free content writing- Plagiarism detection tools- Techniques to avoid plagiarism	**5**

Text Books	1.	Content Writing Step-By-Step by Joseph Robinson published in 2020-KDP Print US
	2.	Content Writing Handbook by Kounal Gupta published in 2021 – Henry Harvin
Reference Books	1.	The No-Fluff Guide to Writing Web Content by Alina Bradford Published in 2019- KDP Print US
	2.	Blog Writing: The Content Creation Blueprint by Anthony James Published in 2018- KDP Print US
E-Learning	1.	C IS FOR CONTENT by Fuzia

Sr. No.	**Name of Activities**
1	Content Brainstorming and Designing
2	Media and Visual Aids and Presentations
3	Writing Styles for Different Content Scenarios
4	Presentation on Free Digital platforms

Course Title: Cyber Ethics and Moral Responsibility										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	H	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTSHL229									
Teaching Mode	Offline	2 Hrs.			Total	75				
Duration of ESE	2 Hrs.					75				

Course Objectives	Define cyber ethics and Morality with how classic ethical frameworks relate to it.
	Apply critical thought to a wide variety of topics pertaining to cyber ethics.
	Clearly articulate arguments both for and against various cyber ethical cases and bullying.
	Demonstrate the ability to include ethical considerations in their decision-making.
	Examine the scope of intellectual property issues and the available protection measures.
Course Outcomes	**After the completion of the course, students shall be equipped with**
	CO1: Cyber Ethics and Morality with its related frameworks.
	CO2: Critical thinking in a varied cyber ethics topics.
	CO3: Articulate arguments and arrive clarity for and against cyber ethical cases. Being vocal and firm on the concern of Cyber bullying.
	CO4: Decision making skills by considering ethical scenarios and its relevant consequences.
	CO5: A better understanding of intellectual property issues and the protective measures.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcome	Program Outcomes and Program Specific 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 O 1	PSO 2	PSO 3
CO1						**1**		**3**	**1**			**1**			
CO2								**1**							
CO3								**3**		**2**					
CO4						**1**	**1**	**2**							
CO5							**1**		**1**						

Course Contents:

Unit	Contents	Hours
1	**Introduction to the course:** Introduction to Cyber Ethics and Morality- The need of Cyber Ethics in current era- Ethical Concepts and Theories- Netiquettes-Developing Ethical Analytical skills and Values	**7**
2	**Ethical Perspectives as a User:** Freedom of Expression-Criminal Liability vs. Accountability- Code of Conduct-Moral Responsibility and Trust- Content Reliability- Decision Making and Reasoning Skills -Online Communities and its usages- Free speech and content control- Plagiarism and Email spam- Cyber-bullying	**12**
3	**Regulating Internet Privacy:** Personal Information on the Internet- Consumer Privacy on the Internet-Professional Ethics- Surveillance and Cyberspace – The Digital Divide-Emerging and converging technologies- Regulating commerce in cyberspace	**7**
4	**Intellectual Property:** Respecting Intellectual Property online- The domain of intellectual Property-Justifications and critiques- Trends of Intellectual property rights	**4**
5	**Cyber Ethics as a practice with case studies**	**5**

Text Books	1.	Cyber Ethics 4.0- Serving Humanity with values edited by Global Ethics.net in 2018
	2.	Raising Humans in a Digital World by Diana Graber- An Imprint of Hapercollins in 2019
Reference Books	1.	Cyber ethics: Social & Moral Issues in the Computer Age edited by Robert M Baird, Reagan Ramsower-Stuart E Rosenbaum in 2000
E-Learning	1.	Cyber Ethics for students and Youth-Education Beaureau- Online Site with Resources

Sr. No.	Name of Activities
1	Group Discussions on real time Scenarios
2	Role Plays
3	Case Studies
4	Group Presentations

SEMES TER – III :

Engineering Economic and Industrial Management													
Sub. Code	Name of the Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total
			Th	Tu	Pr	Total		TAE	CAE	ESE	Int.	Ext.	
23BTMBL201AI	Engineering Economic and Industrial Management	H	2	-	-	2	2	10	15	50	-	-	75

Course Objectives	Understanding of basic knowledge of Economics and its application.
	Understanding of Management as discipline and its practices.
	Strengthening knowledge of management in the functional area of Marketing and Finance.
Course Outcomes	C01-Remember the basic concepts of Micro Economics and its applications.
	C02-understand the basic concepts of Macro Economics and its applications.
	C03-Analyzing the functions of Management and its application.
	C04-Design Marketing strategies by understanding different marketing concepts
	C05-Apply the basic concept of Human Resource Management.

Course Contents:

Unit	Contents	Hours
I	Micro Economics- Features and scope, Demand- Law of demand, assumptions and exceptions, Utility and Indifference curves, Elasticity of demand, Factors of Production, Market and Market Structures: Price and output determination under perfect competition.	7
II	Macro Economics- Features and scope, National Income, circular flow of national income, Functions of central and commercial banks, Inflation, Deflation, Stagflation, Monetary & Fiscal policies of the government.	6
III	Definition, nature and scope of Management, Functions of management - Planning, Organizing, Directing, Controlling, Communication.	5
IV	Marketing management- concepts of marketing, Marketing Mix, Service Marketing, Product Life Cycle, New Product Development, Pricing strategies, Channels of distribution, Promotion Mix	7
V	HRM – Concept, Manpower planning, Recruitment and selection, performance appraisal – Ranking Method, Rating scale method, 360 degree appraisal, Behaviorally Anchored Rating Scale (BARS).	5

Text Books	Modern Economics Theory, by K.K. Dewett, S. Chand & company ltd., 3rd Edition, 2006
	Principles of Management, by P C Tripathi & P N Reddy, Mc Graw Hill Education, 6th Edition.
	Principles of Marketing, by Philip Kotler & Gary Armstrong, Rearson Education, 11th Edition
	Managerial Economics by D. N. Dwivedi, 8th Edition, vikas publication

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Syllabus

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-IV													
23BTSHL230AI	Transform and Numerical Method	PCC4	3	1		4	4	10	15	50			75
23BTAIL202 / 23BTAIP202	Machine Learning Algorithms	PCC5	3		2	5	4	10	15	50	25	25	125
23BTITL204AI	Multidisciplinary Minor II-	MDM2	2			2	2	10	15	50			75
23BTXXLXXAI	Open Elective II	OE2	2			2	2	10	15	50			75
23BTAIL205/ 23BTAIP205	Vocational and Skill Enhancement Elective III	VSEC3	1		2	3	2	10	15		25		50
23BTSHL231AI 23BTSHP231AI	Aptitude and Employability skill	AEC2	1		2	3	2	10	15		25		50
23BTMBL202AI	Entrepreneurship Development Practices	EEMC2	2			2	2	10	15	50			75
23BTSHL233AI	Universal Human Values 2: Understanding Harmony	VEC2	2			2	2	10	15	50			75
TOTAL			**16**	**1**	**6**	**23**	**20**	**80**	**120**	**300**	**75**	**25**	**600**

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Syllabus of Semester IV

Course Title: **Transforms and Numerical Methods**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC4	3	1	--	4	10	15	50	--	--
Course Code	23BTSHL230AI									
Teaching Mode	Offline	4			Total	75			--	
Duration of ESE	2hrs					75				

Course Objectives	1.The objectives of this course is to teach students to comprehend the transform method to solve differential and difference equations.
	2.Learn Numerical methods to solve algebraic, transcendental, simultaneous and ordinary differential equations.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand the mathematical descriptions in Laplace Transform
	CO2: Understand the mathematical descriptions in Z- transform.
	CO3: Understand numerical techniques to solve various algebraic and transcendental equations
	CO4: Apply the knowledge of numerical techniques to solve ordinary differential equations

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program 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	3	3	2	--	1	--	--	--	--	--	--	3	3	3
CO2	3	3	2	--	1	--	--	--	--	--	--	3	3	3
CO3	3	3	2	--	1	--	--	--	--	--	--	3	3	3
CO4	3	3	2	--	1	--	--	--	--	--	--	3	3	3
CO5	3	3	2	--	1	--	--	--	--	--	--	3	3	3

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Course Contents:

Unit	Contents	Hours
I	**Laplace Transforms:** Laplace transform: definition and their simple properties, transform of derivatives and integrals, Evaluation of integrals by Laplace transform, Inverse Laplace transform and its properties, Convolution theorem, Laplace transforms of periodic function and unit step function. Solutions of mathematical models (ODE & PDE) using Laplace Transform. Solution of simultaneous ordinary differential equations by Laplace Transform method.	12
II	**Z-Transforms:** Definition, properties of Z- Transforms, Inverse Z- Transform and relation between Z transform and Laplace Transform. Convolution Theorem, Application of Z-Transform to solve difference equations with constant coefficients.	12
III	**Numerical Methods-I:** Error analysis, Solutions of algebraic and transcendental equations. Bisection method, False position method, Newton-Raphson method and their convergences. Solution of system of linear equations by Gauss Seidel method, Crout's method, Gauss Jordan method, Jacobi's Method	12
IV	**Numerical Methods-II:** Solution of ordinary differential equation by Taylor series method, Runge-Kutta fourth order method, Euler modified method, Picard's Method, Milne's Predictor corrector method. Solution of Simultaneous and higher order differential equations.	12

Text Books	1.	Higher Engineering Mathematics, Grewal B.S.: Khanna Publishers; 2013 Forty Third
	2.	Advanced Engineering Mathematics, Jain, R.K. and Iyengar, S.R.K.
EBooks	1.	http://www.math.ust.hk/~machas/numerical-methods.pdf
Reference Books	1.	Advanced Engineering Mathematics, Kreyszig, E. John Wiley & Sons; 2000, Eight
	2.	Advanced Engineering Mathematics, Jain, R.K. and Iyengar, S.R.K,2007,Third
	3.	Numerical Methods, Dr. P Kandasamy, S.Chand Publishers Edition forty third.
	4.	Introduction to Numerical Analysis, S. Baskar and S. Sivaji Ganesh, 2013

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Course Title: **Machine Learning Algorithms**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	Int	Ext
Course Category	PCC5									
Course Code	23BTAIL202/ 23BTAIP202	3 Hr.	NA	2 Hrs.	4	10	15	50	25	25
Teaching Mode	OFFLINE	5 Hrs			Total	75			50	
Duration of ESE	NA					125				

Course Objectives	1. Understand the basics of machine learning algorithms.
	2. Understand nature of the problem and apply suitable machine learning algorithm
	3. Implement Machine Learning Algorithms on various datasets
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand the fundamentals of machine learning techniques.
	CO2: Apply a wide variety of supervised machine learning algorithms to solve the given problem.
	CO3: Analyze the different modelling techniques and evaluate the performance of the machine learning model.
	CO4: Evaluate popular Machine Learning algorithms like SVM, KNN, PAC, VC to solve the given problems.
	CO5: Implement unsupervised learning algorithms to solve the given problem and evaluate the performance of the Machine Learning Models.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program 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	**2**	**1**	--	--	**1**	--	--	--	1	--	--	**2**	**2**	**2**
CO2	**3**	**3**	--	--	--	**1**	--	--	--	--	--	--	**2**	**3**
CO3	**3**	--	**3**	**2**	--	**2**	--	--	1	--	--	**2**	**2**	**2**
CO4	**3**	1	**3**	**3**	--	1	--	--	--	--	--	**3**	**2**	**3**
CO5	**2**	--	**3**	**2**	**3**	--	--	--	**2**	--	--	**2**	**3**	**2**

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Course Contents:

Unit	Contents	Hours
I	**Introduction to machine learning:** Need for machine learning, basic terminologies used in machine learning, Types of machine learning- Supervised Learning, Unsupervised Learning, Reinforcement Learning, challenges in machine learning, machine learning process, applications of machine learning. **Basics of Learning Theory:** Concept Learning, Hypothesis, Hypothesis Space, Bias, Variance, Well-posed learning problem.	6
II	**Supervised Learning:** Understanding Data: Types of data, Data collection, Data preprocessing, Descriptive statistics. **Regression:** Introduction to regression and regression analysis, Types of errors, cost function, Linear regression, Logistic regression, Gradient Descent **Decision Tree learning:** fundamentals of decision tree learning model, Entropy, Information gain, Building decision tree	8
III	**Modelling and Evaluation:** Predictive models, Descriptive models. Underfitting and over fitting, Pruning, bias-variance tradeoff, cross validation, Model performance evaluation method and techniques. PCA Model and ML Model Inference **Probabilistic learning:** Fundamentals of probability-based learning, Bayes theorem, classification using Bayesian learning.	8
IV	**Popular ML Algorithms:** Support Vector Machine, K-Nearest Neighbor Algorithm, Computational learning theory, PAC learning model, VC Dimension, Ensemble learning	6
V	**Unsupervised Learning:** Introduction to clustering approaches, types of clustering, clustering techniques, Association rules, K-Means algorithm, DBSCAN algorithm, Gaussian mixture model	6

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Sr. No.	Name of Experiments / Mini Projects/ Case Studies	COs
1	Write python program to demonstrate the use of various libraries for machine learning.	CO1
2	For a given set of data write a program to implement **Linear Regression and Logistic regression** algorithm to create a model and evaluate the model.	CO2
3	Write a program to demonstrate the working of the **Decision Tree** based **classification**. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	CO2
4	Write a program to implement the **Naïve Bayesian classifier** for a sample training data set. Compute the accuracy of the classifier, considering few test data sets.	CO3
5	Write a program to implement **Support Vector Machine** for a sample training data set. Compute the accuracy of the classifier, considering few test data sets.	CO4
6	Write a program to implement the **K-Means** Algorithm for a sample training data set. Compute the accuracy of the model, considering few test data sets.	CO5
7	Write a program to implement the **DBSCAN** Algorithm for a sample training data set. Compute the accuracy of the model, considering few test data sets.	CO5
Open Ended Experiments / New Experiments		
8	Medical Image Segmentation	
Details of online Laboratory Resource Material Instruction / Operating Manuals		
1.	Introduction to Fundamentals of Fuzzy Logic and Basic Operations URL: http://vlabs.iitkgp.ernet.in/scte/	
2.	Introduction and implementation to Color Image Processing URL: http://cse19-iiith.vlabs.ac.in/objective.php?exp=colour	
3.	Understating and Implantation of Mean and Covariance URL: http://vlabs.iitb.ac.in/vlab/labscse.html	

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Text Books	1.	Mitchell Tom, Machine Learning. McGraw Hill, 1997.
	2.	S Shridhar, M Vijayalaxmi, Machine Learning, Oxford University Press, 2021
	3.	Saikat Dutt, S Chandramouli, Amit Kumar Das, Machine Learning, Pearson, 2019
E-Books	1.	Understanding Machine Learning: From Theory to Algorithms, By Shai Shalev-Shwartz and Shai Ben-David URL: https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/index.html
	2.	Bayesian Reasoning and Machine Learning By David Barber URL: http://web4.cs.ucl.ac.uk/staff/D.Barber/textbook/091117.pdf
Reference Books	1.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning Data Mining, Inference, and Prediction
	2.	Richard O. Duda, Peter E. Hart, David G. Stork. Pattern classification, Wiley, New York, 2001.
	3.	Machine Learning: The Art and Science of Algorithms that Make Sense of Data (1st Edition) – Peter Falch
	4.	Introduction to machine learning, EthemAlpaydin. —2nd ed., The MIT Press, Cambridge, Massachusetts, London, England.
On line TL Material	1	NPTEL: Introduction to Machine Learning by Prof. Sudeshna Sarkar, IIT Kharagpur. URL: https://onlinecourses.nptel.ac.in/noc21_cs85/preview,
	2	NPTEL: Essential Mathematics for Machine Learning By Prof. Sanjeev Kumar, Prof. S. K. Gupta, IIT Roorkee URL: https://onlinecourses.nptel.ac.in/noc21_ma38/
	3	DataCamp: Machine Learning for Everyone URL: https://www.datacamp.com/courses/machine-learning-for-everyon

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Multidisciplinary Minor-II

Course Title: **SOFTWARE ENGINEERING AND PROJECT MANAGEMENT MD-II**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM-II	2Hrs	--	--	2	10	15	50	--	--
Course Code	23BTITL204AI									
Teaching Mode	Offline	2 Hrs			Total	75				
Duration of ESE	2.5 Hrs					75				

Course Objectives	The student should be made to: 1. Understand the phases in a software project
	2. Understand fundamental concepts of requirements engineering and Analysis Modeling.
	3. Understand the major considerations for enterprise integration and deployment.
	4.Learn various testing and maintenance measures
Course Outcomes	Up on successful completion of this course, student will be able to:
	CO1: Identify the key activities in managing a software project
	CO2: Compare different process models and design techniques.
	CO3: Understand the concepts of requirements engineering and Analysis.
	CO4: Apply quality management and project management procedure for software design and deployment.
	CO5: Remember various software testing and planning approaches.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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	3	2	3	-	-	-	-	-	-	-	3	-	-	-
CO2	3	2	3	-	-	-	-	-	-	-	3	-	-	-
CO3	2	3	3	2	1	-	-	-	-	-	3	-	3	2
CO4	2	3	3	-	-	-	-	-	-	-	3	-	3	3
CO5	3	-	3	1	-	-	-	-	-	-	3	-	-	3

Department of Artificial Intelligence

Course Contents:

Unit	Contents	Hours
I	**SOFTWARE PROCESS** Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models, Agile models, Software Project Management, Project Scheduling – Scheduling, Earned Value Analysis.	7
II	**REQUIREMENTS ANALYSIS AND SPECIFICATION** Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document – Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management-Classical analysis: Structured system Analysis, Petri Nets- Data Dictionary	7
III	**SOFTWARE DESIGN** Design process – Design Concepts-Design Model– Design Heuristic – Architectural Design – Architectural styles, Architectural Design, Architectural Mapping using Data Flow- User Interface Design: Interface analysis, Interface Design –Component level Design: Designing Class based components, traditional Components.	7
IV	**PROJECT MANAGEMENT** Estimation – FP Based, LOC Based, Make/Buy Decision, COCOMO II – Planning – Project Plan, Planning Process, RFP Risk Management – Identification, Projection, RMMM – Scheduling and Tracking –	7
V	**TESTING** Software testing fundamentals-Internal and external views of Testing-white box testing – basis path testing-control structure testing-black box testing Debugging	7

Text Books	1.	Roger S. Pressman, "Software Engineering – A Practitioner's Approach", Seventh Edition, McGraw-Hill International Edition, 2010.
	2.	Ian Sommerville, "Software Engineering", 9th Edition, Pearson Education Asia, 2011.
E--Books	1.	Foundations of Software Engineering by Kevin Amaratunga
	2.	The New Software Engineering by Sue Conger
Reference Books	1.	Rajib Mall, "Fundamentals of Software Engineering", Third Edition, PHI Learning Private Limited, 2009.
	2.	Pankaj Jalote, "Software Engineering, A Precise Approach", Wiley India,2010.
online TL Material	1.	Certification Courses available: https://nptel.ac.in/downloads/106105087/
	2.	Free Courses available: https://swayam.gov.in/course/236-software-enginnering

Department of Artificial Intelligence

Vocational and Skill Enhancement Elective III

Course Title: **Skill Enhancement-II (Data Preprocessing)**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	VSEC3	1	--	2 Hrs.	2	10	15	-	25	
Course Code	23BTAIL205/ 23BTAIP205									
Teaching Mode	Offline				Total	25			25	
Duration of ESE	--					50				

Course Objectives	1. To understand the role and necessity of data pre-processing
	2. To identify and comprehend the various data quality issues.
	3. To learn the applicability of the techniques in data pre-processing.
	4. To relate the pre-processing techniques to real-world applications.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand data using Statistical tools and techniques
	CO2: Apply appropriate techniques for Data Cleaning
	CO3: Analyze Feature Scaling, Data Labeling techniques
	CO4: Evaluate Visualization of data through graph plots.
	CO5: Implement the data pre-processing techniques on real world datasets.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program 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	3	3	--	--	3	--	--	--	--	--	--	--	--	1
CO2	--	3	--	--	3	--	--	--	--	--	--	--	3	--
CO3	--	3	2	--	3	--	--	--	--	--	--	--	--	2
CO4	--	3		--	3	--	--	--	--	--	--	--	--	--
CO5	--	3	3	--	3	--	--	--	3		2	3	--	--

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Course Contents:

Unit	Contents	Hours
I	Introduction, Definitions, need of data preprocessing, understanding data preprocessing, Libraries used for Data preprocessing	4
II	Step and type of Data preprocessing, missing, noise data, data integration, data transformation	4
III	Data Reductions, Dimensionality Reduction, Clustering, data Sampling, Data Discretization	6
IV	Categorical Data, Feature Scaling, encoding categorical features, Normalization and its type, Binarization, Data Labeling, Data Feature Selection.	5
V	Principal Component Analysis (PCA), **t**-distributed stochastic neighbor embedding (t-SNE) in Python with scikit-learn.	5

Text Books	1.	Gerardus Blokdyk, Data pre-processing The Ultimate Step-By-Step Guide,
	2.	M. Shron, O'Reilly, Thinking with Data: How to Turn Information into Insights, Publisher: O'Reilly Media, 2014
	3.	T. Fawcett and F. Provost, Data Science for Business: What you Need to Know about Data Mining and Data Analytic Thinking, Publisher: O'Reilly Media, 2013
E-Books	1.	Salvador García, Julián Luengo, Francisco Herrera, Data Preprocessing in Data Mining, Volume 72, Springer http://users.ece.utexas.edu/~ethomaz/courses/dm/papers/data-preprocessing-book.pdf
	2.	Winter School on "Data Mining Techniques and Tools for Knowledge Discovery in Agricultural Datasets" http://apps.iasri.res.in/ebook/win_school_aa/notes/Data_Preprocessing.pdf
Reference Books	1.	Ralph Kimball, Margy Ross, The Data Warehouse Toolkit, 3rd edition, Publisher: Wiley, 2013
	2.	J. Han, M. Kamber and J.Pei, Morgan Kaufmann, Data Mining, Concepts and Techniques, Publisher: Elsevier, 2006
	3.	Ramesh Sharda, Dursun Delen, Efraim Turban, Business Intelligence and Analytics: Systems for Decision Support, Publisher: Pearson/Prentice Hall, 2014
on line TL Material	1.	http://www.prolearninghub.com/courses/data-warehouse-concepts-design-data-integration/

Department of Artificial Intelligence

List of Practicals

Sr. No.	Name of Practicals
1	Importing Numpy libraries and perform operations
2	Creating data frame and loading dataset and perform operations.
3	Handling missing data value in dataset.
4	Identify and handle outliers in your dataset
5	Execute feature scaling on given dataset.
6	Perform encoding on given dataset.
7	Implement principal component analysis algorithm
8	Perform training and testing on given datasets
9	Implement t-distributed stochastic neighbor embedding (t-SNE) in Python with scikit-learn.
Open Ended Experiments / New Experiments	
10	A] Open Ended Practical: Preprocess a dataset, apply following techniques • Importing the libraries • Import the dataset • Taking care of the missing data • Encoding categorical data • Splitting the dataset into the training and test sets • Feature scaling
11	Virtual Lab: https://python-iitk.vlabs.ac.in/List%20of%20experiments.html

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Course Title: Aptitude and Employability Skills										
Semester	**IV**	**Teaching Scheme**				**Evaluation Scheme**				
						Theory			Practical	
Term	II	L	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	AEC2	1	-	2	3	10	15	-	25	--
Course Code	**23BTSHL231** AI/CS/CY/DS/IT/EC/EE/ME/CE **23BTSHP231** AI/CS/CY/DS/IT/EC/EE/ME/CE									
Teaching Mode	Offline				**Total**	25			25	
Duration of ESE	NA					**50**				

Course Objectives	The Curriculum aims to equip students in order to apply quantitative reasoning and Mathematical analysis methodologies to understand and solve problems.
	To attain conceptual clarity to comprehend reasoning questions in a simple way and arrive at decisions at a logical manner.
	To introduce them with the current market scenarios and equip the students with the essential skills for employability
	To demonstrate self-sufficiency to be highly employable and assimilate how to prepare for personal interview
	To build self-confidence facing any interview and consolidate job and career readiness
Course Outcomes	**CO1:** Students shall draw conclusions or make decisions based on analysis and critique of quantitative information. This leads them to effectively justify the conclusion and execute their plans.
	CO2: Students shall solve real life problems requiring interpretation and comparison of various probabilities to ascertain the best outcomes expected.
	CO3: Students shall exhibit their ability to set clear and realistic professional objective and enabling them to make well informed choices and commercially equipped according to market trends (Resume Building)
	CO4: Students shall be equipped on the application of organizing, planning and execution Skills(Personal Interview)
	CO5: Students shall be well versed to map their personality tied with different job opportunities. (Market Research & Identifying skill gap)

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Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	**3**	**3**												
CO2	**3**	**3**												
CO3				**2**							**2**	2		
C04										**3**				
CO5									**3**	**3**				

Course Contents:

Unit	Contents
I	**Direction**: Introduction to direction nomenclature, Distance covered, Shortest possible distance by pythagoras theorem, Concept of Shadow -**Analogy**: All mathematical analogies -**Seating Arrangement**: Circular and Linear arrangement–**Syllogism**: Deductive reasoning, categorial syllogism, Some, All, few and Venn diagrams
II	**Data sufficiency**: Questions and statements -**Coding and Decoding**: Coding, Decoding & Patterns -**Number Series**: In place of alphabets the required number to be filled and addition and subtraction carried out accordingly – **Cryptarithmetic**: In place of alphabets the required number to be filled and addition and subtraction carried out accordingly
III	**Orientation - Researching Job and Company- Emerging Market Trends:** Experience sharing of Major Campus interviews, Skill Requirements, Current Market trends, Researching the Job and company
IV	**Personal and company commercial:** Guidelines for preparing a 30- 90 second self Introduction .Questions to think about in developing a commercial- Understand "What to avoid" in a commercial - **Self Selling Proficiency**: What to say and do, How to demonstrate commercial awareness in an interview ,Post Interview activity, Telephone etiquette in a phone Interview **Resume Building :**Guidelines on framing resume and cover letter Checklist to ensure completeness , Sample resumes and cover letter references Basic Guidelines on Video Resume an its difference with conventional
V	**Personal Interview- Group Discussion**: Preparation tips on GD and Extempore: Dos' and Donts', Presentation on PI Preparation and FAQs -Role Plays/ Mock Interview with Technical Faculty and Mock Interview by Faculty **Assessment and feedback series:**

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Text Books	1.	Aggarwal, R. S. (2010). A Modern Approach to Verbal & Non-Verbal Reasoning (Revised ed.). S. Chand Publishing. ISBN: 978-8121924986.
	2	Panikar, S., & Sharma, P. (2021). *Communication skills for budding professionals* (2nd ed.). Global Education Ltd
Reference Books	1.	Sharma, A., & Kumar, M. (2018). Quantitative Aptitude for Competitive Examinations. Pearson Education. ISBN: 978-9353061742.
	2.	Nair, M., & Mulay, T. (2024). *The golden book on employability: Get hired...stay hired* (1st ed.). Global Education Ltd.

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Course Title: **Universal Human Values 2: Understanding Harmony**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	VEC2	2	--	--	2	10	15	50	--	--
Course Code	23BTSHL233 AI/CS/CY/DS/ IT/EC/EE/ME/ CE									
Teaching Mode	Offline	3			Total	75			--	
Duration of ESE	2 Hrs.					75				

Course Objectives	Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence
	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
	Strengthening of self-reflection and development of commitment and courage to act.
Course Outcomes	1. Students are expected to become more aware of themselves.
	2. Students are expected to become more aware of their surroundings (family, society, nature).
	3. Students should become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
	4. Students would have better critical ability, they would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
	5. Students would be able to apply what they have learnt to their own self in different day-to-day settings in real life.

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Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO3
CO1						**2**		**3**	**1**			**2**			
CO2			**3**			**2**		**2**		**2**		**2**			
CO3			**3**			**3**	**3**	**2**							
CO4			**2**			**2**	**2**	**2**							
CO5			**1**			**1**	**1**	**2**				**3**			

Course Contents:

Unit	Contents	Hours
I	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education:** Purpose and motivation for the course, Self-Exploration, Continuous Happiness and Prosperity, Right understanding relationship and physical facility, Understanding happiness and prosperity correctly, Method to fulfill the above human aspirations.	8
II	**Understanding Harmony in the Human Being - Harmony in Myself!** Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body', Understanding the Body as an instrument of 'I', Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body.	8
III	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship** Understanding values in human-human relationship, Understanding the meaning of Trust, Understanding the meaning of Respect, Understanding the harmony in the society, Visualizing a universal harmonious order in society.	8
IV	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence** Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature, Understanding Existence as Co-existence, Holistic perception of harmony.	8

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Text Book	1.	Human values and Professonal Ethics by R R Gaur,R Sangal,G P Bagaria, Excel Books, New Delhi,2010
Reference Books	1.	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999
	2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi 2004.
	3.	The story of my experiments with truth-by Mohandas Karamchand Gandhi
	4	Small is beautiful-E.F Schumacher
	5	Slow is beautiful-Cecile Andrews

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Course Title: Entrepreneurship Development Practices										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	EEMC2	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTMBL202AI									
Teaching Mode	Offline	2 Hrs.			Total	75			--	
Duration of ESE	2 Hrs.					75				

Course Objectives	To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.
	To explain and formulate the Problem statement of startup
	To perceive fundamentals of business control strategy in industrial and technological Problems.
Course Outcomes	**After the completion of the course, students shall be equipped with**
	CO1: Identify the problem statement with business and Startup potentials.
	CO2: Identify specific customer segment for the intended solution
	CO3: Make Lean Canvas for their startup model.
	CO4: Make Business plan presentation and pitch Business Plan
	CO5: Identify the challenges and threats in Entrepreneurship.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	**Programme Outcomes**						**Programme Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**		**PSO 1**	**PSO 2**	**PSO3**
CO1	3	2	2	3	3		2	1	-
CO2	3	1	2	2	3		2	2	-
CO3	3	1	1	2	1		1	2	-
CO4	3	2	2	1	2		2	2	-
CO5	2	2	2	1	2		2	2	

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Course Contents:

Unit	Contents	Hours
1	**Introduction to Entrepreneurship:** Stages involved in Entrepreneurship Developments, TRL Levels, Ideation, Design thinking, business strategies.	4
2	**Product Development Framework:** Stagers involved in New Product Development in Entrepreneurship, Emphasize, Problem statement Definition, Ideate, Prototypes & Testing.	5
3	**Business Canvas Model:** Introduction to Business Canvas: Model, Customer segments, Value proposition, Revenue streams, Societal and environmental benefits, Channels, Customer relationships, Key activities, Key resources, Key partners & Cost structure	4
4	**Types of Companies in Entrepreneurship & Legal Compliances:** Types of companies, Proprietary firm, partnership, LLP, Pvt ltd, Public Limited etc, Legal compliances in Entrepreneurship.	4
5	**Discussion & Case studies in Entrepreneurship:** Discussion of recent successful startups as case studies, Presentation of case studies with new design concept business model with proper Canvas Model. Discussion of Entrepreneurship Threats & Challenges in New Startups.	5

Text Books	1.	Hisrich R D, Peters M P, "Entrepreneurship" 11th Edition, Tata McGraw-Hill, 2018.
	2	Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
	2.	Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011
Reference Books	1.	Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2nd Edition Dream tech, 2005
	2.	EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986
E-Learning	1.	NPTEL Course, 'Entrepreneurship essentials', by Prof. Manoj Kumar Mandal, IIT Kharagpur, Link: https://nptel.ac.in/courses/127105007/
	2	NPTEL Course, 'Entrepreneurship, by Prof. C Bhaktvatsalya Rao, , IIT Madras Link: https://nptel.ac.in/courses/110106141
	3	StartupIndia Learning Program sponsored by Upgrad and Governement of India, Link https://startupindia.upgrad.com/login?redirect=startupindia.upgrad. com/v/dashboard& (Free)

Department of Artificial Intelligence

Course Title: **Soft Computing**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC6	3 Hrs	-	2Hrs	4	10	15	50	25	25
Course Code	23BTAIL301 23BTAIP301									
Teaching Mode	Offline	5 Hrs			Total	75			50	
Duration of ESE	2.5 Hrs					125				

Course Objectives	1. Understand Soft Computing concepts, technologies, and applications
	2. Understand the underlying principle of soft computing with its usage in various application. .
	3. Understand different soft computing tools to solve real life problems.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.
	CO2: Apply and Evaluate defuzzification techniques and fuzzy logic controllers to design and optimize real-world fuzzy control systems.
	CO3: Solving single and multi-objective optimization problems using Evolutionary algorithms
	CO4: Implement various Neural Network Architectures for solving complex problems
	CO5: Develop application on different soft computing techniques like Fuzzy, GA and Neural network

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific 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	--	2	2	2	--	--	--	--	--	--	--	--	--	--
CO2	--	--	3	3	--	--	--	--	--	--	--	--	--	3
CO3	--	--	3	3	--	--	--	--	--	--	--	--	--	3
CO4	--	--	3	3	--	--	--	--	--	--	--	--	--	--
CO5	--	--	3	3	3	--	--	--	--	--	--	3	--	3

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Course Contents:

Unit	Contents	Hours
I	Introduction to Soft Computing, Introduction to Fuzzy logic,Fuzzy membership functions, Operations on Fuzzy sets, Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences	6
II	Defuzzyfication Techniques-I, Defuzzyfication Techniques-II, Fuzzy logic controller-I, Fuzzy logic controller-II	6
III	Solving optimization problems, Concept of GA, GA Operators: Encoding, GA Operators: Selection-I, GA Operators: Selection-II, GA Operators: Crossover-I, GA Operators: Crossover-II, GA Operators: Mutation	6
IV	Introduction to EC-I, Introduction to EC-II, MOEA Approaches: Non-Pareto, MOEA Approaches: Pareto-I, MOEA Approaches: Pareto-II	6
V	Introduction to Artificial Neural Networks, Learning rules and various activation functions, Single layer Perceptron , Back Propagation networks, Architecture of Back propagation(BP)Networks, Back propagation Learning, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.	6

Text Books	1.	Principles of Soft Computing by S. N. Sivanandam and S. N. Deepa book to be added in Soft computing Syllabus.
	2.	R. Rajasekaran and G. A and Vijayalakshmi Pa, *Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications*, Prentice Hall of India
	3.	D. E. Goldberg, *Genetic Algorithms in Search, Optimisation, and Machine Learning*, Addison-Wesley
	4.	M Amirthavalli, Fuzzy Logic and Neural Networks, Scitech Publications
E-Books	1.	Timothy J Ross, Fuzzy Logic with Engineering Applications https://www.academia.edu/5333146/Fuzzy_Logic_with_Engineering_Applications_Third_Edition
	2.	Mitchell Melanie, An Introduction to Genetic Algorithms, https://www.boente.eti.br/fuzzy/ebook-fuzzy-mitchell.pdf
Reference Books	1.	Jacek M. Zurada, *Artificial Neural Systems*, PWS Publishing, Boston, 1992 (ISBN 0-314-93391-3)
	2.	"Fuzzy Logic with Engineering Applications" by Timothy J Ross
	3.	Evolutionary Computation: A Unified Approach by Kenneth A. DeJong, MIT Press, 2006, ISBN: 0262041944
On line TL Material	1	https://nptel.ac.in/courses/106/105/106105173/

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Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	Implement different fuzzy set operations
2	Implementation of different fuzzy membership functions
3	Implementation of Fuzzy Logic Controller
4	Implementation of GA using binary encoding for KNAPSACK problem
5	Implementation of various selection technique
6	Implementation of crossover techniques for binary coded GA
7	Implementation of mutation techniques for binary coded GA
8	Implementation of Perceptron Model
9	Implementation of Backpropagation Algorithm
Open Ended Experiments / New Experiments	
1	Implementation of Multilayer feedforward Network on any dataset of your choice
Details of online Laboratory Resource Material Instruction / Operating Manuals	
1.	Soft Computing Tools Lab URL: http://vlabs.iitkgp.ernet.in/scte/

Department of Computer Science and Engineering

Course Title: **FORMAL LANGUAGES AND AUTOMATA**										
Semester	**V**	**Teaching Scheme**				**Evaluation Scheme**				
						Theory			**Practical**	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC6	3 Hrs			3	10	15	50	NA	NA
Course Code	UNCSL301									
Teaching Mode	Offline	3 Hrs			Total	75				
Duration of ESE	2 Hrs 30 mins					75				

Course Objectives	To introduce the fundamental concepts of formal languages, grammars and automata theory.
	Classify machines by their power to recognize languages and use finite state machines to solve problems in computing.
	Use of Turing Machine and Pushdown Automata in Formal Language.
Course Outcomes	**CO1:** Understand the abstract machines and their power to recognize the valid Languages.
	CO2: Apply the knowledge of Automata Theory, Grammars & Regular Expressions for solving various problems
	CO3: Design context free grammars for formal languages.
	CO4: Analyze automata and their computational power to recognize languages.
	CO5: Solve the problems based on Turing Machine.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific 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	PSO2
CO1	3		-	-	1	1		-	-	-	-	1	2	
CO2	-	3		3	2	2		-	-	-	-		3	3
CO3	-	3		3	2	-	-	-	-	-	-	1	3	3
CO4	-		3		2	1	-	-	-	-	-	-	3	
CO5	-		3		2	2	-	-	1	-	-	-	3	

Course Contents:

Unit	Contents	Hours
I	Introduction Basic Mathematical Notation and techniques: Finite State systems Basic Definitions Finite Automaton DFA & NDFA Finite Automaton with €-moves, Regular Languages, Regular Expression Equivalence of NFA and DFA Equivalence of NDFA"s with and without €-moves Equivalence of finite Automaton.	7

II	Regular Expressions: Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions, Properties of Regular Languages Pumping Lemma for Regular Languages, Applications of the Pumping Lemma, Closure Properties of Regular Languages, Decision Properties of Regular Languages.	7
III	Context-Free Grammars: Chomsky hierarchy of languages. Definition of Context-Free Grammars, Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Sentential Forms, Parse Tress, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages.	7
IV	Push Down Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata.	7
V	Turing Machine: Definitions of Turing machines Models ,Computable languages and functions, Techniques for Turing machine construction, Multi head and Multi tape Turing Machines, The Halting problem.	7

Text Books	1.	Introduction to Automata Theory, Languages, and Computation, 3nd Edition, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.
	2.	Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage Learning.
E--Books	1.	"Formal languages and automata theory" by K V N Sunitha; N Kalyani, Publisher: Chennai : Pearson, [2015] ©2015
Reference Books	1.	Introduction to Languages and The Theory of Computation, John C Martin, TMH.
	2	Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
	3	A Text book on Automata Theory, P. K. Srimani, Nasir S. F. B, Cambridge University Press.
	4.	Introduction to Formal languages Automata Theory and Computation Kamala Krithivasan, Rama R, Pearson.
on line TL Material	1.	NPTEL Course Formal Language and Automata, IIT Guwahati https://nptel.ac.in/courses/111/103/111103016/

Department of Computer Science and Engineering

Course Title: **OPERATING SYSTEM**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC7	3 Hrs	NA	2 Hrs	4	10	15	50	25	25
Course Code	UNCSL304/ UNCSL304									
Teaching Mode	Offline	5 Hrs			Total	75			50	
Duration of ESE	2.30 Hrs					125				

Course Objectives	Introduces general idea, structure and functions of operating system
	Making students aware of basic mechanisms used to handle processes, memory, storage devices and files.
	Recent trends in the operating system
Course Outcomes	**CO1**: Understand basic structure and purpose of operating system.
	CO2: Interpret the concepts of process and illustrate various CPU scheduling algorithms.
	CO3: Apply the concepts of inter process communication.
	CO4: Schematize Deadlock & File System security mechanisms in operating systems.
	CO5: Analyze different memory management techniques with advantages and disadvantages.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	**Program Outcomes and Program Specific Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	--	--	--	2	2	--	--	--	--	--	--	2	--
CO2	1	3	3	2	--	--	--	--	--	--	--	--	3	--
CO3	1	--	3	3	--	--	--	--	--	--	--	--	--	3
CO4	2	--	--	--	3	--	--	--	--	--	--	--	2	--
CO5	--	2	--	--	2	3	--	--	--	--	--	--	2	--

Course Contents:

Unit	Contents	Hours
I	**Introduction About OS:** Evolution of OS, Types of OS, Basic h/w support necessary for modern operating systems, services provided by OS, system programs and system calls, system design and implementation.	7
II	**Process & Scheduling** Process concept, process control block, Types of scheduler- FCFS, SJF, LJF, Priority Scheduling, Round Robin, SRTF,LRTF, context switch, threads, multithreading model, goals of scheduling and different scheduling algorithms,	7
III	**Process management and synchronization**: Concurrency conditions, Critical section problem, software and hardware solution, semaphores, conditional critical regions and monitors, classical inter process communication problems	7
IV	**Deadlock & File System:** definitions, Prevention, Avoidance, detection and Recovery, Goals of Protection, access matrix, Deadlock implementation, File concept, Access methods space allocation strategies, disk arm scheduling strategies.	7
V	**Memory Management**: Contiguous allocation, Relocation, Paging, Segmentation, Segmentation with paging, demand paging, Virtual Memory Concepts, page faults and instruction restart, page replacement algorithms, working sets, Locality of reference, Thrashing, Garbage Collection.	7

Text Books	1.	Operating System concepts – Silberchatz; Galvin, Addison Wesley, 6thEdn.
	2.	Modern Operating Systems – Tanenbaum, Pearson Edn. 2nd edn
	3.	Operating Systems: Internals and Design Principles -- William Stallings
E--Books		https://ebooks.lpude.in/computer_application/mca/term_1/DCAP403_OPERATING_SYSTEM.pdf
Reference Books	1.	Operating Systems – S R Sathe, Macmillan Publishers, India, 2008
	2.	Operating System –Milan Milenkovik, McGraw-Hill, 1987
	3.	Operating Systems - 3 rd Edition by Gary Nutt, Pearson Education.
On-line TL Material	1.	https://nptel.ac.in/courses/106/108/106108101/

Sr. No	Name of Experiment	CO Mapping
1	Perform a case study by installing and exploring various types of operating systems on a physical or logical (virtual) machine. (Linux Installation).	**CO1**
2	Implement of different types of system calls.	**CO1**
3	Write a program to implement FCFS,SJF and priority based Algorithm.	**CO2**
4	Write a program to implement Round Robin Algorithm.	**CO2**
5	Write a program to implement Producer Consumer Problem.	**CO3**
6	Write a program to implement Dining-Philosophers Problem.	**CO3**
7	Write a program to implement Bankers algorithm.	**CO4**
8	Write a program to implement Page Replacement.	**CO4**
9	Write a program to implement Memory management algorithm.	**CO5**
10	Write a program to implement Disk Scheduling algorithms.	**CO5**
Open Ended Practical List		
11	Write C programs to simulate Intra & Inter – Process Communication (IPC) techniques: Pipes, Messages, Queues and Shared Memory.	
12	Write C program to Perform Shell Programming.	

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	POOL OF TRACKWISE PROFESSIONAL ELECTIVES				
Track/Elective	**Application Development**	**Machine Learning Engineer**	**Security**	**Computing**	**Data Science**
Track	**Track-I**	**Track-II**	**Track-III**	**Track-IV**	**Track -V**
Professional Elective-I (Credits :4) (Th + Pr) (Semester- V)	Recommendation System 23BTAIL306	Reinforcement Learning 23BTAIL307	Cryptography and Network Security 23BTAIL308	Computer Vision 23BTAIL309	NO SQL Database System 23BTAIL310

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Course Title: Recommendation System										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	Elective-I	3	-	-	3	10	15	50	25	-
Course Code	23BTAIL306 /23BTAIP306									
Teaching Mode	Online	3			Total	75				
Duration of ESE	3 Hrs.					100				

Course Objectives	To understand working of an recommender systems that automate a variety of choice-making strategies with the goal of providing affordable solutions.
	To understand developing recommender for personal choices in working class tier.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand and apply mathematics required for design a recommendation System.
	CO2: Demonstrate collaborative filtering techniques and use it wisely in a recommendation System.
	CO3: Analyze different types of Content-based recommendation System and its use in real time applications.
	CO4: Decide the appropriate knowledge-based recommendation System depending on the requirement and its usage.
	CO5: Evaluate the performance of recommender systems based on various Metrics and design the recommender systems.

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Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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	3	2	2	2	2	-	-	-	-	-	--	--	1	-
CO2	2	3	2	2	2	-	-	-	-	-	--	--	1	-
CO3	2	2	3	3	2	-	-	-	-	-	3	3	2	2
CO4	2	2	3	2	2	1	1	-	-	-	3	3	2	2
CO5	3	2	3	2	2	1	1	-	-	-	3	3	2	2

Unit	Contents	Hours
I	**Introduction:** Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.	7
II	**Collaborative Filtering:** User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.	9
III	**Content-based recommendation:** High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms	9
IV	**Knowledge based recommendation:** Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.	8

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V	**Evaluation** Types of evaluation for recommender systems. Evaluation design. Prediction metrics and ranking metrics **Recommendations in Networks :** Recommendation tasks in networks. Ranking algorithms. Neighbourhood's methods. Heterogeneous network methods. **Learning to Rank**: Pairwise Rank Learning, Listwise Rank Learning, Comparison with Rank-Learning Methods in Other Domains	9

Text Books	1.	Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed.
	2.	Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed
	3.	C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
Reference Books		Manouselis N., Drachsler H., Verbert K., Duval E., RecommenderSystems For Learning, Springer (2013), 1st ed.
	1.	1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction Cambridge University Press(2011), 1st ed. 2.
	2.	2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed. 1.
	3.	3. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed
E-Books	1.	http://pzs.dstu.dp.ua/DataMining/recom/bibl/1aggarwal_c_c_recommender_systems_
		the_textbook.pdf
	2.	https://www.cse.iitk.ac.in/users/nsrivast/HCC/Recommender_systems_handbook.pdf

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On-line TL Material	1.	https://www.coursera.org/learn/basic-recommender-systems
	2.	https://canvas.umn.edu/courses/135116.

Recommendation System(UAIP451)

List of Practical

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Exp. No.	Experiment
1	Write a program to implement Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices.
2	Write a program to use User based collaborative filtering method.
3	Write a program to use Item based collaborative filtering method.
4	Write a program to apply association rule mining techniques
5	Write a program to apply content-based recommendation methods
6	Write a program to implement Probability Theorem based recommendation methods
7	Write a program to implement Ranking algorithms for recommendation systems
8	Write a program to evaluate the recommendation system using various metrics.
9	Design and implement Social Network based recommendation system
	Open ended practical with case study on Recommendation System
10	Students/Learners are instructed to study the Following research paper andsubmit report of the same. (**Recommender System for NetFlix**) Recommendation System for Netflix (vu.nl) https://www.cs.vu.nl/~sbhulai/papers/paper-fernandez.pdf

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Course Title: **Reinforcement Learning (Elective I/V)**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 2	3	--	2	4	10	15	50	25	--
Course Code	23BTAIL307/ 23BTAIP307									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	1. Understand to the basic concepts of reinforcement learning.
	2. Understand the link between reinforcement learning and Machine learning.
	3. Understand how the reinforcement learning mathematical basis are used.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand the mathematics behind reinforcement learning.
	CO2: Describe the various models used in for reinforcement learning & Machine learning.
	CO3: Apply reinforcement learning models to real time application.
	CO4: Evaluate and compare the available reinforcement learning algorithm for improvements.
	CO5: Implement Reinforcement Learning Algorithms for solving real world problems

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Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	**3**	**3**	--	--	--	--	--	--	--	--	--	--	--	--
CO2	--	**3**	**3**	**2**	--	--	--	--	--	--	--	--	**3**	**2**
CO3	--	--	--	--	--	--	**3**	**3**	--	--	--	--	--	--
CO4	--	**2**	**3**	**3**	--	--	--	--	--	--	--	**3**	**3**	**3**
CO5	--	--	--	--	--	--	**2**	**3**	--	--	--	**2**	--	--

Course Contents:

Unit	Contents	Hours
I	**Introduction**: Overview: Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. Introduction to RL, RL framework and applications, Introduction to immediate RL, Bandit optimality, Value function-based methods.	8
II	**Markov Decision Process**: Markov Decision Process: Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	10
III	**Prediction and Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators.	8

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IV	**Advanced Topics in Reinforcement Learning:** Eligibility traces and function approximation methods Least squares methods, Fitted Q-iteration, Deep Q-Networks (DQN), Policy gradient methods, A3C, PPO, Hierarchical reinforcement learning and Partially Observable MDPs (POMDPs)	8
V	**Case Study-Based Projects:** Practical applications and case studies in reinforcement learning, Project-based learning and real-world problem-solving	6

Text Books	1.	Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto, The MIT Press Cambridge, Massachusetts London, England.
	2.	An Introduction to Deep Reinforcement Learning, Vincent François-Lavet, Peter Henderson, Riashat Islam, Marc G. Bellemare and Joelle Pineau, Foundations and Trends in Machine Learning: Vol. 11, No. 3-4. DOI: 10.1561/2200000071.
E-Books	1.	https://www.andrew.cmu.edu/course/10-703/textbook/BartoSutton.pdf.
Online Course	1.	https://onlinecourses.nptel.ac.in/noc19_cs55/preview.
	2.	https://nptel.ac.in/courses/106106143.
Reference Books	1.	Russell, Stuart J., and Peter Norvig. "Artificial intelligence: a modem approach." Pearson Education Limited, 2016.
	2.	Hands-On Reinforcement Learning with Python: Master reinforcement and deep reinforcement learning using OpenAI Gym and TensorFlow.
	3.	Reinforcement Learning: An Introduction (Adaptive Computation And Machine Learning Series.
	4.	Awesome reinforcement learning for cyber security.

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Use Large and real time dataset for experiments.

Sr. No.	Name of Experiments	COs
1	Install and configure RL libraries (OpenAI Gym, TensorFlow/PyTorch, Stable Baselines).	CO1
2	Write a program to create a simple environment and agent interaction loop.	CO1
3	Define a simple grid world environment as an MDP. Implement the state transition dynamics and reward structure	CO2
4	Implement the policy evaluation algorithm for a given policy in a small MDP.	CO2
5	Write a program to implement policy iteration and value iteration. Compare the convergence of both methods on the grid world environment.	CO3
6	Implement the Multi Arm Bandit Problem	CO3
7	Implement the game – Crossing a Maze using RL	CO4
8	Implement TIC-TA-TOE using RL.	CO4
9	Design an RL algorithm to solve the Knapsack problem.	CO5
10	Practical based on virtual lab/open ended using Open AI Gym for RL Algorithms	CO5

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Course Title: Cryptography and Network Security										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	C22	3 Hrs	NA	2 Hrs	4	10	15	50	25	--
Course Code	23BTAIL308/ 23BTAIP308									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs					100				

Course Objectives	• To understand Cryptography Theories, Algorithms and Systems.
	• To understand necessary Approaches and Techniques to build protection mechanisms.
Course Outcomes	At the end of the course, the student should be able to:
	CO1:Understand the fundamentals of networks security, security architecture, threats and vulnerabilities
	CO2: Apply the different cryptographic operations of symmetric cryptographic algorithms.
	CO3: Analyze the different cryptographic operations of public key cryptography.

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	CO4: Evaluate various Authentication schemes to simulate different applications.
	CO5: Ability to recognize and implement various Security practices and System security standards.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2											2	
CO2	2	3	3	3	3						2	2	2	3
CO3	2	3	2	3	3						2	2		3
CO4	2	2	3	3	3	1	1				2	2		3
CO5	3	3	3	3	3	1	1				2	2	2	3

Course Contents:

UNIT	CONTENTS	HOURS

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I	**UNIT I: INTRODUCTION** Security trends – Legal, Ethi cal and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies – Model of networksecurity – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.	6
II	**UNIT II: MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY:** Algebraic structures – Modular arithmetic- Euclid‟s algorithm- Congruence and matrices -Groups, Rings, Fields- Finite fields- SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis – Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard – RC4 –Key distribution.	7
III	**UNIT III: PUBLIC KEY CRYPTOGRAPHY** MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing –Factorization – Euler‟s totient function, Fermat‟s and Euler‟s Theorem – Chinese Remainder Theorem – Exponentiation and logarithm – ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman keyexchange -ElGamal cryptosystem – Elliptic curve arithmetic-Elliptic curve cryptography.	7
IV	**UNIT IV: MESSAGE AUTHENTICATION AND INTEGRITY** Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA –Digital signature and authentication protocols – DSS- Entity Authentication: Biometrics, Passwords, Challenge Response protocols- Authentication applications – Kerberos, X.509.	7
V	**UNIT V: SECURITY PRACTICE AND SYSTEM SECURITY** Electronic Mail security – PGP, S/MIME – IP security – Web Security – SYSTEM SECURITY: Intruders – Malicious software – viruses – Firewalls. Various Adversarial attacks and AI based security techniques.	7

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Textbooks	**TEXT BOOK**: 1. William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006.
Reference Books	**REFERENCES:** 1.C K Shyamala, N Harini and Dr. T R Padmanabhan: Cryptography and Network Security, Wiley India Pvt.Ltd 2. BehrouzA.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007. 3.Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Prentice Hall, ISBN 0-13-046019-2

List of Practical:

Sr. No.	Name of Practical
1	Perform encryption and decryption using Caesar cipher.
2	Perform encryption and decryption using Play Fair Cipher.
3	Perform encryption and decryption using Rail Fence Technique. (Row Transposition Techniques)

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4	Implement Polyalphabetic cipher encryption-decryption.
5	Implement Hill cipher encryption-decryption
6	Implement Simple DES.
7	Implement Diffie–Hellman Key Exchange.
8	Program to generate SHA-1 hash.
9	Implement RSA encryption-decryption algorithm.
10	Implement Digital signature algorithm
	Practical Beyond Syllabus
11	Perform various encryption-decryption techniques with cryptool.
12	Study and use the Wireshark for the various network protocols.

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Course Title: **Computer Vision (Program Elective I/V)**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category		4	--	--	4	10	15	50	25	--
Course Code	23BTAIL309/ 23BTAIP309									
Teaching Mode	OFFLINE	4 Hrs.			Total	75			--	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	1. To introduce traditional Computer Vision, image processing techniques, image filtering, feature detection, segmentation, and object recognition to analyze and manipulate visual data.
	2. To introduce camera calibration, 3D geometry, and depth estimation to accurately model and interpret spatial information from images and their applications to Computer Vision
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Ability to identify and recall fundamental concepts, terms, and theories in image processing and computer vision.
	CO2: Apply various Feature Detection and Segmentation Techniques.
	CO3: Able to understand Camera Calibration and its parameters.
	CO4: Ability to recognize and implement Motion Tracking and Object Recognition.
	CO5: Ability to understand the application of Computer Vision Techniques in Real-world Problems.

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Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	--	**3**	**3**	**3**	**2**	--	--	--	--	--	--	--	**1**	
CO2	--	**3**	**3**	**2**	--	--	--	--	--	--	--	--	**2**	**2**
CO3	--	**3**	**3**	--	--	--	--	--	--	--	--	--	--	**2**
CO4	--	**3**	**3**	--	--	--	--	--	--	--	--	--	--	--
CO5	**2**	**3**	**3**	--	--	--	--	--	--	--	--	--	--	--

Course Contents:

Unit	Contents	Hours
I	**Introduction:** History, Image Formation, Image Representation, Linear Filtering, Image in Frequency Domain, Image Sampling, Image Processing & Feature Extraction, Correlation, Convolution.	8
II	**Visual Features & Representations**: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP, etc. Visual Matching - Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow. **Morphological Operations. Segmentation:** Active contours, split & merge, watershed, region splitting, region merging, graph-based segmentation, mean shift and model finding, Normalized cut.	9
III	**Geometric Techniques in Computer Vision:** Camera calibration; camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.	8
IV	**Motion representation:** the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation.	9

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	Motion tracking: Statistical filtering; iterated estimation; observability and linear systems; the Kalman filter.	
V	**Object recognition and shape representation:** Deep neural architecture and applications, appearance-based methods, invariants, image Eigen spaces.	8

***TAE's should be on code based assignment.**

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Text Books	1.	Computer Vision: Algorithms and Applications, R. Szeliski, Springer, 2011.
	2.	Introductory techniques for 3D computer vision, E. Trucco and A. Verri, Prentice Hall, 1998. 3. Forsyth and Ponce, ―Computer Vision – A Modern Approach‖, Second Edition, Prentice Hall, 2011.
	3.	Forsyth and Ponce, ―Computer Vision – A Modern Approach‖, Second Edition, Prentice Hall, 2011.
E-Books	1.	Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville https://www.deeplearningbook.org/
	2.	Computer Vision: A Modern Approach (Second Edition) by David Forsyth and Jean Ponce- http://luthuli.cs.uiuc.edu/~daf/CV2E-site/cv2eindex.html
Online Course	1	https://www.geeksforgeeks.org/computer-vision/
	2.	https://www.v7labs.com/blog/what-is-computer-vision
	3.	https://nptel.ac.in/courses/108103174
Reference Books	1.	Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman
	2.	Modern Deep Learning and Advanced Computer Vision, A Perspective Approach, Dr.P.S.Jagadeesh Kumar, Prof. Thomas Binford, Dr.J. Ruby, J. Lepika.
	3.	Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman, Reference Books Cambridge University Press.

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List of Practical:

Sr. No.	Name of Practical
1	Implement Linear Filtering & Image Sampling.
2	Implement any Feature Extraction technique
3	Implement Correlation, Convolution.
4	Implement Edge, Blobs & Corner Detection
5	Implement Visual Matching - Bag- of-words technique.
6	Implement Hough transform
7	Implement active contours, split & merge, watershed, region splitting, region merging, graph-based segmentation, mean shift and model finding, Normalized cut.
8	Implement any one classification technique
9	Implement Motion representation & Tracking
10	Implement Vision Transformers
	Practical Beyond Syllabus
11	Case study of Face and person recognition
12	Case study of Image Restoration

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Course Title: NO SQL DATABASE SYSTEM										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	Elective-I	3Hrs	-	2Hrs	4	10	15	50	25	---
Course Code	23BTAIL310/ 23BTAIP310									
Teaching Mode	Offline	5Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	1. Learn about the most advanced Database Management Systems on the large volume of unstructured data generated through social media and many other platforms
	2. To make candidates familiarize with No SQL Technology and give some hands-on on one of the most popular No SQL database Mongo DB.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand the functionalities of No SQL-DB as a document database.
	CO2: Identify the different types of indexes in No SQL-DB for query execution.
	CO3: Analyze the different Aggregation commands in No SQL-DB
	CO4: Evaluate and manage Replication in No SQL-DB.
	CO5: Implement Backup and restore operations.

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Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes & Program Specific 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	2	-	2	3	3	-	-	2	-	-	3	3	2	2
CO2	3	3	2	3	3	2	-	-	-	-	3	2	2	2
CO3	3	3	2	3	3	2	-	-	-	-	3	2	2	2
CO4	3	3	2	3	3	2	-	-	-	-	3	2	2	2
CO5	3	3	2	3	3	2	-	2	-	-	3	2	2	2

Course Contents:

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Unit	Contents	Hours
I	**Introduction to No SQL and Mongo DB:** Need of a database, Different types of database, Relational vs. Nonrelational database, Installation of Mongodb, NoSQL Databases, NoSQL features, Different types of NoSQL databases, Introduction to MongoDB, MongoDB architecture, Data modelling in MongoDB, Advantages of MongoDB over RDBMS, Mongo Shell, Configuration file in MongoDB, Graph based database	6
II	**Indexing** JSON File format for storing documents, Introduction to Documents, Collections, Database Commands in Mongodb, Inserting and Saving Documents Inserting multiple documents, Updating Documents Removing Documents, Document Replacement, Operator and Modifiers, Indexing in MongoDB, Single index Finding index, Multikey index.	8
III	**Aggregation** Aggregation Framework, Pipeline Operations- $match, $sort, $group, Pipeline Operations-,$project, $unwind ,$limit, $skip, MapReduce, Aggregation commands	6
IV	**Replication:** Replication, Advantages of replication, Implementation of replication, Managing Configuration File in MongoDB, Setting up replica set in MongoDB, Replication configuration, Checking the Configuration, Change replication configuration, Replication status, Remove members, Adding new port in replica set, Terminologies used in replication, Help on replication, Adding arbitrator, Stepping down a member	6
V	**Backup and restore:** Export and import of data, Importing from JSON file, Choosing the right database , Database era, Taking decisions on database, , Strengths and weakness of database , Free and open source database	6

Text	1.	NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Author: Sadalage, P. & Fowler, Publication: Pearson Education.

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Books	2.	PramodSadalage and Martin Fowler, NoSQL Distilled, Addison-Wesley Professional, 2012.
	3	Dan McCreary and Ann Kelly, Making Sense of NoSQL, Manning Publications, 2013.
Reference Books	1.	Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement by Eric Redmond and Jim R.
	2.	ShashankTiwari, Professional NoSQL, Wrox Press, Wiley, 2011, ISBN: 978-0-470-94224-6
	3.	Gaurav Vaish, Getting Started with NoSQL, Packt Publishing, 2013.
	4.	Kristina Chodorow, Shannon Bradshaw, MongoDB: The Definitive Guide, 3rd Ed, O'Reilly Media 2018.
Online TL Material	1.	https://nptel.ac.in/courses/106104135 2 3
	2.	https://www.coursera.org/learn/nosql-databases
	3	https://www.edx.org/course/introduction-to-nosql-data-solutions

List of Practical:

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Practical No	Name of Practical	CO Mapped	Mapping with PO and PSO
1	Introduction to Nosql-DB and Installation of MongoDB NoSQL Database.	CO1	PO1, PO3, PO5, PO6, PSO1, PSO2
2	Build the Queries in No-SQL DB (MongoDB) to study operations to Insert, Query, Update, and Delete records (CRUD Operations).	CO1	PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2
3	Build Queries in No-SQL DB (MongoDB) to create and show Database and apply some Queries to Get Specified Output using AND & OR in Nosql-DB, limit and sort records.	CO1	PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2
4	Implement queries in No-SQL DB (MongoDB) to study Indexing in Nosql DB (Indexing and Advanced Indexing)	CO2	PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2
5	Implement Aggregation in Nosql DB (MongoDB) (Aggregation and Map Reduce Functions)	CO3	PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2
6	To study and implement Replication and Sharding in Nosql-DB (MongoDB)	CO4	PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2
7	Implement advanced concepts in MongoDB: geospatial Queries, aggregation pipeline, and operators	CO2, CO3	PO1, PO2, PO3, PO4, PO5, PO6, PO11, PSO1, PSO2

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8	Build a Project with No-SQL DB using MongoDB	CO2, CO3, CO4, CO5	PO1, PO2, PO3, PO4, PO5, PO6, PO8, PO11, PO12, PSO1, PSO2

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Multidisciplinary Minor offer to Other Department

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-III													
23BTAIL203	Fundamentals of Artificial Intelligence	MDM1	2	-	-	2	**2**	10	15	50	-	-	75
SEMESTER-IV													
23BTAIL204	Introduction to Machine Learning Algorithms	MDM2	2	-	-	2	**2**	10	15	50	-	-	75
SEMESTER-V													
23BTAIL311	Application of Natural Language Processing	MDM3	3	-	2	5	**4**	10	15	50	25	-	100

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Course Title: **Application of Natural Language Processing**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM3	3 Hrs	--	2 Hrs	4	10	15	50	25	
Course Code										
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2.5 Hrs					100				

Course Objectives	1. Introduce fundamental NLP concepts and techniques.
	2. Apply advanced NLP models like word embeddings and parsing
	3. Explore NLP applications such as sentiment analysis and BERT
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand the basics of NLP apply text processing and spelling correction techniques.
	CO2: Analyze and apply various language modeling techniques.
	CO3: Evaluate word embeddings, vector space models, and syntax parsing techniques.
	CO4: Demonstrate semantic analysis techniques.
	CO5: Implement NLP operations and applications.

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Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific 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	--	--	3	--	--	--	--	--	--	--	--	--	--	--
CO2	2	--	--	--	--	--	--	--	--	--	--	--	3	--
CO3	--	--	3	3	3	--	--	--	--	--	--	--	3	--
CO4	--	--	3	3	3	--	--	--	--	--	--	--	3	3
CO5	--	--	3	3	3	--	--	--	--	--	--	--	3	3

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Course Contents:

Unit	Contents	Hours
I	**Introduction to NLP:** Basics of NLP (Application, component, phases, steps, Ambiguity), Text Processing, NLP Pipeline. **Spelling Correction:** Spelling correction techniques.	6
II	**Language Modeling:** Types of Language Modeling, N GRAM, Advance smoothing for language modeling with its techniques. **Sequential Models for Tagging** – POS tagging and its types, Maximum Entropy Models, HMM, Conditional Random Fields.	8
III	**Basics:** Bag of word, Word2Vec, Word/Sentence/Text embedding, Tf/IDF, Count vector, Vector space Model, Glove, fastText, Sentence embedding Technique (Doc2Vec) **Introduction to Syntax:** Syntax Parsing, Parsing types, Constituent Parsing, Dependency Parsing, Maximum Spanning Tree, Context Free Grammar.	8
IV	**Introduction to Semantic Analysis**: Distributional Semantics, Sentence Framing, Lexical Semantics, Lexical Semantics with WordNet, Word Sense Disambiguation, Information Retrieval. **Topic Model:** Latent Dirichlet Allocation, Entity Linking. **Language Generation and Discourse Analysis:** Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure.	8
V	**NLP Operations & Applications:** Information Extraction, Relation Extraction, Text Summarization, Text Classification, Sentiment Analysis, Aspect Based Sentiment Analysis and Opinion Mining, Audio & Speech Processing. BERT, LLM, LLaMA. **Ethical Aspects of NLP:** Misinformation and Fake Content Generation, Privacy Concerns in Text Data, Hate Speech and Offensive Language Detection, Transparency and Explainability.	8

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Books	1.	Speech and Language Processing: An Introduction to Natural Language Processing by Dan Jurafsky and James Martin, 3rd Edition , Pearson Publication
	2.	Natural Language Processing with Python: Analysing Text with the Natural Language Toolkit by Steven Bird, Ewan Klein, Edward Loper, O'Reilly Publication
	3.	Foundations of Statistical Natural Language Processing, Chris Manning and Hinrich Schütz, MIT Press, Cambridge
	4.	C. Manning and H. Schutze, "Foundations of Statistical Natural Language Processing", MIT Press. Cambridge, MA:,1999
E--Books	1.	Applied Natural Language Processing, by Dr. Ramasesan R, CMI Publication. URL: https://drive.google.com/file/d/1UuSzMRvYnpg6cnnhJZmN6CidUEq_XYcN/view
	2.	Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit URL: https://www.nltk.org/book/
Reference Books	1.	Natural Language Understanding, Second Edition,by Allen James, Lebanon, Indian Publication
	2.	Foundations of Statistical Natural Language Processing, Manning, Christopher and Heinrich, Schutze, MIT Press, 1999
	3.	Statistical Language Learning, Charniack, Eugene, MIT Press
Online TL Material	1.	NPTEL: Natural Language Processing URL: https://nptel.ac.in/courses/106/105/106105158/
	2.	NPTEL: Applied Natural Language Processing URL: https://nptel.ac.in/courses/106/106/106106211/
	3.	DataCamp : Natural Language Processing in Python URL: https://www.datacamp.com/tracks/natural-language-processing-in-python

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Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	Program should be based on Natural Language Understanding (Lexical Ambiguity, Syntactical Ambiguity, Referential Ambiguity)
2	Program should be based on basic text processing operation on text document.
3	Program should be based on Errors Detection and Corrections
4	Program should be based on Implement N-gram Language model
5	Program should be based on Part-of-Speech (POS) tagging and NER
6	Program should be based on word embedding using Word2Vec/Glove/fastText
7	Program should be based on LSA and Topic model.
8	Program should be based on Parsing (Dependency and Constituency)
9	Program should be based on Text Classification
10	Program should be based on Natural Language Generation
11	Program should be based on HMM/CRF on sequence tagging task
Open Ended Experiments / New Experiments	
1	Develop any one NLP application Sentiment Analysis • Chatbot • Text Summarization Track • Machine Translation • Question/Answering
2	Study and understand the BERT Model
3	Study and understand LLaMA Model
Details of on line Laboratory Resource Material Instruction / Operating Manuals	
1.	N-Grams Smoothing Virtual Lab URL: https://nlp-iiith.vlabs.ac.in/
2.	Summarize a chunk of text to a summary of a user's preference URL: http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/The_Big_Bang_Nerds/labs/exp1/index.html
3.	Online Lab at GitHub URL: https://github.com/virtual-labs/natural-language-processing-iiith

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Course Title: **CLOUD COMPUTING**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	ODD	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	OE3	2	NA		2	10	15	50	NA	NA
Course Code	23BTAIL312									
Teaching Mode	OFFLINE	2 Hrs			Total	75				
Duration of ESE	NA					75				

Course Objectives	To understand Cloud Computing concepts, technologies, architecture and applications
	To understand the underlying principle of cloud virtualization, cloud storage, data management and data visualization
	To understand different cloud programming platforms and tools to develop and deploy applications on cloud
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand cloud computing concepts using popular cloud platforms
	CO2: Demonstrate various cloud programming models and apply them to solve problems on the cloud.
	CO3: Analyze Data Management in Cloud Computing and Resource Management in Cloud)
	CO4: Evaluate Cloud Security and Risk Management
	CO5: Develop cloud computing solutions for an enterprise

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Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	--	3	--	--	--	--	2	--	--	--	--	--	3	--
CO2	1	--	--	--	3	--	--	--	--	--	--	--	3	--
CO3	--	--	3	--	--	--	--	--	--	--	--	--	3	--
CO4	--	--	--	3	--	--	--	--	--	--	--	--	--	2
CO5	--	--	--	--	3	--	--	--	--	--	--	--	--	2

Course Contents:

Unit	Contents	Hours
I	Introduction to Cloud Computing and Virtualization: Virtualization Concepts, Cloud Computing Fundamental: Overview of Computing Paradigm, Evolution of cloud computing, Defining cloud computing, Components of a computing cloud, Essential Characteristics of Cloud Computing, Cloud Taxonomy. Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service (SaaS), Hardware-as-a-service: (HaaS), Oriented Architecture (SOA)	5
II	Cloud Computing Architecture and Service Management in Cloud: Computing Cloud architectural principles, Role of Web services, Benefits and challenges to Cloud architecture, Cloud Service Models, cloud computing vendors. Cloud Services, Management, Performance and scalability of services, tools and technologies used to manage cloud services deployment	6
III	Data Management in Cloud Computing and Resource Management in Cloud)	4
IV	Cloud Security and Risk Management: Cloud Security: Understanding cloud based security issues and threats, Data security and Storage, Identity& Access Management, Risk Management in cloud, Governance and Enterprise Risk Management.	5
V	Open Source and Commercial Clouds: Openstack, AWS, Google Cloud, Microsoft Azure, Cloud Simulator and IoT Cloud Framework, Research trend in Cloud Computing, Fog Computing,	4

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Text Books	1.	Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley,2011
	2.	Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
E--Books	1.	CLOUD COMPUTING Principles and Paradigms Link: http://dhoto.lecturer.pens.ac.id/lecture_notes/internet_of_things/CLOUD%20COMPUTING%20Principles%20and%20Paradigms.pdf
Reference Books	1.	Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
	2.	Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010
Online TL Material	1.	https://nptel.ac.in/courses/106/105/106105167/

Course Title: Research Methodology										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	RM	-.	-	4 Hrs	2	-	-	-	25	-
Course Code	23BTSHP301									
Teaching Mode	Offline	4Hrs			Total				25	
Duration of ESE	-					25				

Course Objectives	1. To understand the role of research methodology in Engineering.
	2. To understand data collection methods and basic instrumentation.
	3. To learn various statistical tools for data analysis.
	4. To develop the ability to apply statistical tools and techniques.
	5. To provide knowledge on sampling design.
Course Outcomes	CO1: Understand the role of research methodology in Engineering
	CO2: Apply appropriate techniques for data collection
	CO3: Analyze collected data using editing, classification, coding, and quantitative methods
	CO4: Apply statistical methods for data analysis
	CO5: Evaluate sampling designs and apply suitable sampling techniques

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific 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	PSO 3
CO1		3		3											
CO2		3		3	1										
CO3		3	3	3	2										
CO4				3	1										
CO5		3		3							2				

Course Contents:

Unit	Contents	Hours
I	**Introduction to Research**: Definition of research, Characteristics of research, Types of research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Overview of research methodology in various areas, Introduction to problem solving, basic research terminology such as proof, hypothesis, lemma etc., Role of Information and Communication Technology(ICT) in research.	6
II	**Data Collection:** Primary Data: Meaning, Importance & limitations.,, Observation , Questionnaire, Interview, Interview Scheduled Social Survey, Case Study Secondary Data: Meaning, Importance& limitations. Sources Secondary Data.	6
III	**Data Analysis And Use Of Quantitative Method**: Editing, Classification and Coding. Categorization, Tabulation, Tables, Graphs, Illustrations. Use of quantitative method in research.	6
IV	**Data Analysis And Use Of Statistical Method:** Statistical Techniques: Measures of Central tendency, Dispersion, Skewness, Kurtosis & Moments, Correlation, Regression. Theory of Attributes & Association, chi squareTest & Distribution.	6
V	**Sampling Design:** Census and sample survey, Characteristics of good sample design, Implications of sample design, Sampling Techniques, Probability or random sampling, Non-probability sampling	6

Text Books	1	Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", SAGE Publications Ltd., 2011.
	2	C.R. Kothari ,"Research Methodology: Methods and Trends", New Age International,2004
	3	Gupta S.C, Fundamentals of Statistics, Himalaya Publication House, Bombay Rajaram V. (1996),
E--Books	1	Wayoc C. Booth : The Craft of Research
	2	David Willinson : Research Tools Kits : A Complete Guide to Practitioner Research
Reference Books	1	Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.
on line TL Material	1	http:// www.shodhaganga.inflibnet.ac.in
	2	http:// www.inflibnet.ac.in.
	3	http:// www.zotero.org

Sr. No.	Name of Experiments / Mini Projects/ Case Studies (Any 8)
1	Report writing explaining importance of research.(CO1)
2	To collect data using two different methods. (CO2)
3	Performing literature review, identifying gaps (CO3)
4	Design simple sampling method for survey(CO3)
5	Raw data coding and classification(CO3)
6	Formulation of hypothesis based on collected data (CO3)
7	Using bar graphs, pie charts for interpreting findings(CO4)
8	Project proposal that includes problem identification.(CO5)
9	Ethical consideration in research methodology.(CO5)

Rubrics

For 25 internal marks

Attendance	Submission	Final Oral presentation/Viva Voce	Total Marks
5	10	10	25