Sri Krishna College of Engineering and Technology

An Autonomous Institution, Affiliated to Anna University

Coimbatore – 641 008

CURRICULUM AND SYLLABI

M.E COMPUTER SCIENCE AND ENGINEERING

REGULATION 2022

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF

COMPUTER SCIENCE AND ENGINEERING

REGULATION 2022

M.E COMPUTER SCIENCE AND ENGINEERING

ABOUT THE DEPARTMENT

VISION

To prepare professionals with high technical, research and entrepreneurial skills as well as ethical values who will contribute to the computational world

MISSION

1. To develop human resources with the ability and attitude to adapt to emerging technological changes through academic and research oriented events
2. To impart necessary professional and entrepreneurial skills through student enrichment programmes.
3. To inculcate effective communication skills and strong ethical values

PROGRAMME OUTCOMES (POs)

Computer Science Engineering Graduates will be able to:

PO1 - **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 - **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 - **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 - **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 - **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 - **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 - **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 - **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 - **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 - **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

To enable graduates to:

1. Pursue higher education and research or have a successful career in industries associated with computer science and engineering, or succeed as entrepreneurs.
2. Be adaptive to the growing needs of global computational environment by engaging in life-long learning.

PROGRAMME SPECIFIC OUTCOMES (PSO)

Upon completion of the programme, graduates will have ability to:

PSO1 Apply the fundamental knowledge for problem solving and analysis as well as conduct investigations in computer science and engineering for sustainable development

PSO2 Design and develop the solutions for real time problems and implement them by using modern software tools in lieu of deploying them in the society for its growth.

PSO3 Inculcate effective communication skills and ethics for lifelong learning.

Mapping of PO's to PEO's

Programme Educational Objectives (PEO)	Programme Outcomes (PO)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
PEO 1	3	3	3	3	2	2	2	3	3	3	2	1
PEO 2	1	1	2	2	3	3	2	1	2	2	2	3

Mapping of PSO's & PEO's

Programme Specific Outcomes (PSO)	Programme Educational Objectives (PEO)	
	PEO1	**PEO2**
1	3	1
2	3	2
3	2	3

1	Reasonably agreed	**2**	Moderately agreed	**3**	Strongly agreed

Sem	Course Title	Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Semester I	Logic, Graph and Automata Theory	3	3	3	1					1			3
	Advanced Data Structures and Algorithms	3	3	3	1								3
	Advanced Operating Systems	3	3	3		1	1		1				3
	Data Structures and Operating Systems Laboratory	3	3	3		2	1		2	2	2		3
Semester II	Advanced Database Technology	3	3	3		2							3
	Network Design and Technologies	3	3	3		1		1	1				3
	Advanced Computer Architecture	3	3	3	1				2				2
	Database and Computer Networks Laboratory	3	3	3		3			2	2	2		3
	Mini Project	3	3	3	2	2	2	1	2	3	3	3	3
Sem III	Dissertation Phase I	3	3	3	2	2	2	2	2	3	3	3	3
Sem IV	Dissertation Phase II	3	3	3	2	2	2	2	2	3	3	3	3
Professional Electives – Stream 1	BioInformatics Techniques and Applications	3	3	3	2	2			1				3
	Computer Vision Analysis	3	3	3	1	1							3
	GPU Computing	3	3	3			1						3
	Cloud Computing and Management	3	3	3	1	2	2						3
	Parallel Programming Paradigms	3	3	3	1	2							3
	Mobile Applications and Services	3	3	3	2	2	1		1				3
	Human Computer Interaction	3	3	3		1	1	2					3
	Social Network Analysis	3	3	3	2	2	2		1				3
	Wireless Networks	3	3	3		2							3

	Deep Learning Architectures and Applications	3	3	3	2	2			1				3
Professional Electives – Stream 2	Image Processing and Analysis	3	3	3	1	2	1		1				3
	Compiler Optimization Techniques	3	3	3	2	1						2	3
	Machine Learning Approaches	3	3	3		2		1				2	3
	Natural Language Processing Models	3	3	3		2		1					3
	Information Retrieval	3	3	3		2							3
	Real time systems	3	3	3	1	1		1	1				3
	Big Data Analytics Frameworks	3	3	3	2	2			2				3
	Digital forensics	3	3	3					2				3
	Industrial Internet of Things	3	3	3		2							3
	Research Methodologies and IPR	3	3	3				2	2			2	3

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNLOGY

M.E Computer Science and Engineering

Regulations 2022

SEMESTER I							
S No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credits**	**Ext/Int**	**Category**
THEORY							
1	22PF101	Logic, Graph and Automata Theory	3/0/0	3	3	60/40	PC
2	22PF102	Advanced Data Structures and Algorithms	3/0/0	3	3	60/40	PC
3	22PF103	Advanced Operating Systems	3/0/0	3	3	60/40	PC
4	22PF5XX	PE – 1	3/0/0	3	3	60/40	PE
5	22PF5XX	PE – 2	3/0/0	3	3	60/40	PE
PRACTICAL							
6	22PF104	Data Structures and Operating Systems Laboratory	0/0/4	4	2	40/60	PC
AUDIT COURSE							
7	22ACXXX	Audit Course 1					AC
			Total	**19**	**17**		

SEMESTER II							
S No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credits**	**Ext/Int**	**Category**
THEORY							
1	22PF201	Advanced Database Technology	3/0/0	3	3	60/40	PC
2	22PF202	Network Design and Technologies	3/0/0	3	3	60/40	PC
3	22PF203	Advanced Computer Architecture	3/0/0	3	3	60/40	PC
4	22PF5XX	PE - 3	3/0/0	3	3	60/40	PE
5	22PF5XX	PE – 4	3/0/0	3	3	60/40	PE
PRACTICAL							
6	22PF204	Database and Computer Networks Laboratory	0/0/4	4	2	40/60	PC
PROJECT							
7	22PF205	Mini Project	2/0/0	2	2	40/60	PW
AUDIT COURSE							
8	22ACXXX	Audit Course 2					AC
			Total	**21**	**19**		

SEMESTER III							
S No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1	22PF5XX	PE – 5	3/0/0	3	3	60/40	PE
2	22PXXXX	Open Elective	3/0/0	3	3	60/40	OE
PROJECT							
3	22PF301	Dissertation Phase I	0/0/20	20	10	40/60	PW
			Total	**26**	**16**		

SEMESTER IV							
S No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
PROJECT							
1	22PF401	Dissertation Phase II	0/0/32	32	16	40/60	PW
			Total	**32**	**16**		

AUDIT COURSES (AC)

S.No.	Course Code	Course Title	Category
1	22AC001	English for Research Paper Writing	AC
2	22AC002	Disaster Management	AC
3	22AC003	Hindi/German for Technical Knowledge	AC
4	22AC004	Value Education	AC
5	22AC005	Constitution of India	AC
6	22AC006	Pedagogy Studies	AC
7	22AC007	Stress Management	AC
8	22AC008	Personality Development through Life Enlightenment Skills	AC

OPEN ELECTIVE COURSES (OE)

S. No.	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1	22PF001	Business Analytics	3/0/0	3	3	60/40
2	22PD001	Industrial Safety	3/0/0	3	3	60/40
3	22PD002	Operations Research	3/0/0	3	3	60/40
4	22PC001	Cost Management of Engineering Projects	3/0/0	3	3	60/40
5	22PC002	Composite Materials	3/0/0	3	3	60/40
6	22PE001	Waste to Energy	3/0/0	3	3	60/40

PROFESSIONAL ELECTIVE COURSES (PE)

Stream 1

S. No.	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1.	22PF501	BioInformatics Techniques and Applications	3/0/0	3	3	60/40
2.	22PF502	Computer Vision Analysis	3/0/0	3	3	60/40
3.	22PF503	GPU Computing	3/0/0	3	3	60/40
4.	22PF504	Cloud Computing and Management	3/0/0	3	3	60/40
5.	22PF505	Parallel Programming Paradigms	3/0/0	3	3	60/40
6.	22PF506	Mobile Applications and Services	3/0/0	3	3	60/40
7.	22PF507	Human Computer Interaction	3/0/0	3	3	60/40
8.	22PF508	Social Network Analysis	3/0/0	3	3	60/40
9.	22PF509	Wireless Networks	3/0/0	3	3	60/40
10.	22PF510	Deep Learning Architectures and Applications	3/0/0	3	3	60/40

Stream 2

S.No.	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
11.	22PF511	Image Processing and Analysis	3/0/0	3	3	60/40
12.	22PF512	Compiler Optimization Techniques	3/0/0	3	3	60/40
13.	22PF513	Machine Learning Approaches	3/0/0	3	3	60/40
14.	22PF514	Natural Language Processing Models	3/0/0	3	3	60/40
15.	22PF515	Information Retrieval	3/0/0	3	3	60/40
16.	22PF516	Real time systems	3/0/0	3	3	60/40
17.	22PF517	Big Data Analytics Frameworks	3/0/0	3	3	60/40
18.	22PF518	Digital forensics	3/0/0	3	3	60/40
19.	22PF519	Industrial Internet of Things	3/0/0	3	3	60/40
20.	22PB519	Research Methodologies and IPR	3/0/0	3	3	60/40

SCHEME OF CREDIT DISTRIBUTION – SUMMARY

S. No	Stream	Credits/Semester				Credits
		I	II	III	IV	
1.	Professional Core(PC)	11	11	-	-	22
2.	Professional Electives(PE)	6	6	3	-	15
3.	Open Electives(OE)	-	-	3	-	3
4.	Audit Courses (AC)	-	-	-	-	-
5.	Project Work (PW)	-	2	10	16	28
Total		**17**	**19**	**16**	**16**	**68**

SEMESTER I

22PF101 LOGIC, GRAPH AND AUTOMATA THEORY 3/0/0/3

Nature of Course J(Problem analytical)

Course Objectives:

1 To develop logical thinking and knowledge on how discrete structures actually helped computer engineers to solve problems occurred in the development of programming languages.

2 To develop theoretical knowledge and understanding of graph theory.

3 To provide strong foundation to the students to expose various emerging new areas like automata theory and appraise them with their relevance in Engineering and Technological field.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1 Apply logical thinking and its applications to computer science [AP]

C101.2 Apply the theoretical knowledge of Graph theory. [AP]

C101.3 Identify and formulate mathematical modeling of non predictable situations using automata techniques. [U]

Course Contents:

Module I Propositional Calculus 15 Hours

Propositions – Logical connectives – Compound propositions – Conditional and biconditional – Truth tables – Tautologies and contradictions – Contrapositive – Logical equivalences and implications –Normal forms – Principal conjunctive and disjunctive normal forms – Rules of inference –Predicates and Quantifiers – Logical equivalences and implications for quantified statements – Theory of inference.

Module II Graph Theory 15 Hours

Basic Concepts – Some special simple graphs – Matrix representation of graphs – paths, cycles, connectivity – Eulerian and Hamiltonian Graphs – Connectedness in Digraphs Trees – Spanning Trees – Binary trees – Shortest path algorithms.

Module III Automata Theory 15 Hours

Introduction – Phrase structure grammar – Types of phrase structure grammar – Ambiguity – Languages – Types of languages – Finite state machines – Deterministic and Non- deterministic finite state machines – Language accepted by a finite automaton and non deterministic finite automaton – Equivalence of FA and NFA – Procedure for finding an FA equivalent to NFA – Turing Machines.

Total Hours: 45 Hours

Text Books:

1. Trembly J.P and Manohar R, “Discrete Mathematical Structures with applications to Computer Science”, Tata McGraw–Hill Pub. Co. Ltd, New Delhi, 2017.
2. Kenneth H.Rosen, “Discrete Mathematics and its Applications”, 7th Edition, Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2018.

Reference Books:

1. T.Veerarajan, “Discrete mathematics with Graph theory and Combinatorics”, Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2017.
2. Ralph.P.Grimaldi, “Discrete and Combinatorial Mathematics: An Applied Introduction”, 5th Edition, Pearson Education Asia, Delhi, 2016.
3. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, “Discrete Mathematical Structures”, 5th Indian reprint, Pearson Education pvt Ltd., New Delhi, 2013.

Web References:

1. http://nptel.ac.in/courses/111104075/DOE
2. http://nptel.ac.in/courses/122104019/discrete structures

Online Resources:

1. http://nptel.ac.in/upcoming_courses.php

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C101.1	Remember	Quiz	4
C101.2	Understand	Assignment	4
C101.3	Apply	Presentation	4
C101.4	Evaluate	Group activity	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	30	30	30
Understand	40	30	30
Apply	20	30	30
Analyse	-	-	-
Evaluate	10	10	10
Create	-	-	-

22PF102 **ADVANCED DATA STRUCTURES AND ALGORITHMS** **3/0/0/3**

Nature of Course G (Theory analytical)

Pre requisites

Course Objectives

1	To Choose appropriate data structure, understand the ADT / Libraries and use it to design algorithms for a specific problem
2	To Understand the necessary mathematical abstraction to solve problems.
3	To Familiarize with advanced paradigms and data structure used to solve algorithmic problems
4	To Come up with analysis of efficiency and proofs of correctness

Course Outcomes:

Upon completion of the course, students shall have ability to

C102.1	Understand the implementation of symbol table using hashing techniques	[U]
C102.2	Develop and analyze algorithms for red-black trees, B-trees, Fibonacci Heaps	[A]
C102.3	Apply suitable design strategy for solving problems	[AP]
C102.4	Compute the time complexities of various algorithm design techniques.	[AP]
C102.5	Understand the various advanced design analysis techniques to solve the Polynomial (P) Time and Non - Polynomial (NP) Time Problem	[U]

Course Contents

Module I Elementary Data Structures and Introduction to Analysis **15 Hours**

Elementary Data Structures: Stacks and queues - Linked lists - Implementing pointers and objects -Representing rooted trees. Hash Tables: Direct-address tables - Hash tables - Hash functions - Open addressing. Binary Search Trees: Querying a binary search tree - Insertion and deletion - Randomly built binary search trees. Red-Black Trees - Augmenting Data Structures. Elementary Graph Algorithms: Representations of graphs - Breadth-first search - Depth-first search - Growth of Functions: Asymptotic notations – Standard notations and common functions - Divide-and-Conquer: The maximum-subarray problem – Strassen's algorithm for matrix multiplication – solving recurrences:- substitution method, recursion-tree method. Randomized algorithms Heap sort- Quick sort - Sorting in Linear Time.

Module II Advanced Data Structures **15 Hours**

B-Trees: Definition of B-trees - Basic operations on B-trees - Deleting a key from a B-tree - Fibonacci Heaps: Structure of Fibonacci heaps - Mergeable-heap operations - Decreasing a key and deleting a node - Bounding the maximum degree. Data Structures for Disjoint Sets: Disjoint-set operations- Linked-list representation of disjoint sets - Disjoint-set forests. Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem. Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm

Module III Advanced Design and Analysis Techniques **15 Hours**

Dynamic Programming: Elements of dynamic programming - Matrix-chain multiplication – Optimal binary search trees. Greedy Algorithms: An activity-selection problem - Elements of the greedy strategy. Amortized Analysis: Aggregate analysis - accounting method, potential method -Dynamic tables. Topological sort - Strongly connected components - Minimum Spanning Trees - Single-Source Shortest Paths - All-Pairs Shortest Paths - Maximum Flow NP-Completeness:

Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems

Total Hours: 45 Hours

Text Books:

1. T.H. Cormen, C.E. Leiserson,R.L. Rivest and C. Stein, " Introduction to Algorithms", Prentice Hall of India ,3rd Edition ,2012
2. Mark Allen Weiss, Data Structures and Algorithms in C++, Pearson, 3rd Edition,2009.
3. E. Horowitz, S. Sahni and S. Rajasekaran, Computer Algorithms / C++, University Press, 2nd Edition,2008.

Reference Books:

1 S.Sridhar, Design and Analysis of Algorithms‖, First Edition, Oxford University Press,1st Edition, 2014.

2 Adam Drozdex, Data Structures and algorithms in C++. New Delhi: Cengage Learning, 4th Edition, 2012.

Web References:

1 http://cs-fundamentals.com/data-structures/data-structures-tutorials.php

2 https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-851-advanced-data-structures-spring-2012/index.htm

Online Resources:

1 https://www.coursera.org/learn/advanced-data-structures

2 https://onlinecourses.nptel.ac.in/noc18_cs25/preview

3 https://nptel.ac.in/courses/106102064/

<table>
<tr><th colspan="6">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="5">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
<tr><th colspan="3">CA 1 (20 Marks)</th><th colspan="2">CA2 (20 Marks)</th><th rowspan="3">Theory Examination (60 Marks)</th></tr>
<tr><th rowspan="2">SA 1 (12 Marks)</th><th colspan="2">FA 1</th><th rowspan="2">SA 2 (12 marks)</th><th colspan="2">FA 2</th></tr>
<tr><th>Component -I (4 marks)</th><th>Component –II (4 marks)</th><th>Component -I (4 marks)</th><th>Component -II (4 marks)</th></tr>
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<tr><th colspan="4">Assessment Methods & Levels (based on Blooms' Taxonomy)</th></tr>
<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom's Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C102.1</td><td>Apply</td><td>Assignment</td><td>4</td></tr>
<tr><td>C102.2</td><td>Apply</td><td>Class Tutorials</td><td>4</td></tr>
<tr><td>C102.3</td><td>Understand</td><td>Quiz</td><td>4</td></tr>
</table>

C102.4 & C102.5	Apply	Program Implementation	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	20	20	20
Apply	30	30	30
Analyse	50	50	50
Evaluate	-	-	-
Create	-	-	-

22PF103 **ADVANCED OPERATING SYSTEMS** **3/0/0/3**

Nature of Course G (Theory analytical)

Pre requisites -

Course Objectives:

1 To illustrate the fundamentals of Operating Systems

2 To relate the concept of operating system to distributed operating systems

3 To identify the components and management aspects of Real time, Mobile operating systems

Course Outcomes:

Upon completion of the course, students shall have ability to

C103.1 Recognize the basics of operating systems [U]

C103.2 Analyze the Process and Memory Management Concepts [A]

C103.3 Relate the concepts of operating systems to distributed operating systems [A]

C103.4 Identify the different features of real time and mobile operating systems [A]

Course Contents:

Module I Introduction **15 Hours**

Overview – Synchronization Mechanisms – Processes and Threads - Process Scheduling – Deadlocks: Detection, Prevention and Recovery – Models of Resources – Memory Management Techniques.

Module II Distributed Operating Systems **15 Hours**

Architectures- Design issues – Communication models – clock synchronization – mutual exclusion – election algorithms- Distributed Deadlock detection Distributed scheduling - Distributed shared memory - Distributed File system – Multimedia file systems - File placement – Caching

Module III Real Time and Mobile Operating Systems **15 Hours**

Basic Model of Real Time Systems - Characteristics- Applications of Real Time Systems- Real Time Task Scheduling - Handling Resource Sharing - Mobile Operating Systems–Micro Kernel Design - Client Server Resource Access – Processes and Threads - Memory Management – File system. **Case Study:** Linux System: Design Principles - Kernel Modules - Process Management Scheduling – Memory Management - Input-Output Management - File System - Interprocess Communication. iOS and Android: Architecture and SDK Framework - Media Layer - Services Layer - Core OS Layer – File System.

Total Hours: 45 Hours

Text Books:

1. Singhal, Mukesh & N.G. Shivaratri, Advanced Concepts in Operating Systems, Tata McGraw-Hill, 1st Edition, 2008.
2. Abraham Silberschatz, Peter B.Galvin , Greg Gagne, “Operating System Concepts” , Wiley,10th Edition, 2018.

Reference Books:

1. Daniel P Bovet and Marco Cesati, “Understanding the Linux kernel”, O’Reilly, 3rd Edition, 2005.

2. A. S. Tanenbaum, Distributed Operating Systems, Pearson Education, 1st Edition,2016.
3. A. S. Tanenbaum, Modern Operating Systems, Pearson Education,4th Edition, 2015.
4. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 1st Edition, 2007.
5. Neil Smyth, "iPhone iOS 4 Development Essentials – Xcode", Payload media,4th Edition, 2011.

Web References:

1. https://nptel.ac.in/courses/106108101/
2. https://www.geeksforgeeks.org/operating-systems/

Online Resources:

1. https://grid.cs.gsu.edu/~cscyqz/courses/aos/aoslectures.html
2. https://lecturenotes.in/subject/185/advanced-operating-system-aos

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C103.1	Understand	Quiz	4
C103.2	Analyse	Writing Skills	4
C103.3	Analyse	Class Presentation	4
C103.4	Analyse	Assignment	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	20	10	10
Understand	30	40	40
Apply	30	30	30

Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

22PF104 **DATA STRUCTURES AND OPERATING SYSTEMS LABORATORY** **0/0/4/2**

Nature of Course M (Practical Application)

Co requisites Advanced Data Structures and Algorithms, Advanced Operating Systems

Course Objectives:

1	To choose appropriate data structure, understand the ADT / Libraries and design algorithms for a specific problem
2	To dramatize with advanced paradigms and data structure to solve algorithmic problems
3	To relate the concept of operating system to distributed operating systems
4	To identify the components and management aspects of Real time operating systems

Course Outcomes:

Upon completion of the course, students shall have ability to

C104.1	Demonstrate the concepts of Linked list and hashing technique.	[AP]
C104.2	Develop algorithms for red-black trees and B-trees	[AP]
C104.3	Apply suitable design strategy for solving problems	[AP]
C104.4	Analyze the Process and Memory Management Concepts	[AP]
C104.5	Relate the concepts of operating systems to distributed operating systems	[AP]
C104.6	Design an application for real time operating systems	[AP]

Course Contents:

List of Experiments for Data Structures:

1. Implementation of Linked List using Templates.
2. Implementation of Hash Tables.
3. Implementation of Red Black Trees.
4. Implementation of Randomly built Binary Search tree.
5. Implementation of Divide and Conquer algorithm for Maximum sub-array problem and Strassen's algorithm for matrix multiplication.
6. Implementation of B-Trees.
7. Implementation of Fast Fourier Transform application.
8. Implementation of Dynamic Programming for Matrix-chain multiplication and Optimal Binary Search Tree.
9. Implementation of Greedy algorithm for Topological sort and Minimum Spanning Tree.
10. Implementation of Shortest path for Source Shortest Paths and All-Pairs Shortest Paths.

List of Experiments for Operating Systems:

1. Simulation and Analysis of Non Pre emptive and Pre emptive CPU Scheduling Algorithms.
2. Simulation of Producer – Consumer Problem using Semaphores.
3. Implementation of Dining Philosopher's Problem to demonstrate Process Synchronization.
4. Simulation of Banker's Algorithm for Deadlock Avoidance.
5. Analysis and Simulation of Memory Allocation and Management Techniques.
6. Designing a RMI lottery application in distributed operating systems.
7. Designing a RPC lottery application in distributed operating systems.
8. Designing a CORBA lottery application in distributed operating systems.
9. Implementing an alarm clock in real time operating systems.
10. Design an efficient Traffic Control System to avoid traffic congestion in Metro Cities.

Total Hours: 60 Hours

Text Books:

1. T.H. Cormen, C.E. Leiserson,R.L. Rivest and C. Stein, " Introduction to Algorithms", Prentice Hall of India ,3rd Edition ,2012.
2. Mark Allen Weiss, Data Structures and Algorithms in C++, Pearson Education,3rd Edition, 2009.
3. Singhal, Mukesh & N.G. Shivaratri, Advanced Concepts in Operating Systems, Tata McGraw-Hill, 1st Edition, 2008.
4. Abraham Silberschatz, Peter B.Galvin , Greg Gagne, “Operating System Concepts” 10th Editon, Wiley,2018.

Reference Books:

1. S.Sridhar, “Design and Analysis of Algorithms”, Oxford University Press, 1st Edition 2014.
2. Adam Drozdex, Data Structures and algorithms in C++, Cengage Learning, 4th Edition, 2012.
3. Daniel P Bovet and Marco Cesati, “Understanding the Linux kernel”, 3rd Edition, O’Reilly,2005.
4. A. S. Tanenbaum, “Distributed Operating Systems”, Pearson Education,1st Edition,2016.

Web References:

1. http://cs-fundamentals.com/data-structures/data-structures-tutorials.php
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-851-advanced-data-structures-spring-2012/index.htm
3. https://nptel.ac.in/courses/106108101/
4. https://www.geeksforgeeks.org/operating-systems/

Online Resources:

1. https://www.coursera.org/learn/advanced-data-structures
2. https://onlinecourses.nptel.ac.in/noc18_cs25/preview
3. https://grid.cs.gsu.edu/~cscyqz/courses/aos/aoslectures.html
4. https://lecturenotes.in/subject/185/advanced-operating-system-aos

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (60%)**		**End Semester Examination (40%)**
	FA (45 Marks)	**SA (15 Marks)**	**Practical Examination (40 Marks)**
Remember	20	20	20
Understand	20	20	20
Apply	60	60	60
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

SEMESTER II

22PF201 ADVANCED DATABASE TECHNOLOGY 3/0/0/3

Nature of Course G (Theory analytical)

Pre requisites -

Course Objectives:

1. To understand the database system, data models, database languages.
2. To appraise different normalization techniques for efficient database design.
3. To acquire knowledge on parallel and distributed databases.
4. To illustrate the principles of object oriented databases and XML databases.
5. To gain knowledge about the various intelligent databases.

Course Outcomes:

Upon completion of the course, students shall have ability to

C201.1	Identify the appropriate database models for any application.	[U]
C201.2	Design an efficient relational database system with optimal query processing.	[AP]
C201.3	Design parallel and distributed databases.	[AP]
C201.4	Interpret the real world data using object oriented databases and XML databases.	[AP]
C201.5	Analyze the various intelligent databases.	[A]

Course Contents:

Module I Introduction and data models 15 Hours

Database systems architecture, Data models - Entity-Relationship model, ER diagram notation, examples- Reduction of ER model to relational schema-Relational Model- Fundamentals of SQL- Domains and Integrity constraints-Views-Triggers-Procedures and functions – Embedded and Dynamic SQL-Query processing and optimization -Normalization and relational database design.

Module II Advanced databases 15 Hours

Centralized and Client-Server Architectures – Parallel Systems – Distributed Systems – Parallel Databases – I/O Parallelism – Inter- and Intra-Query Parallelism – Inter- and Intra-operation Parallelism – Distributed Database concepts – Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing. XML Databases- XML Data Model – DTD – XML Schema – XML Querying-Object oriented database concepts- Object Oriented Languages -ODMG Model and object relational databases.

Module III Intelligent Databases 15 Hours

Introduction: Active and deductive databases-Temporal and Spatial databases – Mobile databases - Multimedia databases – In-memory database -NoSQL databases.

Total Hours: 45 Hours

Text Books:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, “Database System Concepts”, 6th Edition, McGraw-Hill, 2011.
2. Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”, Pearson Education, 7th Edition 2016.
3. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database System”, Pearson education,8th Edition, 2006.
4. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari,”Advanced Database Systems”, Morgan Kaufmann publishers,2006.

Reference Books:

1. Peter rob, Carlos Coronel, "Database Systems – Design, Implementation and Management", 9th Edition, Thomson Learning, 2009.
2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", Mc.Graw Hill, 3rd Edition 2014.
3. Won Kim, MIT Press, "Introduction to Object Oriented Databases", MIT Press, 2003.
4. V.S.Subramanian, "Principles of Multimedia Database Systems", Harcourt India Pvt Ltd., 2001.
5. Vijay Kumar, "Mobile Database Systems", John Wiley & Sons, 2006.

Web References:

1. http://users.sdsc.edu/~ludaesch/Paper/moc98.pdf
2. https://dzone.com/articles/what-an-in-memory-database-is-and-how-it-persists
3. http://nosql-database.org/

Online Resources:

1. https://www.udemy.com/database-management-system
2. https://www.coursera.org/learn/database-management
3. www.tutorialspoint.com/dbms/
4. http://www.nptelvideos.in/2012/11/database-management-system.html

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C201.1	Understand	Tutorial	4
C201.2	Apply	Assignment	4
C201.3	Apply	Case Study	4
C201.4 & C201.5	Analyse	Technical Presentation	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	20	10	10
Understand	30	40	40

Apply	30	30	30
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

22PF202 NETWORK DESIGN AND TECHNOLOGIES 3/0/0/3

Nature of Course: D (Theory Application)

Pre requisites: -

Course Objectives:

1 To understand the principles required for network design
2 To explore various technologies in the wireless domain
3 To study about 3G and 4G cellular networks
4 To understand the paradigm of Software defined networks
5 To develop skills in modelling and evaluating network design architecture in Real time systems

Course Outcomes:

Upon completion of the course, students shall have ability to

C202.1	Identify the components required for designing a network	[U]
C202.2	Design a network at a high-level using different networking technologies	[AP]
C202.3	Analyze the various protocols of wireless and cellular networks	[A]
C202.4	Discuss the features of 4G and 5Gnetworks	[U]
C202.5	Experiment with software defined networks	[AP]
C202.6	Experiment with cisco network simulators	[AP]

Course Contents:

Module I Network Design & Wireless Networks 15 Hours

Advanced multiplexing – Code Division Multiplexing, DWDM and OFDM – Shared media networks – Switched networks – End to end semantics – Connectionless, Connection oriented, Wireless Scenarios –Applications, Quality of Service – End to end level and network level solutions. LAN cabling topologies – Ethernet Switches, Routers, Firewalls and L3 switches – Remote Access Technologies and Devices – Modems and DSLs – SLIP and PPP – Core networks, and distribution networks. IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth – Protocol Stack – Security – Profiles

Module II Cellular Networks & 4G Networks 15 Hours

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN –Core and Radio Network Mobility Management – UMTS Security LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks – Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) - 4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Introduction to 5G.

Module III Software Defined Networks 15 Hours

Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework. **Use Case Scenarios for Network Design** Benefits of a Hierarchical Network Design – Design Methodology Used By Network Designers – Design Considerations For the Core, Distribution and Access Layers, Design Considerations for the Network Enterprise Edge, Design Considerations to Support Remote Access, Design Considerations for Enterprise Wireless, Data center and Server farms. Cisco Simulators for

Network Design.

Total Hours: 45 Hours

Text Books:

1. Erik Dahlman, Stefan Parkvall, Johan Skold, 4G:LTE/LTE-Advanced for Mobile Broadband‖, Academic Press, 2nd Edition,2014.
2. Jonathan Rodriguez,'Fundamentals of 5G Mobile Networks', Wiley, 2015.
3. Larry Peterson and Bruce Davie,'Computer Networks: A Systems Approach', Morgan Kauffman, 5th edition, 2011.
4. Martin Sauter, "From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband", Wiley, 2nd Edition, 2014.

Reference Books:

1. Martin Sauter, 'Beyond 3G-Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web 2.0", Wiley,2009.
2. Naveen Chilamkurti, Sherali Zeadally, Hakima Chaouchi,'Next Generation Wireless Technologies", Springer, 2013.
3. Paul Goransson, Chuck Black, 'Software Defined Networks: A Comprehensive Approach", Morgan Kauffman, 2014.
4. Savo GGlisic,'Advanced Wireless Networks–4G Technologies", John Wiley & Sons, 2007.
5. Thomas D.Nadeauand Ken Gray,'SDN–Software Defined Networks", O'Reilly Publishers, 2013.
6. Ying Dar Lin, Ren-Hung Hwang and Fred Baker,'Computer Networks: An Open Source Approach", McGraw Hill, 2011.

Web References:

1. https://www.scte.org/documents/pdf/CCNA4%20Sample.pdf
2. https://www.cisco.com › Solutions › Design Zone - Design Guides
3. https://www.researchgate.net/publication/322049839_Network_Design_Report

Online Resources:

1. https://nptel.ac.in/courses/106105081/
2. https://www.transitionaldata.com/network-design-best-practices-247-internet-businesses-white-paper/
3. https://ieeexplore.ieee.org/document/7324121

<table>
<tr><th colspan="6">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="5">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
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<tr><th>Component -I (4 marks)</th><th>Component –II (4 marks)</th><th>Component -I (4 marks)</th><th>Component -II (4 marks)</th></tr>
</table>

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C202.1 & C202.4	Understand	Online Quiz	3
C202.2 & C202.3	Analyse	Assignment	3
C202.5 & C202.6	Apply	Case Study	10

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	40	50	50
Apply	40	50	40
Analyse	20	-	10
Evaluate	-	-	-
Create	-	-	-

22PF203 **ADVANCED COMPUTER ARCHITECTURE** **3/0/0/3**

Nature of Course D (Theory Application)

Pre requisites -

Course Objectives:

1 To explain the fundamental concepts of Computer architecture and its operations.

2 To demonstrate the organization of ALU and the Control unit.

3 To identify various types of Memory and various types of communication with I/O devices.

4 To examine about pipelining and handling hazards.

5 To discuss the parallel processing in a single and multiprocessors.

Course Outcomes:

Upon completion of the course, students shall have ability to

C203.1	Express the basics structure of computers, operations and instructions.	[U]
C203.2	Articulate the design of ALU and Control unit.	[AP]
C203.3	Illustrate memory hierarchy, I/O Communications and its impact on computer cost/performance.	[AP]
C203.4	Infer the ways to take advantage of instruction level parallelism for high performance processor design.	[A]
C203.5	Describe parallel processing architectures.	[U]

Course Contents:

Module I Computer Organization & Architecture **15 Hours**

Introduction-functional units - measuring and reporting performance- Quantitative principles of computer design. Instruction set principles and examples- classifying instruction set Architectures - memory addressing. **ALU & Control Unit:** ALU design – Addition –Subtraction-Multiplication-division- Multiple bus organization-Hardwired control – Micro programmed control-examples.

Module II Memory Hierarchy& I/O Sub System **15 Hours**

Introduction- Basic concepts of Main memory – types –organization - Speed – Size and cost – Cache memories –Improving cache performance – reducing cache miss penalty reducing miss rate – reducing hit time-Virtual memory – Memory management requirements. Buses – Standard I/O Interfaces – Interrupt – DMA.

Module III Instruction-Level Parallelism and its Exploitation **15 Hours**

Pipelining-Basic concepts –Basic Compiler Techniques for Exposing ILP -Reducing Branch Costs with Prediction -Overcoming Data Hazards with Dynamic Scheduling -Hardware-Based Speculation -Exploiting ILP Using Multiple Issue and Static Scheduling -Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation. **Introduction to Parallel Processing:** Forms of Parallel Processing: Flynn's classification, SIMD and MIMD operations, Symmetric Shared Memory Multiprocessors, Distributed shared memory- Directory Based Coherence-snoopy bus based cache coherence - Interconnection networks-Synchronization-RAID.

Total Hours: 45 Hours

Text Books:

1 Carl Hamachar, Zvonco Vranesic and Safwat Zaky, Computer Organization, McGraw- Hill, 6th Edition 2012.
2 John P. Hayes, Computer Architecture and Organization, McGraw-Hill 3rd edition, 2013.

Reference Books:

1 David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Elsevier, 4th Edition 2012.
2 K. Hwang and Naresh Jotwani, "Advanced Computer Architecture, Parallelism, Scalability, Programmability", Tata McGraw Hill, 2nd Edition, 2010.

Web References:

1. https://www.coursera.org/learn/comparch
2. https://nptel.ac.in/courses/106102062/
3. https://nptel.ac.in/courses/106105033/

Online Resources:

1. https://www.tutorialspoint.com/parallel_computer_architecture/parallel_computer_architecture_cache_coherence_synchronization.htm
2. https://searchstorage.techtarget.com/definition/RAID
3. https://edux.pjwstk.edu.pl/mat/264/lec/main120.html

<table>
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<tr><th colspan="3">CA 1 (20 Marks)</th><th colspan="2">CA2 (20 Marks)</th><th rowspan="3">Theory Examination (60 Marks)</th></tr>
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</table>

<table>
<tr><th colspan="4">Assessment Methods & Levels (based on Blooms' Taxonomy)</th></tr>
<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom's Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C203.1</td><td>Understand</td><td>Quiz</td><td>4</td></tr>
<tr><td>C203.2</td><td>Apply</td><td>Tutorial</td><td>4</td></tr>
<tr><td>C203.3</td><td>Apply</td><td>Assignment</td><td>4</td></tr>
<tr><td>C203.4 & C203.5</td><td>Analyse</td><td>Case study</td><td>4</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
</table>

Bloom's Level	Continuous Assessment (24%)		End Semester Examination (60%) [60 Marks]
	CIA1 [12 Marks]	CIA2 [12 Marks]	
Remember	-	-	-
Understand	40	30	30
Apply	40	40	40
Analyse	20	30	30
Evaluate	-	-	-
Create	-	-	-

22PF204 DATABASE AND COMPUTER NETWORKS LABORATORY 0/0/4/2

Nature of Course L (Problem Experimental)

Co requisites Advanced Database Technology, Network Design and Technologies

Course Objectives:

1. To understand the concept of designing a database with the necessary attributes.
2. To know the methodology of Accessing, Modifying and Updating data & information from the relational databases.
3. To understand the purpose of views and triggers.
4. To develop procedures, functions and an application.
5. To understand the fundamental concepts of socket programming and network protocols.
6. To learn network simulation tools and develop applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C204.1	Construct an Entity Relationship (E-R) diagram for any application.	[AP]
C204.2	Design a normalized relational database and write queries to retrieve information.	[AP]
C204.3	Develop any real time information system with all realistic constraints.	[AP]
C204.4	Demonstrate various socket programming.	[AP]
C204.5	Implement different routing protocols.	[AP]
C204.6	Develop various applications by using advanced concepts of computer networks.	[AP]

Course Contents:

List of Experiments:

1. Study of SQL commands-DDL, DML, Nested Queries & Join Queries.
2. Working with Views, Triggers, Procedures and Functions
3. Database Design using ER diagram and Normalization
4. Database implementation (Mini Project)
5. Working with NoSQL Databases (PIG/HIVE)
6. Applications using TCP Sockets / UDP Sockets like
   - Echo client and echo server
   - File transfer
   - Remote command execution
   - SMTP
7. Study of Network simulator (NS)
8. Some Network protocol simulation using NetSim, NS2, etc. for
   - Implementation of Sliding Window Protocol.
   - Implementation of Routing Protocols.
9. Programs using RPC.
10. Development of applications such as DNS/ HTTP/ E – mail/ Multi - user Chat.

Total Hours: 60 Hours

Text Books:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, “Database System Concepts”, 6th Edition, McGraw-Hill, 2011.

3. Paul N. Weinberg. James R. Groff. Andrew J. Oppel, "SQL. The Complete Reference", Third edition, McGraw-Hill,3rd Edition,2010.
4. Elliotte Rusty Harold, "Java Network Programming, Developing Networked Applications", O'Reilly Media, 4th Edition, 2013.

Reference Books:

1. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2016.
2. Esmond Pitt, "Fundamental Networking in Java", Springer, 2006.
3. Kenneth L. Calvert, Michael J. Donahoo, "TCP/IP Sockets in Java: Practical Guide for Programmers" , Morgan Kaufmann Publisher, 2nd Edition, 2008.

Web References:

1. https://www.udemy.com/database-management-system
2. http://nosql-database.org/
3. https://www.coursera.org
4. http://www.w3schools.com/
5. https://www.udemy.com/topic/computer-network/

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (60%)**		**End Semester Examination (40%)**
	FA (45 Marks)	**SA (15 Marks)**	**Practical Examination (40 Marks)**
Remember	20	20	20
Understand	20	20	20
Apply	60	60	60
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

PROFESSIONAL ELECTIVE COURSES STREAM 1

22PF501 **BIOINFORMATICS TECHNIQUES AND APPLICATIONS** **3/0/0/3**

Nature of Course D (Theory Application)

Pre requisites

Course Objectives:

1 To learn the fundamentals of bioinformatics techniques and applications

2 To understand bioinformatics algorithms, analysis and phylogenetic concept

3 To understand open problems and issues in replication and molecular clocks

4 To study and acquire knowledge on assemble genomes, human genome and sequencing technologies

Course Outcomes:

Upon completion of the course, students shall have ability to

C501.1	Describe the genomic technologies in bioinformatics applications	[U]
C501.2	Identify and analyse distinct bioinformatics algorithms	[A]
C501.3	Demonstrate the understanding of replication and molecular clocks in bioinformatics	[AP]
C501.4	Interpret assemble genomes and DNA sequencing Technologies	[AP]

Course Contents:

Module I Introduction and Fundamentals & **Bioinformatics Algorithms and Analysis** **15 Hours**

Need for Bioinformatics technologies, Overview of Bioinformatics technologies, Applications, Fundamentals of genes, genomics, molecular evolution – genomic technologies –beginning of bioinformatics - genetic data –sequence data formats – secondary database – examples – data retrieval systems – genome browsers. Sequence alignment and similarity searching in genomic databases: BLAST and FASTA – additional bioinformatics analysis involving nucleic acid sequences-additional bioinformatics analysis involving protein sequences – Phylogenetic Analysis**.**

Module II DNA Replication and Molecular Clocks & Assemble Genomes And Sequences **15 Hours**

Beginning of DNA replication – open problems – multiple replication and finding replication – computing probabilities of patterns in a string-the frequency array-converting patterns-solving problems- finding frequents words-Big-O notation –case study-The Tower of Hanoi problem. Methods of assemble genomes – string reconstruction – De Bruijn graph – Euler‘s theorem – assembling genomes –DNA sequencing technologies – sequence antibiotics – Brute Force Algorithm – Branch and Bound algorithm – open problems – comparing biological sequences- Case Study –Manhattan tourist Problem.

Module III Human Genome **15 Hours**

Human and mouse genomes-random breakage model of chromosome evolution – sorting by reversals – greedy heuristic approach – break points- rearrangements in tumor and break point genomes-break point graphs- synteny block construction -open problems and technologies.

Total Hours: 45 Hours

Text Books:

1. Ion Mandoiu and Alexander Zelikovsky, “Computational Methods for Next Generation Sequencing Data Analysis — Wiley series 2016.
2. Philip Compeau and Pavel pevzner, —Bioinformatics Algorithms: An Active Learning Approach,2nd Edition, 2015.

Reference Books:

1. Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison , "Biological Sequence Analysis", Cambridge University Press,2013.
2. Supratim Choudhuri, —Bioinformatics For Beginners, Elsevier, 2014.
3. Neil C. Jones, Pavel A. Pevzner, Pavel Pevzner "An Introduction to Bioinformatics Algorithms", MIT Press, 2004.

Web References:

1. https://onlinecourses.nptel.ac.in/noc18_bt01/preview
2. https://nptel.ac.in/syllabus/106104018/

Online Resources:

1. https://www.cs.helsinki.fi/bioinformatiikka/mbi/courses/07-08/itb/slides/itb0708_slides_83-116.pdf
2. https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-discovery-and-structure-of-dna/v/dna-deoxyribonucleic-acid
3. https://www.cs.indiana.edu/~predrag/files/cohen_2004.pdf

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C501.1	Understand	Quiz	4
C501.3	Apply	Writing Skills	4
C501.4	Apply	Class Presentation	4
C501.2	Analyse	Assignment	4
Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination**
	CIA1	**CIA2**	

	[12 Marks]	**[12 Marks]**	**(60%) [60 Marks]**
Remember	-	-	-
Understand	20	20	20
Apply	30	30	30
Analyse	50	50	50
Evaluate	-	-	-
Create	-	-	-

22PF502 **COMPUTER VISION ANALYSIS** **3/0/0/3**

Nature of Course: D (Theory application)

Course Objectives:

1 To focus on development of algorithms and techniques to analyze and interpret the visible world around us.
2 To understand the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis, stochastic optimization etc.
3 To explore and contribute to research and further developments in the field of computer vision.

Course Outcomes:

Upon completion of the course, students shall have ability to

C502.1 Develop algorithms and techniques to analyze and interpret the visible world around us. [U]
C502.2 Demonstrate multi-dimensional signal processing, feature extraction, pattern analysis, stochastic optimization techniques. [AP]
C502.3 Design and explore research and further developments in the field of computer vision. [AP]
C502.4 Analyze a problem and assess the strengths and weaknesses of different methods and techniques for solving it. [AP]

Course Contents:

Module I Digital Image Formation and low-level processing **15 Hours**

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. Depth estimation and Multi-camera views - Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel. Feature Extraction - Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Module II Image Segmentation **15 Hours**

Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection. Pattern Analysis - Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Module III Motion Analysis **15 Hours**

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Shape from X - Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Total Hours: 45 Hours

Text Books:

1 Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2 Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2015.

Reference Books:

1 Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2nd Edition, 2004.
2 K. Fukunaga, "Introduction to Statistical Pattern Recognition", Academic Press, Morgan Kaufmann, 2nd Edition, 2013.
3 R.C. Gonzalez and R.E. Woods, Digital Image Processing, Prentice Hall, 2002.

Web References:

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2. IJCV (International Journal of Computer Vision) - Springer.

Online References:

1. 16-385 - Computer Vision, Spring 2018 (Instructor: Ioannis Gkioulekas)
2. 16-385 - Computer Vision, Spring 2017 (Instructor: Kris Kitani)

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<tr><td>C502.1</td><td>Understand</td><td>Online Quiz</td><td>4</td></tr>
<tr><td>C502.2</td><td>Understand</td><td>Assignment</td><td>4</td></tr>
<tr><td>C502.3</td><td>Apply</td><td>Group Assignment</td><td>4</td></tr>
<tr><td>C502.4</td><td>Apply</td><td>Case Study</td><td>4</td></tr>
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<tr><th>CIA1 [12 Marks]</th><th>CIA2 [12 Marks]</th></tr>
<tr><td>Remember</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Understand	60	60	60
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

22PF503 **GPU COMPUTING** **3/0/0/3**

Nature of Course D (Theory Application)

Pre requisites -

Course Objectives:

1 To learn parallel programming with Graphics Processing Units (GPUs).
2 To understand basic of memory operations and synchronization.
3 To implement kernel functions.
4 To analyse efficient programs using GPU programming models.

Course Outcomes:

Upon completion of the course, students shall have ability to

C503.1	Understand Graphical Processing units	[U]
C503.2	Demonstrate the working of memory operations and synchronization.	[AP]
C503.3	Implement parallel programs on GPUs.	[AP]
C503.4	Analyse efficient parallel algorithms and design applications using OPENCL and CUD	[A]

Course Contents:

Module I Introduction **15 Hours**

History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, **Memory**: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.

Module II Synchronization **15 Hours**

Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU. **Functions**: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries. **Case Studies**: Image Processing, Graph algorithms, Simulations, Deep Learning

Module III Graphical Processing Programming: OPENCL AND CUDA **15 Hours**

Introduction to CUDA – CUDA programming examples – CUDA execution model – CUDA memory hierarchy – CUDA case study - introduction to OpenCL – OpenCL programming examples – Programs and Kernels – Buffers and Images – Event model – OpenCL case study

Total Hours: 45 Hours

Text Books:

1. David Kirk, Wen-meiHwu, “Programming Massively Parallel Processors: A Hands-on Approach”, Morgan Kaufman; 2010.
2. A. Munshi, B. Gaster, T. G. Mattson, J. Fung, and D. Ginsburg, “OpenCL programming guide”, Addison Wesley, 2011.
3. Rob Farber, “CUDA application design and development”, Morgan Haufmann, 2011.

Reference Books:

1 Shane Cook, “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, Morgan Kaufman; 2012.

Web References:

1. https://nptel.ac.in/syllabus/syllabus_pdf/106102114.pdf
2. https://developer.nvidia.com/educators/existing-courses

Online Resources:

1. https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html
2. https://www.nvidia.in/object/deep-learning-courses-in.html

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<tr><td>C503.1</td><td>Understand</td><td>Quiz</td><td>4</td></tr>
<tr><td>C503.2</td><td>Apply</td><td>Writing Skills</td><td>4</td></tr>
<tr><td>C503.3</td><td>Apply</td><td>Class Presentation</td><td>4</td></tr>
<tr><td>C503.4</td><td>Analyse</td><td>Assignment</td><td>4</td></tr>
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Bloom's Level	Continuous Assessment (24%)		End Semester Examination (60%) [60 Marks]
	CIA1 [12 Marks]	CIA2 [12 Marks]	
Remember	-	-	-
Understand	40	30	30
Apply	40	40	40
Analyse	20	30	30
Evaluate	-	-	-
Create	-	-	-

22PF504 **CLOUD COMPUTING AND MANAGEMENT** **3/0/0/3**

Nature of Course: D (Theory application)

Pre requisites:

Course Objectives:

1. To recognize the basic concepts of virtualization and cloud infrastructure.
2. To demonstrate cloud enabling technologies and its applications.
3. To analyse the core issues of cloud computing such as security and interoperability.
4. To learn the concepts of map reduce programming.
5. To understand open source tools for cloud and real time applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C504.1	Discover the architecture, service models and deployment models of Cloud.	[AP]
C504.2	Experiment rudimentary aspects of cloud application development.	[A]
C504.3	Identify security aspects of each cloud model.	[U]
C504.4	Employ MapReduce Application using Hadoop setup.	[AP]
C504.5	Infer a private cloud with open source cloud tools and deploy simple cloud services.	[A]

Course Contents:

Module I Introduction to Cloud Computing Systems **15 Hours**

Introduction: Distributed Computing and Enabling Technologies, Cloud Fundamentals: Cloud Definition, Evolution, Architecture, Applications, deployment models, and service models. Virtualization: Issues with virtualization, virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, virtualization of data centers Containerization, Docker, Kubernetes - SLA Management. Interoperability and Service Monitoring. MapReduce and its extensions to Cloud HDFS, and GFS. Computing

Module II Cloud Management Tools **15 Hours**

Implementation: Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Introduction to Open Source Tools for IaaS: Eucalyptus, OpenStack. Open Source Tools for PaaS: Paasmaker, Cloudify. Open Source Tools for SaaS: Google Drive, Dropbox. OpenSource Tools for Research: CloudSim, GreenCloud, Salesforces - Deployment of Web Services from Inside and Outside a Cloud Architecture – REST API

Module III Security Issues and Fault Tolerance **15 Hours**

Security: Vulnerability Issues and Security Threats, Application-level Security, Data level Security, and Virtual Machine level Security, Infrastructure Security, and Multi-tenancy Issues. Intrusion detection System. Identity Access Management, Migration and Fault Tolerance: Broad Aspects of Migration into Cloud, Migration of virtual Machines and techniques. Fault Tolerance Mechanisms.

Total Hours: 45 Hours

Text Books:

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, “Cloud Computing Principles and Paradigms”, Wiley Publishers, 2011.
2. Naresh kumar sehgal, Pramod Chan P Bhatt “Cloud computing : concepts and practices” Springer, 2018

3. K. Chandrasekaran, “Essentials of Cloud Computing”, CRC Press, 2014.
4. Barrie Sosinsky, “Cloud Computing Bible”, Wiley Publishers, 2010.
5. Michael Miller, “Cloud Computing: Web-based Applications that change the way you work and collaborate online”, Pearson Education, 2008.
6 Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, “Mastering Cloud computing”, McGraw Hill, 2013.
7 Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, “Openstack Operational Guide”, O’Reilly, 2014.
8 Tim Mather, Subra Kumaraswamy, Shahed Latif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”, O’Reilly, 2010.

Reference Books:

1 Cloud Infrastructure and Services Participant Guide Volume 1 & 2 (EMC Education Services, Oct 2011)
2 Toby Velte, Antohy T Velte, Robert Elsenpeter, “Cloud Computing: A Practical Approach”, McGraw Hill, 2009.
3 David S. Linthicum, “Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide”, 2010.

Web References:

1. https://nptel.ac.in/courses/106105167/
2. https://www.coursera.org/specializations/cloud-computing#courses
3 https://www.udemy.com/learn-cloud-computing-from-scratch/

Online Resources:

1. https://www.udemy.com/docker-and-kubernetes-the-complete-guide/
2. https://dzone.com/articles/container-technologies-overview
3 https://dzone.com/articles/container-technologies-overview
4 https://www.tutorialspoint.com/restful/restful_first_application.htm

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Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C504.1	Apply	Quiz	4
C504.3	Understand	Writing Skills	4
C504.2 & C504.5	Analyse	Class Presentation	4
C504.4	Apply	Assignment	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	40	40	40
Apply	60	50	40
Analyse	-	10	20
Evaluate	-	-	-
Create	-	-	-

22PF505 **PARALLEL PROGRAMMING PARADIGMS** **3/0/0/3**

Nature of Course F (Programming Concepts)

Pre requisites

Course Objectives:

1 To familiarize the issues in parallel computing.

2 To describe distributed memory programming using MPI.

3 To understand shared memory paradigm with Pthreads and with OpenMP.

4 To learn the GPU based parallel programming using OpenCL.

Course Outcomes:

Upon completion of the course, students shall have ability to

C505.1	Identify issues in parallel programming.	[U]
C505.2	Develop distributed memory programs using MPI framework.	[AP]
C505.3	Design and develop shared memory parallel programs using Pthreads and using OpenMP.	[AP]
C505.4	Implement Graphical Processing OpenCL programs.	[AP]

Course Contents:

Module I Foundations of Parallel Programming **15 Hours**

Motivation for parallel programming - Concurrency in computing – basics of processes, multiprocessing, and threads – cache – cache mappings – caches and programs – virtual memory – instruction level parallelism – hardware multi-threading – SIMD – MIMD – interconnection networks – cache coherence – shared-memory model – issues in shared-memory model – distributed-memory model – issues in distributed-memory model – hybrid model – I/O – performance of parallel programs – parallel program design**.**

Module II Distributed Memory Programming With MPI **15 Hours**

Basic MPI programming – MPI_Init and MPI_Finalize – MPI communicators – SPMD- programs– MPI_Send and MPI_Recv – message matching – MPI- I/O – parallel I/O – collective communication – Tree-structured communication -MPI_Reduce – MPI_Allreduce, broadcast, scatter, gather, allgather – MPI derived types – dynamic process management – performance evaluation of MPI programs- A Parallel Sorting Algorithm **Shared Memory Paradigm with Pthreads & OpenMP** : Basics of threads, Pthreads – thread synchronization – critical sections – busy waiting – mutex – semaphores – barriers and condition variables – read write locks with examples - Caches, cache coherence and false sharing – Thread safety-Pthreads case study. Basics OpenMP – Trapezoidal Rule-scope of variables – reduction clause – parallel for directive – loops in OpenMP – scheduling loops –Producer Consumer problem – cache issues – threads safety in OpenMP – Two- body solvers- Tree Search

Module III Graphical Processing Paradigms: OpenCL and Introduction To CUDA 15 Hours

Introduction to OpenCL – Example-OpenCL Platforms- Devices-Contexts - OpenCL programming – Built-In Functions-Programs Object and Kernel Object – Memory Objects - Buffers and Images – Event model – Command-Queue - Event Object - case study. Introduction to CUDA programming.

Total Hours: 45 Hours

Text Books:

1. A. Munshi, B. Gaster, T. G. Mattson, J. Fung, and D. Ginsburg, “OpenCL programming guide”, Addison Wesley, 2016.

2 M. J. Quinn, “Parallel programming in C with MPI and OpenMP”, Tata McGraw Hill, 2003.

3 Peter S. Pacheco, “An introduction to parallel programming”, Morgan Kaufmann, 2011.

Reference Books:

1 Rob Farber, “CUDA application design and development”, Morgan Haufmann, 2011.

2 W. Gropp, E. Lusk, and A. Skjellum, “Using MPI: Portable parallel programming with the message passing interface”, MIT Press, 3rd Edition, 2014.

Web References:

1. https://nptel.ac.in/syllabus/106102114/
2. https://ugcmoocs.inflibnet.ac.in/download/course/curriculum/nptel/noc18-cs55.pdf

Online Resources:

1. https://nptel.ac.in/syllabus/syllabus_pdf/106102114.pdf

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C505.1	Understand	Quiz	4
C505.2	Apply	Case Study	4
C505.3	Apply	Class Presentation	4
C505.4	Apply	Assignment	4

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	40	30	30
Apply	40	40	40
Analyse	20	30	30
Evaluate	-	-	-
Create	-	-	-

22PF506 **MOBILE APPLICATIONS AND SERVICES** **3/0/0/3**

Nature of Course: F (Programming Concepts)

Pre requisites: -

Course Objectives:

1	To understand fundamentals and identify need and scope for mobile applications.
2	To learn the technologies and frameworks for designing and deploying mobile applications in Android and iPhone marketplace for distribution.
3	To study and take into account technical constraints, communication interfaces and user interfaces.
4	To explore emerging technologies and tools used to design and implement feature-rich mobile applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C506.1	Identify the system requirements, target platform and users to define mobile applications	[U]
C506.2	Describe the frameworks, development lifecycle and tools for mobile applications	[U]
C506.3	Implement mobile applications using Android SDK, iOS and cross-platform frameworks.	[AP]
C506.4	Analyze services, emerging technologies and tools used to design and implement feature-rich mobile applications.	[A]

Course Contents:

Module I Introduction **15 Hours**

Need for mobile applications – Cost of Development – Importance of Mobile strategies in the Business world-Market and business drivers for mobile application- Requirements gathering and validation for mobile applications- –Mobile Myths, Third party framework – Publishing and delivery of Mobile Applications-Marketing. Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools. Communications via Network and the Web: State Machine, Correct Communications Model, Android Networking and Web, Telephony. Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony

Module II Technology: Android **15 Hours**

Establishing the development environment –Android architecture - Activities and views – Interacting with UI – Persisting data using SQLite – Packaging and deployment- Interaction with server side applications- Using Google Maps, GPS and Wifi –Integration with social media applications. **IOS:** Introduction to Objective C – iOS features – UI implementation – Touch frameworks – Data persistence using Core Data and SQLite – Location aware applications using Core Location and Map Kit – Integrating calendar and address book with social media application – Using Wifi -iPhone marketplace.

Module III Applications and Services **15 Hours**

Creating Consumable Web Services for Mobile Devices- Understanding web services-Using web service languages (formats)-Creating an example service-Debugging web services. Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia Recent trends in Communication protocols for IOT nodes, mobile computing techniques in IOT, agents based communications in IOT.

Total Hours: 45 Hours

Text Books:

1. Bill Phillips, Chris Stewart, Kristin Marsicano," Android Programming: The Big Nerd Ranch Guide ,3rd Edition,2017.
2. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", Wrox, 2012.
3. Wei-Meng Lee, Beginning Android™ 4 Application Development, John Wiley & Sons,2012

Reference Books:

1. Charlie Collins, Michael Galpin, Matthias Kappler, "Android in Practicell, DreamTech", 2012.
2. James Dovey , Ash Furrow, "Beginning Objective C", Apress, 2012.
3. David Mark, Jack Nutting, Jeff LaMarche, Frederic Olsson, —Beginning iOS 6 Development: Exploring the iOS SDK, Apress, 2013.

Web References:

1. https://nptel.ac.in/courses/106106147/
2. https://www.coursera.org/learn/android-programming

Online Resources:

1. http://developer.android.com/develop/index.html.
2. https://www.google.com/search?client=firefox-b-d&q=ios+development+course

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Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C506.1	Understand	Quiz	4
C506.2	Understand	Assignment	4
C506.3	Apply	Class Presentation	4
C506.4	Analyse	Mini Project	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-

Understand	40	30	30
Apply	40	40	40
Analyse	20	30	30
Evaluate	-	-	-
Create	-	-	-

22PF507 **HUMAN COMPUTER INTERACTION** **3/0/0/3**

Nature of Course: C (Theory)

Pre requisites:

Course Objectives:

1 To identify the basic Interaction Design and way it can be used in product design.

2 To apply an interactive design process and universal design principles to designing HCI systems.

3 To analyze and discuss Usability design issues in groupware, ubiquitous computing, virtual reality and world wide web- related environments.

Course Outcomes:

Upon completion of the course, students shall have ability to

C507.1	Explain the capabilities of both humans and computers from the viewpoint of human information processing.	[U]
C507.2	Describe and use HCI design principles, standards and guidelines.	[U]
C507.3	Analyze tasks and dialogs of relevant HCI systems based on task analysis and dialog design.	[A]
C507.4	To apply appropriate HCI techniques to design systems that are usable by people	[AP]

Course Contents

Module I Introduction and Design of an Interactive system **15 Hours**

The human, The computer, The interaction, Paradigms, Usability of Interactive Systems, Guidelines, Principles, and Theories-Design Process- Interaction design basics, HCI in the software process, Design rules, Implementation support, Evaluation techniques, Universal design, User support-Design Issues- Quality of Service, Balancing Function and Fashion, User Documentation and Online Help, Information Search, Information Visualization

Module II Models and Theories **15 Hours**

Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration models, Task analysis, Dialogue notations and design, Models of the system, Modeling rich interaction

Module III Interaction Styles and New Interaction Techniques **15 Hours**

Interaction Styles- Direct Manipulation and Virtual Environments, Menu Selection, Form Filling and Dialog Boxes, Command and Natural Languages, Interaction Devices, Collaboration and Social Media Participation-New modes of human-computer communication -Voice Gesture -Eye movement -Tangible user interfaces -Brain-computer interfaces- Virtual Reality-Speech Recognition and Translation, Multimodal System System-Study of latest UI and UX tools -Rapid UI, Sketch, Figma, Balsamiq.

Total Hours: 45 Hours

Text Books:

1. Alan Dix, Janet Finlay, G D Abowd, R Beale, “Human Computer Interaction”, Pearson Education, 3rd Edition, 2009
2. Ben Shneiderman “Designing the User Interface - Strategies for Effective Human Computer Interaction”, Pearson Education, 3rd Edition, 2010.

Reference Books:

1 Rosson, M. and Carroll, J "Usability Engineering: Scenario-Based Development of Human-Computer Interaction" , Morgan Kaufmann, 2002.

2 Alan Cooper, Robert Reimann, David Cronin, "The Essentials of Interaction Design", Wiley, 4th Edition, 2007

3 Nielsen, J. "Usability Engineering", Morgan Kaufmann, 1993.

4 Heim, S "The Resonant Interface: HCI Foundations for Interaction Design", Addison-Wesley, 2007.

Web References:

1 https://www.oswego.edu/human-computer-interaction/human-computer-interaction-useful-links

2 https://www.interaction-design.org/courses/ui-design-patterns-for-successful-software

3 http://www.nixdell.com/classes/HCI-and-Design-Spring-2017/The-Design-of-Everyday-Things-Revised-and-Expanded-Edition.pdf

Online Resources:

1 http://hcibib.org/

2 https://in.udacity.com/course/human-computer-interaction--ud400

3 https://onlinecourses.nptel.ac.in/noc18_de03

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<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom's Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C507.1</td><td>Understand</td><td>Quiz</td><td>4</td></tr>
<tr><td>C507.2</td><td>Understand</td><td>Assignment</td><td>4</td></tr>
<tr><td>C507.3</td><td>Analyse</td><td>Case Study</td><td>4</td></tr>
<tr><td>C507.4</td><td>Apply</td><td>Case Study</td><td>4</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th rowspan="2">Bloom's Level</th><th colspan="2">Continuous Assessment (24%)</th><th rowspan="2">End Semester Examination (60%) [60 Marks]</th></tr>
<tr><th>CIA1 [12 Marks]</th><th>CIA2 [12 Marks]</th></tr>
</table>

Remember	-	-	-
Understand	40	30	30
Apply	40	40	40
Analyse	20	30	30
Evaluate	-	-	-
Create	-	-	-

22PF508 **SOCIAL NETWORK ANALYSIS** **3/0/0/3**

Nature of Course: F (Theory programming)

Pre requisites: -

Course Objectives:

1 To understand and represent the components of social network.
2 To extract the web community from web archive.
3 To understand the evolution of the social network.
4 To apply the text mining algorithms for extracting sentiment analysis and user opinion from social media.

Course Outcomes:

Upon completion of the course, students shall have ability to

C508.1	To understand the components of social network and represent them in a suitable form for mining.	[U]
C508.2	To employ Hadoop for performing data analysis	[A]
C508.3	To apply community mining algorithms for analyzing social networks	[AP]
C508.4	To understand the evolution and trend analysis of social networks	[U]
C508.5	To apply link prediction algorithm for	[AP]
C508.6	To apply the text mining algorithms for extracting sentiment analysis and user opinion from social media.	[AP]

Course Contents:

Module I Introduction and Modeling and Visualization **15 Hours**

Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks. Modeling and visualization: Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce- Ontological representation of social individuals and relationships.

Module II Mining Communities and Evolution **15 Hours**

Aggregating and reasoning with social network data, Advanced Representations - Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks. Evolution :Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction - Bayesian Probabilistic Models - Probabilistic Relational Models

Module III Text and Opinion Mining **15 Hours**

Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering - Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining – Review Classification – Tracking sentiments towards topics over time

Total Hours: 45 Hours

Text Books:

1 Charu C. Aggarwal, “Social Network Data Analytics”, Springer; 2011

2 Peter Mika, “Social Networks and the Semantic Web”, Springer, 1st edition, 2007.

3 Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 1st edition, 2010.

Reference Books:

1 Guandong Xu , Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, Springer, 1st edition, 2011.

2 Giles, Mark Smith, John Yen, “Advances in Social Network Mining and Analysis”, Springer, 2010.

3 Ajith Abraham, Aboul Ella Hassanien, Václav Snášel, “Computational Social Network Analysis: Trends, Tools and Research Advances”, Springer, 2009.

Web References:

1 http://www.w3schools.com/

2 http://www.tutorialspoint.com

3 www.researchgate.net/publication/241060171...

Online Resources:

1 https://nptel.ac.in/courses/106106169

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C508.1 & C508.4	Understand	Quiz	4
C508.2	Analyse	Assignment	4
C508.3 & C508.6	Apply	Class Presentation	4
C508.5	Apply	Group Project	4

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	20	20	20

Understand	40	40	40
Apply	40	40	30
Analyse	-	-	10
Evaluate	-	-	-
Create	-	-	-

22PF509 **WIRELESS NETWORKS** **3/0/0/3**

Nature of Course: C (Theory Concept)

Pre requisites: -

Course Objectives:

1. Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols.
2. Evaluate the performance of sensor networks and identify bottlenecks.
3. Device appropriate data dissemination protocols and model links cost.

Course Outcomes:

Upon completion of the course, students shall have ability to

C509.1	Describe and explain radio standards and communication protocols for wireless sensor networks.	[U]
C509.2	Explain the function of the node architecture and use of sensors for various applications.	[AP]
C509.3	Be familiar with sensor network database, security and tools.	[U]
C509.4	Understand design considerations for Infrastructure establishment and routing protocols.	[U]
C509.5	Understand the Sensor node management, sensor network middleware, operating system.	[U]

Course Contents:

Module I Introduction & MAC Protocols for WSN **15 Hours**

Overview of sensor networks- Constraints and challenges – Advantages of sensor networks- Applications- Collaborative processing – Key definitions in sensor networks – Tracking scenario – Problem formulation – Distributed representation and interference of states – Tracking multiple objects – sensor models- Performance comparison and metrics. Introduction to Markov Chain - Properties - Classification and Analysis - MAC protocols –fundamentals of wireless MAC protocols– Low duty cycle protocols and wake up concepts - Asynchronous Duty cycled. x - MAC Analysis (Markov Chain) – Contention-Based protocols – Schedule-Based protocols- IEEE 802.15.4 standard and ZigBee - General Issues - Geographic, Energy – Aware Routing - Attribute based routing.

Module II Infrastructure Establishment and Routing Protocols **15 Hours**

Topology control – Clustering -Time Synchronization – Localization and Positioning – Task driven sensing – Role of sensor nodes – Information based tasking - Routing and aggregation. Issues in designing a routing protocol -Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, mobile nodes, Data-centric routing – SPIN, Directed Diffusion, Gradient-based routing – COUGAR, ACQUIRE, Hierarchical Routing – LEACH, PEGASIS, Location Based Routing – GAF, GEAR. Analysis of opportunistic routing (Markov Chain)

Module III Sensor Network Database, Security and Tools **15 Hours**

Sensor Database Challenges – Querying the physical environment – Interfaces – In-network aggregation – Data centric storage – Data indices and range queries – Distributed Hierarchical aggregation – Temporal data. Possible attacks, countermeasures, SPINS, Static and dynamic keydistribution. Sensor Node Hardware– Node level software platforms – Operating system TinyOS – Node level simulators – State centric programming.

Total Hours: 45 Hours

Text Books:

1. Feng Zhao, Leonidas Guibas, “Wireless sensor networks an information processing approach”, Mogan kanufmann publishers, 2004.
2. Edgar H callaway,Jr “Wireless sensor networks : Architectures and protocols”, Auerbach Publication, 2004.
3. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice”, Wiley | 2010.

Reference Books:

1 Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, springer 2010.
2 Kazem Sohraby, Daniel Minoli and Taieb Znati, “wireless sensor networks -Technology, Protocols, and Applications”, Wiley, 2007.

Online Resources:

1 https://nptel.ac.in/courses/106105160/21
2 https://nptel.ac.in/noc/individual_course.php?id=noc17-cs07

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C509.1	Understand	Assignment	4
C509.2	Apply	Class Presentation	4
C509.3	Understand	Quiz	4
C509.4 & C509.5	Understand	Seminar	4

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	20	20	20
Apply	30	30	30

Analyse	50	50	50
Evaluate	-	-	-
Create	-	-	-

22PF510 DEEP LEARNING ARCHITECTURES AND APPLICATIONS 3/0/0/3

Nature of Course: G (Theory analytical)

Pre requisites:

Course Objectives:

1 To explain the basic concepts of neural networks and deep networks.
2 To discuss the major architectures of deep networks.
3 To examine the core concepts in deep architecture tuning
4 To demonstrate the applications of deep learning.

Course Outcomes:

Upon completion of the course, students shall have ability to

C510.1	Distinguish neural and deep networks.	[U]
C510.2	Select the appropriate deep network architecture.	[U]
C510.3	Analyze the performance of a deep learning network.	[A]
C510.4	Apply deep learning for solving real world problems.	[AP]

Course Contents:

Module I **15 Hours**

Foundations of Neural Networks - Neural Networks - Training Neural Networks – Activation Functions - Loss Functions - Hyperparameters. **Fundamentals of Deep Networks** – Defining Deep Learning - Common Architectural Principles of Deep Networks - Building Blocks of Deep Networks.

Module II **15 Hours**

Major Architectures of Deep Networks - Unsupervised Pre-Trained Networks - Convolutional Neural Networks - Recurrent Neural Networks - Recursive Neural Networks. Tuning Deep Networks **- Tuning Specific Deep Network Architectures**- Convolution Neural Networks (CNNs)- Recurrent Neural Networks- Restricted Boltzmann Machines- DBNs.

Module III **15 Hours**

Applications-Large-Scale deep learning – Computer Vision – Speech Recognition – Natural Language Processing- Recommender systems.

Case Study- Applications of Deep Learning in Health care, Deep learning tools.

Total Hours: 45 Hours

Text Books:

1. Adam Gibson, Josh Patterson, Deep Learning, A Practitioner's Approach, O'Reilly Media, 2017.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

Reference Books:

1. Daniel Graupe, Deep Learning Neural Networks: Design and Case Studies, World Scientific Publishing, 2016.
2. Yu and Li Deng, Deep Learning: Methods and Applications, Now Publishers Inc, 2014.
3. Zurada, J.M. "Introduction to Artificial Neural systems", Jaico Publishing House, 2012.

Web References:

1 http://deeplearning.cs.cmu.edu/
2 http://deeplearning.net/
3 https://arxiv.org/pdf/1706.05098.pdf

Online Resources:

1 http://nptel.ac.in/courses/
2 https://www.udacity.com/course/deep-learning--ud730
3 https://bigdatauniversity.com/courses/introduction-deep-learning/
4 https://cognitiveclass.ai/courses/deep-learning-tensorflow/

5 https://www.coursera.org/lecture/machine-learning-projects/multi-task-learning-l9zia

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						End Semester Examination (60 %)
CA 1 (20 Marks)			CA2 (20 Marks)			Theory Examination (60 Marks)
SA 1 (12 Marks)	FA 1		SA 2 (12 marks)	FA 2		
	Component -I (4 marks)	Component –II (4 marks)		Component -I (4 marks)	Component -II (4 marks)	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)	Marks
C510.1	Understand	Online Quiz	4
C510.2	Understand	Assignment	4
C510.3	Analyse	Case Study	4
C510.4	Apply	Technical Presentation	4

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (24%)		End Semester Examination (60%) [60 Marks]
	CIA1 [12 Marks]	CIA2 [12 Marks]	
Remember	20	10	10
Understand	40	40	40
Apply	10	30	30
Analyse	30	20	20
Evaluate	-	-	-
Create	-	-	-

PROFESSIONAL ELECTIVE COURSES STREAM 2

22PF511 **IMAGE PROCESSING AND ANALYSIS** **3/0/0/3**

Nature of Course: D (Theory Application)

Pre requisites:

Course Objectives:

1 To illustrate basic & advanced concepts of digital image processing

2 To apply wavelets, compression & segmentation concepts in real-time projects

3 To illustrate basic concepts of image restoration and feature extraction

4 To develop image processing programs using MATLAB

Course Outcomes:

Upon completion of the course, students shall have ability to

C511.1	To illustrate basic & advanced concepts of digital image processing	[U]
C511.2	To apply wavelets, compression & segmentation concepts in real-time projects	[AP]
C511.3	To illustrate basic concepts of image restoration and feature extraction	[AP]
C511.4	To develop image processing programs using MATLAB	[AP]

Course Contents:

Module I **15 Hours**

Mathematical tools, Intensity transformations and spatial filtering, Histogram processing, Lowpass &highpass spatial filters, Frequency domain – Preliminary concepts, DFT, DCT, Lowpass &highpass frequency domain filters, Image restoration and reconstruction. MATLAB tool for image processing – Basic image manipulations, DCT, DWT, Filters.

Module II **15 Hours**

Image transformation, compression and segmentation: Wavelet transforms – Matrix-based transforms, Correlation, Walsh-Hadamard transform, Slant transform, Haar transform. Color image processing, color models, Image compression – Fundamentals, Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-length coding, Block transform coding, JPEG standard. Image segmentation - Point, Line, and Edge Detection, Canny edge detector, Marr-Hildreth edge detector, Basic Global Thresholding.

Module III **15 Hours**

MATLAB tool for edge detection, color model and color conversion. Image restoration and Feature extraction: Degradation/restoration model – Noise model, Spatial filters, Frequency domain filters, Estimating the Degradation Function, Inverse filtering, Minimum mean square error (Wiener) filter, Feature extraction – Boundary preprocessing, Boundary feature descriptors, Region feature descriptors

Total Hours: 45 Hours

Text Books:

1 Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson Education, 2018.

2 Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Tata McGraw-Hill, 2nd Edition, 2010.

3 Scott E Umbaugh, "Digital Image Processing and Analysis: Applications with MATLAB and CVIP tools", CRC Press, 3rd Edition, 2017.

Reference Books:

1 Jason M. Kinser, "Image Operators: Image Processing in Python", CRC Press, 2018.

2 S. Sridhar, “Digital Image Processing”, Oxford university press, 2011.

3 Annadurai S., Shanmugalakshmi R., “Fundamentals of Digital Image Processing”, Pearson Education (Singapore) Pvt. Ltd., 2007.

Web References:

1. https://nptel.ac.in/courses/117105079/
2. https://nptel.ac.in/courses/117105101/

Online Resources:

1. http://www.imageprocessingplace.com/
2. https://ocw.mit.edu/courses/media-arts-and-sciences/mas-622j-pattern-recognition-and-analysis-fall-2006/

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C511.1	Understand	Quiz	4
C511.2	Apply	Assignment	4
C511.3	Apply	Technical presentation	4
C511.4	Apply	Mini-project	4

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	40	60	50
Apply	60	40	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

22PF512 COMPILER OPTIMIZATION TECHNIQUES 3/0/0/3

Nature of Course : C (Theory Concept)

Pre requisites

Course Objectives:

1 To predict the optimizations techniques for simple program blocks.
2 To illustrate optimizations on procedures, control flow and parallelism.
3 To impart the inter-procedural analysis and optimizations.
4 To underline the concepts about resource utilization.

Course Outcomes:

Upon completion of the course, students shall have ability to

C512.1	Underline the different optimization techniques for simple program blocks.	[R]
C512.2	Design performance enhancing optimization techniques.	[U]
C512.3	Perform the inter-procedural analysis and optimizations.	[U]
C512.4	Employ Resource Utilization Techniques.	[AP]

Course Contents:

Module I Intermediate Representations and Analysis, Early and Loop Optimization

15 Hours

Review of Compiler Structure - Structure of an Optimizing Compiler - Issues in designing an Intermediate Languages - LIR, MIR, HIR - Importance of Code Optimization - Early Optimizations: Constant-Expression Evaluation - Scalar Replacement of Aggregates - Algebraic Simplifications and Re-association - Value Numbering - Copy Propagation - Sparse Conditional Constant Propagation. Redundancy Elimination: Common - Sub-expression Elimination - Loop-Invariant Code Motion - Partial-Redundancy Elimination - Redundancy Elimination and Re-association - Code Hoisting. Loop Optimizations: Induction Variable Optimizations - Unnecessary Bounds Checking Elimination.

Module II Optimization and Scheduling **15 Hours**

Procedure Optimizations: Tail-Call Optimization and Tail-Recursion Elimination - Procedure Integration - In-Line Expansion - Leaf-Routine Optimization and Shrink Wrapping. Code Scheduling: Instruction Scheduling - Speculative Loads and Boosting - Speculative Scheduling - Software Pipelining - Trace Scheduling - Percolation Scheduling. Control-Flow and Low-Level Optimizations: Unreachable-Code Elimination - Straightening - If Simplifications - Loop Simplifications -Loop Inversion – Un-switching - Branch Optimizations - Tail Merging or Cross Jumping - Conditional Moves - Dead-Code Elimination - Branch Prediction - Machine Idioms and Instruction Combining.

Module III Inter Procedural Optimization, Register Allocation and Optimizing for Memory

15 Hours

Symbol table – Runtime Support - Interprocedural Analysis and Optimization: Interprocedural Control Flow Analysis - The Call Graph - Interprocedural Data-Flow Analysis - Interprocedural Constant Propagation - Interprocedural Alias Analysis - Interprocedural Optimizations - Interprocedural Register Allocation - Aggregation of Global References. Register Allocation: Register Allocation and Assignment - Local Methods - Graph Coloring - Priority Based Graph Coloring - Other Approaches to Register Allocation. Optimization for the Memory Hierarchy: Impact of Data and Instruction Caches - Instruction-Cache Optimization - Scalar Replacement of Array Elements - Data-Cache Optimization - Scalar vs. Memory-Oriented Optimizations.

Total Hours: 45 Hours

Text Books:

1 Randy Allen and Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence based Approach”, Morgan Kaufman, 2001.

2 Keith Cooper, Linda Torczon, "Engineering a Compiler", Morgan Kaufmann, Second Edition, 2011.

3 Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques, and Tools", Addison Wesley, 2nd Edition, 2007.
4 Steven Muchnick - Advanced Compiler Design and Implementation, Morgan Kaufman Publishers, 1997.

Reference Books:

1 Andrew W. Appel, Jens Palsberg, "Modern Compiler Implementation in Java", Cambridge University Press, 2nd Edition, 2002.
2 Robert Morgan, “Building an Optimizing Compiler”, Digital Press, 1998

Web References:

1 https://www.tutorialspoint.com/compiler_design/compiler_design_code_optimization.htm
https://suif.stanford.edu/~courses/cs243/
2 http://infolab.stanford.edu/~ullman/dragon/w06/w06.html
3 https://nptel.ac.in/courses/106108052/2

Online Resources:

1 https://openlibrary.org/books/OL667341M/Advanced_compiler_design_and_implementation
2 https://www.slideshare.net/gakojebev/advanced-compiler-design-and-implementation-free

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C512.1	Remember	Quiz	4
C512.2	Understand	Assignment	4
C512.3	Understand	Class Presentation	4
C512.4	Apply	Group Project	4
Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	

Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

22PF513 **MACHINE LEARNING APPROACHES** **3/0/0/3**

Nature of Course: G (Theory analytical)

Pre requisites:

Course Objectives:

1	To discuss basic concepts of machine learning and its usage in real world scenarios
2	To explain different supervised learning techniques, merits and demerits
3	To describe about the Graphical models and their applicability to real world problems
4	To employ discovering clusters in the given data and also apply different clustering algorithms in different datasets
5	To interpret dimensionality reduction for the given data

Course Outcomes:

Upon completion of the course, students shall have ability to

C513.1	Infer the acquired knowledge on recalling the applications of machine learning	[U]
C513.2	Interpret the concepts behind different types of learning and their appropriateness	[AP]
C513.3	Apply appropriate learning technique for a given real world problem	[AP]
C513.4	Analyse the observations for a given set of data	[A]
C513.5	Discuss the effectiveness of different learning techniques for different kinds of data and applications	[U]

Course Contents:

Module I **15 Hours**

Introduction to Machine Learning: what and why, Designing a learning system, Issues. Examples of Machine Learning Applications, Overview: Supervised Learning, Learning Associations, Classification, Regression, Unsupervised learning, Semi Supervised learning and Reinforcement Learning.

Module II **15 Hours**

Supervised Learning: Generative vs discriminative learning, Gaussian mixture models, Decision Tree learning, Neural Networks- feed forward and backward propagation, Support Vector machines, Instance based learning, Ensemble learning. Graphical models: Bayesian Learning, Markov random Fields, Hidden Markov model, Issues of HMM, conditional random fields.

Module III **15 Hours**

Regression: Linear regression, logistic regression, Over fitting, Model selection. Unsupervised learning: Discovering clusters, Discovering latent factors, Discovering graph structure, Dimensionality reduction-Principal Component Analysis Case studies Conditional Random Field Learning for OCR, Structure Learning for Identifying Skeleton Structure, Human Action Recognition with Kinect.

Total Hours: 45 Hours

Text Books:

1. Ethem Alpaydin, “Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)”, MIT Press, 3rd Edition, , 2014.
2. Kevin P. Murphy, “Machine Learning A probabilistic Perspective”, MIT press, 2012
3. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Pearson 4th Edition , 2007.

Reference Books:

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2. Jason Bell, “Machine learning – Hands on for Developers and Technical Professionals”, Wiley, 1st Edition, 2014.
3. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2nd Edition, 2014.
4. Tom M. Mitchell – Machine Learning, MCGraw-Hill, 1997

Web References:

1. https://onlinecourses.nptel.ac.in/noc16_cs18/preview
2. https://freevideolectures.com/course/2257/machine-learning
3. https://www.coursera.org/learn/machine-learning

Online Resources:

1. https://www.analytixlabs.co.in/machine-learning-course-certification-training
2. https://in.udacity.com/course/intro-to-machine-learning--ud120-india

<table>
<tr><th colspan="7">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="6">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
<tr><th colspan="3">CA 1 (20 Marks)</th><th colspan="3">CA2 (20 Marks)</th><th rowspan="3">Theory Examination (60 Marks)</th></tr>
<tr><th rowspan="2">SA 1 (12 Marks)</th><th colspan="2">FA 1</th><th rowspan="2">SA 2 (12 marks)</th><th colspan="2">FA 2</th></tr>
<tr><th>Component -I (4 marks)</th><th>Component –II (4 marks)</th><th>Component -I (4 marks)</th><th>Component -II (4 marks)</th></tr>
</table>

<table>
<tr><th colspan="4">Assessment Methods & Levels (based on Blooms’ Taxonomy)</th></tr>
<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom’s Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C513.1 & C513.5</td><td>Understand</td><td>Quiz</td><td>4</td></tr>
<tr><td>C513.3</td><td>Apply</td><td>Writing Skills</td><td>4</td></tr>
<tr><td>C513.4</td><td>Apply</td><td>Class Presentation</td><td>4</td></tr>
<tr><td>C513.2</td><td>Analyze</td><td>Assignment</td><td>4</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
</table>

Bloom's Level	Continuous Assessment (24%)		End Semester Examination (60%) [60 Marks]
	CIA1 [12 Marks]	CIA2 [12 Marks]	
Remember	-	-	-
Understand	20	20	20
Apply	30	30	30
Analyse	50	50	50
Evaluate	-	-	-
Create	-	-	-

22PF514 NATURAL LANGUAGE PROCESSING MODELS 3/0/0/3

Nature of Course: D (Theory application)

Course Objectives:

1	To recognize the basic concepts of Language models and word level analysis
2	To examine the syntactic and semantic analysis of Natural Language processing.
3	To describe the various representations of discourse processing in Natural Language.
4	To categorize the various applications of Natural Language Processing.

Course Outcomes:

Upon completion of the course, students shall have ability to

C514.1	Recognize the various Language models and word level analysis.	[U]
C514.2	Experiment the syntactic and semantic analysis of natural language processing.	[A]
C514.3	Analyse the various applications of Natural Language Processing.	[A]

Course Contents:

Module I Overview and Word Level Analysis of NLP 15 Hours

Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages-NLP Applications-Information Retrieval. Language Modeling: Various Grammar- based Language Models-Statistical Language Model. Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging.

Module II Discourse Processing and Machine Translation of NLP 15 Hours

Syntactic Analysis: Context-free Grammar-Constituency- Parsing-Probabilistic Parsing. Semantic Analysis: Meaning Representation-Lexical Semantics- Ambiguity-Word Sense Disambiguation. Discourse Processing: cohesion-Reference Resolution- Discourse Coherence and Structure.

Module III Machine Translation and Information Extraction in NLP 15 Hours

Machine Translation –Issues in Machine Translation - Classical MT and the Vauquois Triangle-Statistical MT - Phrase-Based Translation Model - Alignment in MT –IBM Models –Evaluation. Information Extraction – Named Entity Recognition - Relation Detection and Classification – Temporal and Event Processing - Template-Filling - Biomedical Information Extraction. APPLICATIONS OF NLP: Question Answering and Summarization -Information Retrieval -Factoid Question Answering - Summarization - Single and Multi-Document Summarization - Focused Summarization - Evaluation. Dialog and Conversational Agents – Properties of Human Conversations - Basic Dialogue Systems - VoiceXML - Information- State and Dialogue Acts - Markov Decision Process Architecture.

Total Hours: 45 Hours

Text Books:

1. Daniel Jurafsky, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2014.
2. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.
3. Nitin Indurkhya, Fred J. Damerau, “Handbook of Natural Language Processing”, (Chapman & Hall/CRC Machine Learning & Pattern Recognition), 2nd Edition, 2010.

Reference Books:

1. James Allen, “Natural Language Understanding”, Addison Wesley, 2nd Edition, 2007.
2. Alexander Clark, Chris Fox, Shalom Lappin, “The Handbook of Computational Linguistics and Natural Language Processing”, Wiley-Blackwell, 2012.

Web References:

1. https://nptel.ac.in/syllabus/106101007/
2. https://dl.acm.org/results.cfm?query=Natural+language+processing&Go.x=0&Go.y=0
3. https://machinelearningmastery.com/applications-of-deep-learning-for-natural-language-processing/

Online Resources

1. https://towardsdatascience.com/a-practitioners-guide-to-natural-language-processing-part-i-processing-understanding-text-9f4abfd13e72
2. https://www.edx.org/course/natural-language-processing-3
3. https://www.coursera.org/learn/language-processing

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C514.1	Understand	Assignment	4
C514.2	Analyse	Quiz	4
C514.3	Analyse	Case study	8

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	20	20	20
Apply	30	40	40
Analyse	50	40	40

Evaluate	-	-	-
Create	-	-	-

22PF515 **INFORMATION RETRIEVAL** **3/0/0/3**

Nature of Course: G (Theory & Analytical)

Course Objectives:

1 To understand the information retrieval techniques from the world wide web

2 To understand the concepts of IR models

3 To explore various data management techniques

Course Outcomes:

Upon completion of the course, students shall have ability to

C515.1	Understand data modelling, indexing and searching techniques	[U]
C515.2	Apply classification and clustering techniques on text documents	[AP]
C515.3	Understand ethics in an information society	[U]
C515.4	Improve business performance and decision making	[AP]

Course Contents:

Module I Modeling, Indexing and Searching **15 Hours**

Motivation-Basic Concepts-Early Developments-IR System Architecture-Retrieval Process-Web: Introduction-Web Characteristics-The Impact of The Web on IR-IR Versus Web Search-Challenges-Search Engines-Boolean Retrieval. Modeling: Taxonomy and Characterization of IR Models-Boolean Model-Vector Model-Probabilistic Models-Set Theoretic Models-Algebraic Models-Structured Text Retrieval Models-Models for Browsing. Indexing: Introduction-Index Construction-Index Compression. Searching: Sequential Searching-Pattern Matching.

Module II Classification and Clustering **15 Hours**

Text classification and Naïve Bayes-Vector Space Classification-Support Vector Machines and Machine Learning on Documents-Flat Clustering-Hierarchical Clustering-Matrix Decomposition and Latent Semantic Indexing. Organizations and Information Systems – Impact of Information Systems – Ethics in an information society – IT Infrastructure – Infrastructure Components – Hardware Platform Trends – Software Platform Trends

Module III Managing Data Resources **15 Hours**

Organizing Data in Traditional File Environment - Database Approach to Data Management – Using Databases to improve Business Performance and Decision Making.

Total Hours: 45 Hours

Text Books:

1 Ricardo Baeza-Yates,Berthier Ribeiro-Neto,"Modern information retrieval" Pearson 2011.

2 Christopher D.Manning,Prabhakar Raghavan,Hinrich Schutze, "Introduction to information retrieval",Cambridge university press,4th edition 2012.

3 Kenneth C. Laudon, Jane Price Laudon and Rajanish Dass, "Management Information Systems – Managing the digital firm", Pearson Education, 2010.

Reference Books:

1 C.D. Manning, P. Raghvan and H. Schutze, "Introduction to Information Retrieval", Cambridge University Press, 2008.

2 Stephen Buettcher, Charles L.A. Clarke and Gordon V. Carmack, “Information Retrieval: Implementing and Evaluating Search Engines”, MIT Press, 2010.

3 Turban, McLean and Wether, “Information Technology for Management –Transforming Organisations in the Digital Economy”, John Wiley, 2008.

Web References:

1. Data Mining and Knowledge Discovery, Wiley
2. Information Systems Journal, Wiley
3. Conference on Information and Knowledge Management (CIKM)

Online References:

1. Information Retrieval, Springer
2. Knowledge and Information Systems, Springer
3. World Wide Web, Springer

<table>
<tr><th colspan="6">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="5">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
<tr><th colspan="3">CA 1 (20 Marks)</th><th colspan="2">CA2 (20 Marks)</th><th rowspan="3">Theory Examination (60 Marks)</th></tr>
<tr><th rowspan="2">SA 1 (12 Marks)</th><th colspan="2">FA 1</th><th rowspan="2">SA 2 (12 marks)</th><th colspan="2">FA 2</th></tr>
<tr><th>Component -I (4 marks)</th><th>Component –II (4 marks)</th><th>Component -I (4 marks)</th><th>Component -II (4 marks)</th></tr>
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<tr><th colspan="4">Assessment Methods & Levels (based on Blooms’ Taxonomy)</th></tr>
<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom’s Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C515.1</td><td>Understand</td><td>Online Quiz</td><td>4</td></tr>
<tr><td>C515.3</td><td>Understand</td><td>Assignment</td><td>4</td></tr>
<tr><td>C515.2</td><td>Apply</td><td>Group Assignment</td><td>4</td></tr>
<tr><td>C515.4</td><td>Apply</td><td>Case Study</td><td>4</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
</table>

<table>
<tr><th rowspan="2">Bloom’s Level</th><th colspan="2">Continuous Assessment (24%)</th><th rowspan="2">End Semester Examination (60%) [60 Marks]</th></tr>
<tr><th>CIA1 [12 Marks]</th><th>CIA2 [12 Marks]</th></tr>
<tr><td>Remember</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Understand</td><td>60</td><td>60</td><td>60</td></tr>
</table>

Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

22PF516 **REAL TIME SYSTEMS** **3/0/0/3**

Nature of Course: C (Theory Concept)

Pre requisites:

Course Objectives:

1	To identify the issues related to the design and analysis of systems with real-time constraints.
2	To illustrate the features of Real time OS.
3	To recognize the various Uniprocessor and Multiprocessor scheduling mechanisms.
4	To relate the difference between traditional and real time databases.
5	To recognize the various real time communication protocols and techniques.

Course Outcomes:

Upon completion of the course, students shall have ability to

C516.1	Recognize various specifications and scheduling mechanism for real time systems.	[U]
C516.2	Analyze various measures for real time systems	[A]
C516.3	Apply communication protocols and databases in real time applications	[AP]
C516.4	Apply principles of real time system design techniques to develop real time applications.	[AP]

Course Contents:

Module I Real Time Specification and Scheduling **15 Hours**

Introduction, Structure of a Real Time System, Task classes, Performance Measures for Real Time Systems, Estimating Program Run Times, Issues in Real Time Computing, Task Assignment and Scheduling, Classical uniprocessor scheduling algorithms, Fault Tolerant Scheduling.

Module II Real Time Communication and Databases **15 Hours**

Communication Media, Network topologies and architecture issues, protocols, RT Database Basic Definitions, Real time Vs General Purpose Databases, Main Memory Databases, Transaction priorities and aborts, Concurrency control issues, Disk scheduling algorithms, Two phase approach to improve predictability, Maintaining Serialization Consistency, Databases for Hard Real Time System.

Module III Programming Languages, Tools and Techniques **15 Hours**

Hierarchical decomposition, Run-time error handling, Overloading, Timing specification, Fault-Tolerance and Reliability Evaluation Techniques, Clock Synchronization.

Total Hours: 45 Hours

Text Books:

1. C.M. Krishna, Kang G. Shin,"Real-Time Systems", McGraw-Hill International Editions, 2010.

Reference Books:

1. Philip.A.Laplante, "Real Time System Design and Analysis", Prentice Hall of India, 3rd Edition, 2004
2. Jane W.S. Liu, "Real-Time Systems", Pearson Education India, 2000.
3. Allen Burns, Andy Wellings, "Real Time Systems and Programming Languages", Pearson Education, 2003.

Web References:

1. https://nptel.ac.in/downloads/106105086/
2. https://nptel.ac.in/courses/106105172/

Online Resources:

1. https://www.geeksforgeeks.org/operating-system-real-time-systems/
2. https://users.ece.cmu.edu/~koopman/des_s99/real_time/

<table>
<tr><th colspan="6">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="5">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
<tr><th colspan="3">CA 1 (20 Marks)</th><th colspan="2">CA2 (20 Marks)</th><th rowspan="3">Theory Examination (60 Marks)</th></tr>
<tr><th rowspan="2">SA 1 (12 Marks)</th><th colspan="2">FA 1</th><th rowspan="2">SA 2 (12 marks)</th><th colspan="2">FA 2</th></tr>
<tr><th>Component -I (4 marks)</th><th>Component –II (4 marks)</th><th>Component -I (4 marks)</th><th>Component -II (4 marks)</th></tr>
</table>

<table>
<tr><th colspan="4">Assessment Methods & Levels (based on Blooms' Taxonomy)</th></tr>
<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom's Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C516.1</td><td>Understand</td><td>Quiz</td><td>4</td></tr>
<tr><td>C516.2</td><td>Analyse</td><td>Writing Skills</td><td>4</td></tr>
<tr><td>C516.3</td><td>Apply</td><td>Class Presentation</td><td>4</td></tr>
<tr><td>C516.4</td><td>Apply</td><td>Assignment</td><td>4</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
</table>

Bloom's Level	Continuous Assessment (24%)		End Semester Examination (60%) [60 Marks]
	CIA1 [12 Marks]	CIA2 [12 Marks]	
Remember	-	-	-
Understand	20	20	20
Apply	30	30	30
Analyse	50	50	50
Evaluate	-	-	-
Create	-	-	-

22PF517 BIG DATA ANALYTICS FRAMEWORKS 3/0/0/3

Nature of Course: G (Theory and analytical)

Prerequisite:

Course Objectives:

1 To understand the big data frameworks.

2 To provide an insight to different data analysis methods.

3 To learn stream computing.

4 To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

Course Outcomes:

Upon completion of the course, students shall have ability to

C517.1 Understand how to leverage the insights from big data analytics. [U]

C517.2 Analyze data by utilizing various statistical and data mining approaches. [A]

C517.3 Perform analytics on real-time streaming data. [AP]

C517.4 Understand the various NoSQL alternative database models. [U]

Course Contents:

Module I Introduction to Big Data 15 Hours

Big Data – Definition, Characteristic Features – Big Data Applications - Big Data vs Traditional Data - Risks of Big Data - Structure of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools.

Module II Hadoop Framework 15 Hours

Distributed File Systems - Large-Scale File System Organization – HDFS concepts - MapReduce Execution, Algorithms using Map Reduce, Matrix-Vector Multiplication – Hadoop YARN DATA ANALYSIS Statistical Methods: Regression modeling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data - Predictive Analytics – Data analysis using R.

Module III Mining Data Streams 15 Hours

Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream - Mining Data Streams and Mining Time-series data - Real Time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions. BIG DATA FRAMEWORKS Introduction to NoSQL – Aggregate Data Models – Hbase: Data Model and Implementations – Hbase Clients – Examples – Cassandra: Data Model – Examples – Cassandra Clients – Hadoop Integration. Pig – Grunt – Pig Data Model – Pig Latin – developing and testing Pig Latin scripts. Hive – Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries

Total Hours: 45 Hours

Text Books:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2nd Edition,2014
2. Benjamin Bengfort, Jenny Kim, “Data Analytics with Hadoop An Introduction for Data Scientists”, O'Reilly Media, 2016.

3 James, G., Witten, D., Hastie, T., Tibshirani, R, “An Introduction to Statistical Learning with Applications in R”, Springer,2013.
4 William McKinney, “Python for Data Analysis”, O'Reilly Media,2nd Edition, 2017.

Reference Books:

1 Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, Wiley and SAS Business Series, 2012.
2 David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
3 Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2nd Edition, 2007.
4 Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
5 P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
6 Richard Cotton, "Learning R – A Step-by-step Function Guide to Data Analysis, O‘Reilly Media, 2013.

Web references

1 https://www.edx.org/course/subject/data-analysis-statistics
2 https://www.coursera.org/browse/data-science/data-analysis?languages=en
3 https://www.udemy.com/python
4 https://www.simplilearn.com/big-data-and-analytics/big-data-hadoop-architect-masters-program
5 https://www.edureka.co/big-data-and-hadoop?gclid=EAIaIQobChMIw8nI_KSz4QIVxxW
6 https://www.udemy.com/topic/big-data/
7 https://www.coursera.org/specializations/big-data

Online resources

1 https://bigdatauniversity.com/
2 https://public.tableau.com/en-us/s/resources
3 https://pythonprogramming.net/data-analysis-python-pandas-tutorial-introduction/
4 http://www.statistics.com/data-analytics-courses

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz,**	**Marks**

		Assignment, Case study, Seminar, Group Assignment)	
C517.1	Understand	Assignment	4
C517.2	Analyse	Quiz	4
C517.3	Apply	Case study	4
C517.4	Understand	Presentation	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	20	30	20
Apply	30	30	40
Analyse	50	40	40
Evaluate	-	-	-
Create	-	-	-

22PF518 **DIGITAL FORENSICS** **3/0/0/3**

Nature of Course: D (Theory Application)

Pre-Requisite:

Course Objectives:

1	Describe the in-depth knowledge of rapidly changing and fascinating field of computer forensics.
2	Inspect the different cyber crime scenes, E-evidence collection and preservation.
3	Analyze the various forensics processes and procedures, data acquisition and validation and e-discovery tools.

Course Outcomes:

Upon completion of the course, students shall have ability to

C518.1	Describe the computer forensics and methods used for cyber crime scene analysis.	[U]
C518.2	Illustrate the proper evidence management methods in digital forensics	[AP]
C518.3	Identify the secured open source tools for different types of forensics.	[A]

Course Contents:

Module I Digital Forensics Science and Computer Crime **15 Hours**

Forensics science, computer forensics, and digital forensics. Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber-criminalistics area, holistic approach to cyber-forensics.

Module II Cyber Crime Scene Analysis **15 Hours**

Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation. Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.

Module III Computer Forensics, Network Forensics & Mobile Forensics **15 Hours**

Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, and Complete a case, Critique a case, Network Forensics: open-source security tools for network forensic analysis, requirements for reservation of network data. Mobile forensics techniques, mobile forensics tools**.** Case Study: Recent trends in mobile forensic technique and methods to search and seizure electronic evidence. Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008.

Total Hours: 45 Hours

Text Books:

1. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications,2015.
2. John Sammons, The Basics of Digital Forensics, Elsevier,2012
3. Digital Forensics with Open Source Tools.Cory Altheide and Harlan Carvey, ISBN:978-1-59749-586-8, Elsevier publication, April 2011.

Reference Books:

1. Jonathan Ham,Sherri Davidoff, “Network Forensics: Tracking Hackers Through Cyberspace”, Prentice Hall, 2012

2. Warren G. Kruse II and Jay G. Heiser, “Computer Forensics: Incident Response Essentials”, Addison Wesley, 2002.

Web References:

1. https://resources.infosecinstitute.com/category/computerforensics/introduction/computer-forensics-salary-data/
2. https://www.hackingarticles.in/best-of-computer-forensics-tutorials/
3. https://www.youtube.com/watch?v=3z3Iau04gt8

Online Resources

1. https://www.cs.nmt.edu/~df/lectures.html
2. https://www.open.edu/openlearn/science-maths-technology/digital-forensics/content-section-0?active-tab=content-tab
3. https://www.lynda.com/Developer-tutorials/Computer-Forensics-Essential-Training/170337-2.html

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<tr><th colspan="7">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="6">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
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<tr><th colspan="4">Assessment Methods & Levels (based on Blooms’ Taxonomy)</th></tr>
<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom’s Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C518.1</td><td>Understand</td><td>Assignment</td><td>3</td></tr>
<tr><td>C518.2</td><td>Apply</td><td>Presentation</td><td>3</td></tr>
<tr><td>C518.3</td><td>Analyse</td><td>Quiz</td><td>10</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
</table>

<table>
<tr><th rowspan="2">Bloom’s Level</th><th colspan="2">Continuous Assessment (24%)</th><th rowspan="2">End Semester Examination (60%) [60 Marks]</th></tr>
<tr><th>CIA1 [12 Marks]</th><th>CIA2 [12 Marks]</th></tr>
<tr><td>Remember</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Understand</td><td>20</td><td>-</td><td>20</td></tr>
<tr><td>Apply</td><td>40</td><td>40</td><td>40</td></tr>
<tr><td>Analyse</td><td>40</td><td>60</td><td>40</td></tr>
<tr><td>Evaluate</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Create</td><td>-</td><td>-</td><td>-</td></tr>
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22PF519 **INDUSTRIAL INTERNET OF THINGS** **3/0/0/3**

Nature of Course: G (Theory Analytical)

Pre requisites:

Course Objectives:

1 To understand the vision of IOT from a global context.
2 To enable the students to understand the State of the Art – IOT Architecture.
3 To interpret the use of internet principles, protocols and network management in IOT.
4 To help the students to understand the principles of design in prototyping and provide ability to change and modify it.
5 To be able to analyze the concepts of Industry 4.0
6 To illustrate the Application of Industrial IOT

Course Outcomes:

Upon completion of the course, students shall have ability to

C517.1	Understanding the concepts of IOT from a global context	[U]
C517.2	Infer the architecture of IOT and future development	[U]
C517.3	Understand the role of network layers in Data Management using IOT.	[U]
C517.4	Interpret the features of prototyping the embedded devices for IOT applications.	[AP]
C517.5	Design and develop an effective usage of IIOT deployment for different sectors.	[A]
C517.6	Illustrate the application of IIOT and identify Real World Design Constraints.	[AP]

Course Contents:

Module I Fundamentals of IoT and IoT Protocols **15 Hours**

Introduction – Characteristics - Physical design - Sensing & actuation- Protocols – Logical design – Enabling technologies –Input and output devices for IoT – IoT Levels – Domain Specific IoTs – IoT vs M2M. Future developments, Possible Architecture for the future IoT-Internet communication- IP addresses, MAC addresses- TCP and UDP ports- Application layer protocols- IEEE 802 committee family of protocols- physical layer-Media access control layer

Module II Industry 4.0 **15 Hours**

Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis, Cyber security in Industry 4.0

Module III Industrial IoT **15 Hours**

Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems, Business Model and Reference Architecture: IIoT-Business Models, IIoT Reference Architecture- Industrial IoT-Layers: IIoT Sensing, IIoT Processing, IIoT Communication IIoT Networking, Cloud Computing in IIoT- Fog Computing in IIoT, Security in IIoT - Application Domains: Factories and Assembly Line, Food Industry, Healthcare, Plant Safety and Security, Applications of UAVs in Industries.

Total Hours: 45 Hours

Text Books:

1 Adrian McEwen, Hackim Cassimally, “Designing the Internet of Things”, John Wiley and Sons Ltd., UK, 1st Edition 2014.
2 Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016
3 Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, “Internet of Things: Cyber manufacturing Systems”, Springer, 2017.

Reference Books:

1 Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, Apress Publications, 1st Edition, 2013.
2 Manoel Carlos Ramon, “Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 1st Edition, 2014
3 Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things - key applications and Protocols",Wiley, 1st Edition, 2012.

Web References:

1 http://www.cisco.com/c/en_in/solutions/internet-of-things/resources.html
2 https://openwsn.atlassian.net/wiki

Online Resources:

1 http://iot.ieee.org/newsletter/january-2016/hypercat-resource-discovery-on-the-internet-of-things.html
2 https://www.coursera.org/specializations/Internet-of-things

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component -II (4 marks)**	

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C517.1	Understand	Quiz	2
C517.2	Understand	Quiz	2
C517.3	Understand	Quiz	2
C517.4	Apply	Group Assignment	4
C517.5	Analyse	Simulation Exercise	3
C517.6	Apply	Simulation Exercise	3

Summative assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	10	10	10
Understand	40	20	40
Apply	50	30	30
Analyse	-	40	20
Evaluate	-	-	-
Create	-	-	-

22PB519 RESEARCH METHODOLOGIES AND IPR 3/0/0/3

Nature of Course: G (Theory Analytical)

Pre requisites:

Course Objectives:

1. To impart knowledge of handling data for carrying out research work effectively.
2. To impart the ability to use optimization technique for problem solving.
3. To impart decision making skills using statistical tool.
4. To impart report writing skills.
5. To impart knowledge about the procedure for filing patent and protecting intellectual properties right.

Course Outcomes:

Upon completion of the course, students shall have ability to

C519.1	Understand the fundamental search concepts and data collection methods for conducting research work.	[U]
C519.2	Experiment the test hypothesis and analyze the outcome.	[A]
C519.3	Report the research work and write research proposals for various funding agencies.	[AP]
C519.4	Analyze the procedure for patent rights, licensing and transfer of technology.	[A]

Course Contents:

Module I **15 Hours**

FUNDAMENTALS AND DATA COLLECTION: Research methodology - definition, objectives, mathematical tools for analysis, Research design. Types of research, exploratory research, conclusive research, modelling research, algorithmic research, Research process- steps. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. **HYPOTHESES TESTING AND ANALYSIS:** Hypotheses testing – Testing of hypotheses concerning means, concerning variance – one tailed Chi-square test. Introduction to Discriminant analysis, Factor analysis, cluster analysis, multidimensional scaling, conjoint analysis. **OPTIMIZATION TOOLS:** Introduction about Taguchi, Artificial Neural Network, Grey Relationship Analysis, Design of Experiment, Life cycle Assessment.

Module II **15 Hours**

REPORT WRITING AND PRESENTATION: Report writing- Types of report, guidelines to review report, report format, typing instructions, oral presentation, power point presentation, Data analysis using excel sheet, Proposal submission for funding agencies. Plagiarism, tools to avoid plagiarism, research ethics. Case study: (Use software) report format, Prepare review paper, Reference formation end note, Grammar verification. **PATENT RIGHTS:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Module III **15 Hours**

NATURE OF INTELLECTUAL PROPERTY: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Total Hours: 45 Hours

Text Books:

1 Ranjith Kumar, “Research Methodology”, SAGE Publication, 2018.
2 Robert Coe, Michael Waring, Larry V Hadges, James Aruthur, “Research Method and Methodology in Education”, SAGE Publication, 2017.
3 Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.

Reference Books:

1 Dahlia K. Remler, Gregg G. Van Ryzin, “Research Methods in Practice (Strategies for Description and Causation)”, SAGE Publication, 2015.
2 Uwe Flick, “Introducing Research Methodology-A Beginner”, SAGE, 2015.
3 T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.

Web References:

1 https://nptel.ac.in/courses/109103024/40
2 https://nptel.ac.in/syllabus/107108011/
3 http://textofvideo.nptel.ac.in/121106007/lec26.pdf

Online Resources:

1 https://www.wipo.int/edocs/pubdocs/en/intproperty/958/wipo_pub_958_3.pdf
2 https://www.isical.ac.in/~palash/research-methodology/RM-lec9.pdf

<table>
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<tr><th colspan="5">Continuous Assessment (40%)</th><th>End Semester Examination (60 %)</th></tr>
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<tr><th colspan="4">Formative assessment based on Capstone Model (16%)</th></tr>
<tr><th>Course Outcome</th><th>Bloom’s Level</th><th>Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)</th><th>Marks</th></tr>
<tr><td>C519.1</td><td>Understand</td><td>Assignment</td><td>4</td></tr>
<tr><td>C519.2</td><td>Analyse</td><td>Quiz</td><td>4</td></tr>
<tr><td>C519.3</td><td>Apply</td><td>Case study</td><td>4</td></tr>
<tr><td>C519.4</td><td>Analyse</td><td>Case study</td><td>4</td></tr>
<tr><th colspan="4">Summative assessment based on Continuous and End Semester Examination</th></tr>
<tr><th rowspan="2">Bloom’s Level</th><th colspan="2">Continuous Assessment (24%)</th><th rowspan="2">End Semester Examination (60%) [60 Marks]</th></tr>
<tr><th>CIA1 [12 Marks]</th><th>CIA2 [12 Marks]</th></tr>
</table>

Remember	40	40	40
Understand	20	20	20
Apply	20	20	20
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

OPEN ELECTIVE COURSES

22PF001 **BUSINESS ANALYTICS** **3/0/0/3**

Nature of Course: G (Theory and analytical)

Prerequisite:

Course Objectives:

1	To understand the technology and processes associated with Business Intelligence framework.
2	To provide insight of Data Warehouse implementation methodology, project life cycle and multidimensional data modeling.
3	Given a business scenario, to identify the metrics, indicators and make recommendations to achieve the business goal.
4	To Design an enterprise dashboard that depicts the key performance indicators which helps in decision making.

Course Outcomes:

Upon completion of the course, students shall have ability to

C001.1	Understand how to leverage the insights from business analytics.	[U]
C001.2	Analyze data by utilizing various statistical and data mining approaches.	[A]
C001.3	Perform analytics on real-time business data.	[AP]
C001.4	Understand the various key performance indicators which helps in decision making.	[U]

Course Contents:

Module I **15 Hours**

Introduction to Business Intelligence Introduction to digital data: Introduction, Types –structured, semi-structured and unstructured Introduction to OLTP and OLAP: OLTP Vs OLAP, Architectures (MOLAP, ROLAP, HOLAP), OLAP Operations BI Definitions & Concepts: BI Framework, Data Warehousing concepts and its role in BI, BI Infrastructure Components – BI Process, BI Technology, BI Roles & Responsibilities, Business Applications of BI, BI best practices

Module II **15 Hours**

Basics of Data Integration Data Integration: Concepts, needs and advantages of using data integration, introduction to common data integration approaches, Meta data -types and sources, Introduction to data quality, data profiling concepts and applications. Introduction to Multi-Dimensional Data modelling Multidimensional data model: Introduction to data and dimension modelling, data modelling basics, Types, Techniques, fact and dimension tables, Dimensional models Measures and Metrics: Introduction to business metrics and KPIs, KPI usage in companies Creating cubes using Microsoft Excel

Module III **15 Hours**

Basics of Enterprise Reporting Reporting: A typical enterprise, Malcolm Baldrige - quality performance framework, Balanced scorecard, Enterprise dashboard, Balanced scorecard vs. enterprise dashboard, Best practices in the design of enterprise dashboards Applications: Understanding BI and mobility, BI and cloud computing, BI for ERP systems, Social CRM and BI

Total Hours: 45 Hours

Text Books:

1. RN Prasad and Seema Acharya, “Fundamental of Business Analytics”, Wiley India Pvt. Ltd, 2016.
2. U. Dinesh Kumar Business Analytics –The Science of Data-Driven Decision Making” Wiley India Pvt. Ltd, 2017.

Reference Books:

1 John Boyer, Bill Frank, Brian Green, Tracy Harris, and Kay Van De Vanter “Business Intelligence Strategy: A Practical Guide for Achieving BI Excellence”, IBM Corporation, 2010.
2 Swain Scheps “Business Intelligence for Dummies”, Wiley Publishing Inc, 2008.
3 Cindi Howson “ Successful Business Intelligence:Secrets to making BI a killer App”, McGraw Hill, 2008.
4 Elizabeth Vitt, Michael Luckevich, Stacia Misner “Business Intelligence: Making Better Decisions Faster”, Microsoft Press,2008.

Web references

1 https://www.ngdata.com/business-analytics-resources/
2 https://www.wileyindia.com/business-analytics-the-science-of-data-driven-decision-making.html
3 https://www.greatlearning.in/business-analytics-certificate-program
4 https://www.sisense.com/blog/18-resources-comparing-business-intelligence-vendors/
5 https://www.ngdata.com/top-business-intelligence-blogs/
6 https://www.dundas.com/support/blog/the-best-business-intelligence-resources-of-2018
7 https://blog.capterra.com/learn-about-business-intelligence-resources/

Online resources

1 https://www.coursera.org/specializations/business-analytics
2 https://www.edx.org/learn/business-intelligence
3 https://www.online.colostate.edu/certificates/business-intelligence/
4 https://mva.microsoft.com/training-topics/business-intelligence#!lang=1033

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<tr><td>C001.2</td><td>Analyse</td><td>Quiz</td><td>4</td></tr>
<tr><td>C001.3</td><td>Understand</td><td>Case study</td><td>4</td></tr>
<tr><td>C001.4</td><td>Understand</td><td>Presentation</td><td>4</td></tr>
</table>

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	-	-	-
Understand	-	30	20
Apply	50	30	40
Analyse	50	40	40
Evaluate	-	-	-
Create	-	-	-