Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

B. Tech. (Computer Engineering) Syllabus (Semester V-VIII)

2020 Iteration (w.e.f. 2021-22)

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

Sem V									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	PC	CS301	Theory of Computation	3	0	0	6	9	3
2	PC	CS302	Software Engineering	3	0	2	5	10	4
3	PC	CS303	Foundation of Signal Processing	3	0	2	5	10	4
4	PC	CS304	Distributed Computing	3	0	2	5	10	4
5	SBC	CS305	Internet Technology Lab	1	0	2	5	08	2
6	ABL	SVXX/STXX	SEVA II or III /SATVA II or III	0	0	0	2	02	1
7	HSSE	HSEX3	HSS-III	2	0	0	3	05	2
8	S/M	SCX2/MNX2	SCOPE-II/Minor-II						3
TOTAL				**15**	**0**	**8**	**32**	**55**	**20**

Sem VI (Cat 1- For Students who have NOT preferred semester long internship)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	OE	OEXXX	Open Elective-I	2	0	2	4	8	3
2	PC	CS306	Compiler Construction	3	0	2	5	10	4
3	PC	CS307	Cryptography and System Security/Artificial Intelligence and Machine Learning	3	0	2	5	10	4
4	PE	CS3X1	PE-I	2	0	2	4	8	3
5	PE	CS3X2	PE-II	2	0	2	4	8	3
6	SBC	CS308	Mini Project-II	0	0	0	8	08	3
7	ABL	SVXX/STXX	SEVA II or III /SATVA II or III	0	0	0	3	03	1
8	S/M	SCX3/MNX3	SCOPE-III/Minor-III						3
TOTAL				**12**	**0**	**10**	**33**	**55**	**21**

Sem VI (Cat 2-For Students who have preferred semester long internship)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	PE*	CS3X1	PE-I	2	0	2	4	8	3
2	PE*	CS3X2	PE-II	2	0	2	4	8	3
4	SBC	CS310	Industry Internship	0	0	0	40	40	15
5	S/M*	SCXX/MNXX	SCOPE-III/Minor-III						3
		*To be completed online mode or allied courses from MOOCs							**21**

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

Sem VII									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	OE	OEXXX	OE-II	2	0	2	4	8	3
2	OE	OEXXX	OE-III*	2	0	2	4	8	3
3	PE	CS4X3	PE-III	2	0	2	4	8	3
4	PE	CS4X4	PE-IV	2	0	2	4	8	3
5	SBC	CS401	Main Project Stage-I	0	0	0	4	04	2
6	ABL	SVXX/STXX	SEVA-IV/SATVA-IV	0	0	0	04	04	2
7	S/M/H	SCX4/MNX4 /HOXX	SCOPE-IV/Minor-IV/Honors-I						3
TOTAL				**8**	**0**	**8**	**24**	**40**	**16**
*OE-III must be from Basic Science Elective or Engineering Science Elective									

Sem VIII (Option A : Cat1/Cat2)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	OE *	OEHXX	OE-IV	2	0	2	4	8	3
2	PE	CS4X5	PE-V	2	0	2	4	8	3
3	PE	CS4X6	PE-VI	2	0	2	4	8	3
4	SBC	CS402	Main Project Stage-II	0	0	0	12	12	6
5	ABL	SVXX/STXX	SEVA-IV/SATVA-IV	0	0	0	4	04	2
6	H	HOXX	Honors-II						3
	*May be taken from MOOCs, Essentially Humanities, Management related								
TOTAL				**6**	**0**	**6**	**28**	**40**	**17**

Sem VIII (Option B : Only for Cat1 students)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
2	SBC	CS403	Main Project Stage-II	0	0	0	36	36	16
3	ABL	SVXX/STXX	SEVA-IV/SATVA-IV	0	0	0	4	04	1
4	H	HOXX	Honors-II						3
	*May be taken from MOOCs, Essentially Humanities, Management related								
TOTAL				**0**	**0**	**0**	**40**	**40**	**17**

Department of Computer Engineering

Table 2 - PROGRAM ELECTIVES

Program Elective / Thread	Program Elective-I	Program Elective-II	Program Elective- III	Program Elective- IV	Program Elective- V	Program Elective- VI
AI and Data Science	CS311: Soft Computing	CS312: Natural Language Processing	CS413: Deep Learning	CS414: Big Data Analytics and Information Retrieval	CS311, CS312, CS321, CS322, CS331(1X), CS332(1Y), 2T11,2T12, 2T21,2T22, 2X, 2Y	CS311, CS312, CS321, CS322, CS331(1X), CS332(1Y), 2T11,2T12, 2T21,2T22, 2X, 2Y
Network and Security	CS321: High Performance Computing	CS322: Cloud Computing	CS423: Information and System Security	CS424: Digital Forensics and Cyber Security		
GENERAL	CS311, CS312, CS321, CS322, CS331(1X), CS332(1Y), 2T11,2T12, 2T21,2T22, 2X, 2Y	CS311, CS312, CS321, CS322, CS331(1X), CS332(1Y), 2T11,2T12, 2T21,2T22, 2X, 2Y	CS413, CS423, CS431(1P), CS432(1Q), 2T13,2T23, 2P, 2Q	CS413, CS423, CS431(1P), CS432(1Q), 2T13,2T23, 2P, 2Q		

In this case the Computer Engineering Department has to offer CS311, CS312, CS321, CS322, CS331(1X), CS332(1Y), CS413, CS423, CS414, CS424, CS431(1P), CS432(1Q) i.e. 12 Courses to take care of 6 Elective Baskets, where,

CS331(1X): Human Machine Interaction

CS332(1Y): Advanced Algorithm and Complexity

CS431(1P) : Internet of Things

CS432(1Q) : Blockchain Technology

Note: Please refer to the separate document for "Open Electives and Syllabus" to choose Open Electives

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

Semester-V

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Theory of Computation	3	0	0	6	9	3	0	0	3
		Examination Scheme								
CS301/IT301		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	CS201/IT201: Discrete Structures and Graph Theory
Course Objective: To give an overview of the theoretical foundations of computer science from the perspective of formal languages which provides the mathematical foundation of formal models of computation, and fundamentals of formal grammars and languages that is used in most areas of computer science.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
CS301.1	Design finite automaton for a regular expressions and languages.
CS301.2	Apply the properties of regular languages.
CS301.3	Construct the grammar for a language and convert it into normal forms.
CS301.4	Design and Evaluate Pushdown Automata and Turing Machine for a language.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS301.1	3	3	2	-	1	-	-	-	1	1	-	-
CS301.2	3	2	-	-	-	-	-	-	1	1	-	-
CS301.3	2	3	-	-	1	-	-	-	1	1	-	-
CS301.4	2	2	2	-	1	-	-	-	1	1	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS301.1	-	-	-	-	-	-	-
CS301.2	-	-	-	-	-	-	-
CS301.3	-	-	-	-	-	-	-
CS301.4	-	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Sets, Relations and Languages**	1,5	3
	1.1	Relations and functions		
	1.2	Alphabets and languages		
	1.3	Types of proof		
2	Title	**Finite Automata**	1,3,5	7
	2.1	Regular languages and regular expressions		
	2.2	Finite Automata, Nondeterministic Finite Automata, Nondeterministic Finite Automata with ϵ-transitions		
	2.3	Kleene's theorem		
	2.4	NFA to DFA Conversion		
	2.5	Finite Automata with output (Moore and Mealy Machine)		
3	Title	**Regular Languages**	1,4	6
	3.1	The pumping lemma for regular languages, Applications of the pumping lemma		
	3.2	Closure properties for regular languages		
	3.3	Equivalence and minimization of automata: Testing equivalence of states, Minimization of DFA's		
4	Title	**Context-Free Grammars and Languages**	1,5	5
	4.1	Context free grammars: Definition of context free grammars, Derivations using a grammar, The language of a grammar, Sentential forms		
	4.2	Parse trees: Constructing parse trees, From inferences to trees, From trees to derivations, From derivations to recursive inferences		
	4.3	Ambiguity in grammars and languages: Ambiguous grammars, Removing ambiguity from grammars		
5	Title	**Pushdown Automata**	1,2	6
	5.1	Definition of the pushdown automaton: The formal definition of pushdown automata, A graphical notation for PDA's, Instantaneous descriptions of a PDA		
	5.2	The languages of a PDA: Acceptance by final state, Acceptance by empty stack, From empty stack to final state, From final state to empty stack		
	5.3	Equivalence of PDA's and CFG's: From grammars to pushdown automata, From PDA's to Grammar		
	5.4	Deterministic pushdown automata: Definition of a deterministic PDA, Regular languages and deterministic PDA's, DPDA's and context free languages		
6	Title	**Properties of Context-Free Languages**	1,2,3	5
	6.1	Eliminating useless symbols, Computing the generating and reachable symbols, Chomsky normal form, Greibach normal form		

	6.2	The Pumping lemma for context free languages: Applications of the pumping lemma for CFL's		
7	**Title**	**Introduction to Turing Machines**	1,2,	**6**
	7.1	Turing machines: Formal definition of a Turing machine, Examples of Turing machines		
	7.2	Halting Problem, Post Correspondence Problem (PCP)		
	7.3	Variants of Turing machines: Multitape Turing Machines		
	7.4	Church-Turing hypothesis		
8	**Title**	**Recursively Enumerable Languages**	3	
	8.1	Recursively Enumerable and recursive		**4**
	8.2	Enumerating a language		
	8.3	Context sensitive languages and the Chomsky hierarchy		
	Self Study	**Tractable and Intractable Problems:** Tractable and Possibly Intractable Problems: P and NP, Polynomial-Time Reductions and NP-Completeness, Cook's Theorem	3	**5***
			Total (* Not included)	**42**

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Automata Theory, Languages, and Computation	Third	John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman	Pearson	2008
2	Introduction to the Theory of computation	Third	Michael Sipser	Cengage	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
3	Introduction to Languages and the Theory of Computation	Fourth	John C. Martin	McGraw-Hill	2010
4	Elements of the Theory of Computation	Second	Harry R. Lewis, Christos H. Papadimitriou	Pearson	2015
5	Automata and Computability	--	Dexter C. Kozen	Springer	1997

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Software Engineering	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS302/IT302		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Object-oriented programming language -CS102, DBMS-IT/CS204
Course Objective: To understand the best practices in software engineering and gain knowledge to analyze, design, implement and test software project.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS302.1/IT302.1	Analyze software requirements.
CS302.2/IT302.2	Apply UML models for a project.
CS302.3/IT302.3	Evaluate system architecture and develop detailed task schedule from the overall estimates and planning.
CS302.4/IT302.4	Illustrate different coding principles with unit test process.
CS302.5/IT302.5	Understand the need for DevOps.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS302.1 /IT302.1	-	3	-	-	-	-	-	-	2	2	-	-
CS302.2 /IT302.2	-	2			2	-	-	-	2	2	-	-
CS302.3 /IT302.3	-	3	2	1	2	-	-	-	2	2	2	-
CS302.4 /IT302.4	-		3	-	2	-	-	-	2	-	-	-
CS302.5 /IT302.5	-	1	1	-	-	-	-	-	-	-	-	1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS302.1/IT302.1	IT-3/ CS-3	-	-	-	-	-	-
CS302.2/IT302.2	IT-3/CS-3	IT-2	CS-2	-	-	-	-
CS302.3/IT302.3	IT-3/CS-3	IT-2	CS-2	-	IT-2	CS-2	-
CS302.4/IT302.4	IT-3/CS-3	-	-	-	IT-2	CS-2	-
CS302.5/IT302.5	IT-1/CS-3	CS-2	IT-1	-	-	CS-2	IT-1

Department of Computer Engineering

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate ✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**		06
	1.1	Software Development Challenges, Software Scope, The Human Side of Software Development	1,2	
	1.2	Software Methodologies and Related Process Models with applications, Traditional Life Cycle Models, Waterfall, Incremental, Iterative models, Agile Software Engineering Process Models, SCRUM, Extreme Programming	1,2	
2		**Requirements Management and Project Planning**		10
	2.1	Requirements Development Methodology, Specifying Requirements, Eliciting Accurate Requirements, Documenting Business Requirements, SRS, Defining User Requirements, Validating Requirements, Achieving Requirements Traceability, Managing Changing Requirements, Agile Requirements Engineering	1,2	
	2.2	Scheduling, Work Breakdown Structure, Gantt Chart, Pert Chart, Critical Path, Earned Value Analysis, Schedule & Cost slippage, Estimation, Decomposition techniques, Empirical estimation models, Software Risk Management**:** Risk Identification, Risk Projection, Risk Refinement, RMMM Plan	1,2	
3		**Software Analysis**		08
	3.1	Difference between Structured & Object-Oriented analysis, Structured Analysis, Data Flow Diagrams	4,5	
	3.2	Object Oriented Analysis, Uses Case, Class diagram, Interaction diagrams, Activity diagram, State Chart diagram, Component & Deployment diagram	4,5	
4		**Software Design & Development**		08
	4.1	Software Architecture, Architectural and Pattern-Based Design, Model Driven Architectures	1,2	
	4.2	Software Development, Component Infrastructures, Refactoring, Test Driven Development (TDD)	1,2	
	4.3	DevOps, Continuous Integration, Continuous Deployment, System Provisioning and Configuration Management	3	
	4.4	Software Change Management, Change Control, Version Control	1,2	
5		**Software Quality & Testing**		10
	5.1	Software Quality Concepts, Quality Assurance, Quality Control, Formal Technical Reviews	1,2	

	5.2	Software Metrics, Product Metrics – McCall's Quality Factor, Metrics for Analysis Model and Design Model, Project Metrics, Process Metrics, Metrics for Source Code	1,2	
	5.3	Software Testing, Unit Testing, Integration Testing, System Testing	1,2	
6	**Self Study**	Advance Topic in software Engineering		**05***
		○ Design Pattern		
			Total(* Not included)	**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Gather requirements and write a project proposal for case study. Prepare SRS document. (Use IEEE template)
2	Design UML diagram -Use Case, Class diagram
3	Design UML diagram -Interaction diagrams
4	Design Data flow diagram (level 0 and1) for the case study.
5	Create work breakdown structure and schedule the activities
6	Develop Risk Mitigation, Monitoring and Management Plan for the case study.
7	Create versions of software using version control tool.
8	Implement any one Module from chosen case study.
9	Prepare test cases and perform Unit Testing (test scenario, test cases, test data)
10	Study on continuous Integration using DevOp

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Software Engineering: A Practitioner's Approach	Ninth Edition	Roger S. Pressman and Bruce Maxim	McGraw-Hill	2019
2	Fundamentals of Software Engineering	Fifth Edition	Rajib Mall	PHI Learning	2018

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
3	The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations	--	Gene Kin, Patrick Debois, John Willis, Jez Humble, and John Allspaw	IT Revolution Press	2016
4	UML for Java Programmers	--	Robert C. Martin	Pearson	2006
5	UML Distilled: A Brief Guide to the Standard Object Modeling Language	Third Edition	Martin Fowler	Addition Wesley	2003

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Foundation of Signal Processing	3	0	2	5	10	3	0	1	4
		Examination Scheme								
CS303/IT303		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Introduction to Signals and Systems) or equivalent
Course Objective: Foundations of Digital Signal Processing! The study of digital signal processing explores how we transform data into new representations to better understand, compress, and leverage it. The course begins with a rigorous review of tools from Signals and Systems: sampling, convolution, Fourier representations and flow graph, fast linear filtering algorithms. It also comoares DSP Processor and General-Purpose Processor.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS303.1/IT303.1	Interpret DT signal and perform signal manipulation in Time Domain and Frequency Domain
CS303.2/IT303.2	Develop FFT flow-graph
CS303.3/IT303.3	Implement Fast Linear filtering algorithms
CS303.4/IT303.4	Compare the DSP processor with General Purpose Processor (GPP)

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS303.1/IT303.1	2	2	-	-	-	-	-	-	-	-	-	-
CS303.2/IT303.2	-	-	3	-	-	-	-	-	-	-	-	-
CS303.3/IT303.3	-	-	3	-	-	-	-	-	-	-	-	-
CS303.4/IT303.4	-	2	-	-	-	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS303.1/IT303.1	-	-	-	3	-	-	-
CS303.2/IT303.2	-	-	-	3	3	-	-
CS303.3/IT303.3	-	-	-	3	3	-	-
CS303.4/IT303.4	-	-	-	3	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate ✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Discrete-Time Signal	1, 2	12

	1.1	Introduction: Signals, Systems, and Signal, Continuous Time signal, Discrete - Time signal and representation, Digital signal, The Sampling theorem, Some elementary discrete time signals, Classification of Discrete - Time Signals, Modifications of Discrete - Time Signals.	1, 2	
	1.2	Operations on Discrete - Time Signals: Linear Convolution, Circular Convolution, Matrix Representation of Circular Convolution, Linear Convolution using Circular Convolution, Auto and Cross Correlation.	1, 2	
	1.3	Discrete - Time systems: Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non causal. Representation of system using impulse response, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) system, Response of the FIR system using convolution.	1, 2	
2	**Title**	**Discrete Fourier Transform**	1, 2	**08**
	2.1	Introduction to DTFT, Relation between DFT and DTFT, DFT of DT signal, Inverse DFT.	1, 2	
	2.2	Properties of the DFT: Scaling and Linearity, Symmetry for real valued signal, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals Energy Theorem.	1, 2	
3	**Title**	**Fast Fourier Transform**	1, 2	**08**
	3.1	Fast Fourier Transform: Need of FFT, Radix-2 DIT-FFT algorithm	1, 2	
	3.2	Flow graph for N=4 and 8 using Radix-2 DIT-FFT, Inverse FFT algorithm, Comparison of complex and real, multiplication and additions of DFT and FFT	1, 2	
4	**Title**	**DSP Algorithms**	1, 2	**08**
	4.1	Fast Circular Convolution Algorithm, Fast Linear Convolution Algorithm.	1, 2	
	4.2	Linear FIR filtering using Overlap Add Algorithm and Overlap Save Algorithm and implementation using FFT.	1, 2	
5	**Title**	DSP Processors and Applications of DSP	3	**06**
	5.1	Need DSP processor, Difference between DSP processor & General Purpose (GP) Processor.	3	
	5.2	Case study of DSP applications to Speech Signal Processing and Biomedical Signal Processing.	3	
6	**Self Study**	Multi-rate Signal Processing: Up sampling and Down sampling, Signal Compression, Carl Correlation Coefficient for measurement of degree of similarity between two signals.	1, 2, 3, 4, 5	**05***
			Total(* Not included)	**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	**Title of the Experiment**
1	Signal Operations

2	Discrete Convolution
3	Discrete Correlation
4	Discrete Fourier Transform
5	Magnitude and Phase Spectrum
6	Fast Fourier Transform
7	Overlap Add Method using FFT
8	Overlap Save Method using FFT
9	Application of DSP Part I
10	Application of DSP Part II

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing : Principles, Algorithms and Applications	Fourth Edition	Proakis Manolakis	Pearson Education, ISBN 81-317-1000-9	2007
2	Digital Signal Processing	First Edition	S. Salivahanan, A. Vallavaraj, C. Gnanapriya	TataMcgraw Hill ISBN 978-0-07-066924-6	2010
3	Digital Signal Processing: A Computer Science Perspective	First Edition published on 25th Sept, 2000	Jonathan (Y) Stein	Copyright © 2000 John Wiley & Sons, Inc Print ISBN:9780471295464 |Online ISBN:9780471200598 |DOI:10.1002/047120059X	2000

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
4	Digital Signal Processing: A Practical Approach	--	Emmanuel C. Ifeachor, Barrie W. Jervis	Pearson Education ISBN 0-201-59619- 9	2001
5	Digital Signal Processing	Sixth Edition	P. Ramesh Babu	Scitech Publication	2014

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Distributed Computing	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS304/IT304		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Operating Systems, Computer Networks and Communications
Course Objective: To familiarize students with the fundamental concepts, techniques and design of Distributed Systems and use of distributed computing applications domains.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS304.1/IT304.1	Understand the principles and desired properties of distributed systems.
CS304.2/ T304.2	Apply the various communication techniques for distributed communication.
CS304.3/IT304.3	Apply the concepts of process, naming, consistency, replication and faults tolerance in distributed environment.
CS304.4/IT304.4	Apply the algorithms such as clock synchronization, election, and mutual exclusion in distributed applications.
CS304.5/IT304.5	Identify the challenges in developing distributed applications.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS304.1/ IT304.1	2	1	-	-	-	-	-	-	-	-	-	2
CS304.2/ IT304.2	2	2	2	1	-	-	-	2	2	1	-	2
CS304.3/ IT304.3	2	2	2	1	-	-	-	2	2	1	-	2
CS304.4/ IT304.4	2	2	2	1	-	-	-	2	2	1	-	2
CS304.5/ IT304.5	2	2	2	1	-	-	-	1	2	1	-	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS304.1/ IT304.1	1	1	1	-	
CS304.2/ IT304.2	1	1	1	-	1
CS304.3/ IT304.3	1	1	1	-	1
CS304.4/ IT304.4	1	1	1	-	1
CS304.5/ IT304.5	1	1	1	-	1

Department of Computer Engineering

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze✓	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Distributed Systems**		
	1.1	Definition, Type, Goals, Distributed Computing Models, Issues in Distributed Systems.	1,2	**08**
	1.2	Hardware Concepts, Software Concepts, The Client-Server Model, Positioning Middleware, Models of Middleware, Services offered by Middleware, models of Distributed Algorithms and some fundamental problems.	1,2	
2	**Title**	**Communication In Distributed Systems**		**12**
	2.1	Introduction to Message Passing, Desirable Features of a Good Message-Passing System, Issues in IPC by Message Passing, Synchronization, Buffering, Multi-datagram Messages, Group Communication.	1,2	
	2.2	Remote Procedure Call (RPC): Basic RPC Operations, Parameter Passing, Extended RPC Models. Remote Object Invocation: Distributed Objects, Binding a Client to an Object, Static Vs Dynamic RMI Message Oriented Communication: Persistence and synchronicity in communication, Message Oriented Transient and Persistent Communications	1,2	
3	**Title**	**Process in Distributed Systems**		**6**
	3.1	Introduction to Threads, Threads in Distributed Systems, Clients, Server	1,2	
	3.2	Code Migration: Approaches to Code Migration, Models, Migration and Local Resources, Migration in Heterogeneous Systems	1,2	
4	**Title**	**Synchronization in Distributed Systems**		**10**
	4.1	Clock Synchronization: Physical Clocks, Global Positioning System, Clock Synchronization Algorithms; Logical Clocks: Lamport's Logical Clocks, Vector Clocks	1,2	
	4.2	Election Algorithms: Bully and Ring; Mutual Exclusion: Centralized Algorithm, Decentralized Algorithm, Distributed Algorithm, Token Ring Algorithm, Comparison of Algorithms; Load Balancing: Goals, Types, Strategies.	1,2	
5	**Title**	**Consistency and Replication**		**6**

	5.1	Reasons for Replication, Object Replication, Replication as Scaling Technique Data Replication in Distributed Systems, Goals, Types, Schemes,	1	
	5.2	Data-Centric Consistency Models, Client Centric Consistency Models Continuous Consistency, Consistent Ordering of Operations	1	
6	**Self Study**	Naming Entities, Locating Mobile Entities, Distribution Protocols, Consistency Protocols, Faults Tolerance: Process Resilience, Distributed Commit, Recovery	1,2	**8***
			Total(* Not included)	**42**

Laboratory Component

Sr. No	Title of the Experiments
1	Implementation of Client Server Communication using RPC/RMI.
2	Implementation of Clock Synchronization (logical/physical).
3	Implementation of Election algorithm.
4	Implementation of Mutual Exclusion algorithm.
5	Implementation of Client Server based program to check data consistency.
6	Implement Load Balancing Algorithms
7	Mini Project

Text Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Distributed Systems– Principles and Paradigms.	First Edition	Andrew S. Tanenbaum, Maarten Van Steen	PHI	2004
2	Distributed Operating Systems Concepts and Design	Second Edition	P. K. Sinha	PHI	2010

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Distributed Systems – Concept and Design	Fourth Edition	George Coulouris, Jean Dollimore, Tim Kindberg, & Gordon Blair	Pearson	2010
2	Distributed VOD Systems	First Edition	Sudhir D. & Bandu B.M	Research India Publication	2011

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SBC	Internet Technology Lab	1	0	2	5	8	1	0	1	2
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS305/IT305		Theory	--		--		--			--
		Laboratory	100		--		100			200

Pre-requisite Course Codes, if any.	CS208/IT208 Mini Project
Course Objective: : To impart a knowledge of different Internet Technologies.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS305.1/IT305.1	Develop a sophisticated web UX
CS305.2/IT305.2	Create, integrate and test REST based web services
CS305.3/IT305.3	Design secured web application/ web services
CS305.4/IT305.4	Demonstrate behaviour of web crawlers and testing of web application

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS305.1 /IT305.1	-	-	1		3	-	-	-	-	-	-	-
CS305.2 /IT305.2	-	-	-	2	3	-	-	-	-	-	-	-
CS305.3 /IT305.3	-	-	-	1	3	-	-	-	-	-	-	-
CS305.4 /IT305.4	-	-	-	1	3	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS305.1/IT305.1	-	-	-	-	-	3(CS)	3(IT)
CS305.2/IT305.2	-	-	-	-	-	3(CS)	3(IT)
CS305.3/IT305.3	-	-	-	-	-	3(CS)	3(IT)
CS305.4/IT305.4	-	-	-	-	-	3(CS)	3(IT)

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Designing UI**		**2**
	1.1	Fundamentals of UX Design, Defining UX Solutions, Design Communication and Visualizing Ideas	1	
2		**Web content management system**		**1**
	2.1	Introduction to Web CMS, different types of Web CMS	2	
3		**Web services**		**2**
	3.1	Introduction to web service, REST architecture	3	
4		**Web mashups**		**1**
	4.1	Introduction to web mashups, server side mashups, client side mashups	2	
5		**Secured Web application**		**2**
	5.1	Introduction to Web Tokens, Auth2.0, OAuth, Access token	2	
6		**Integration of web services**		**2**
	6.1	Introduction to Mule ESB, Introduction to Anypoint studio, Integrating Web Services using Any point studio	4	
7		**Web crawlers**		**2**
	7.1	Introduction to web crawler, role of crawler in the internet, concept of page ranking	3	
8		**Testing web applications**		**2**
	8.1	Introduction to different types of testing, manual testing, automated testing, performance testing and functional testing, open source tools used for testing	2	
				14

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Design web pages using HTML, CSS and javascript
2	Design UX for a given problem definition by using open source UX tools
3	Create a website using web CMS (Node Js/Angular Js/React Js/Flask/Django/Wordpress/Joomla etc.)
4	Create a Restful webservice to demonstrate different HTTP methods
5	Testing of restful web service using Postman/ARC
6	Create a web mashup of web services using open source framework
7	Design secured Web application using web token
8	Integration of web services using open source integration tools like Mulesoft
9	Demonstrate the behavior of Web Crawlers/ spiders (use XPATH,CSS PATH),extract information and store it in the database.
10	Test the web application using open source testing tools like Selenium, Test runner and Junit

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Sketching the User experiences	Second edition	Bill Buxton	Diane Cerra	2010
2	Rich Internet Application AJAX and Beyond	Third edition	Dana Moore, Raymond Budd, Edward Benson	WROX Publisher	2017
3	Web Technology	Second Edition	Srinivasan	Pearson	2014
4	API Recipes with Mulesoft(r) Anypoint Platform	First Edition	WHISHWORKS Editorial Board	White falcon	2017

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
5	Internet Technology And Web Design	First Edition	R. K. JAIN	Khanna Book Publishing Company	2015
6	Understanding the Internet: A Clear Guide to Internet Technologies	First Edition	Keith Sutherland	A Butterworth-Heinemann Title	2016
7	RESTful Web APIs: Services for a Changing World	Third edition	Leonard Richardson, Mike Amundsen, Sam Ruby	O'REILLY	2013

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

Semester-VI

Department of Computer Engineering

Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Compiler Construction	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
CS306		Theory	75		75		150		300	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	CS301T: Theory of Computation
Course Objective: To explore the principles, algorithms, and data structures involved in the design and construction of compilers	
Course Outcomes (CO):*At the End of the course students will be able to*	
CS306.1	Understand fundamentals of language processing activities and its relationships among all phases of the language processor.
CS306.2	Understand the working of lexical, syntactic and semantic analysis phases of a compiler.
CS306.3	Apply different techniques of intermediate code generation and machine code optimization to solve problem.
CS306.4	Analyze the role of memory management as pertaining to run time storage management for compiler.
CS306.5	Understand concepts of assemblers and macro processor to increase readability and productivity.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS306.1	1	1	-	-	-	-	-	2	-	-	-	1
CS306.2	2	1	2	2	2	-	-	2	-	-	-	1
CS306.3	2	2	2	-	-	-	-	2	-	-	-	1
CS306.4	1	2	2	-	-	-	-	2	-	-	-	1
CS306.5	1	2	2	2		-	-	2	-	-	-	1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS306.1	-	-	1	-	-
CS306.2	-	-	2	-	-
CS306.3	-	-	2	-	-
CS306.4	-	-	2	-	-
CS306.5	-	-	1	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze✓	Evaluate	Create

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Language Processor**		06
	1.1	**Introduction to Language Processor:** Programming language and Language Processors, Language Processing activities, fundamentals of Language Processing.	1,2	
	1.2	**Lexical Analysis**: Role of Lexical Analyzer (Scanner), Input buffering, Specification and recognition of tokens, Lexical analyzer generator- LEX, Optimization of DFA-Based Pattern Matchers.	1	
2	Title	**Syntax and Semantic Analysis**		10
	2.1	**Syntax Analysis:** Role of Syntax Analyzer (Parser), Top-down parsing- Recursive descent and predictive parsers (LL), Bottom-Up parsing - Operator precedence parsing, LR,SLR and LALR parsers, Parser Generator-YACC	1	
	2.2	**Semantic Analysis (Syntax Directed Translation):**Syntax directed definitions, Evaluation order for SDDs , Applications of Syntax Directed Translation, Syntax Directed Translation Schemes	1	
3	Title	**ICG and Code Generation**		09
	3.1	**Intermediate Code Generation:** Variants of Syntax Trees, Three-Address code, Types and Declarations, Translations of Expressions, Type Checking, Control flow, Backpatching, Switch-statements.	1	
	3.2	**Code Generation:** Issues in the design of Code Generator , Target language and Addresses, Basic Blocks and Flow graphs, Optimization of Basic Blocks, Simple Code Generator: Register and Address Descriptors, Code Generation Algorithm, Design of Functions	1	
4	Title	**Code Optimization and RTE**		09
	4.1	**Code Optimization:** Principal sources of Optimization, Peephole Optimization, Register Allocation and Assignment, Instruction Selection by Tree Rewriting, Optimal Code Generation for Expressions, Loops in Flow Graphs,	1	
	4.2	**Run Time Environment:** Storage Organization, Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management, Garbage Collection	1	
5	Title	**Assembler and Macro-processor**		08
	5.1	**Assembler:** Elements of Assembly Language Programming, Simple Assembly Scheme, Pass structure of Assemblers, Design of Two-pass Assemblers and one-pass assemblers	2	
	5.2	**Macros and Macro Processors:** Macro definition and calls, Macro expansion, nested macro calls, Macro Facilities, Design of Macro Processor	2	

6	**Self Study**	**Instruction-Level Parallelism:** Processor Architectures, Code-Scheduling Constraints, Basic-Block Scheduling	1	**05***
			Total(* Not included)	**42**

List of Experiments

Sr. No	Title of the Experiment
1	Design Lexical analyzer for different programming languages*and implement using flex/lex tool.
2	Write a program to implement optimization of DFA-Based Pattern Matchers.
3	Design syntax analyzer for various grammars and implement using different parsing techniques* (Top-down and Bottom-up).
4	Design SDD and SDT for different grammars* and implement using yacc/bison utility.
5	Write a program to generate three address code for different types of programming* language constructs
6	Write a program to find Basic blocks and generate flow graph for the given three address code.
7	Write a program to implement Code generation algorithm.
8	Write a program to create optimize code using different code optimization techniques*
9	Design a two-pass assembler.
10	Design a two pass Macro processor

* Instructor should provide distinct programming languages/parsing techniques/optimization techniques/grammars for different batches.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Compilers, Principles, Techniques and Tools	Second Edition	Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman	Pearson Education	2007
2	Systems Programing	First Edition	D. M. Dhamdhere	Tata McGrow Hill	2011

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Compiler Design and Implementation	First Edition	Steven Muchnick	Morgan Kaufmann Publishers	1997
2	Engineering a Compiler	Second Edition	Cooper &Torczon	Elsevier	2003
3	Lex and Yacc	Second Edition	John Levine, Tony Mason & Doug Brown	O'Reilly	1995

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Cryptography and System Security	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS307A		Theory	75		75		150			300
		Laboratory	50		-		50			100

Pre-requisite Course Codes, if any.	CS207
Course Objective: To apply and analyze different cryptography and system security protocols/techniques	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS307A.1	Describe the different types of the cryptographic algorithms to secure information.
CS307A.2	Apply different cryptographic techniques to solve security-related problems.
CS307A.3	Create a message digest from data to authenticate authorized user
CS307A.4	Use system security practices

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS307A.1	3	-	-	-	-	-	-	-	-	-	-	-
CS307A.2	3	3	-	-	-	-	-	-	-	-	-	-
CS307A.3	-	3	-	-	-	-	-	-	-	-	-	-
CS307A.4	-	3	3	3	2	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS307A.1	-	-	-	-	-	-	-
CS307A.2	-	-	-	-	-	-	-
CS307A.3	-	-	-	-	-	-	-
CS307A.4	-	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to Security and Cryptography**		10
	1.1	Introduction Security Attacks, Security Goals, Computer criminals, Methods of defense, Security Services, Security Mechanisms	1,4	
	1.2	Basics of Cryptography Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Other Cipher Properties-Confusion, Diffusion, Block and Stream Ciphers.	1,2,3	
2	Title	**Secret and Public Key Cryptography Techniques**		10
	2.1	Secret Key Cryptography Data Encryption Standard(DES), Strength of DES, Block Cipher Design Principles and Modes of Operations, Triple DES, AES	1,2,3	
	2.2	Public Key Cryptography Principles of Public Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange	1,2,3	
3	Title	**Hashing Algorithms and Authentication Protocols**		12
	3.1	Cryptographic Hash Functions Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Codes – Message Authentication Requirements and Functions, HMAC, Digital signatures, Digital Signature Schemes, Digital Signature Standards.	1,2,3	
	3.2	Authentication Protocols, Kerberos, Key Management and Distribution, X.509 Directory, Authentication service, Public Key Infrastructure, Electronic Mail Security: Pretty Good Privacy, S/MIME, Domain Key Identified Mail (DKIM).	1,2,3	
4	Title	**Security**		10
	4.1	IDS and Firewalls: Intrusion Detection System, Types of IDS, Firewalls Characteristics, Types of Firewalls, Placement of Firewalls, Firewall Configuration,	1,2,3,4	
	4.2	Internet Protocol Security (IPSec) Architecture, Authentication Header, Encapsulating Security Payload, Combining security Associations, Internet Key Exchange,	1,2,3,4	
	4.3	Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Electronic Payment. Non-cryptographic protocol Vulnerabilities, DoS, DDoS, Session Hijacking and Spoofing, Software Vulnerabilities-Phishing, Buffer Overflow, Format String Attacks, SQL Injection.	1,2,3,4	
	Self Study	International Data Encryption algorithm (IDEA) algorithm, Blowfish algorithm, Elliptic Curve Cryptography, DMZ Architecture, and QR Code generation and scanning, Honeypots, DNSSEC		*8
			Total(* Not included)	42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implement different substitution techniques.
2	Implement different transportation techniques.
3	Implementation of RSA algorithm.
4	Implementation of Diffie-Hellman key exchange algorithm.
5	Generate and calculate Hashes and checksum files.
6	Implement Pretty Good Privacy (PGP) security method.
7	Implement SNORT Intrusion Detection System.
8	Configure Firewall rules using IP tables.
9	Implement SQL Injection.
10	Implement Session Hijacking attack.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Cryptography and Network Security: Principles and Practice	Fifth Edition	William Stallings	Pearson	2011
2	Network Security and Cryptography	Second Edition	Bernard Menezes	Cengage Learning	2011
3	Cryptography and Network Security	First Edition	Behrouz A Fourouzan	TMH	2007
4	Security in Computing	Fifth Edition	Charles P. Pfleeger	Pearson Education	2015

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Cryptography and Network	Second Edition	Behrouz A Fourouzan, Debdeep Mukhopadhyay	TMH	2010
2.	Computer Security Art and Science	First Edition	Matt Bishop	Addison-Wesley	2002

Department of Computer Engineering

Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Artificial Intelligence and Machine Learning	3	0	2	5	10	3	0	1	4
CS307B		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	CS202/IT202: Data Structures, MA203: Probability and Statistics
Course Objective: This course covers the fundamental concepts of Artificial Intelligence and machine learning.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS307B.1	Understand AI building blocks presented in intelligent agents
CS307B.2	Solve the problems using suitable searching methods.
CS307B.3	Solve the problems using suitable reasoning and knowledge representation methods.
CS307B.4	Apply suitable machine learning technique for a given problem
CS307B.5	Design an intelligent system using different AIML techniques for real life problems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS307B.1	2	3	-	-	2	-	-	-	-	-	2	-
CS307B.2	2	3	2	2	-	-	-	-	-	-	2	-
CS307B.3	2	3	2	2	-	-	-	-	-	1	2	-
CS307B.4	2	3	-	-	2	-	-	-	-	2	2	-
CS307B.5	2	3	2	2	2	-	-	-	-	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS307B.1	-	-	-	-	-	-	-
CS307B.2	-	-	-	-	-	-	-
CS307B.3	-	-	-	-	-	-	-
CS307B.4	CS1/IT-1	CS:1/IT-1	CS:1/IT-1	-	-	-	-
CS307B.5	CS: 2 IT-2	CS: 2/IT-2	CS: 2/IT-2	-	IT-2	CS: 2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate✓	Create

Theory Component

Department of Computer Engineering

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Artificial Intelligence**	1	04
	1.1	Definition of AI, History and Future of AI, Problem solving Approach to Typical AI problem.		
	1.2	**Intelligent Agents and Environment** What is an Intelligent Systems, Types of Agents, structure of agent.		
	1.3	Environments and Its Properties, PEAS Representation for an Agent		
2	**Title**	**Problem solving by Searching**	1	10
	2.1	Searching: characteristics and issues in design of search programs		
	2.2	**Uninformed search techniques:** State Space Search, Depth First Iterative Deepening		
	2.3	**Informed Search methods:** Heuristic Search, Hill Climbing.		
	2.4	**Adversarial Search:** Game playing, Min-Max Search, Alpha-Beta Pruning		
3	**Title**	**Knowledge Representation and Reasoning**		08
	3.1	Reasoning: Representing and Reasoning with Uncertain Knowledge		
	3.2	Knowledge representation: A Knowledge-Based Agent, The Wumpus World.		
	3.3	Propositional Logic, First-order predicate logic, Forward and Backward Chaining		
4	**Title**	**Introduction to Machine Learning**		12
	4.1	Introduction: What is Machine Learning, History and overview of machine learning,	2,3	
	4.2	Types of Machine Learning – Supervised, Unsupervised Semi-Supervised Learning and Reinforcement Learning, Design a Learning System, The curse of dimensionality		
	4.3	Evaluating a hypothesis: Model selection, training/validation/testing procedures, diagnosing bias versus variance and vice versa, regularization and bias/variance, learning curves	2,3	
5	**Title**	**Linear Models for Regression**		**8**
	5.1	Two Simple Approaches to Prediction: Least Squares and Nearest Neighbors	4	
	5.2	Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods		
6	**Self Study**	**Linear model for Classification**: Logistic Regression, Linear Discriminant Analysis, Perceptron, Support Vector Machines, PCA	3,4	**5***
			Total(* Not included)	42

Department of Computer Engineering

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implement an Intelligent agent.
2	Implement a given problem using the searching technique.
3	Implement a given problem using knowledge representation and reasoning rules
4	To design and implement an intelligent system, incorporating the matching algorithm and the rule language. 1. It should provide a fact base updating function. 2. It should provide a function that checks the rules' LHS and return which rules were matched. 3. It should support firing RHS according to matches. Using SWISH Prolog or Java or Python or any other open-source tool
5	Implement supervised learning algorithms.
6	Implement unsupervised learning algorithms.
7	Implement the regression model
8	Minor project covering the concepts of AIML on the real life problem statements.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Artificial Intelligence: A Modern Approach	Third Edition	Stuart Russell and Peter Norvig	Prentice-Hall	2009
2	Machine Learning A Probabilistic Perspective	First Edition	Kevin P. Murphy	Massachusetts Institute of Technology	2012
3	Machine Learning,	First Edition	Tom.M.Mitchell	McGraw Hill International Edition	1997
4	The Elements of Statistical Learning	Second Edition	Trevor Hastie Robert Tibshirani Jerome Friedman	Springer	2009

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
5	Artificial Intelligence: Making a System Intelligent	First Edition	Nilakshi Jain	Wiley Publication	2019
6	Pattern Recognition and Machine Learning,	First Edition	C. M. Bishop	Springer	2013

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Soft Computing	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CS311		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: This course introduces three important soft computing techniques like Neural network, Fuzzy Logic and Genetic algorithms in brief. Students will be able to understand the supervised and unsupervised learning algorithm for real world applications. The design of fuzzy logic controller helps them to develop an adaptive control system for industrial operations. This course also covers the importance of optimizations and its use in computer engineering fields.	
Course Outcomes (CO):*At the End of the course students will be able to*	
CS311.1	Illustrate the basic principles of soft computing techniques.
CS311.2	Apply the supervised and unsupervised neural network learning algorithm for real world applications
CS311.3	Design fuzzy controller system using different FIS.
CS311.4	Solve optimization problems using genetic algorithms.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS311.1	2	-	-	-	-	-	-	-	-	-	-	-
CS311.2	2	2	-	-	-	-	-	-	2	2	-	-
CS311.3	3	2	2	-	-	-	-	-	2	2	-	-
CS311.4	3	2	2	-	-	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS311.1	1	1	1	-	-	-	-
CS311.2	2	2	2	-	-	-	-
CS311.3	2	2	2	-	-	-	-
CS311.4	2	2	2	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to Soft Computing**	T3,T4,R1,	04
	1.1	Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.		
2	Title	**Neural Networks**	T1,T3,R1, R2	10
	2.1	Basics of Neural Networks: Introduction to Neural Networks, Biological Neural Networks and their artificial models, McCulloch Pitt model, Hebb Network, Linear separability. Supervised Learning algorithms: Perceptron (Single Layer, Multilayer), Delta learning rule, Back Propagation algorithm. Un-Supervised Learning algorithms: Winner take all, Self-Organizing Maps, Learning Vector Quantization.		
3	Title	**Fuzzy Set theory**	T2,T3,R1, R3	10
	3.1	Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Fuzzy Max-Min and Max-Product Composition ,Membership function, Fuzzy extension principle, Fuzzy Systems-fuzzification, defuzzification methods, and design of fuzzy controllers.		
4	Title	**Genetic Algorithms**	T3,R1,R4	4
	4.1	Biological Background: The Cell, Chromosomes, Genetics, Reproduction, Selection, Traditional Optimization and Search Techniques Simple GA, Operators in GA, Encoding, Selection, Crossover, Mutation, Stopping Condition for GA .Applications of GA.		
5	Self Study	Recurrent Neural Networks, Deep Learning: Deep Belief Network, Deep Reinforcement Learning		4*
			Total(* Not included)	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To implement (MP-Neuron) Mc-Culloch Pitts Model.
2	To implement Transfer/Activation Functions. A symmetric hard limit transfer function. A Binary step activation function. A Bipolar step activation function. A saturating linear transfer function. A hyperbolic tangent sigmoid (tansig) transfer function. A log-sigmoid transfer function

<table>
<tr><td>3</td><td>To implement Basic Neural Network learning rules.

PROBLEM TO DISTINGUISH BETWEEN APPLES AND ORANGES
A produce dealer has a warehouse that store a variety of fruits & vegetables. When fruit is brought to the warehouse , a various types of fruits may be mixed together. The dealer wants a machine that will sort the fruit according to type . There is a conveyer belt on which the fruit is loaded .This conveyer passes through a set of sensors, which measure three properties of fruits :shape , texture and weight.
Bias= < Any Value>

<table>
<tr><td>Type of sensor</td><td>Output of sensor</td><td>Condition</td></tr>
<tr><td rowspan="2">Shape sensor</td><td>1</td><td>if fruit is approx. round</td></tr>
<tr><td>0</td><td>if fruit is elliptical.</td></tr>
<tr><td rowspan="2">Texture Sensor</td><td>1</td><td>If surface is smooth</td></tr>
<tr><td>0</td><td>If surface is rough</td></tr>
<tr><td rowspan="2">Fruit sensor</td><td>1</td><td>Apple</td></tr>
<tr><td>0</td><td>Orange</td></tr>
</table>
Design a perceptron to recognize these patterns using Joone Editor.</td></tr>
<tr><td>4</td><td>Write a program to design a perceptron to recognize these patterns for the problem statement in experiment No.3.(Use any Open source tools)</td></tr>
<tr><td>5</td><td>To implement Multilayer Perceptron Learning algorithm.(EBPTA)</td></tr>
<tr><td>6</td><td>To implement an unsupervised learning algorithm (KSOFM) for pattern classification problem.</td></tr>
<tr><td>7</td><td>To implement an unsupervised learning algorithm (LVQ) for pattern classification problem.</td></tr>
<tr><td>8</td><td>To implement fuzzy set and fuzzy relations for a given problem.</td></tr>
<tr><td>9</td><td>To design and implement Fuzzy Controller for a given problem</td></tr>
<tr><td>10</td><td>To apply genetic algorithms for a given problem.</td></tr>
</table>

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Artificial Neural Systems	--	Jacek M. Zurada	Jaico Publishing House	1992
2	Fuzzy Logic with Engineering Applications	Third Edition	Timothy J. Ross	Wiley India	1995
3	Principles of Soft Computing	Second Edition	S. N. Sivanandam and S. N. Deepa	Wiley, India	2011
4	Deep Learning (Adaptive Computation and Machine Learning)	First Edition	I. Goodfellow, Y. Bengio, A. Courville, F. Bach	O' Reilly	2016
5	Neural Networks, Fuzzy Logic and Genetic Algorithms	Kindle edition	S.Rajasekaran and G.A.Vijayalaks	PHI Learning	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Neuro-Fuzzy and Soft Computing– A Computational Approach to Learning and Machine Intelligence	First Edition	Jang J.S.R, Sun C. T. and Mizutani E.	PHI	1997
2	Fundamentals of Neural Networks – Architectures, Algorithms, And Applications	First Edition	Laurene Fausett	Pearson Education	2004
3	Fuzzy Set Theory and its Applications	Second Edition	H.J. Zimmermann	Allied Publishers Ltd.	1996
4	An Introduction to Genetic Algorithms	Fifth Edition	Melanie Mitchell	The MIT Press	1999
5	Neural Network Design	Second Edition	Hagan, Demuth, Beale	CENGAGE Learning, India Edition	1996

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	High Performance Computing	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CS321		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any	Operating Systems, Computer and Communication Networks, Computer Architecture and Organization
Course Objective: To familiarize students with the fundamental concepts, techniques and design of parallel computing and use of parallel computing application area.	
Course Outcomes (CO):*At the End of the course students will be able to*	
CS321.1	Comprehend fundamental concepts and communication pattern of parallel programming in high performance computing.
CS321.2	Use MPI and OpenMP message passing paradigm in parallel programs for loosely and tightly coupled parallel systems.
CS321.3	Analyze the performance of parallel programs of high performance computing systems.
CS321.4	Design parallel algorithm for achieving high performance of standard single threaded algorithm

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS321.1	3	-	-	-	-	-	-	-	-	-	-	-
CS321.2	-	-	-	-	3	-	-	-	-	-	-	-
CS321.3	2	3	-	-	-	-	-	-	-	-	-	-
CS321.4	1	1	3	-	-	-	-	-	-	-	-	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS321.1	-	-	2	-	-
CS321.2	-	-	-	-	-
CS321.3	-	-	-	-	-
CS321.4	-	-	2	-	1

BLOOM'S Levels Targeted

Remember	Understand	Apply	Analyze	Evaluate	Create ✔

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Parallel Programming and Platforms**		7
	1.1	Implicit Parallelism, Limitations of Memory System Performance, Parallel Computing Platforms, Parallel Platforms Physical Organization	1	
	1.2	Parallel Machine Communication Costs, Interconnection Networks Routing, Process-Processor Mapping, Mapping Techniques, MPI and OpenMP, Examples of MPI* and OpenMP* Programming – Conjugate Gradient Method, Jacobi Method	1,2	
2	**Title**	**Analytical Modeling of Parallel Programs**		7
	2.1	Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, Granularity Effect on Performance, Parallel Systems Scalability	1	
	2.2	Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs, Examples of Analysis of Parallel Programming – Boundary Value Problem, n-Body Problem	1,2	
3	**Title**	**Parallel Algorithm Design**		7
	3.1	Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads	1	
	3.2	Task/Channel Model, Foster's Design Methodology, Examples of Parallel Programming Design – Sieve of Eratosthenes, Floyd's Algorithm	1,2	
4	**Title**	**Communication Operations**		7
	4.1	One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations	1	
	4.2	Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Examples of Parallel Programming Communication – Matrix Vector Multiplication, Matrix Multiplication	1,2	
5	**Self Study**	• **MPI –** Building Blocks, Communication-Computation Overlapping, Collective Communication, Computation Operations, Groups and Communicators • **OpenMP –** Shared-Memory Model, Critical Sections, Reductions, Data and Functional Parallelism • **GPU Programming –** Basic Programming Concepts.	1,2	**4 ***
			Total(* Not included)	**28**

Department of Computer Engineering

List of Experiment

Sr. No	Title of the Experiment
1	Implement Circuit Satisfiability Problem and comment on NP-Hard by increasing number of input to Boolean circuit.
2	Implement Minimum Vertex Cover and comment on NP-hard by increasing number on set size.
3	Implement Linear Systems solution using Conjugate Gradient Method through Parallel MPI and OpenMP programming and then analyze the algorithm.
4	Implement Linear Systems solution using Jacobi Method through Parallel MPI and OpenMP programming and then analyze the algorithm.
5	Implement Boundary Value Problem using Foster's Design Methodology
6	Implement n-Body Problem using Foster's Design Methodology
7	Implement Sieve of Eratosthenes with different data decomposition options using Parallel MPI programming
8	Implement Floyd's version of All-Pair Shortest-Paths Problem through all steps of parallel algorithm design namely partitioning, communication, agglomeration and mapping using Parallel MPI programming.
9**	Implement Matrix-Vector Multiplication using various Data Decomposition Options using Parallel MPI programming and then analyze the algorithm.
10**	Implement Matrix Multiplication algorithm through i) Sequential Algorithm, ii) Parallel Algorithm - a) Rowwise Block-Striped Decomposition and b) Cannon's Algorithm using Parallel MPI programming and then analyze the algorithm.

** Instructor can consider mini project instead of these two experiments.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Parallel Computing	Second Edition	Ananth Grama	Addison Wesley,	2003
2	Parallel programming in C with MPI and Open MP	First Edition	Michael J Quinn	McGraw-Hill	2003

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Computer Architecture: Parallelism, Scalability, Programmability	Second Edition	Kai Hwang, Naresh Jotwani	McGraw-Hill	2008
2	Introduction to High Performance Computing for Scientists and Engineers	First Edition	Georg Hager, Gerhard Wellein	CRC Press	2010

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Natural Language Processing	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CS312		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Artificial Intelligence and Machine Learning, Basic knowledge of Python

Course Objective: To provide the students the techniques and tools to devise and develop Natural Language Processing (NLP) components and applications. The course will cover the foundations, building blocks and applications of NLP, with an emphasis on the necessary linguistic intuitions as well as a broad coverage of statistical and deep learning models that can be used for language tasks. NLP is an important topic in Artificial Intelligence with a wide range of applications, from sentiment analysis to machine translation. Modern NLP is primarily based on statistical methods and machine learning algorithms, where linguistic information is provided by instances of uses of language. For most NLP tasks, state of the art approaches are based on neural models, which will be at the core of this module. However, significant attention will be given to the linguistic principles that underpin the field.

Course Outcomes (CO): ***At the End of the course students will be able to***

CS312.1	Identify the language processing tasks.
CS312.2	Evaluate solutions for a range of natural language components using existing algorithms, techniques and frameworks, including part-of-speech tagging, language modeling, parsing and semantic role labeling.
CS312.3	Apply algorithms for single and multi-class classification problems.
CS312.4	Apply statistical and deep learning techniques to language applications such as machine translation.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS312.1	3	-	2	-	-	-	-	-	-	-	-	-
CS312.2	-	-	2		-	-	-	-	-	-	-	-
CS312.3	3	-	2	-	-	-	-	-	-	-	-	-
CS312.4	3	-	-	-	2	-	-	-	2	-	-	3

Department of Computer Engineering

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS312.1	2	-	-	-	-	-	-
CS312.2	2	2	-	-	-	-	-
CS312.3	2	-	-	-	-	-	-
CS312.4	2	2	2		2	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate ✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introducing NLP: Patterns and structure in language**	1,2	7
	1.1	A brief history of natural language processing, language challenges, applications, classical vs statistical vs deep learning-based, Basic concepts in linguistic data Structure: Morphology, syntax, semantics, pragmatics, Tokenized text and pattern matching-Recognizing names, Stemming, Tagging Parts of speech-identify parts of speech, Constituent structure.		
	1.2	Syntax: Coding regular expressions, tree diagrams for a regular language, Regular grammars and Context-free grammar. Usage of regular expressions, Introduction to natural language processing: grammars and parsing, Word structure.		
2	Title	**Computational tools for text analysis**	1,2	5
	2.1	Natural Language Toolkit (NLTK): Corpora and other data resources, Uses of corpora: Lexicography, Grammar and syntax, Stylistics, Training and evaluation, Basic corpus analysis: Frequency distribution building and analyzing a corpus.		

	2.2	Data structures: strings and sequences, Tokenization in the NLTK, Tokenizing text, Stemming: Comparing stemmers, Tagging: RE tagging, Trained taggers and backoff, Transformation-based tagging.		
3	**Title**	**Statistically based techniques for text analysis**	1,2	**10**
	3.1	Fundamentals of machine learning: Naive Bayes classifiers, Hidden Markov models; Viterbi decoding, Information and entropy; Decision trees and maximum entropy classifiers, N-gram		
		language models, Neural language models (RNNs, LSTMs, GRUs, Bert Model)		
	3.2	Machine learning in action: document classification, Information extraction: Types of information extraction, Regular expressions for personal names, Information extraction as sequential classification: chunking and Named Entity Recognition (NER), Limitations of statistical methods.		
4	**Title**	**Analyzing sentences: Syntax and Parsing**	1,2	**6**
	4.1	Grammars and parsing, Context Free Grammar (CFG), parsing with CFG, Building feature based grammar: Grammatical features; Processing feature structures and extracting feature based grammar. Rules-based and probabilistic parsing: Neural models for parsing; Semantic role labeling; Sequence to sequence modelling - machine translation (SMT, NMT, Attention).		
	4.2	Analyzing meaning of sentences: Propositional Logic, First-order logic, Semantics and discourse semantics.		
6	**Self Study**	Chunking and chinking with NLTK, Generative grammar, Speech Processing.		**2***
			Total(* Not included)	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Install NLTK and perform basic Corpus analysis using NLTK such as (i) frequency distribution (ii) learn about morphological features of a word by analysing it.
2	(i) Generate word forms from root and suffix information.(ii) Understanding the morphology of a word by the use of Add-Delete table
3	(i) Calculate bigrams from a given corpus and calculate probability of a sentence. (ii) to

	apply add-one smoothing on sparse bigram table
4	Classification using suitable classification model (NB)
5	Calculate emission and transition matrix which will be helpful for tagging Parts of Speech using Hidden Markov Model.
6	Find POS tags of words in a sentence using Viterbi decoding
7	Perform chunking by analyzing the importance of selecting proper features for training a model and size of training.
8	Capture linguistic patterns and grammatical constructions with feature based grammars
9	Build and perform neural model for parsing
10	Analyze the importance of context and size of training corpus in POS.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Natural Language Processing with Python	First Edition	Steven Bird, Ewan Klein & Edward Loper	O'Reilly Media, Inc. ISBN: 9780596516499	2009
2	Natural Language Processing with PyTorch	First Edition	Delip Rao & Brian McMahan	O'Reilly Media, Inc. ISBN:9781491978238	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Neural Network Methods for Natural Language Processing	First Edition	Yoav Goldberg	Morgan and Claypool	2017
2	Linguistic Fundamentals for Natural Language Processing	First Edition	Emily M. Bender	Morgan and Claypool	2013

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Cloud Computing	2	0	2	5	10	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS322		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	CS206: Operating Systems, CS207: Computer Communications and Networks, CS304: Distributed Computing
Course Objective: To get the knowledge of Basics of cloud computing, Key concepts of virtualization, Different Cloud Computing services, Cloud Implementation, Programming and Mobile cloud computing	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS322.1	Illustrate cloud service models, deployment models and mobile cloud computing.
CS322.2	Compare different virtualization technologies.
CS322.3	Use different cloud computing services for a given scnerios.
CS322.4	Analyze the components of open stack and Google Cloud platform.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS322.1	-	3	-	-	-	-	-	-	-	2	-	-
CS322.2	-	-	2		3	-	-	-	-	-	-	-
CS322.3	-	-	2	-	-	-	-	-	-	2	-	2
CS322.4	-	-	-	-	2	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS322.1	2	-	-	-	-
CS322.2	-	-	-	-	-
CS322.3	2	-	-	-	-
CS322.4	-	-	2	-	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
			✓		

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	Introduction to Cloud Computing	**1,2**	**4**
	1.1	Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud Computing, Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models		
	1.2	Cloud computing architecture, Advantages and Disadvantages of Cloud Computing.		
2	**Title**	**Virtualization**	**1,2**	**8**
	2.1	Virtualization: Characteristics of virtualized environment, Understanding the importance of Hypervisors, Type I & Type II Hypervisors.		
	2.2	Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization of CPU, Memory and I/O Devices , Virtualization and Cloud Computing		
	2.3	Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware and HyperV, VirtualBox, Containers/docker, image building registry ,volumes secrets, networks		
3	**Title**	**Cloud Computing Services**	**1,2,3**	**8**
	3.1	Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, and Infrastructure as a service.		
	3.2	Anything as a service or Everything as a service (XaaS): Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service		
	3.3	Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.		
4	**Title**	**Cloud Implementation, Programming and Mobile Cloud Computing**	**2,3,4**	**8**
	4.1	OpenStack Cloud Architecture: Feature of Open stack, Components of Open stack, mode of operations		
	4.2	Programming support for Google apps engine GFS, Bigtables, Chubby, Google APIs.		
	4.3	Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing		
5	**Self Study**	AWS cloud computing Platform, a) Elastic Compute Cloud(EC2): Compute Basics, Instance types, Life cycle of instances. b) Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3. c) Elastic Block Storage (EBS):Basics and Types of EBS Volumes d)Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP).	**1 to 5**	**5***
			Total(* Not included)	**28**

Department of Computer Engineering

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Creating and running virtual machines on Hosted Hypervisors like KVM Type1. Vmware Workstation,Oracle Virtualbox
2	Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV
3	Implement IaaS using your resources. Technology: OpenStack / Eucalyptus
4	Installation and Configuration of Ulteo to demonstrate on demand Application delivery over web browser to explore SaaS Environment.
5	To demonstrate installation and Configuration of Open stack Private cloud.(MS AZ and Google Cloud)
6	Create IAM role in AWS
7	Create EC2 instance How to connect with the instance
8	Demonstrate Platform as a Service using Google app Engine/IBM BlueMix/tSuru
9,10	Title: Mini Project Objective: Using the concepts studied throughout the semester students shall be able to 1. Create their private cloud for the institute using the available resources. 2. Apply security concepts to secure a private cloud. 3. Implement efficient load balancing. 4. Compare various virtualization technologies with given resources. 5. Create cloud applications such as messenger, photo editing website, your own social media etc.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Enterprise Cloud Computing	First Edition	Gautam Shroff	Cambridge	2010
2	Cloud Computing Principles and Paradigms	Second Edition	Rajkumar Buyya, James Broberg, Andrzej Goscinski	Wiley	2013
3	Distributed and Cloud Computing	First Edition	Kai Hwang Geoffrey C. Fox Jack J. Dongarra	Morgan Kofmann	2012

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
4	Cloud Computing: Web Based Applications that Change the Way You Work and Collaborate Online	First Edition	Miller Michael	Pearson Education India	2008
5	Cloud Computing – A practical Approach	First Edition	Velte T., Velte A., Elsenpeter R.	Tata McGrawHill	2017

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Human Machine Interaction	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
CS331(1X)		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	CS302,CS305
Course Objective: This course provides an opportunity to learn and apply the design principles of Human Machine Interaction. Learners will learn the basic human psychology of everyday actions and will be able to design an UI prototype of an application. This course covers the discussion on various interaction design concepts. The laboratory experiments are designed to practice the concepts and to adopt the systematic approach for interface design using various UX tools.	
Course Outcomes (CO):*At the End of the course students will be able to*	
CS331.1	Identify the various design principles used for interacting between human and machine.
CS331.2	Apply human psychology of everyday actions and UI design process for real world applications.
CS331.3	Implement mobile, windows and web based application
CS331.4	Evaluate and justify UI design
CS331.5	Create application for social and technical task.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS331.1	2	-	2	-	-	-	-	-	-	-	-	-
CS331.2	2	-	2	-	-	-	-	-	-	-	-	-
CS331.3	2	3	-	-	2	-	-	-	-	-	-	-
CS331.4	2	-	2	-	-	-	-	-	-	-	-	-
CS331.5	2	3	-	-	-	-	-	-	-	-	-	-

Department of Computer Engineering

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS331.1	1	-	-	-	-
CS331.2	1	-	-	-	-
CS331.3	-	2	-	2	-
CS331.4	-	2	-	-	-
CS331.5	-	2	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction**	1-6	06
	1.1	Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields.		
	1.2	The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction;		
	1.3	Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error;		
2	Title	**Understanding Goal Directed Design**	1-6	06
	2.1	Goal directed design; Implementation models and mental models; Beginners, experts and intermediates – designing for different experience levels		
	2.2	Understanding users; Modeling users – personas and goals.		
3	Title	**Design Guidelines**	1-6	04
	3.1	perception, Gesalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, time.		
4	Title	**Graphical User Interface and Web Interface**	2,4	06
	4.1	The Graphical User Interface: Popularity of graphics, the concept of direct manipulation, characteristics of GUI,		
	4.2	Web user Interface: Interface popularity, characteristics. Principles of user interface design.		
5	Title	**Interaction Styles and Communication:**	2,4	06
	5.1	**Interaction Styles:** Menus, Windows, Device-based and Screen-based Controls.		

	5.2	**Communication:** Text messages, Feedback and Guidance, Icons, Multimedia and colors.		
	Self Study	UX tools: Figma, Just In Mind and any open source tool for prototype designing Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications.		
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To Study of open source UX tools (Justinmind Prototype, Pidoco, Marvel Prototype) and create a simple design for a given problem definition.
2	**Know your client** a. Design an app that can teach mathematics to children of 4-5 years age in schools in Rural Sector. b. Design an app that can teach mathematics to children of 4-5 years age in schools in Urban Sector. c. Design a site that can help people to sell their handmade products in metro cities. d. Design a site that can connect housewives and keep them engaged.
3	**Goal oriented design** - Design an experience for passengers whose flight /train is delayed.
4	**Design Principles** - Understand principles of good UI design by heuristic evaluation. Design UI that would connect all college students to the online events happening on-campus during the college festival. User should be able to browse all events sorted on time, category and place. The user should also be able to subscribe to events and get notified about their start time and also be able to send invites to friends to attend an event with them
5	**Menus & Navigation** – Redesign of a user interface (Suggest and implement changes in Existing User Interface)
6	**Windows & Screen controls** – **a.** Design a navigator for a student new in your Institute. **b.** Design a navigator for a person new in tourist city/ village. **c.** Motor paralysis for differently able people. **d.** Vaccination App design with localization
7	**Icons** - Design appropriate icons pertaining to a given domain.(Eg. Greeting cards)
8	**Colors** – Design a personal website for any socio technical problem Use statistical graphics for better visualization.
9	Design a Map based UI(Web User) for Mumbai Dabbawalas with localization feature.
10	To calculate screen complexity of existing Graphical User Interface and redesign the interface to minimize the screen complexity.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Human Computer Interaction	Third Edition	Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale	Peason,Prentice Hall	2003
2	The Essential Guide to User Interface Design	Third Edition	Wilbert O. Galitz,	Wiley publication	2007
3	Design of everyday things	Second Edition	Donald A. Normann	Basic Books; Reprint edition	2013
4	Galitz's Human Machine Interaction	First Edition	Kalbande,Kanade,Iyer	Wiley Publications	2015

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
5	Interaction Design:Beyond Human Computer Interaction	Fifth Edition	Rogers Sharp Preece	Wiley publications	2019
6	Mobile Design and Development	First Edition	Brian Fling	, O'Reilly Media Inc.,	2009.

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Advanced Algorithm and Complexity	2	0	2	4	8	2	0	1	3
CS332(1Y)		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	Data Structures , Design and Analysis of Algorithms
Course Objective: This course provides the theoretical backbone of computer science and is required in the daily work of the successful developer/programmer. The goal of this course is to provide a solid background in the design, analysis and performance of the major classes of advanced algorithms.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS332.1	Analyze the asymptotic performance of algorithms.
CS332.2	Apply divide and conquer strategy to solve problems.
CS332.3	Apply the concept of dynamic programming and Linear Programming approach to solve the engineering problems.
CS332.4	Apply Parallel and Randomized, Geometrical algorithms to solve the engineering problems.
CS332.5	Apply number theoretic algorithms to solve the engineering Problems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS332.1	2	2	1	-	-	-	-	2	2	2	-	2
CS332.2	2	2	2	-	-	-	-	2	2	2	-	2
CS332.3	3	2	2	-	-	-	-	2	2	2	-	2
CS332.4	2	2	2	-	-	-	-	2	2	2	-	2
CS332.5	**2**	**2**	**2**	-	-	-	-	**2**	**2**	**2**	-	**2**

Department of Computer Engineering

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS332.1	1	1	1	-	-	2	-
CS332.2	1	1	2	-	-	2	-
CS332.3	1	1	2	-	-	2	-
CS332.4	1	1	2	-	-	2	-
CS332.5	1	1	2	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction**		06
	1.1	The role of Algorithms in computing, Analyzing algorithms, Designing Algorithms, Analysis of Insertion Sort and Merge sort.	1	
	1.2	Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis, Recurrences, The substitution method, The recursion-tree method, The master method.	1	
2	Title	**Dynamic and Linear Programming**		12
	2.1	**Dynamic Programming:** Elements of dynamic programming, Assembly Line Scheduling, Matrix-chain multiplication, Longest common subsequence.	1, 2	
	2.2	**Linear Programming:** Standard and Slack Forms, Formulation, Graphical Solution, Simplex Method, Big-M Method, duality, Application of LPP, Sensitivity analysis, transportation and assignment problems.	1, 4	
3	Title	**Probabilistic Analysis, Parallel and Randomized Algorithms**		10
	3.1	The Hiring Problem, Indicator Random Variables, Randomized Algorithms, The Birthday Paradox, Balls and Bins, Las Vegas and Monte Carlo, Markov Chain Model	1	

	3.2	Parallel Algorithms: Sieve of Prime, Sieve of Eratosthenes with interleave and Block decomposition, analysis of algorithms, Floyd's version of All-Pair Shortest-Paths Problem through four steps of parallel algorithm design namely partitioning, communication, agglomeration and mapping decomposition	3	
4	**Self Study**	Number Theoretic Algorithms; Parallel Algorithms: Analysis, Models, Structures Design Techniques, Dynamics Multithreading, Greedy Schedule, Multithreaded algorithms, Cache oblivious algorithm; Computational Geometry: Line-segment Properties, Determining whether any pair of segments intersects, Finding the convex hull	1, 2	8*
			Total(* Not included)	**28**

Laboratory Component:

Sr. No	Title of the Experiment
1	Randomly Generate 2 lacs elements and apply various sorting methods and compare their performance. (Weightage of 2 Experiments)
2	Implementation of divide and conquer approach.
3	Implementation of Dynamic Programming Problems
4	Implementation of Linear Programming Problems
5	Implementation of Parallel/Randomized Algorithms
6	Mini Project: Real life problem using the concepts of data structures and Algorithms (Weightage 4 Experiments)

Text Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Algorithms	Third Edition	Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein	MIT Press	2009
2	Parallel programming in C with MPI and Open MP	First edition	Michael J Quinn	Mc Graw Hill	2003

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
3	Fundamentals of Computer Algorithms	Second Edition	Horowitz E, Sahni S and S.Rajasekaran	Galgotia Publications	2010
4	Operations Research	Seventh Edition	P K Gupta, D S Hira	Sultan Chand & Sons	2018

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Mini Project-II	0	0	0	8	8	0	0	0	3
		Examination Scheme								
CS308		Component	ISE		MSE		ESE			Total
		Theory	-		-		-			-
		Laboratory	200		-		100			300

Pre-requisite Course Codes, if any.	
Course Objective: This course inculcates self-learning, research, and entrepreneurship attitude in students. Students will be able to understand the formal project development process to complete a project in a team. It will help students to develop communication, organizational skills and maturity through discussion, presentation etc.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS308.1	Conduct a survey of basic and contemporary literature in the preferred field by identifying problems based on societal /research needs.
CS308.2	Formulate the problem statement by making judgments on validity of ideas.
CS308.3	Conclude suitable inferences from obtained results through theoretical/experimental/simulations-based analysis.
CS308.4	Develop interpersonal skills to work as member of a team.
CS308.5	Prepare a report of the findings for the study conducted in the preferred domain.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS308.1	2	2	-	-	-	2	1	3	3	3	-	2
CS308.2	2	3	2	2	-	-	1	3	3	3	-	2
CS308.3	2	2	2	2	2	-	-	3	3	3	-	2
CS308.4	-	-	-	-	-	-	-	3	3	3	3	2
CS308.5	2	2	-	-	-	-	-	3	3	3	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS308.1	2	2	2	-	2
CS308.2	2	2	2	-	2
CS308.3	2	2	2	-	2
CS308.4	2	2	2	-	2
CS308.5	2	2	2	-	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓

Department of Computer Engineering

Mini Project II is an opportunity to inculcate the research aptitude in students. It helps them to identify research gaps and come up with possible solutions. Students should be able to analyze these solutions for feasibility of their implementation. Mini project II is based on a small research project correlating scientific knowledge and day to day experience which encourages development of scientific attitude to solve real life problems among students.

Steps for Research:

✓ Keen observation of the surrounding/society

✓ Read existing Literature to understand and identify the research gaps

✓ Analysis of the problem

✓ Formulation of the problem statement

✓ Collection of relevant information by formulating research questions

✓ Suggesting plan of action

✓ Conducting experiments and draw conclusion

✓ To find the possible solution to rectify the problem

✓ To execute experiments and remedial measures wherever possible

Students can seek guidance from teachers, other experts and make effective use of other sources of information available around them. Students must ensure that problem to be manageable in one semester.

Criteria of a good project:

✓ Appropriate idea, clear understanding, and proper presentation of the concept

✓ Quality of work

✓ Project plan and its execution

✓ Credibility of the work

✓ Probable impact of the work on the attitude of students and society

✓ Scientific attitude, creativity and novelty reflected in project work and analysis of the situation

✓ Utility and innovation of the remedial measures

✓ Desirability, Feasibility and Viability in real life

The H/W and S/W resources required to complete the Mini Project II may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

- ✓ Learning additional skills
- ✓ Development of ability to define and design the problem and lead to its accomplishment with proper planning
- ✓ Learn the behavioral discipline by working in a team. Students should work in groups of three on the Mini Project-II.

Evaluation:

Project report should be submitted on A-4 size pages. Use both printing. Report must carry project title, student details, certificate, and acknowledgements. Other sections of the report shall be decided by the department based on projects. But it must have introduction, necessity of project, objectives, hypothesis, plan, observations, and analysis of results, conclusion, and references along with other sections related to technology.

The ISE and ESE evaluation will be carried out based on the rubrics framed by the Department. ISE marks will be based on the performance of the individual student in three phases of evaluation. The evaluation of the Phase-I will be based on Title approval where the domain and scope of the project will be evaluated. Phase-II will be based on presentation of the selected approach, Justification and Design. Evaluation of Phase-III will be based on demonstration of implementation, testing, presentation and technical report.

The ESE marks will be based on demonstration in front of the expert appointed by the Department. In the ESE examination each individual student would be assessed for his/her contribution in selecting the originality of the problem statement, understanding and knowledge gained about the task completed through presentation/demonstration, work done, and preparing the technical report/poster/technical paper of the project in the standard format provided by the Department.

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

Semester-VII

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Deep Learning	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS413		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	The prerequisites for this course are: 1) Basic knowledge of Python. 2) Basic linear algebra and probability.

Course Objective: This course aims to present the mathematical, statistical and computational challenges of building stable representations for high-dimensional data. This data should be 2D-4D images, text and speech. Selected topics of Deep Learning, discussing its origination from neural networks to major trends, giving rise to deep learning models. Special emphasis will be on Optimization techniques, hyper parameters tuning, Convolutional architectures, Sequential architecture and Generative Adversarial Networks. Also lab oriented objectives are full filled through various experiments

Course Outcomes (CO): ***At the End of the course students will be able to***

CS413.1	Compare the architectures of Neural network and deep neural networks and relevant properties.
CS413.2	Identify various ways of selecting suitable model parameters, hyper parameters and stochastic optimization methods that are crucial for training deep neural networks.
CS413.3	Determine characteristics of datasets and suitable computing environment to select suitable building blocks of neural networks including fully connected layers, convolutional and recurrent layers.
CS413.4	Apply deep Learning techniques like generative, representative or discriminative to solve various real life problems using modern tools.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS413.1	3	-	3	-	-	-	-	-	-	-	-	-
CS413.2	-	-	3	-	-	-	-	-	-	-	-	-
CS413.3	3	-	-	-	-	-	-	-	-	-	-	-
CS413.4	3	-	-		3	-	-	-	-	-	-	-

Department of Computer Engineering

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS413.1	2	-	-	-	-	-	-
CS413.2	-	2	-	-	-	-	-
CS413.3	2	-	-	-	-	-	-
CS413.4	-	2	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate ✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Neural Networks and Deep learning**	1,2	7
	1.1	Introduction to Deep Learning: What is a Neural Network?, Supervised Learning with Neural Networks, Why is Deep Learning taking off? Analyze the major trends driving the rise of deep learning, and give examples of where and how it is applied today.		
	1.2	Neural Networks: Binary Classification, Logistic Regression. Logistic Regression Cost Function, Gradient Descent. Derivatives and relevant examples, Computation Graph, Derivatives with a Computation Graph, Logistic Regression Gradient Descent and relevant example, Vectorization and Vectorizing Logistic Regression's Gradient.		
	1.3	Deep Neural Networks: Deep L-layer Neural Network, Building Blocks of Deep Neural Networks, Forward and Backward Propagation, Parameters vs Hyper parameters		
2	Title	**Optimization, Tuning and Interpretability**	1,2,4	7

	2.1	Practical Aspects of Deep Learning: Train / Dev / Test sets, Bias / Variance, Basic Recipe for Machine Learning, Regularization, Dropout, Normalizing Inputs, Vanishing / Exploding Gradients, Weight Initialization for Deep Networks, Numerical Approximation of Gradients.		
	2.2	Optimization Algorithm: Mini-batch Gradient Descent, Exponentially Weighted Averages, Bias Correction in Exponentially Weighted Averages, Gradient Descent with Momentum, RMSprop, Adam Optimization Algorithm, Learning Rate Decay and Problem of Local Optima		
	2.3	Hyperparameter Tuning, Batch Normalization and Programming Frameworks: Tuning Process, Using an Appropriate Scale to pick Hyperparameters, Hyperparameters Tuning in Practice: Pandas vs. Caviar, Normalizing Activations in a Network, Batch Normalization, Softmax Regression, Training a Softmax Classifier.		
3	**Title**	**Convolutional Neural Net (CNN) and Sequential Model**	1,2,3	**7**
	3.1	Foundation of CNN: Computer Vision, Edge Detection Example, Padding, Strided Convolutions, Convolutions Over Volume, One Layer of a Convolutional Network, Simple Convolutional Network Example, Pooling Layers, CNN Example		
	3.2	Sequential Model: Introduction, Notations, Recurrent Neural Network Model, Backpropagation Through Time, Different Types of RNNs, Language Model and Sequence Generation, Sampling Novel Sequences, Vanishing Gradients with RNNs, Gated Recurrent Unit (GRU), Long Short Term Memory (LSTM), Bidirectional RNN, Deep RNNs		
4	**Title**	**Representation learning & Generative Learning using Autoencoders and Generative Adversarial Network (GAN)**	1,2,3,4	**7**
	4.1	Autoregressive, Reversible, Autoencoders, Variational autoencoder Architecture,		
	4.2	Generative Adversarial Networks, GAN Cost Function. DCGAN		
5	**Self Study**	Pytorch, Tensor Flow, Keras, etc		**2***
			Total(* not included)	**28**

Department of Computer Engineering

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Learning TensorFlow API and Keras API
2	Build and train deep neural networks, identify architecture parameters, implement vectorized neural networks and deep learning to applications
3	Train test sets, analyze variance for DL applications, use standard techniques and optimization algorithms, and build neural network in TensorFlow
4	Implement convolutional neural networks (convnets): Using data augmentation to mitigate overfitting + Using a pre-trained convnet to do feature extraction + Fine-tuning a pre-trained convent + Visualizing what convnets learn and how they make classification decisions
5	Build and train RNNs, work with NLP and word embeddings
6-10	Capstone project covering the concepts of Deep Learning on real world problem statements.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Deep Learning	First Edition	Goodfellow, I., Bengio,Y., and Courville, A.	MIT Press	2016
2	Fundamentals of Deep Learning	First Edition	Nikhil Buduma	O'Reilly	2017
3	Generative Deep Learning	First Edition	David Foster	O'Reilly	2019
4	Deep Learning using Python	First Edition	Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka	Wiley	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
5	Deep Learning: Methods and Applications	1st	Deng & Yu	Now Publishers	2011
6	Deep Learning Cookbook	1st	Douwe Osinga	O'Reilly	2017

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Information and System Security	2	0	2	4	8	2	0	1	3
CS423		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	Operating Systems Computer Networks
Course Objective: To develop basic understanding of policies, standards and practices for evaluation of system security.	
Course Outcomes (CO):*At the End of the course students will be able to*	
CS423.1	Interpret the fundamental results towards the limitation of computer security.
CS423.2	Contrast the different types of security policies and mechanism
CS423.3	Justify the mechanism-policy mapping through assurance and approvals based on evidence.
CS423.4	Describe the options available for receiving an evaluation of trust level of the system.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS423.1	2	1	-	-	-	-	-	-	-	-	-	2
CS423.2	2	-	-	-	-	-	-	-	-	-	-	2
CS423.3	2	-	1	1	-	1	-	2	-	1		2
CS423.4	2	1	1	1	-	-	-	2	-	-	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CS423.1	1	1	-	-	-
CS423.2	2	1	-	-	-
CS423.3	3	1	2	-	-
CS423.4	3	1	2	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze✓	Evaluate	Create

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Overview of Information Security**		7
	1.1	**Introduction** - Basic Components, Threats, Policy and Mechanism, Assumptions and Trust, Assurance, Operational and Human Issues	1,2	
	1.2	**Foundation Results** - Protection State, Access Control Matrix Model, General Security Question, Take-Grant Protection Model	1,2	
2	**Title**	**Security Policies - I**		7
	2.1	**Security Policy Basics** - Types, Role of Trust, Types of Access Control, Policy Languages. **Confidentiality Policies** - Goals, Bell-LaPadula Model, Tranquility	1,2	
	2.2	**Integrity Policies** – Goals, Biba Integrity Model, Lipner's Integrity Matrix Model, Trust Models.	1,2	
3	**Title**	**Security Policies - II**		7
	3.1	**Hybrid Policies** - Chinese Wall Model, Role-Based Access Control, Attribute-Based Access Control Model	1,2	
	3.2	**Access Control Mechanisms** - Access Control Lists, Capabilities, Locks, Ring based Access Control, Propagated Access Control Lists	1,2	
4	**Title**	**Assurance and System Evaluation**		7
	4.1	**Assurance and Trust** – Requirements Definition and Analysis, System and Software Design Assurance, Implementation and Integration Assurance, Building Secure and Trusted Systems.	1,2	
	4.2	**System Evaluation**- Principles of Secure Design, Goals of Formal Evaluation, TCSEC: 1983–1999, ITSEC: 1991–2001, CISR Requirements 1991.	1,2	
5	**Self-Study**	a) Formal Verification Techniques b) Formal Specification	1,2	**4***
			Total(* Not included)	**28**

List of Experiments

Sr. No	Title of the Experiment
1	Experiment on Access Control Matrix Model
2	Experiment on Take-Grant Protection Model
3	Experiment on Policy Language
4	Experiment on Bell-LaPadula Model
5	Experiment on Biba Integrity Model
6	Experiment on Role-Based Access Control
7	Experiment on Attribute-Based Access Control Model
8	Experiment on Access Control Mechanisms
9	Capstone project for evaluating the system the level of trust of the system through assurance evidence so that the mechanism meets security policy.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Computer Security: Art and Science	Second Edition	Matt Bishop, Elisabeth Sullivan & Michelle Ruppel	Addison-Wesley Professional	2018
3	Introduction to Computer Security	First Edition	Matt Bishop	Addison-Wesley Professional	2005

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
3	Computer Security: Principles and Practice	Fourth Edition	William Stallings & Lawrie Brown	Pearson Education	2018
4	Cryptography and Network Security Principles and Practices	Fourth Edition	William Stallings	Addison-Wesley Professional	2005
5	Cryptography and Network Security	Second Edition	Behrouz A. Forouzan, Debdeep Mukhopadhyay	McGraw-Hill Education	2010

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Big Data Analytics and Information Retrieval	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS414		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Artificial Intelligence & Machine Learning-CS303

Course Objective:
1) Provide overview of growing field of big data analytics.
2) Demonstrate tools required to perform information retrieval from Big Data.
3) Enable students to solve complex real-world problems for decision support.

Course Outcomes (CO): ***At the End of the course students will be able to***

CS414.1	Identify challenges in big data management and inadequacy of existing technology to analyze big data problem.
CS414.2	Apply scalable algorithms based on Hadoop and Map Reduce to perform Big Data Analytics.
CS414.3	Use big data tools for information retrieval.
CS414.4	Use stream data model to provide real time analysis of big data.
CS414.5	Analyze data using graphs.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS414.1	-	2		-	-	-	-	-	-	-	-	-
CS414.2	-	3	3	-	-	-	-	-	2	2	-	
CS414.3	-	3	2	-	2	-	-	-	2	2	-	1
CS414.4	-	1	2	-	2	-	-	-	2	2	-	-
CS414.5	-	1	1	1	2	-	-	-	2	2	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
CS414.1	2	-	-	-	-	-
CS414.2	2	-	-	-	-	-
CS414.3	2	-	2	-	1	1
CS414.4	2	-	2	-	1	1
CS414.5	2	-	2	-	1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate ✓	Create

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	1	04
	1.1	Big Data - Introduction to Big Data & Big Data Challenges, Characteristics of Big Data, Case Study of Big Data Solutions, Linkage between Big Data and Data Science, Distinguish what are and what are not big data problems ,Data sources of Big Data, Big data Modelling techniques introduction		
	1.2	Hadoop - Comparison with other systems- RDBMS, Grid Computing, Analyse data with Hadoop – Map & Reduce		
2		**Hadoop Components**	1	06
	2.1	Difference between Hadoop 1.x and 2.x		
	2.2	Hadoop 2.x Core Components – HDFS, MapReduce , YARN Master Nodes & Slave Nodes, How MapReduce works - Anatomy of a MapReduce Job Run, Failures, Shuffle & Sort, Task Execution		
	2.3	Related Projects – Introduction – Flume, Sqoop, Pig, Hbase		
3		**Spark for Information Retrieval**	2	06
	3.1	Introduction to Spark - Spark Architecture & applications - DataFrame Transformation, Aggregation, Joins, Data Sources, CSV Files, JSON Files, Parquet Files		
	3.2	Spark SQL- Catalog, Tables, Views, Select Statements		
4		**Mining Data Streams for Information Retrival**	3	06
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Query, Issues in Stream Processing, Sampling Data in a Stream		
	4.2	Filtering Streams - The Bloom Filter		
	4.3	Counting Distinct Elements in a Stream - The Count-Distinct Problem, The Flajolet-Martin Algorithm		
	4.4	Counting Ones in a Window - The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm		
5		**Link Analysis**	3	06
	5.1	PageRank Definition, Structure of the web, dead ends, Using Page ranking in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to consolidate the Result Vector, Topic sensitive Page Rank, Link Spam, Hubs and Authorities		
6	**Self Study**	Graph Databases overview, Modeling data & Importing data using Neo4j, Use Case Example- Using a graph model for recommendations	**Ref 2**	**04***
			Total(* not included)	**28**

Department of Computer Engineering

Laboratory Component. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Install Hadoop and execute word count program and study Hadoop file management commands
2	MapReduce program in Hadoop
3	Pig Script for big data information retrieval using relational algorithm
4	Spark program to execute parallel operations
5	Data transfer using flume
6	Use Sqoop for data transfer from RDBMS to Hadoop
7	Implement Bloom filter
8	Analytics using Neo4j graph database
9	Stage 1 - Mini Project. One real life large data application to be implemented (Use standard Datasets available on the web)
10	Stage 2 - Mini Project. One real life large data application to be implemented (Use standard Datasets available on the web)

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Hadoop: The Definitive Guide	Fourth Edition	Tom White	O'Reilly	2015
2	Spark: The Definitive Guide	First Edition	Bill Chambers,Matei Zaharia	O'Reilly	2018
3	Mining of Massive Datasets	Second Edition	Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman	Cambridge University Press	2014

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Hadoop in Practice	First Edition	Alex Holmes	Manning	2012
2	Learning Neo4j	First Edition	Rik Van Bruggen	Packt	2014

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Digital Forensics and Cybersecurity	2	0	2	4	8	2	0	1	3
CS424		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Computer Communication Network CE 41
Course Objective:	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS424.1	Illustrate the science of digital forensic
CS424.2	Categorize the different areas within digital forensics and apply solid foundational grounding for digital investigations and protection of resources from unauthorized activity.
CS424.3	Apply the tools and tactics associated with digital forensics
CS424.4	Identify the requirements of cybersecurity for critical infrastructure and learn to comply such requirements within suitable cyber security framework.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS424.1	-	2	-	-	-	-	-	-	-	-	-	-
CS424.2	-	2	-	-	-	-	-	-	-	-	-	-
CS424.3	-	-	-	-	3	-	-	-	-	-	-	-
CS424.4	-	-	-	-	-	2	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS424.1	2	-	-	-	-	-	-
CS424.2	-	2	-	-	-	-	-
CS424.3	2	-	-	-	-	-	-
CS424.4	-	2	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✔	Analyze ✔	Evaluate	Create ✔

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Digital Forensics Science**	1,2	5
	1.1	Introduction to Digital Forensic Science, Planning and development of Digital Forensic lab.		
	1.2	The phases of Digital Forensic investigative process: Identification, Preservation, Collection, Examination, Analysis, Presentation, Decision.		
2	**Title**	Sub categories of Digital Forensic	1,2	**7**
	2.1	Media Analysis (Hard drives, RAM, flash memory, PDAs, diskettes etc): Examining physical media for evidence, Chain of Custody (CoC),Powered-on versus powered-off device acquisition, Write blocking, Data imaging and hashing, Mobile and portable Device forensics, Device and data acquisition guidelines and best practices,		
	2.2	Code Analysis: Review of software for malicious signatures, Network Analysis: Scrutinize network traffic and logs to identify and locate.		
3	**Title**	**Incident Response Methodology and Tools**	1,2	8
	3.1	Preparation, Detection, Containment, Analysis, Eradication, Recovery and Follow up.		
	3.2	Evidence Acquisition and Preservation, Drive and partition recognition in Linux, Maintaining evidence integrity, Image acquisition using *Guymager*. File Recovery and Data Carving with *Foremost*, *Scalpel*, and *Bulk Extractor*, Forensic test images used in *Foremost* and *Scalpel*, Using Foremost for file recovery and data carving, Using *Scalpel* for data carving, Bulk_extractor. Memory Forensics with *Volatility*.		
	3.3	Autopsy – The Sleuth Kit, Kit, Sample, Network and Internet Capture Analysis with Xplico, Packet capture analysis using Xplico,		
4	**Title**	**Cybersecurity**	3,4	**8**
	4.1	Introduction to Cybersecurity framework of NIST, Five functions of cybersecurity and critical infrastructure security (Nuclear power plant, smart grid, SCADA, Industrial Control System Security)		
	4.2	Introduction to SOC/SIEM, Advance techniques in Cyber security like Machine learning and Game theory		
5	**Self-study**	Cloud Forensic, IT security policy for any given sector (BFSI),		2*
			Total(* Not included)	**28**

Department of Computer Engineering

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Setting up Digital Forensic lab
2	Computer Forensic using open source tool (Autopsy, Sleuth kit and TCT)
3	Memory Forensics using open source tool (Volatality)
4	Network Forensics using open source tools (Xplico and Tshark)
5	Email Forensics using online utilities
6	Evaluating commercial Digital forensic tools (EnCase Forensic)
7	IoT Forensic Case Study
8	Cloud Forensic
9	Implementing SIEM
10	Mini Project on Cybersecurity using advance Technique

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Forensics with Kali Linux	Second Edition	Shiva V. N. Parasram	Packt	2017
2	Computer Forensics: Incident Response Essentials	--	First Warren G. Kruse II and Jay G. Heiser	Addison-Wesley Professional	2001
3	NIST Cyber Security Framework https://www.nist.gov/cyberframework/online-learning			NIST online	
4	Framework for improving critical infrastructure of Cyber security https://nvlpubs.nist.gov/nistpubs/CSWP/NIST.CSWP.04162018.pdf			NIST Online	

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Guide to Computer Forensics and Investigations	Second Edition	Nelson, B, Phillips, A, Enfinger, F, Stuart, C	Thomson Course Technology	2006
2	Computer Forensics, Computer Crime Scene Investigation	First Edition	Vacca, J	Charles River Media,	2005

Department of Computer Engineering

Course Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Internet of Things (IoT)	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component		ISE		MSE	ESE		Total	
CS431 (1P)		Theory		50		50	100		200	
		Laboratory		50		--	50		100	

Pre-requisite Course Codes, if any.	Computer Communication and Networks,OS, CSS
Course Objective: To provide overview of key components of Internet of Things, architecture, protocols, services, monitoring and security. It covers the technical strategy and implementing IoT applications using commercial IoT offerings and various open source technologies and map it to Industry IoT stack.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS431.1	Describe the Internet of Things and its components, protocols, architecture and services.
CS431.2	Design IoT systems through Python, Physical Servers.
CS431.3	Develop IoT system through IoT Cloud solutions
CS431.4	Perform IoT Systems and Security Management.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS431.1	2	-	-	-	-	-	-	-	-	-	-	-
CS431.2	-	-	2	-	3	-	-	-	-	-	-	-
CS431.3	-	-	2	-	2	-	-	-	-	-	-	-
CS431.4	-	-	2	-	2	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS431.1	1	-	-	-	-	-	-
CS431.2	1	-	-	-	-	-	-
CS431.3	1	-	-	-	-	-	-
CS431.4	1	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✔	Analyze	Evaluate	Create

Department of Computer Engineering

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to IoT**		
	1.1	Introduction to IoT – Definition, Characteristics, Physical and Logical Designs, IoT Protocols, IoT Communications Models and API, IoT Enabling Technologies, IoT Levels and Deployment Templates, IoT Examples, M2M, Industrial IoT(IIoT) and architecture.	1,2	**8**
	1.2	RFID Technology – Working of RFID, Components of an RFID system, RFID Transponder (tag) classes, Standards, System architecture, Localization and Handover Management, Technology considerations, Performance Evaluation, Applications	1,2	
	1.3	Wireless Sensor Networks – History, Sensor Nodes, Connecting Nodes, Networking Nodes, Securing Communication	1,2	
2	**Title**	**IoT Logical design and Physical Server**		**6**
	2.1	IoT Systems Logical Design – Python Data Types, Type conversion, Control Flow, Python Functions, Modules, File Handling, Classes, Python Packages for IoT	1	
	2.2	IoT Physical Servers – Cloud Storage Models, Communication APIs, WAMP, Xively Cloud, Django	1	
3	**Title**	**IoT Cloud Services and Security**		**7**
	3.1	IoT Cloud Services - RESTful Web API, Amazon Web Services for IoT, IBM Watson IoT Platform	1	
	3.2	Cloud IoT Security Controls - Authentication, Amazon AWS IAM, End-to-End Security Recommendation, Secure bootstrap and enrollment of IoT devices, Security Monitoring, Enterprise IoT Cloud Security Architecture.	3	
4	**Title**	**IoT System Management**		**7**
	4.1	IoT System Management – SNMP, Network Operator Requirements, NETCONF, YANG	1	
	4.2	IoT Platform Design Specification – Requirements, Process, Domain Model, Service, IoT Level, Function, Operational view, Device and Component Integration, Application Development	1	
5	**Self Study**	**IoT Data Analytics** – Apache Hadoop, Batch Data Analysis, Hadoop YARN **IoT Data Analytics** – Apache Oozie, Apache Spark, Apache Storm, Chef, Chef Case Studies, Puppet, NETCONF-YANG	1	***5**
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Setting up and Configuration of IoT Hardware/Software
2	Implementing MQTT Protocol
3	Securing MQTT Protocol

4	Setting Up IoT Gateway(M2M)
5	Managing IoT System using SNMP and YANG
6	Configuration of IoT operating systems Contiki
7	Configuring IoT Cloud Services
8	Security Monitoring of IoT
9	Mini Project Part-1 (Smart Parking System)
10	Mini Project Part-2 (Energy Management)

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Internet of Things: A Hands-On Approach	First Edition	Arsheep Bahga , Vijay Madisetti	University Press	2015
2	The Internet of Things: Connecting Objects	First Edition	Hakima Chaouchi	Wiley-ISTE	2010
3	Practical Internet of Things	First Edition	Brian Russell, Drew Van Duren	Packt	2016

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications	First Edition	Adeel Javed	Apress	2016
2	Designing the Internet of Things	-	Adrian McEwen	Wiley	2013
3	The Silent Intelligence: The Internet of Things	First Edition	Daniel Kellmereit	Lightning Source Inc	2014

Department of Computer Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Blockchain Technology	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS432(1Q)		Theory	50		50		100			200
		Laboratory	50		-		50			100

Pre-requisite Course Codes, if any.	CSS
Course Objective: To apply and analyze different cryptography and system security protocols/techniques	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS432.1	Apply the basics concepts of blockchain technology, Bitcoin and Ethereum.
CS432.2	Implement a smart contract on the Ethereum test network
CS432.3	Build a Decentralized Application running on a decentralized peer-to-peer network
CS432.4	Evaluate the use cases for a new blockchain and/or cryptocurrency.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS432.1	2	-	-	-	-	-	-	-	-	-	-	-
CS432.2	-	-	2	-	-	-	-	-	-	-	-	-
CS432.3	-	-	-	-	2	-	-	-	-	-	-	-
CS432.4	-	2	2	-	3	2	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS432.1	2	-	-	-	-	2	-
CS432.2	2	-	-	-	-	2	-
CS432.3	2	-	-	-	-	2	-
CS432.4	2	-	-	-	-	2	-

Department of Computer Engineering

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Blockchain Technology**		10
	1.1	Introduction – basic ideas behind blockchain, landscape of digitalization and Blockchain Technology . Architecture : Centralised , Distributed and Decentralised Architecture and Blockchain vs Distributed Ledger Technology (DLT)	1,2,3,4	
	1.2	The consensus problem - Asynchronous Byzantine Agreement - AAP protocol and its analysis - akamoto Consensus on permission-less, nameless, peer-to-peer network – Abstract Models for BLOCKCHAIN - ARAY model - RLA Model – Proof of Work (PoW) as random oracle - formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains – Hybrid models (PoW + PoS). Cryptographic basics for cryptocurrency – Cryptography premitives for Blockchain and Data struture for blockchain a short overview of Hashing, signature schemes, encryption schemes and elliptic curve cryptography		
2		**Cryptocurrency**		06
	2.1	Bitcoin - Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks – double spending - mathematical analysis of properties of Bitcoin.	1,2,3,4	
	2.2	Programming in Bitcoin Stack base language Permissioned Blockchain: Basics, Distributed consensus Consensus, RAFT Consensus, Byzantine General Problem, Practical Byzantine Fault Tolerance		
3		**Hyperledger Fabric**		06
	3.1	Transaction Flow. Hyperledger Fabric Details, Fabric - Membership and Identity Management, Hyperledger Fabric Network Setup, Fabric Demo on IBM Blockchain Cloud. Hyperledger Composer – Application Development. Hyperledger Composer - Network Administration, Ethereum - Ethereum Virtual Machine (EVM) - Wallets for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts.	1,2,3,4	
	3.2	Blockchain: Enterprise use cases Alternative coins – Ethereum and Smart contracts Alternative coins – Ethereum 1.0 and Ethereum 2.0, IOTA		

4		**Applications Blockchain Technology**		**06**
	4.1	Uses of Blockchain in E-Governance, Land Registration, Medical Information Systems, and smart cities	1,2,3,4	
	4.2	Uses of Blockchain in smart industries, anomaly detections, FinTech -Shaping the Financial World, IoT		
	Self Study	Scaling the blockchain: payment channels and state channels Scaling the blockchain using optimism and using SNARK Privacy in public blockchain: de-anonymizing the blockchain and mixing		**04***
			Total(* Not included)	**28**

Text Books

Sr. No	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
T1	Mastering Bitcoin: Unlocking Digital Cryptocurrencies	First Edition	Andreas M. Antonopoulos	O'Reilly Media	2014
T2	Bitcoin and cryptocurrency technologies: a comprehensive introduction.	First Edition	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder	Princeton University Press	2016
T3	Zero to Blockchain - An IBM Redbooks course,	First Edition	Bob Dill, David Smits	IBM Redbooks	2017
T4	Blockchain	First Edition	Melanie Swan	O'Reilly Media	2015
	Hyperledger Fabric - https://www.hyperledger.org/projects/fabric				

Reference Books

Sr. No	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
R1	"Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contracts"	First Edition	Alan T. Norman		2017

R2	"Blockchain: Ultimate Beginner's Guide to Blockchain Technology - Cryptocurrency, Smart Contracts, Distributed Ledger, Fintech, and Decentralized Applications"	First Edition	Matthew Connor		2017
R3	Blockchain – A practical guide to developing business, law, and technology solutions	First Edition	Joseph J. Bambara and Paul R. Allen	McGraw Hill	2018

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Cryptosystems - I
2	Cryptosystems - II
3	Merkle Tree and genesis block
4	Bootstrapping
5	Hyperledger Fabric
6	Hyperledger Fabric - Ethereum
7	Bitcoin Cryptocurrency
8	Application : Land Registration
9	Application: Smart Contract
10	Application : FinTech

Books:

[1] Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos
[2]Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press,2016. (Free download available)
[3] Blockchain by Melanie Swa, O'Reilly
[4] Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
[5] Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits - https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

References:

[1] Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015 (article available for free download)
[2] J.A.Garay et al, The bitcoin backbone protocol - analysis and applications EUROCRYPT 2015 LNCS VOl 9057, (VOLII), pp 281-310. (Also available at eprint.iacr.org/2016/1048).
[3] R.Pass et al, Analysis of Blockchain protocol in Asynchronous networks , EUROCRYPT 2017, (eprint.iacr.org/2016/454) .
[4] R.Pass et al, Fruitchain, a fair blockchain, PODC 2017 (eprint.iacr.org/2016/916).

Department of Computer Engineering

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of Computer Engineering

Semester-VIII

Department of Computer Engineering

Sem VIII (Option A : Cat1/Cat2)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	OE *	OEHXX	OE-IV	2	0	2	4	8	3
2	PE	CS4X5	PE-V	2	0	2	4	8	3
3	PE	CS4X6	PE-VI	2	0	2	4	8	3
4	SBC	CS402	Main Project Stage-II	0	0	0	12	12	6
5	ABL	SVXX/STXX	SEVA-IV/SATVA-IV	0	0	0	4	04	2
6	H	HOXX	Honors-II						3
	*May be taken from MOOCs, Essentially Humanities, Management related								
TOTAL				**6**	**0**	**6**	**28**	**40**	**17**

Sem VIII (Option B : Only for Cat1 students)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
2	SBC	CS403	Main Project Stage-II	0	0	0	36	36	16
3	ABL	SVXX/STXX	SEVA-IV/SATVA-IV	0	0	0	4	04	1
4	H	HOXX	Honors-II						3
	*May be taken from MOOCs, Essentially Humanities, Management related								
TOTAL				**0**	**0**	**0**	**40**	**40**	**17**