Bharatiya Vidya Bhavan's

Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai)

Revision: SPIT-1-18

Master of Technology (M.Tech.)
in
Computer Engineering
(Program Code: PCE)

First Year Master of Technology
(Sem. I and Sem. II)
Effective from Academic Year 2018 -19

Board of Studies Approval: 14/12/2017

Academic Council Approval: 20/01/2018

Dr. D. R. Kalbande	*Dr. Surendra Rathod*	*Dr. Prachi Gharpure*
Head of Department	*Dean Academics*	*Principal*

Principal
Sardar Patel Institute of Technology
Bhavans Andheri Campus
Munshi Nagar, Andheri (West),
Mumbai - 400 058.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
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Scheme of Curriculum for Computer Engineering M.Tech. Program

Scheme for M. Tech. Computer Engineering (SEM I to SEM IV)						
SEM I						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
CE911	Advanced Algorithm and Complexity	PC	4	-	-	4
CE912	Big Data Analytics and Management	PC	4	-	-	4
CE913	Information and System Security	PC	4	-	-	4
CEL911	PG Laboratory –I	PC	-	-	2	1
CEL912	PG Laboratory –II	PC	-	-	2	1
CES911	Seminar -I	PC	-	-	2	1
CEE91X	**Professional Elective-I**	PE	3	-	-	3
ILE91X	**Institute Elective-I**	OE	3	-	-	3
	Total		18	-	6	21
SEM II						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
CE921	Network Analysis and Design	PC	4	-	-	4
CE922	High Performance Computing	PC	4	-	-	4
CE923	User Experience Design	PC	3	-	-	3
CEL921	PG Laboratory –III	PC	-	-	2	1
CEL922	PG Laboratory –IV	PC	-	-	2	1
CEL923	PG Laboratory –V	PC	-	-	2	1
CES921	Seminar -II	PC	-	-	2	1
CEE92X	**Professional Elective-II**	PE	3	-	-	3
ILE92X	**Institute Elective-II**	OE	3	-	-	3
	Total		17	-	8	21
SEM III						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
CES931	Seminar -III	PC	-	-	6=(2X3)	3
CEP931	Dissertation-I	PR	-	-	24	12
	Total		-	-	30	15
SEM IV						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
CEP941	Dissertation-II	PR	-	-	30	15
	Total		-	-	30	15

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Evaluation Scheme

M.Tech Computer Engineering (SEM I)					
Course Code	**Course Name**	**Marks**			
		ISE	**MSE**	**ESE**	**Total**
CE911	Advanced Algorithm and Complexity	20	20	60	100
CE912	Big Data Analytics and Management	20	20	60	100
CE913	Information and System Security	20	20	60	100
CEL911	PG Laboratory –I	40	--	20	60
CEL912	PG Laboratory –II	40	--	20	60
CES911	Seminar -I	50	--	--	50
CEE91X	Professional Elective-I	20	20	60	100
ILE91X	Institute Elective-I	20	20	60	100
	Total				**670**
M.Tech Computer Engineering (SEM II)					
Course Code	**Course Name**	**Marks**			
		ISE	**MSE**	**ESE**	**Total**
CE921	Network Analysis and Design	20	20	60	100
CE922	High Performance Computing	20	20	60	100
CE923	User Experience Design	20	20	60	100
CEL921	PG Laboratory –III	40	--	20	60
CEL922	PG Laboratory –IV	40	--	20	60
CEL923	PG Laboratory –V	40	--	20	60
CES921	Seminar -II	50	--	--	50
CEE92X	Professional Elective-II	20	20	60	100
ILE92X	Institute Elective-II	**--**	**--**	**--**	**--**
	Total				**630**
M.Tech Computer Engineering (SEM III)					
Course Code	**Course Name**	**Marks**			
		ISE	**MSE**	**ESE**	**Total**
CES931	Seminar –III	50	--	50	100
CEP931	Dissertation-I	50	--	100	150
	Total				250
M.Tech Computer Engineering (SEM IV)					
Course Code	**Course Name**	**Marks**			
		ISE	**MSE**	**ESE**	**Total**
CEP941	Dissertation-II	100	--	100	200
	Total				200

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Code	Professional Elective-I Subjects
CEE911	Modern Operating System
CEE912	Image Analysis and Interpretation
CEE913	Natural Language Processing
CEE914	Advanced Soft Computing

Code	Professional Elective-II Subjects
CEE921	Internet of Things
CEE922	ICT for Social Cause
CEE923	Machine Vision
CEE924	Machine Learning

Code	Institute Elective-I Subjects
ILE911	Project Management
ILE912	Management Information System
ILE913	Operation Research
ILE914	Cyber Security and Laws
ILE915	Entrepreneurship Development and Management

Code	Institute Elective-II Subjects Massive Open Online Course (MOOC)
ILE921	Department will suggest MOOC courses equivalent to 3 credits.

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Typical credit and load structure for PG (Computer Engineering) Program:

S.N.	**Course Domain**	**Credits/Semester**				Total Credits
		I	II	III	IV	
4	PC	14	14	-	-	28
5	PE	03	03	-	-	06
6	OE	03	03	-	-	06
7	PR	01	01	15	15	32
Total Credits		**21**	**21**	**15**	**15**	72

Semester	Units/Week			Total Units/ Week	Total Credits
	L	T	P		
I	18	-	06	24	21
II	17	-	08	25	21
III	-	-	30	30	15
IV	-	-	30	30	15

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SEMESTER I

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Scheme for M. Tech. Computer Engineering (SEM I to SEM IV)						
SEM I						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
CE911	Advanced Algorithm and Complexity	PC	4	-	-	4
CE912	Big Data Analytics and Management	PC	4	-	-	4
CE913	Information and System Security	PC	4	-	-	4
CEL911	PG Laboratory –I	PC	-	-	2	1
CEL912	PG Laboratory –II	PC	-	-	2	1
CEE91X	**Professional Elective-I**	PE	3	-	-	3
ILE91X	**Institute Elective-I**	OE	3	-	-	3
	Total		18	-	4	20

Code	Professional Elective-I Subjects
CEE91A	Modern Operating System
CEE91B	Image Analysis and Interpretation
CEE91C	Natural Language Processing
CEE91D	Advanced Soft Computing

Code	Institute Elective-I Subjects
ILE911	Project Management
ILE912	Management Information System
ILE913	Operation Research
ILE914	Cyber Security and Laws
ILE915	Entrepreneurship Development and Management

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CE911	Advanced Algorithms and Complexity(AAC)	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	1. Data Structures 2. Discrete Structures 3. Introduction to Algorithms 4. Programming Languages A strong understanding of programming and a solid background in discrete mathematics, including probability, are necessary prerequisites to this course.	
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Analyze worst-case running times of algorithms using asymptotic analysis
	CO2	Describe the divide-and-conquer paradigm and clarify when an algorithmic design situation calls for it.
	CO3	Describe the greedy paradigm and clarify when an algorithmic design situation calls for it
	CO4	Demonstrate a familiarity with applied algorithmic settings.
	CO5	Apply the concept of linear programming to optimize the solution
	CO6	Describe the idea of backtracking, branch and bound strategy to solve some problems.

Module No.	Unit No.	Topics	Ref.	Hrs.
Foundations	1.1	The role of Algorithms in computing, Analyzing algorithms, Designing Algorithms	1,2	10
	1.2	Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis	1,2	
Divide and Conquer Approach	1.3	Recurrences, The substitution method, The recursion-tree method, The master method, Randomized algorithms, Linear time sorting	1,2	
	1.4	Divide and Conquer Approach: Analysis of Merge sort, Analysis of Quick sort, Strassen, Fibonacci, Polynomial Multiplication	1,2	
Dynamic Programming	2.1	Assembly-line Scheduling, Matrix-chain multiplication, Elements of dynamic programming, Matrix-chain multiplication , Longest common subsequence	1,2	10
Greedy Algorithms	2.2	Elements of the greedy strategy, Huffman codes, Minimum Spanning Trees.	1	
Amortized Analysis	2.3	Aggregate analysis, The accounting method, Table Doubling, The potential method	1	

Graph Algorithms	3.1	Single-Source Shortest Paths-The Bellman-Ford algorithm, Dijkstra's algorithm, Difference constraints and shortest paths All-Pairs Shortest Paths-The Floyd-Warshall algorithm Maximum Flow-Flow networks, The Ford-Fulkerson method, Maximum bipartite matching, Red Black Tree	1,2	10
NP Completeness	3.2	NP-Completeness: NP-completeness and reducibility, NP-completeness proofs, NP-complete problems,	1,4	
Approximation Algorithms	4.1	Approximation algorithms: The vertex-cover problem, The traveling-salesman problem, The set covering problem, The subset-sum problem	1,2	6
Applied Algorithms	4.2	Number-Theoretic : Number Theoretic notion, Greatest common divisor, The Chinese remainder theorem, RSA String Matching Algorithms :The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm, Probabilistic Algorithm: Game Theoretic Techniques Randomized Algorithms: Monte Corlo and Las Vegas algorithm	1,3	8
Linear Programming	5.2	Standard and Slack Forms, Formulation, Simplex algorithm, Duality	1,2	8
Advance topic	5.3	Parallel Algorithms, Dynamics Multithreading, Greedy Scheduler, Multithreaded Algorithms, cache oblivious algorithm	1,2,3	
			Total	**52**

In-Semester Examination (ISE): The assessment includes the submission of a term paper by each student on the contemporary work related to Advanced Algorithms and Complexity.

References:

[1] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, India Second Edition

[2] Horowitz, Sahani and Rajsekaran, Fundamentals of Computer Algorithms", Galgotia

[3] Rajeev Motwani, PrabhakarRaghavan, " Randomized Algorithm", Cambridge University Press

[4] Aho, Hopcroft, Ullman: The Design and analysis of algorithms", Pearson Education 2. Vijay V. Vajirani, "Approximation Algorithms",Spring

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CE912	Big Data Analytics and Management(BDAM)	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	Core Java, awareness of RDBMS is desirable	
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the basic concepts of Big Data and Hadoop as processing platforms for Big Data
	CO2	Understand the need of Map Reduce and to develop Mapper, Reducer tasks
	CO3	To understand Text Analytics, Recommendation System and Clustering approaches
	CO4	Understand concept of data streams, Link Analysis, Social Mining Graphs and its real life applications
	CO5	Learn about the different options for importing or loading data into HDFS data sources such as relational databases, data warehouses, web server logs

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Big Data and Hadoop	2	10
	1.1	Hadoop Ecosystem, Hadoop Architecture(Name Node, Job Tracker, Task Tracker, Data Node, Secondary Name Node), JobTracker functionality , Namenode Backup(SNN)		
	1.2	Apache Hadoop and Hadoop Ecosystem, HDFS Storage,	2	
	1.3	Hadoop File System APIs, Anatomy of a File Read, Anatomy of a File Write, Rack Awareness		
2		Developing Map Reduce	1,2	12
	2.1	Distributed Computing Concept (Map and Reduce), Anatomy of a MapReduce Job Run(MR1), Running on a cluster, Packaging, Launching a Job, The MapReduce Web UI , Retrieving the Results 167, Debugging a Job 169	2	
	2.2	Map Reduce Algorithms, Matrix-Vector Multiplication, Map Reduce and Relational Operators, Matrix Multiplication of Large Matrices, Shuffle and Sort,	1	
	2.3	Hadoop Logs, Remote Debugging, Advanced Map Reduce Concepts, Combiner, Partitioner, Distributed Cache(Map Side Join), Reduce Side join	2	

3		Clustering Approaches, Text Analytics and Recommendation System	1	10
	3.1	CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries		4
	3.2	Introducing text mining, text mining techniques, Understanding Text Mining Process, Sentiment Analysis		3
	3.3	Introduction to RS, content based RS, collaborative RS, hybrid RS. Issues and challenges RS, examples of real word RS, e.g., Amazon, mobile RS, etc.		3
4	**4.1**	Mining Data Streams : Introduction, The Stream Data Model Sampling Data in a Stream : Obtaining a Representative Sample , The General Sampling Problem, Filtering Streams: The Bloom Filter, Analysis., Counting Distinct Elements in a Stream, Counting Ones in a Window:		5
	4.2	Link Analysis : PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank, Topic sensitive Page Rank, link Spam, Hubs and Authorities.		3
	4.3	Mining Social Nework Graphs : Mining Social-Network Graphs 11.1 Social Networks as Graphs, Clustering of Social-Network Graphs, SimRank		2
5		Managing Big Data	2, 3	10
	5.1	Moving Data into Hadoop • Load Scenarios 1. Understand how to load data at rest, in motion 2. Understand how to load data from common data sources e.g. RDBMS • Using Sqoop 1. Import data from a relational database table into HDFS 2. Use Sqoop import and export command		
	5.2	• Flume Overview 1. Describe Flume and its uses 2. How Flume works • Using Flume 1. List the Flume configuration components 2. Describe how to start and configure a Flume agent		
	5.3	• Introduction to Oozie Workflows 1. Explain the use for Oozie workflows 2. Describe a workflow 3. List some of the workflow elements • Oozie Coordinator 1. Explain the use for the Oozie coordinator 2. List some of the coordinator elements		

		3. Describe how to submit a workflow job and a coordinator job		
			Total	**52**

References:

[1] Jure Leskovec, Anand Rajaraman, Jeffrey Ullman, "Mining Massive Datasets", Cambridge University Press, 2nd Edition.

[2] Tom White, "Hadoop, the Definitive Guide", O'Reilly, Yahoo Press, 3rd Edition.

[3] Tanmay Deshpande, "Hadoop Real-World Solutions Cook Book", Packt Publishing, 2nd Edition.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CE913	Information and System Security(ISS)	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		CE43 CE52
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Provide the basic results of computer security and its limitations.
	CO2	Contrast the different types of security policies, standards and practices.
	CO3	Describe the major types of cryptographic algorithms and typical applications.
	CO4	Understand the role of management in enforcing security policies, standards and practices.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction** - Basic Components, Threats, Policy and Mechanism, Assumptions and Trust, Assurance, Operational and Human Issues, Access Control Matrix, Protection State, Access Control Matrix Model, Protection State Transitions, Copying, Owning, and the Attenuation of Privilege,	1,2	4
	1.2	**Foundation Results** - The General Question of Security, Take-Grant Protection Model, Expressive Power and the Models	1,2	4
	1.3	**Security Policies** - Types, The Role of Trust, Types of Access Control, Policy Languages.	1,2	2
2	2.1	**Confidentiality Policies** - Goals of Confidentiality Policies, The Bell-LaPadula Model, Tranquility, The Controversy over the Bell-LaPadula Model.	1,2	4
	2.2	**Integrity Policies** – Goals, Biba Integrity Model, Lipner's Integrity Matrix Model, Clark-Wilson Integrity Model	1,2	4
	2.3	**Hybrid Policies** - Chinese Wall Model, Clinical Information Systems Security Policy, Originator Controlled Access Control, Role-Based Access Control	1,2	4
3	3.1	**Noninterference and Policy Composition** - The Problem, Deterministic Noninterference, Non-deducibility, Generalized Noninterference, Restrictiveness.	1,2	5
	3.2	**Cryptography** - Classical Cryptosystems, Public Key Cryptography, Cryptographic Checksums.	1,2	2

	3.3	**Key Management** - Session and Interchange Keys, Key Exchange, Key Generation, Cryptographic Key Infrastructures, Storing and Revoking Keys, Digital Signatures	1,2	4
4	**4.1**	**Cipher Techniques** – Basics, Problems, Stream and Block Ciphers, Networks and Cryptography, Example Protocols	1,2	3
	4.2	**Authentication** - Basics, Passwords, Challenge-Response, Biometrics, Location, Multiple Methods	1,2	3
	4.3	**Security Systems** - Design Principles, **Identity** - Files and Objects, Users, Groups and Roles, Naming and Certificates, Identity on the Web.	1,2	3
5	**5.1**	**Access Control Mechanisms** - Access Control Lists, Capabilities, Locks and Keys, Ring-Based Access Control, Propagated Access Control Lists.	1,2	3
	5.2	**Information Flow** - Basics and Background, Non-lattice Information Flow Policies, Compiler-Based Mechanisms, Execution-Based Mechanisms, Example Information Flow Controls.	1,2	4
	5.3	**Confinement Problem** - The Confinement Problem, Isolation, Covert Channels, **Assurance** - Introduction to Assurance, Assurance and Trust, Building Secure and Trusted Systems.	1,2	3
			Total	**52**

In-Semester Examination (ISE): The assessment includes the submission of a term paper by each student on the contemporary work related to Information and System Security.

References:

[1] Matt Bishop, "*Computer Security: Art and Science*", Addison-Wesley Professional, FIRST Edition, 2002.

[2] Matt Bishop, "*Introduction to Computer Security*", Addison-Wesley Professional, FIRST Edition, 2005.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEL911	PG Laboratory –I (Advanced Algorithm and Complexity Laboratory)	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		-		20		60

Pre-requisite Course Codes	Data Structures, Analysis of Algorithms, Programming Languages, CE911(Advanced Algorithm and Complexity)	
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Analyze the complexities of various problems in different domains.
	CO2	Prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains.
	CO3	Ability to apply and implement learned algorithm design techniques and data structures to solve problems.
	CO4	Ability to implement different operations of red-black trees and binomial heaps.
	CO5	To demonstrate dynamic programming algorithms.
	CO6	Ability to implement Graph algorithms in solving variety of problems.

Exp. No.	Experiment Details	Ref.	Marks
1	Sorting of 2 lacs element using various sorting methods by applying files operation	1,3	10
2	Implementation of Red-Black trees and its various operations.	1,2	05
3	Implementation of Dynamic programing: matrix chain multiplication Cutting rod example	1	05
4	Implementation of Binomial Heaps and its various operations	1,3	05
5	Implementation of Bellman ford , Johnson's algorithm for sparse graphs	1	05
6	Implementation of Ford Fulkerson algorithm , push -relabel to front methods	1,2	05
7	Implementation of Simplex algorithm	1	05
	Total Marks		**40**

References:

[1] T.H.Coremen , C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd edition, PHI publication 2005.

[2] John Kleinberg, Eva Tardos, "Algorithm Design", Pearson

[3] Ellis Horowitz, Sartaj Sahni , S. Rajsekaran. "Fundamentals of computer algorithms" University press.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEL912	PG Laboratory –II (Big Data Analytics and Managements Laboratory)	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		-		20		60

Pre-requisite Course Codes		Data Structures, Analysis of Algorithms, CE912(Big Data Analytics and Managements)
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Describe big data and use cases from selected business domains
	CO2	Install, configure, and run Hadoop and HDFS
	CO3	Perform map-reduce analytics using Hadoop
	CO4	Clarify NoSQL big data management
	CO5	Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data Analytics

Exp. No.	Experiment Details	Ref.	Marks
1	**HDFS**: Start by reviewing HDFS. You will find that its composition is similar to your local Linux file system. You will use the hadoop fs command when interacting with HDFS. 1. Review the commands available for the Hadoop Distributed File System 2. Copy file foo.txt from local disk to the user's directory in HDFS 3. Get a directory listing of the user's home directory in HDFS 4. Get a directory listing of the HDFS root directory 5. Display the contents of the HDFS file user/fred/bar.txt 6. Move that file to the local disk, named as baz.txt 7. Create a directory called input under the user's home directory 8. Delete the directory input old and all its contents 9. Verify the copy by listing the directory contents in HDFS	1,2	**10**
2	**MapReduce** 1. Create a JOB and submit to cluster 2. Track the job information 3. Terminate the job 4. Counters in MR Jobs with example 5. Map only Jobs and generic map examples 6. Distributed cache example 7. Combiners, Secondary sorting and Job chain examples	1,2,3	**10**
3	**MapReduce (Programs)** Using movie lens data	1,2,3	**10**

	1. List all the movies and the number of ratings 2. List all the users and the number of ratings they have done for a movie 3. List all the Movie IDs which have been rated (Movie Id with at least one user rating it) 4. List all the Users who have rated the movies (Users who have rated at least one movie) 5. List of all the User with the max, min, average ratings they have given against any movie 6. List all the Movies with the max, min, average ratings given by any user		
4	**Extract facts using Hive OR Extract sessions using Pig** Hive allows for the manipulation of data in HDFS using a variant of SQL. This makes it excellent for transforming and consolidating data for load into a relational database. In this exercise you will use HiveQL to filter and aggregate click data to build facts about user's movie preferences. The query results will be saved in a staging table used to populate the Oracle Database.	4,3	**10**
		Total Marks	**40**

References:

[1] Tom White, "Hadoop: The Definitive Guide", Third Edition, O' Reilley, 2012.

[2] Eric Sammer, "Hadoop Operations", O'Reilley, 2012.

[3] Vignesh Prajapati, Big data analytics with R and Hadoop, SPD 2013.

[4] E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.

[5] Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.

[6] Alan Gates, "Programming Pig", O'Reilley, 2011.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE91A	Modern Operating System(MOS)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Apply the principles and concepts in analyzing and designing Advance Operating System.
	CO2	Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system
	CO3	Analyze the performance and reliability of different Advanced Operating Systems.
	CO4	Solve the problems in real time task scheduling and mobile operating systems
	CO5	Apply the concepts on database operating systems in real life applications
	CO6	Compare mobile device architectures

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction:** Types of Advanced Operating Systems.	1	04
	1.2	Architectures and design issues of Network operating system, DOS, Middleware, RTS, DBOS		
	1.3	Introduction to process, Concurrent processes, Critical Section problems, other synchronization problems.		
2	2.1	**Distributed operating Systems, Scheduling and synchronization:** Scheduling: Issues in load distributing, Components of load distributing algorithms, Stability, Load distributing algorithms, Performance Comparison, Selecting a suitable load sharing Algorithm.	1,5,6	12
	2.2	**Synchronization:** Physical and logical clocks. Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms, Mutual Exclusion Algorithms. Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.		
3	3.1	**Real Time Systems**: Basic Model of Real time systems , Characteristics, Applications of Real time systems, Real time task	1,2,8	16

		scheduling, Types of tasks and their characteristics, Task Scheduling, Clock driven Scheduling , Hybrid Schedulers, Event driven Scheduling, EDF Scheduling, Rate Monotonic Algorithm, handling resource sharing Resource Handling: Resource Sharing, Priority Inversion, PIP,PCP,HLP, Scheduling real time tasks in distributed systems		
	3.2	**Mobile operating systems:** Micro kernel design, client server resource access, Processes and threads, Memory management, File systems.		
4	**4.1**	**Database Operating systems:** Concurrency control : Database systems, Concurrency control model of database systems , Problem of Concurrency Control, serializability theory, Distributed Database Systems	1,6	6
	4.2	**Concurrency Control Algorithms :** Basic synchronization Algorithms, Lock based, Timestamp based and Optimistic Algorithms, Concurrency Control Algorithms : Data Replication		
5	**5.1**	**CASE STUDIES:** Linux system: Design Principles , Kernel modules , Process management scheduling , memory management , I/O management , file systems , inter process communication	3,5	4
	5.2	IOS and Android: Architecture and SDK frame work , Media layer , Services layer , core os layer , file Systems		
			Total	**42**

References:

[1] Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems" .MC Graw Hill education.

[2] Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson education.

[3] Neil Smyth, "IPhone IOS 4 Development Essentials – Xcode", Fourth edition, Payload media, 2011

[4] Daniel P Bovet and Marco Cesatl, "Understanding the Linux kernel",3rd edition, O'Reilly,2005

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[6] Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.

[7] Andrew S.Tanenbaum, "Distributed Operating System", Pearson Education.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE91B	Image Analysis and Interpretation (IAI)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		Digital Image Processing
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the importance of Image Analysis and Interpretation.
	CO2	Analyze various techniques of Image Analysis
	CO3	Analyze various transforms.
	CO4	Use the methods of image analysis and interpretation for various Image Processing applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Image processing System**		04
	1.1	What is Digital Image Processing? Image types.	1	02
	1.2	Examples of Fields that Use Digital Image Processing.		01
	1.3	Light and the electromagnetic spectrum, Image digitization		01
2		**Image Enhancement in Spatial domain**		08
	2.1	Gray level transformations: Point Processing	1,2,3	03
	2.2	Histogram Equalization		02
	2.3	Neighborhood Processing, Spatial Filtering, Smoothing and Sharpening Filters, Median Filter.		03
3		**Image Analysis**		08
	3.1	Data Structure for Image Analysis: Levels of image data representation, Traditional image data structures, Hierarchical data structures	1,2,3,4,5,7	03
	3.2	Image Segmentation :Thresholding , Edge based Segmentation		03
	3.3	Region Based Segmentation,		02
4		**Discrete Image Transform**		09
	4.1	Need for transform, Introduction to Unitary and Orthogonal Transform,	2,3,4	02
	4.2	Discrete Cosine Transform, Singular Value Decomposition, K-L transform, Wavelet Transform.		04
	4.3	The Kronecker Product ,Hadamard Transform, Fast Hadamard Transform, Walsh Transform, Haar Transform		03
5		**Image Feature Extraction**		09

	5.1	Spatial Feature Extraction, Transform Feature Extraction	**1,2,4,7**	03
	5.2	Geometry features, Moment based features,		04
	5.3	Texture based features.		02
6		**Applications and Case Study**		**04**
	6.1	Remote Sensing	**1,2,6**	02
	6.2	Medical Imaging		02
			Total	**42**

References:

[1] Rafael C. Gonzalez and Richard E.Woods,Pearson "*Digital Image Processing* " Prentice Hall, 2nd Edition,

[2] Anil K. Jain, "*Fundamentals of Digital Image Processing*", PHI

[3] S Jayaraman, S Esakkirajan, and T Veerakumar "*Digital Image Processing* ", Tata McGraw-HillEducation Private Limited

[4] Milan Sonka, Vaclav Hlavac and Roger Boyle," *Image Processing, Analysis, and Machine Vision* ", Thomson, 2nd Edition.

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[6] Robert A. Schowengerdt, "*REMOTE SENSING, Models and Methods for Image Processing",* ELSEVIER, 3rd Edition.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE91C	Natural Language Processing(NLP)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		Programming Methodology & Data Structure Probability & Statistics Theory of Computer Science
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	To model linguistic phenomena with formal grammars.
	CO2	To design, implement, and analyze NLP algorithms.
	CO3	Apply NLP techniques to design real world NLP applications.
	CO4	Implement proper experimental methodology for training and evaluating empirical NLP systems.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction	1,4	3
	1.1	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing ,		
	1.2	Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP- Machine translation,		
	1.3	question answering system, Information retrieval, Text categorization , text summarization & Sentiment Analysis		
2		Word Level Analysis	1,3,4	7
	2.1	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology;		
	2.2	Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST ,		
	2.3	Lexicon free FST - Porter stemmer. N –Grams- N-gram language model, Ngram for spelling correction.		
3		Syntax analysis	1,3	8
	3.1	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging,		
	3.2	Stochastic POS tagging, Issues –Multiple tags & words, Unknown words, class based n –grams.		
	3.3	Context Free Grammar – Constituency , Context free rules & trees, Sentence level construction , Noun Phrase, coordination,		

		agreement, the verb phrase & sub categorization		
4		Semantic Analysis		8
	4.1	Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases,	1,2,3	
	4.2	Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Wordnet,		
	4.3	Selectional restriction based disambiguation & limitations , Robust WSD – machine learning approach and dictionary based approach		
5		Pragmatics	1,2,3	8
	5.1	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference,		
	5.2	preferences in pronoun interpretation , algorithm for pronoun resolution .Text coherence, discourse structure		
6		Applications (preferably for Indian regional languages)	1,2,3,4,5	8
	6.1	Machine translation, Information retrieval.		
	6.2	Question answers system, categorization, summarization, sentiment analysis		
			Total	**42**

References:

[1] Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.

[2] Christopher D.Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing ", MIT Press, 1999.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE91D	Advanced Soft Computing(ASC)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		Fundamental of AI and Soft Computing
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Identify the various characteristics of soft computing techniques.
	CO2	Apply & design fuzzy controller system.
	CO3	Apply the supervised and unsupervised learning algorithm for real world applications.
	CO4	Solve the problem using associative memory networks
	CO5	Design hybrid system applications

Module No.	Unit No.	Topics	Ref.	Hrs.
		Introduction		
1	1.1	Differentiate Hard and Soft Computing	1,5	2
	1.2	Soft Computing Constituents		
	1.3	Neuro Fuzzy and Soft Computing Characteristics		
2		**Fuzzy Logic & Rough Set Theory**		
	2.1	Fuzzy Relations and Fuzzy Rules, Generalized Modens Ponens, Defuzzification and its Types	1,2,5,7	10
	2.2	Fuzzy Inference Systems, Design of Fuzzy Controller, Introduction to Rough Sets		
3		**Supervised and Unsupervised Network**		
	3.1	Supervised Network : Error Back Propagation Training Algorithm, Radial Basis Function	1,2,3,8,9	12
	3.2	Unsupervised Network: Kohenon Self Organizing Maps, Basic Learning Vector Quantization, Basic Adaptive Resonance Theory		
4		**Associative Memory Network**		
	4.1	Introduction, Hebb Rule, Outer Product Rule	4	10
	4.2	Types of associative Memory Network :Auto associative and Hetero associative memory networks,		
	4.3	BAM network, Hopfield Network		

5		**Hybrid Systems**		
	5.1	Fuzzy-Neural Systems, Neuro-Genetic Systems, Fuzzy-Genetic Systems	2,9	4
6		**Applications and Case Study**		
	6.1	Automobile Fuel Efficiency using ANFIS	1	4
	6.2	Color Receipe prediction using CANFIS		
			Total	**42**

References:

[1] J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.

[2] S. Rajasekaran and G.A.Vijaylakshmi Pai.. Neural Networks Fuzzy Logic, and GeneticAlgorithms, Prentice Hall of India.

[3] Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.

[4] S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ILE911	Project Management	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Manage the selection and initiation of individual projects in the enterprise.
	CO2	Conduct project planning activities that accurately forecast project costs, timelines, and quality.
	CO3	Implement processes for successful resource, communication, and risk and change management
	CO4	Demonstrate effective project execution and control techniques that result in successful projects
	CO5	Conduct project closure activities and obtain formal project acceptance
	CO6	Demonstrate Team work and team spirit and how to overcome the conflicts

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Project Life cycle	1	8
	1.2	Project selection criteria, Risk considerations in selection	1	
	1.3	Project bid, RFP	1	
	1.4	Managing conflicts and the Art of negotiation	1, 3	
2	2.1	Project plan –WBS	1, 2	8
	2.2	Project activity and risk planning	1, 2	
	2.3	RACI Matrix and Agile projects	1	
	2.4	Budgeting , Estimating cost and Risk	1	
3	3.1	Scheduling- Network Diagrams	1, 2	10
	3.2	CPM- crashing a project	1, 2	
	3.3	Resource loading and leveling	1, 2	
	3.4	Constrained resource scheduling	1, 2	
4	4.1	Monitoring and controlling cycle	1, 3	10
	4.2	Earned value analysis	1, 3	
	4.3	Control of Change and scope creep	1, 3	
5	5.1	Project procurement management, outsourcing	3	6
	5.2	Project Auditing	1	
	5.3	Project termination process	1	
			Total	42

References:

[1] Jack Meredith and S. J. Mantel, "*Project Management*", Wiley, 8th Edition.

[2] John M. Nicholas, "*Project Management-Business and Technology* ", PHI, 2nd edition

[3] Jack T. Marchewka,"*Information Technology Project Management", Wiley*, 4th Edition.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ILE912	Management Information System(MIS)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Identify key factors of the business problem. Clearly define a business problem using key facts
	CO2	Critically analyze defined business problem using widely used analytical techniques and models
	CO3	Propose potential alternative solution, evaluate them and recommend an appropriate solution
	CO4	Identify Information Requirements from external Systems in order to integrate different aspects of business
	CO5	Apply MIS concepts in e-Business.
	CO6	Explain ethical, social and security issues in MIS

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction: Level of management activities, Types of MIS	1	6
	1.2	Role of MIS in global business	1,4	
	1.3	Strategic information System, Porter's value-chain Model	1	
2	2.1	Information system planning: Creating an IS plan	2	8
	2.2	IS growth model-Nolan six stage model,	2	
	2.3	Three stages of planning process	2	
3	3.1	Decision Support System: Simon's model of Decision Making	1,2	8
	3.2	Methods for Decision Making, Decision support techniques	1,2	
	3.3	Components of DSS, BI and Knowledge management system	1	
4	4.1	Enterprise systems: Enterprise Resource Planning (ERP) systems	5	8
	4.2	Customer Relationship Management (CRM)	5	
	4.3	Supply Chain Management System (SCM)	5	
5	5.1	E-Business Systems	3	8
	5.2	E-commerce: Digital Markets, Digital Goods	6,4	
	5.3	E-Governance- objectives and delivery models	1	
6	6.1	Ethical and Social Issues in Information Systems	4	4
	6.2	Securing Information Systems	4	
			Total	42

References:

[1] D.P. Goyal, "Management Information Systems- Managerial Perspectives", Vikas publishing House, 4th Edition

[2] Gordon B Davis & Margethe H Olson "Management Information Systems", TMH

[3] James O'Brien, George M. Marakas, Ramesh Behl, "Management Information Systems", McGraw Hill Education, 10th Edition, , 2013.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ILE913	Operations Research(OR)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course	Linear Algebra Analysis of Algorithms	
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Translate real world problems into mathematical formulation
	CO2	Solve problems based on linear programming, Transportation model and Integer programming
	CO3	Design a dynamic system as a queuing model and compute important performance measures
	CO4	Solve problems using dynamic programming
	CO5	Solve network models like the shortest path, minimum spanning tree, and maximum flow problems
	CO6	Develop the mathematical formulation of real world problems using Game theory

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Operations Research :** Introduction to OR Modeling Approach and various real life situations **Linear Programming:** Introduction to linear programming, Formulation of the problem, Graphical method, Simplex method, Duality and Sensitivity analysis **Transportation Model:** Definition of the transportation model, non-traditional transportation models, Transportation algorithm, Assignment model **Integer Programming** Formulations, Zero-one problem-additive algorithm, Gomary's cutting plane algorithm, Branch and bound algorithm for IP	1,2,5,8	14
2		**Dynamic Programming:** Introduction, recursive nature of computations in Dynamic programming, forward and backward recursion, Dynamic programming applications	1,7	6

3		**Network Models:** Minimum spamming trees, Shortest path problems, Maximum flow problems, Minimum cost flow problem, CPM and PERT	1,5,6,8	6
4		**Queuing model:** Introduction, Basic Definitions and Notations, Axiomatic Derivation of the arrival and Departure (Poisson Queue), Pure Birth and Death Models, Poison Queue Models	1,2,6	6
5		**Non linear Programming:** Gradient Method, Kuhn Tucker conditions, Quadratic Programming, Convex programming	1,3,7	5
6		**Game Theory:** Introduction, Two Person zero sum Game, Saddle Point, Mini-Max and Maxi-mini Theorems, Games without saddle point, Graphical Method, Principle of Dominance.	3,5,7	5
			Total	**42**

References:

[1] Hamdy A. Taha, "Operations Research: An Introduction", Prentice-Hall of India, 6th Edition.

[2] F.S. Hiller, G. J. Lieberman, "*Introduction to Operations Research,*", McGraw Hill, 8th Edition.

[3] Kanti Swarup, P. K. Gupta, Man Mohan " *Operations Research,*", S. Chand & Sons, 14th Edition.

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[7] J. K. Sharma, "*Operations Research Theory and Applications*", MacMillan, 2nd Edition

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ILE914	Cyber Security and Laws	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE	Total	
		20		20		60	100	

Pre-requisite Course Codes		Communication Networks
After successful completion of the course students will able to:		
Course Outcomes	CO1	Identify and classify various cybercrimes with respect to organizational weaknesses in order to mitigate the security risk and estimate the impact on society and world
	CO2	Interpret and apply Indian IT laws in various legal issues
	CO3	Compute security risk and analyze it
	CO4	Analyze the results of vulnerability scans of vulnerability assessment and generate report with penetration testing
	CO5	Apply Information Security Standards compliance during software design and development

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Cyber Security**	1,2	10
		Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	1	
		Cyber offenses & Cybercrimes: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices	1,7	
2		**Tools and Methods Used in Cybercrime:** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks,Identity Theft (ID Theft)	1,2	06
3		**Security Risk Assessment and Risk Analysis:** Risk Terminology, Laws, Mandates, and Regulations,Risk Assessment Best Practices,The Goals and Objectives of a Risk Assessment, Best Practices for Quantitative and Qualitative Risk Assessment. **Vulnerability Assessment and Penetration Testing (VAPT):**	7,8,10	12

		VAPT An Overview,Goals and Objectives of a Risk and Vulnerability Assessment,Vulnerability Assessment Phases-Discovery,Exploitation/Analysis , Reporting Penetration Testing Phases-Discover/Map,Penetrate Perimeter,Attack Resources, Network and Web VAPT Process		
4		**Cyber Security Laws and Legal Perspectives:** The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	1,4	08
5		**Indian IT Act:** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments **Information Security Standard compliances:** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI-DSS	1,2,4, 6	04
			Total	**40**

References:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi.
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
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4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
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7.Michael Gregg & David Kim,Inside Network Security Assessment: Guarding Your IT Infrastructure, Pearson Publication
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10. Douglas J. Landoll, The Security Risk,Assessment Handbook-Second Edition ,Auerbach Publications
11. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
12. Website for more information , A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ILE915	Entrepreneurship Development and Management(EDM)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the concept of entrepreneurship with strategic planning
	CO2	Analyze the international market for entrepreneurship
	CO3	Study of e- governance in Entrepreneurship
	CO4	Acquaint with entrepreneurship and management of business with IT
	CO5	Understand data science for Entrepreneurship and generate knowledge base of technology entrepreneurship

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Entrepreneurship**	1	6
	1.1	Importance Of Entrepreneurship, concept of Entrepreneurship, characteristics of successful Entrepreneur, classification of Entrepreneur		
	1.2	Myths of Entrepreneurship, Entrepreneurial development models, problems faced by Entrepreneurs and capacity building for Entrepreneurship, profile of successful Entrepreneurship		
2		**Setting up a small business enterprise**	1	6
	2.1	Identifying the business opportunity, Business opportunities in various sector		
	2.2	Formalities for setting up of a small business enterprise, Environment pollution related clearance		
3		**Strategic management in small business**	1	6
	3.1	Organic life cycle		
	3.2	Strategic management, The essence of business ethics		
4		**Corporate governance**	2	6
	4.1	Introduction, role for board of directors, size and composition of board of directors, board structure, agency theory, board committee, two tier boards, effectiveness of BoD role of CEO role top management skill required corporate values style of strategic management		

	4.2	Factors affecting Entrepreneurship growth, Factors affecting Entrepreneurship: economic factors, non-economic factors, Government action	3	
5		**Selecting international business opportunities**	7	6
	5.1	Foreign in market selection model, Developing foreign market indicators, Primary Vs secondary foreign market data		
	5.4	Sources of country market data, Competitive positioning International competitive information		
6		**IT for entrepreneurship innovation**		6
	6.1	Enlisting online communication in web 2.0	4	
	6.2	Role of websites and E-commerce in the development of global start-ups, E- entrepreneurship the principle of funding electronics venture, The relationship between internet entrepreneurs idea generation and porter's generic strategies e- learning the cornerstone to transferring entrepreneurship knowledge	5	
7		**The knowledge base of technology entrepreneurship**	6	6
	7.1	Capitalization of science and technology knowledge practices trends and impact on techno entrepreneurship		
	7.2	Drivers for green strategy for enhancing sustainable techno entrepreneurship in emerging economics		
			Total	**42**

References:

[1] Poornima Charantimath, "*Entrepreneurship development and Small Business Enterprise",* Pearson
[2] R. Srinivasan "*Strategic Management: The Indian Context*"
[3] S S Khanka "*Entrepreneurial Development*"
[4] Tobias Kollmann, Andreas Kuckertz "*E-entrepreneurship and ICT Ventures: Strategy… (Hardcover*)"
[5] Zhao, Fang "*Information Technology Entrepreneurship and Innovation*"
[6] François Thérin "*Handbook of Research on Techno-Entrepreneurship*", Second Edition
[7] Robert D. (Dale) Hisrich "*International Entrepreneurship: Starting, Dev*" (Paperback)
[8] Robert D Hisrich, Michael P Peters, A Shapherd, "*Entrepreneurship*", latest edition, The McGrawHill Company
[9]Vasant Desai, "*Entrepreneurial development and management*", Himalaya Publishing House

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SEMESTER II

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Scheme for M. Tech. Computer Engineering (SEM I to SEM IV)						
SEM II						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
CE921	Network Analysis and Design	PC	4	-	-	4
CE922	High Performance Computing	PC	4	-	-	4
CE923	User Experience Design	PC	3	-	-	3
CEL921	PG Laboratory –III	PC	-	-	2	1
CEL922	PG Laboratory –IV	PC	-	-	2	1
CEL923	PG Laboratory –V	PC	-	-	2	1
CES921	Seminar -I	PR	-	-	2	1
CEE92X	**Professional Elective-II**	PE	3	-	-	3
ILE92X	**Institute Elective-II**	OE	3	-	-	3
	Total		17	-	8	21

Code	Professional Elective-II Subjects
CEE92A	Internet of Things
CEE92B	ICT for Social Cause
CEE92C	Machine Vision
CEE92D	Machine Learning

Code	Institute Elective-II Subjects Massive Open Online Course (MOOC)
ILE921	Department will suggest MOOC courses equivalent to 3 credits.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CE921	Network Analysis and Design (NDA)	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	Computer Networks	
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the theoretical issues in protocol design and apply it to Quality of service in networks
	CO2	Understand issues in the design of network processors and apply them to design network systems
	CO3	Simulate working of wired and wireless networks to understand networking concepts
	CO4	Develop solutions by applying knowledge of mathematics, probability, and statistics to network design problems.
	CO5	Understand the basics of software defined networking and explore research problems in that area.

Module No.	Unit No.	Topics	Ref.	Hrs.
Internetworking	1.1	Congestion control and Resource allocation: Issues of Resource Allocation, Queuing Disciplines: FIFO, Fair Queuing, TCP Congestion Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.	1,2	05
	1.2	Congestion-Avoidance Mechanisms: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF)	1.2	05
Routing	2.1	IPv4 Routing Principles, Routing Information Protocol (RIP), IGRP and EIGRP, OSPF for IPv4 and IPv6, Border Gateway Protocol (BGP), EIGRP, High Availability Routing	2.3	08
IPv6	3.1	IPv4 deficiencies, patching work done with IPv4, IPv6 addressing, multicast, Anycast, ICMPv6, Neighbour Discovery, Routing, Resource Reservation, IPv6 protocols		08
Network Design	4.1	Designing the network topology and solutions-Top down Approach: PPDIOO – Network Design Layers - Access Layer, Distribution Layer, Core/Backbone Layer, Access Layer Design,	1,2	14

		Backbone Network Design, Enterprise LAN Design: Ethernet Design Rules and Campus Design best practices, Virtualization and Data Center Design, Wireless LAN Design, WAN Design: Traditional WAN Technologies, VPN Design.		
Ad Hoc Wireless Networks	**5.1**	MAC Protocols for Ad Hoc Wireless Networks: MACA/W, MACA-BI, DPRMA, MACA/PR. Routing Protocols for Ad Hoc Wireless Networks: DSDV, DSR, AODV, ZRP. Transport Layer: ATCP.	4,5	08
Software Defined Networking and OpenFlow	**5.2**	Introduction to Software Defined Networking, Control and Data Planes, SDN Controllers, Introduction to Openflow Protocol, Network Function Virtualization-Concepts.	5,6	04
			Total	**52**

In-Semester Examination (ISE): The assessment includes the submission of a term paper by each student on the contemporary work related to Network Analysis and Design.

References:

[1] Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Elsevier, Fourth Edition.

[2] Philip M. Miller, TCP / IP: The Ultimate Protocol Guide Applications, Access and Data Security - Vol 2, Wiley.

[3] Pete Loshin, IPv6: Theory, Protocols and Practice, Morgan Kaufmann, 2nd Edition, 2004.

[4] C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architectures and, Prentice Hall, 2004.

[5] Thomas D NAdeau and Ken Grey, Software Defined Networking, O'Reilly, 2013.

William Stallings, High-Speed Networks and Internets, Pearson Education, 2nd Edition, 2002.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CE922	High Performance Computing (HPC)	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE	Total	
		20		20		60	100	

Pre-requisite Course Codes		CE44, CE45, CE62
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the different parallel computing approaches and platforms to achieve High Performance Computing.
	CO2	Determine the communication pattern and network technology for High Performance Computing
	CO3	Design High Performance Computing System using MPI and OpenMP.
	CO4	Perform heterogeneous Computing using GPGPU and OpenCL.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Parallel Computing Models –** Computing History, Multiprocessor and Multicomputer, Multi-vector and SIMD Computers, PRAM and VLSI Models, Architectural Developmental Tracks	1	3
	1.2	**Program and Network Properties** – Conditions and Parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architectures	1	3
	1.3	**Principle of Scalable Performance** – Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches	1	3
2	2.1	**Communication Operations -** One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations	2	3
	2.2	**High Speed Networks** – Evolution, Design Issues, Fast Ethernet, High Performance Parallel Interface (HiPPI), Asynchronous Transfer Mode (ATM), Scalable Coherent Interface (SCI), ServerNet, Myrinet, Memory Channel, Synfinity	3	5
	2.3	**Lightweight Messaging Systems** - Latency/Bandwidth Evaluation, Traditional Communication Mechanisms, Lightweight Communication Mechanisms, Kernel-Level Lightweight	3	4

		Communications, User-Level Lightweight Communications		
3	**3.1**	**Active Messages (AM)** - AM Programming Model, AM Implementation, Analysis, Programming Models on AM	3	3
	3.2	**Analytical Modeling** - Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs, Other Scalability Metrics	2	4
	3.3	**Parallel Programming Design** – Preliminaries Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, The Task/Chanel Model, Foster's Design Methodology.	2,4	5
4	**4.1**	**Message-Passing Interface (MPI)** – Model, Interfaces, Functions, Circuit Satisfiability Problem	4	4
	4.2	**MPI Examples** - Sieve Eratosthenes, Flyod's Algorithm, Performance Analysis, Matrix-Vector Multiplication, Document Classification	4	3
	4.3	**Shared-Memory Programming & OpenMP –** Model, Loops, critical sections, Reductions, Data and Functional parallelism, Conjugate and Jacobi Method.	4	3
5	**5.1**	**Introduction to OpenCL** – Execution Environment, Memory Model, Writing Kernel, OpenCL Device Architectures,	5	3
	5.2	**OpenCL Concurrency –** Concurrency and Execution Model, Synchronization,	5	3
	5.3	**CPU/GPU OpenCL Implementation** – OpenCL on an AMD Phenom II X6 and Radeon HD6970 GPU	5	3
Total				**52**

In-Semester Examination (ISE): The assessment includes the submission of a term paper by each student on the contemporary work related to High Performance Computing.

References:

[1] Kai Hwang, Naresh Jotwani, "*Advanced Computer Architecture: Parallelism, Scalability, Programmability*", Mcgraw-Hill Education, SECOND Edition, 2008.

[2] Ananth Grama, "*Introduction to Parallel Computing*", Addison Wesley, SECOND Edition, 2003.

[3] Rajkumar Buyya, "*High Performance Cluster Computing: Architectures and Systems Volume 1*", Prentice Hall PTR, FIRST Edition, 1993.

[4] Michael J. Quinn, "*Parallel Programming in C with MPI and OpenMP*", McGraw HIll, FIRST Edition, 2003

[5] Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, Dana Schaa, "*Heterogeneous Computing with OpenCL*", Morgan Kaufmann, FIRST Edition, 2011

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CE923	User Experience Design(UXD)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE	Total	
		20		20		60	100	

Pre-requisite Course Codes		Mobile and Web Technologies Software Engineering
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Differentiate between UI and UX.
	CO2	Design life cycle template to enhance User Experience design
	CO3	Analyze UX design process for users
	CO4	Apply design thinking to model the prototype
	CO5	Evaluate and analyze user experiences using different UX evaluation techniques
	CO6	Analyze UX design guidelines to build innovative and user friendly application

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to UI and UX design**	1,5,6,7	4
	1.1	History of User interface designing, User interface Design Goals		
	1.2	What is UX, Ubiquitous interaction, Emerging desire for usability, From usability to user experience		
	1.3	Emotional impact as part of the user experience, User experience needs a business case, Roots of usability.		
2		**The Wheel : The UX design lifecycle Template**	1	6
	2.1	Introduction, A UX process lifecycle template, Choosing a process instance for your project, The system complexity space		
	2.2	Meet the user interface team, Scope of UX presence within the team, More about UX lifecycles.		
3		**The UX design Process:** **Contextual Inquiry: Eliciting Work Activity Data**	1,2,3	10
	3.1	Introduction, The system concept statement, User work activity gathering, Look for emotional aspects of work practice, Abridged contextual inquiry process, Data-driven vs. model-driven inquiry		
	3.2	Contextual Analysis, Extracting Interaction Design Requirements, Constructing Design-Information Models.		

4		**The UX design Process:** Information Architecture, Interaction design and prototyping		**10**
	4.1	**Design Thinking, Ideation, and Sketching:** Introduction, Design paradigms, Design thinking, Design perspectives, User personas, Ideation, Sketching, More about phenomenology	**1,3**	
	4.2	**Mental Models and Conceptual Design:** Mental Models, Conceptual design, Storyboards, designing influencing user behavior, design for embodied interaction.		
	4.3	**Wireframes and Prototyping:** wireframes, depth and breadth of a prototype, Fidelity of prototypes, interactivity of prototypes, software tools in prototypes.		
5		**UX Evaluation , Analysis and Reporting**		**10**
	5.1	**UX goals, metrics and targets:** UX goals, UX target tables, UX metrics.	**1,2**	
	5.2	**UX Evaluation Techniques:** Formative Vs Summative evaluation and its types, types of evaluation data, some data collection techniques, variations in formative evaluation results.		
	5.3	**Analysis and Reporting:** Quantitative and qualitative data analysis and reporting.		
6		**UX Design guidelines**		**2**
	6.1	UX design guidelines and examples.	**1**	
Total				**42**

References:

[1] Rex Hartson and Pardha Pyla, The UX Book, MK publications.
[2] Jesmond Allen and James Chudley , Smashing UX Design ,John Wiley and sons
[3] steve krug, Don't make me think
[4] Russ Unger and Carolyn Chandler ,A Project Guide to UX Design, Peachpit Press
[5] Jesse James Garrett, The Elements of User Experience, AIGA, New Riders
[6] Donald A. Norman, "The design of everyday things", Basic books.
[7] Wilbert Galitz, The Essential Guide to User Interface Design, Second Edition, Wiley Publications

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEL921	PG Laboratory –III (Network Analysis and Design Laboratory)	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		-		20		60

Pre-requisite Course Codes		Computer Networks, CE921(Network Analysis and Design)
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Classify network services, protocols and architectures, explain why they are layered.
	CO2	Choose key Internet applications and their protocols, and apply to develop their own applications using the sockets API.
	CO3	Clarify develop effective communication mechanisms using techniques like connection establishment, queuing theory, recovery Etc.
	CO4	Clarify various congestion control techniques.

Exp. No.	Experiment Details	Ref.	Marks
1	**PART A:** Implement the following using C/C++: 1. Write a program to transfer the contents of a requested file from server to the client using TCP/IP Sockets (using TCP/IP Socket programming). 2. Write a program to archive Traffic management at Flow level by implementing Closed Loop Control technique. (Leaky Bucket Algorithm) 3. Write a program to implement dynamic routing strategy in finding optimal path for data transmission. (Bellman ford algorithm). 4. Write a program to implement Link State Routing (Dijkstra Algorithm). 5. Write a program for implementing the error detection technique while data transfer in unreliable network code using CRC (16-bits) Technique. 6. Write a program for providing security for transfer of data in the network. (RSA Algorithm) 7. Write a program for encrypting 64 bit playing text using DES algorithm.	1,2	**20**

2	**PART B:** Simulation Programs using OPNET /NS2 or any other equivalent software 1. Simulate a 3 node point to point network with duplex links between them. Set the Queue size and vary the bandwidth and find the number of packets dropped. 2. Simulate a four-node point-to-point network, and connect the links as follows: n0->n2, n1->n2 and n2->n3. Apply TCP agent changing the parameters and determine the number of packets sent/received by TCP/UDP 3. Simulate the different types of internet traffic such as FTP and TELNET over network and analyze the throughput.	1,2,3	**20**
		Total Marks	**40**

References:

[1] **Douglas E Comer, "**Internetworking with TCP/IP, Principles, Protocols and Architecture" 6th Edition, PHI - 2014

[2] **Uyless Black** "Computer Networks, Protocols , Standards and Interfaces" 2nd Edition - PHI

[3] **Behrouz A Forouzan** "TCP/IP Protocol Suite" 4th Edition – Tata McGraw-Hill

[4] Larry **Peterson and Bruce S Davis** "Computer Networks :A System Approach" 5th Edition, Elsevier -2014

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEL922	PG Laboratory –IV (High Performance Computing Laboratory)	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		-		20		60

Pre-requisite Course Codes		CE44 CE45 CE62 CE922(High Performance Computing)
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the different parallel computing approaches and platforms to achieve High Performance Computing.
	CO2	Determine the communication pattern and network technology for High Performance Computing
	CO3	Design High Performance Computing System using MPI and OpenMP.
	CO4	Perform heterogeneous Computing using GPGPU and OpenCL.

Exp. No.	Experiment Details	Ref.	Marks
1	**First OpenMP program:** The aim of this lab is to develop our first OpenMP program and write some non-trivial OpenMP programs. We will use a few OpenMP constructs and functions that are in fact very powerful for parallelising most C programs. Although we will use further constructs in the future labs and also in the project. You can compile openmp programs by using the compiler flag `gcc -fopenmp file.c`		**05**
2	**High performance computation of Pi**	1,2,3	**05**
3	**How to access the cluster:** We have set up a HPC cluster for this unit and you need to do the programming projects on the cluster. You can also write your lab code on the cluster. The cluster should be accessible both on and off campus.		**05**
4	**Project 1: Parallelization of column-wise matrix collisions** M is a data matrix of n rows and k columns where, Mi represents ith row-vector and Mj represents jth column-vector as the figure below. Each row-vector is of size k and each column-vector is of size n. Mij represents a data element from row i and column j. The value of each data element Mij lies between 0 and 1. Assume that there is no missing value in this n x k matrix M.		**10**
5	**How to run MPI code on the cluster**		**05**

6	**Project -2: A combined MPI and OpenMP implementation of Parallelization of column-wise matrix collisions:** This project is a continuation from the first project. The aim of the project is to implement the program from the first project into a combined MPI-OpenMP framework. This is quite a common apparoach for exploiting both coarse and fine grain parallelism in programs. A problem is partitioned coarsely at the top level and finely within each individual part. The coarse level partitioning is done using MPI and the finer level partitioning is usually done on a multi-core machine or on a Graphics Processing Unit (GPU). The aim of the project is to partition the matrix into smaller parts and distribute these parts to different computers by using MPI. The computation on each part would now occur within the individual nodes using the cores available on those nodes. The coding in the project will be minimal; it is the case quite often that parallelizing a piece of sequential code requires only small but well thought out modifications.		**10**
		Total Marks	**40**

References:

[1] Kai Hwang, Naresh Jotwani, "*Advanced Computer Architecture: Parallelism, Scalability, Programmability*", Mcgraw-Hill Education, SECOND Edition, 2008.

[2] Ananth Grama, "*Introduction to Parallel Computing*", Addison Wesley, SECOND Edition, 2003.

[3] Rajkumar Buyya, "*High Performance Cluster Computing: Architectures and Systems Volume 1*", Prentice Hall PTR, FIRST Edition, 1993.

[4] Michael J. Quinn, "*Parallel Programming in C with MPI and OpenMP*", McGraw HIll, FIRST Edition, 2003

[5] Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, Dana Schaa, "*Heterogeneous Computing with OpenCL*", Morgan Kaufmann, FIRST Edition, 2011

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEL923	PG Laboratory V: UXD lab	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		-		20		60

Pre-requisite Course Codes		Mobile and web technologies, software Engineering
Course Outcomes	CO1	Demonstrate the use of UX tools.
	CO2	Create real life application with end-to-end understanding of User experience practices.
	CO3	Develop map based UI for social and technical task.
	CO4	Evaluate the design of the application using User Experience principles.

Exp. No.	Experiment Details	Ref.	Marks
1	To Study of open source UX tools (Justinmind Prototype, Pidoco, Marvel Prototype) and create UX design for a given problem definition.	1,2	5
2	Design a Map based UI(Mobile User) forTransport applications like Ola,Uber etc.	1,2	5
3	Design a Map based UI(Web User) for Mumbai Dabbawalas with localization feature.	1,2	5
4	Pick a website/app that you use on a daily basis (eg. facebook, gmail, whatsapp, zomato, etc). Evaluate the product based on user experience principles and give suggestions for improvement. Explain usability testing process for the same.	1,2	5
5	Museum of London: Visit the application on http://www.webcredible.com/case-studies/non-profit/museum-london/ Study and identify the challenges in design and evaluate UX principles applied for helping visitors to engage with the past, present and future. Suggest any such App design in Indian scenario for any one Museum in India. Explain usability testing for the same. Localization framework for designing the localizable UI.	1,2	5
6	Design UI for kinder garden student to teach mathematics.	1,2	5
7	Design UI for any differently abled users..	1,2	5
8	Design UI for analysis of number of children suffering from juvenile diabetic children in India. The design aims at providing solutions for improving quality treatment and making the treatment affordable.	1,2	5
Total			40

Note: Students should study and review the literature for the above mentioned case studies. They should prepare and submit the report including the conceptual design, site map, screen design layout,

wireframes, gray scale design of the interface, final sketch of the design, ordering screen before implementing the design for the assigned task. They should study the UX principles, draw the information architecture if necessary and finally test it usability. The Final design should be deliverable to the user.

Reference:

[1] Rex Hartson and PardhaPyla, The UX Book, MK publications.

[2] Russ Unger and Carolyn Chandler ,A Project Guide to UX Design, Peachpit Press

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE92A	Internet of Things(IOT)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE	Total	
		20		20		60	100	

Pre-requisite Course Codes		CEL35, CE45, CE52
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Define Internet of Things and its components.
	CO2	Perform IoT Systems management.
	CO3	Design IoT systems through Python, Physical Servers and Cloud Solution.
	CO4	Analyze the system through Data Analytics tools.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	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	1	3
	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	2	4
	1.3	**Wireless Sensor Networks** – History, Sensor Nodes, Connecting Nodes, Networking Nodes, Securing Communication	2	2
2	2.1	**IoT System Management** – SNMP, Network Operator Requirements,	1	3
	2.2	**IoT System Management** – NETCONF, YANG	1	2
	2.3	**IoT Platform Design Specification –** Requirements, Process, Domain Model, Service, IoT Level, Function, Operational view, Device and Component Integration, Application Development	1	3
3	3.1	**IoT Systems Logical Design** – Python Data Types, Type conversion, Control Flow	1	3
	3.2	**IoT Systems Logical Design** – Python Functions, Modules, File Handling, Classes, Python Packages for IoT.	1	2
	3.3	**IoT Physical Servers –** Cloud Storage Models, Communication APIs, WAMP, Xively Cloud, Django	1	3

4	**4.1**	**IoT Cloud Services** - RESTful Web API, Amazon Web Services for IoT	1	2
	4.2	**IoT Data Analytics** – Apache Hadoop, Batch Data Analysis, Hadoop YARN	1	3
	4.3	**IoT Data Analytics** – Apache Oozie, Apache Spark, Apache Storm, Chef, Chef Case Studies, Puppet**,** NETCONF-YANG	1	3
5	**5.1**	**Arduino Programming Building Blocks** – Basics, Internet Connectivity, Communication Protocols.	3	4
	5.2	**IoT Patterns**: Real-time Clients, Remote control, On-demand Clients, Web Apps.	3	3
	5.3	**IoT Patterns:** Machine to Human, Machine to Machine, Platforms	3	2
Total				**42**

In-Semester Examination (ISE): The assessment includes the submission of a term paper by each student on the contemporary work related to Internet of Things.

References:

[1] Arsheep Bahga, Vijay Madisetti, "*internet of Things: A Hands-On Approach*", University Press, FIRST Edition, 2015.

[2] Hakima Chaouchi, "*The Internet of Things: Connecting Objects*", Wiley-ISTE, FIRST Edition, 2010.

[3] Adeel Javed, "*Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications*", Apress, FIRST Edition, 2016.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE92B	Information and Communication Technologies (ICT) for Social Cause	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	To understand technologies used in ICT.
	CO2	To design and implement ICT application for societal benefits
	CO3	To demonstrate use of emerging technology for social applications
	CO4	To apply Knowledge based ICT tool for social cause
	CO5	To develop an ICT tool as an expert system for different domains

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Basics of ICT :**		
	1.1	Introduction to ICT, Challenges and opportunities in using technology for a social cause, Understanding the social and cultural influences that affect users. Creating an ICT – handling text, data and media	1	4
2		**Communication Techniques in ICT**		
	2.1	Mobile Techniques – CDMA, Mobile wireless WiMAX, Advanced wireless technologies, Bluetooth Satellite Techniques – architecture AND working principles GPS/GPRS	1,2,3,4	8
	2.2	Cloud computing – Introduction, cloud services, Cloud service providers		
	2.3	GIS– Working principle and architecture for ICT		
3		**Data acquisition in ICT**		
	3.1	Recognition systems RFID,OMR Data acquisition process for MEMS devices Sensors – Programming, communication with cloud.	6	8
	3.2	Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc		
4		**Data Management in ICT**		
	4.1	Data management, Data storage structures	6	6
5		**Knowledge management in ICT**		
	5.1	Knowledge elicitation, Knowledge Engineering Methodology, Knowledge representation and visualization techniques Automatic discovery programs	6	8

	5.2	Data visualization, Auditing knowledge management, Linking knowledge management to business performance		
6		**ICT applications and Social Audit**		
	6.1	Study of ICT applications in various domains such as Agriculture, Healthcare, Education, SCM, Finance, Law.	1,7,8	8
	6.2	Social Audit: The Social Audit Tool (SAT), Social Audit Tool , Social Auditing, Characteristics of the SAT, Uses of the SAT , Benefits of the SAT, The SAT Methodology , Purposes, Method, and Approach of the SAT, Implementing the SAT, The Social Auditor		
			Total	**42**

References:

[1] Paul Warren , Jhon Davies, David Brown , Wiley Publication ,ICT Futures :Delivering Pervasive Realtime And Secure Services, Wiley Publication

[2] Jochen Schiller, *"Mobile communications",* Addison wisely, Pearson Education

[3] Dr.K.Elangovan, GIS Fundamentals, Applications and Implementation, New India Publications.

[4] Anthony T. Velte , Cloud Computing : A practical Approach, Tata McGraw-Hill

[5] NadimMaluf , An Introduction to Microelectromechanical systems Engineering , ,Artech House

[6] Jessica Keyes , Knowledge management business intelligence , and content management : The IT practitioner's Guide by

[7] S.R. Verma , ICTs for transfer of technology tools and techniques , New India

[8] USAID, Social Audit Tool Handbook, Using the Social Audit to Assess the Social Performance of Microfinance Institutions, 2008.

Sardar Patel Institute of Technology

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE92C	Machine Vision(MV)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE	Total	
		20		20		60	100	

Pre-requisite Course Codes		Digital Image Processing
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Understand the concepts of recognition methodology and image enhancement in frequency domain.
	CO2	Analyze the various methods of digital manipulation of images.
	CO3	Analyze the various image compression techniques.
	CO4	Understand the Projective geometry

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Recognition Methodology and Image Enhancement in Frequency Domain**		**05**
	1.1	Recognition Methodology: Conditioning, Labeling, Grouping, Extracting, And Matching.	**1**	1
	1.2	Frequency domain: Introduction to the Fourier transform and frequency domain concepts,	**2**	1
	1.3	Filters: Smoothing frequency-domain filters, Sharpening frequency domain filters. (Ideal, Butterworth and Gaussian). Homomorphic Filtering	**2**	3
2		**Image Segmentation and Region Analysis**		**08**
	2.1	Edge Linking using Hough Transform, Thresholding (Otsu's method), and Region growing Segmentation, Split and Merge Technique.	**1,2, 3,4**	04
	2.2	Connected Component Labeling: Iterative Algorithm and Classical Algorithm	**1**	02
	2.3	Region Analysis: Region properties, External points, Spatial moments, Mixed spatial gray-level moments, Boundary analysis: Signature properties.	**1**	02
3		**Morphological Image Processing**		**08**
	3.1	Binary Morphological Operators, Opening ,Closing	**2,5**	02
	3.2	Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening,	**5,**7	04
	3.3	Morphological algorithm operations on Gray scale Images	**2,5**	02
4		**Image Representation and Description**		**06**
	4.1	Image Representation: Chain Code, Polygonal approximations,	**2,5**	02

		Boundary Segments		
	4.2	Boundary and Regional Descriptors: Shape Numbers, Fourier Descriptors, Topological Descriptors	**2,5**	02
	4.3	Use of Principal components for Description.	**2**	02
5		**Image Compression**		**09**
	5.1	Introduction, Redundancy, Fidelity Criteria, Elements of Information theory.	**2,3**	03
	5.2	Lossless Compression Techniques : Huffman Coding, Run Length Coding, Arithmetic Coding, LZW Coding, Differential PCM,	**5,6**	03
	5.3	Lossy Compression Techniques: Improved Gray Scale Quantization, Transform Coding, Vector Quantization, JPEG, MPEG-1.	**2,3**	03
6		**Geometry for 3-D Vision and Knowledge-Based Vision**		**06**
	6.1	3D vision tasks: Marr's theory, The 3D representation	**3**	01
	6.2	Geometry for 3-D Vision: Projective geometry, camera calibration, Stereo vision	**3,7**	03
	6.3	Control strategies: Hierarchical control , Heterarchical Control	**1,3**	02
			Total	**42**

References:

[1] Robert Haralick and Linda Shapiro, "*Computer and Robot Vision*", Vol I, II, Addison Wesley, 1993.

[2] Rafel C. Gonzalez and Richard E. Woods, "*Digital Image Processing*", Pearson Education Asia, Third Edition, 2009,

[3] Milan Sonka ,Vaclav Hlavac and Roger Boyle," *Image Processing, Analysis, and Machine Vision* ", Thomson, Second Edition.

[4] B. Chandra and D. Dutta Majumder, "*Digital Image Processing and Analysis*", Prentice Hall of India Private Ltd

[5] S Jayaraman, S Esakkirajan, and T Veerakumar "*Digital Image Processing* ", Tata McGraw-Hill Education Private Limited

[6] Khalid Sayood , "*Introduction to DATA COMPRESSION*", ELSEVIER, Third Edition.

[7] Ramesh Jain, Rangachar Kasturi, and Brian G. Schunck, "*MACHINE VISION*", McGraw-Hill INTERNATIONAL EDITIONS.

[8] Anil K. Jain, "*Fundamentals and Digital Image Processing*", Prentice Hall of India Private Ltd, Third Edition

[9] S. Sridhar, "*Digital Image Processing*", Oxford University Press.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CEE92D	Machine Learning(ML)	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE	Total	
		20		20		60	100	

Pre-requisite Course Codes		Fundamentals of AI and Soft Computing, Statistics and probability
At the end of successful completion of the course, students will be able to		
Course Outcomes	CO1	Exhibit the knowledge about basic concepts of Machine Learning
	CO2	Identify machine learning techniques suitable for a given problem
	CO3	Solve the problems using various machine learning techniques
	CO4	Apply Dimensionality reduction techniques.
	CO5	Design application using machine learning techniques

Module No.	Unit No.	Topics	Ref	Hrs.
1		**Introduction to Machine Learning**		4
	1.1	Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	1,2,3,4	
2		**Introduction to Neural Network**		4
	2.1	Introduction – Fundamental concept – Evolution of Neural Networks – Biological Neuron, Artificial Neural Networks, NN architecture, Activation functions, McCulloch-Pitts Model.	6	
3		**Learning with Regression and trees:**		10
	3.1	**Learning with Regression:** Linear Regression, Logistic Regression. **Learning with Trees:** Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART).	2,3	
4		**Learning with Classification and clustering:**		10
	4.1	**Classification:** Rule based classification, classification by Bayesian Belief networks, Hidden Markov Models. **Support Vector Machine**: Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	3,4	

	4.2	**Clustering:** Expectation Maximization Algorithm, Supervised learning after clustering, Radial Basis functions.	2	
5		**Dimensionality Reduction:**		**8**
	5.1	Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis, Single value decomposition.	1,4	
6		**Machine Learning Applications**		
	6.1	Learning Associations, Classification, Regression, Unsupervised learning.	2	**6**
		Total		**42**

References:

[1] Peter Harrington "Machine Learning In Action", DreamTech Press
[2] Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
[3] Tom M.Mitchell "Machine Learning" McGraw Hill
[4] Stephen Marsland, "Machine Learning An Algorithmic Perspective" CRC Press
[5] J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
[6] Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.