RAJALAKSHMI ENGINEERING COLLEGE
CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM

M.E. COMPUTER SCIENCE AND ENGINEERING
REGULATION 2019

Vision

To promote highly ethical and innovative computer professionals through excellence in teaching, training and research.

Mission

- To produce globally competent professionals, motivated to learn the emerging technologies and to be innovative in solving real world problems.
- To promote research activities amongst the students and the members of faculty that could benefit the society.
- To impart moral and ethical values in their profession.

PROGRAMME OUTCOMES (POs)

The Post Graduate Degree Program in Computer Science and Engineering will prepare students to be able to:

PO1: Independently carry out research /investigation and development work to solve practical problems.

PO2: Write and present a substantial technical report/document.

PO3: Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Analyze existing complex problems in an area of specialization; develop innovative and research-oriented methodology to provide ICT based solutions.

PO5: Apply algorithmic principles, computer science theory to design a system that meet the specified needs with appropriate consideration on health and safety, environmental, societal, ethical and sustainable factors.

CURRICULUM

M.E. COMPUTER SCIENCE AND ENGINEERING
Regulation 2019 | Total Credits: 70

SEMESTER I								
SI. NO.	**COURSE CODE**	**COURSE TITLE**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY COURSES								
1.	MH19104	Applied Probability and Statistics	FC	4	3	1	0	4
2.	CP19101	Advanced Data Structures and Algorithms	PC	3	3	0	0	3
3.	CP19102	Advanced Operating Systems	PC	3	3	0	0	3
4.	CP19103	Advanced Software Engineering	PC	3	3	0	0	3
5.	PG19101	Research Methodology and IPR	MC	3	3	0	0	3
LABORATORYCOURSES								
6.	CP19111	Advanced Data Structures Laboratory	PC	4	0	0	4	2
7.	CP19112	Advanced Software Engineering Laboratory	PC	4	0	0	4	2
NON CREDIT COURSES								
8.	AC19101	English for Research Paper Writing	MC	3	3	0	0	0
			TOTAL	**27**	**18**	**1**	**8**	**20**

SEMESTER II								
SI. NO.	**COURSE CODE**	**COURSE TITLE**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY COURSES								
1.	CP19201	Advanced Databases	PC	3	3	0	0	3
2.	CP19202	Networking Technologies	PC	3	3	0	0	3
3.		Program Elective – I	PE	3	3	0	0	3
4.		Program Elective – II	PE	3	3	0	0	3
LABORATORY COURSES								
5.	CP19211	Advanced Databases Laboratory	PC	4	0	0	4	2
6.		Laboratory Based on Program Electives	PE	4	0	0	4	2
7.	CP19216	Mini Project with Seminar	EEC	4	0	0	4	2
NON CREDIT COURSES								
8.	AC19201	Constitution of India	MC	3	3	0	0	0
			TOTAL	**27**	**15**	**0**	**12**	**18**

SEMESTER III								
SI. NO.	**COURSE CODE**	**COURSE TITLE**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY COURSES								
1.		Program Elective –III	PE	3	3	0	0	3
2.		Program Elective – IV	PE	3	3	0	0	3
3.		Program Elective – V	PE	3	3	0	0	3
4.		Open Elective	OE	3	2	1	0	3
LABORATORY COURSES								
5.	CP19311	Project Phase – I	EEC	12	0	0	12	6
			TOTAL	**24**	**11**	**1**	**12**	**18**

SEMESTER IV								
SI. NO.	**COURSE CODE**	**COURSE TITLE**	**Category**	**Contact Periods**	**L**	**T**	**P**	**C**
LABORATORY COURSES								
1.	CP19411	Project Phase – II	EEC	28	0	0	28	14
			TOTAL	**28**	**0**	**0**	**28**	**14**

Total Credits: 70

PROGRAM ELECTIVES (PE)							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**Semester**
1.	DS19203	Machine Learning Techniques	3	0	0	3	II
2.	CP19P01	Wireless Sensor Networks	3	0	0	3	II
3.	CP19P02	Cloud Infrastructure	3	0	0	3	II
4.	CP19P03	Digital Forensics	3	0	0	3	II
5.	DS19204	Computer Vision	3	0	0	3	II
6.	CP19P04	Advanced Wireless and Mobile Networks	3	0	0	3	II
7.	CP19P05	Data Science	3	0	0	3	II
8.	CP19P06	Big Data Analytics	3	0	0	3	II
9.	CP19P07	Web Search & Information Retrieval	3	0	0	3	III
10.	CP19P08	User Interface Design	3	0	0	3	III
11.	CP19P09	GPU Computing	3	0	0	3	III
12.	CP19P10	Queuing theory and Modeling	3	0	0	3	III
13.	CP19P11	Parallel Algorithms	3	0	0	3	III
14.	CP19P12	Mobile Applications and Services	3	0	0	3	III
15.	CP19P13	DNA Computing	3	0	0	3	III
16.	CP19P14	Secure Software Design	3	0	0	3	III
17.	CP19P15	Distributed Databases	3	0	0	3	III
18.	CP19P16	Intelligent Systems	3	0	0	3	III

PROGRAM ELECTIVES – LABORATORY COURSES							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Semester**
1.	CP19212	Cloud Infrastructure Lab	0	0	4	2	II
2.	CP19213	Big Data Analytics Lab	0	0	4	2	II
3.	CP19214	Wireless Sensor Networks Lab	0	0	4	2	II
4.	CP19215	Digital Forensics Lab	0	0	4	2	II

OPEN ELECTIVE COURSES (OE)							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Semester**
1	CP19O31	Business Analytics	3	0	0	3	III
2	ED19O32	Operations Research	2	1	0	3	III
3	PG19O31	Cost Management of Engineering Projects	3	0	0	3	III
4	PG19O32	Waste to Energy	3	0	0	3	III
5	ED19O31	Industrial Safety	3	0	0	3	III
6	ED19O33	Composite Materials	3	0	0	3	III

SUMMARY OF ALL COURSES

S.NO	**Course Category**	**Credits per Semester**				**Total Credits**
		1	**2**	**3**	**4**	
1.	FC	4				4
2.	PC	13	8			21
3.	PE		8	9		17
4.	OE			3		3
5.	EEC		2	6	14	22
6.	MC	3				3
	Total	**20**	**18**	**18**	**14**	**70**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
MH19104	APPLIED PROBABILITY AND STATISTICS	BS	3	1	0	4

Objectives:	
•	To understand the concept of random variable and probability distribution for solving problems.
•	To develop the concept of correlation and regression and to apply in real life problems.
•	To understand the techniques of forecasting.
•	To develop the skills on decision making using the concept of testing of hypothesis.

UNIT-I	ONE DIMENSIONAL RANDOM VARIABLES	12
Random variables - probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – functions of a Random Variable.		
UNIT-II	**TWO DIMENSIONAL RANDOM VARIABLES**	**12**
Joint distributions – marginal and conditional distributions – functions of two-dimensional random variables – regression curve – correlation.		
UNIT-III	**ESTIMATION THEORY**	**12**
Unbiased Estimators – method of moments – maximum likelihood estimation - curve fitting by principle of least squares – regression lines		
UNIT-IV	**TESTING OF HYPOTHESES**	**12**
Sampling distributions - Type I and Type II errors – Tests based on Normal, t, chi-square and F distributions for testing of mean, variance and proportions – tests for independence of attributes and goodness of fit.		
UNIT-V	**MULTIVARIATE ANALYSIS**	**12**
Random vectors and matrices - mean vectors and covariance matrices –multivariate normal density and its properties - principle components population principal components- principle components from standardized variables.		
	Total Contact Hours : 60	

Course Outcomes: On completion of the course, the students will be able to	
•	Use the concept of MGF and probability distribution for solving problems that arise from time to time.
•	Apply the concept of correlation and regression in real life situation.
•	Apply the concept of estimation theory and curve fitting for forecasting.
•	Enable the students to use the concepts of Testing of Hypothesis for industrial problems
•	Identify and analyze the principle components of different process.

Reference Books(s):	
1	Veerarajan T, "Probability, statistics and random process with queueing theory and queueing networks", 4th Edition, McGraw - Hill Publishing Company Limited.
2	Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, 5th Edition.
3	Gupta S.C. and Kapoor V.K, "Fundamentals of Mathematical Statistics", Sultan and Sons.
4	Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Thomson and Duxbury.
5	Richard Johnson, "Miller & Freund's Probability and Statistics for Engineer", Prentice – Hall,7th Edition, 2007.
6	Dallas E Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury. Press,1998.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
MH19104.1	3	2	2	2	1
MH19104.2	3	2	2	2	1
MH19104.3	3	3	2	3	2
MH19104.4	3	3	2	3	2
MH19104.5	3	3	2	3	3
AVERAGE	3	2.6	2	2.6	1.8

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19101	ADVANCED DATA STRUCTURES AND ALGORITHMS	PC	3	0	0	3

Objectives:	
•	To understand the usage of algorithms in computing.
•	To learn and use hierarchical data structures and its operations.
•	To learn the usage of graphs and its applications.
•	To select and design data structures and algorithms that is appropriate for problems.
•	To study about NP Completeness of problems.

UNIT-I	ROLE OF ALGORITHMS IN COMPUTING	9
Algorithms –Introduction: Classical Algorithms–Analyzing Algorithms – Designing Algorithms– Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions– Solving Recurrences: The Substitution Method – Master theorem method– The Recursion–Tree Method.		
UNIT-II	**HIERARCHICAL DATA STRUCTURES**	**9**
Binary Search Trees: Basics –Insertion, Deletion and Search– Red-Black Trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion –B-Trees: Definition– Basic operations on B-Trees – Deleting a key from a B-Tree– Fibonacci Heaps: structure – Merge able-heap operations– Decreasing a key and deleting a Node–Bounding the maximum degree.		
UNIT-III	**GRAPHS**	**9**
Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components– Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim– Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd, Warshall Algorithm, Johnson's algorithm for sparse graphs.		
UNIT-IV	**ALGORITHM DESIGN TECHNIQUES**	**9**
Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming –Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy– Huffman Codes.		
UNIT-V	**NP COMPLETE AND NP HARD**	**9**
NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP-Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Design data structures and algorithms to solve computing problems.
•	Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.
•	Understand the importance of Graphs and its applications.
•	Apply suitable design strategy for problem solving.
•	Differentiate NP complete and NP hard.

Reference Books(s):	
1	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 2006.
2	Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, Pearson Education.
3	S. Sridhar, "Design and Analysis of Algorithms", First Edition, Oxford University Press. 2014
4	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, Prentice-Hall, 2011.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19101.1	3	-	1	2	-
CP19101.2	2	-	1	1	1
CP19101.3	3	-	2	1	-
CP19101.4	2	-	1	2	1
CP19101.5	2	-	2	1	1
AVERAGE	2	-	1	1	1

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19102	ADVANCED OPERATING SYSTEMS	PC	3	0	0	3

Objectives:	
•	To learn the fundamentals of Operating Systems.
•	To gain knowledge on distributed operating system concepts.
•	To gain insight on to the distributed resource management components.
•	To know the components and task scheduling of Real time operating systems.
•	To learn fundamentals of Android and iOS Mobile operating systems.

UNIT-I	FUNDAMENTALS OF OPERATING SYSTEMS	9
Operating System Structure – Types of Advanced Operating Systems – Synchronization mechanisms – Critical Section Problem – Language Mechanisms for Synchronization– Process Deadlocks– Detection, Prevention, Avoidance – Virtualization.		
UNIT-II	**DISTRIBUTED OPERATING SYSTEMS**	**9**
Issues in Distributed Operating System – Architecture – Communication Primitives – Lamport's Logical Clocks – Causal Ordering of Messages – Lamport's Distributed Mutual Exclusion – Suzuki Kasami Broadcast algorithm – Agreement Protocols– Classification, Solutions to the Byzantine Agreement Problem		
UNIT-III	**DISTRIBUTED RESOURCE MANAGEMENT**	**9**
Distributed File Systems – Design Issues – Distributed Shared Memory – Algorithms for Implementing DSM – Issues in Load Distribution – Recovery in Concurrent Systems – Fault Tolerance – Two Phase Commit Protocol – Case Study– Hadoop Distributed File System–Google File System		
UNIT-IV	**REAL TIME AND DATABASE OPERATING SYSTEMS**	**9**
Introduction to Real Time Operating Systems – Structure of Real Time Systems– Estimating Program Runtimes – Task Scheduling – Rate Monotonic – Preemptive Earliest Deadline First – Case study on eCOS–Database Operating System – Requirements		
UNIT-V	**MOBILE OPERATING SYSTEMS**	**9**
Android – Architecture – Security Model – Android Application Package Format– Code Signing – APK Install Process – System Updates and Root Access– iOS– Architecture and SDK Framework		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Understand operating system concepts and apply synchronization mechanisms
•	Apply Byzantine Agreement protocols to real life applications
•	Analyze load distribution and manage resources in a Distributed Operating System
•	Make proper estimation of program runtimes and scheduling in real time systems
•	Install APK and do mobile phone rooting

Reference Books(s):	
1	Mukesh Singhal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems- Distributed, Database and Multiprocessor Operating Systems", Tata McGraw-Hill, 2001
2	A. Silberschatz, Peter B. Galvin, G. Gagne, "Operating System Concepts", 9th Edition, Wiley, 2016
3	C.M. Krishna and Kang G. Shin, "Real-Time Systems", Tata McGraw-Hill, 2010.
4	Qing Li and Caroline Yao, "Real-Time Concepts for Embedded Systems", CMP Books, 2006
5	Neil Smyth, "iPhone iOS 4 Development Essentials- Xcode", Fourth Edition, Payload Media, 2011.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19102.1	2	2	1	1	2
CP19102.2	3	3	2	3	2
CP19102.3	2	1	2	1	1
CP19102.4	2	1	2	1	1
CP19102.5	2	-	2	-	-
AVERAGE	2.2	1.75	1.8	1.5	1.5

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19103	ADVANCED SOFTWARE ENGINEERING	PC	3	0	0	3

Objectives:	
•	To understand basic concepts of software engineering and agile methodology.
•	To analyze and design a software project with Unified Process.
•	To do project management and cost estimation.
•	To understand software testing approaches.
•	To be familiar with advance software engineering concepts.

UNIT-I	**INTRODUCTION**	**9**
Software engineering concepts – Development activities – Software lifecycle models – Rational unified process–Agile methods– Project Management– Project Planning		
UNIT-II	**REQUIREMENTS ENGINEERING**	**9**
Software Requirements: Functional and Non-Functional requirements– User Requirements– System Requirements – Requirements elicitation and analysis–Requirement Discovery– Requirements Validation and Management		
UNIT-III	**ARCHITECTURE AND DESIGN**	**9**
Architectural patterns – Design patterns – Modeling Data – Object-oriented design using the UML Data Flow Diagrams– Software Implementation Techniques–Coding Practices–Refactoring.		
UNIT-IV	**TESTING**	**9**
Software Testing – Software testing strategies – Testing Conventional applications – OO Testing – Development testing– Test-driven development– Release testing– User testing – Software maintenance Quality Management		
UNIT-V	**ADVANCE SOFTWARE ENGINEERING**	**9**
Software Reuse–Component based software engineering–Distributed software engineering – Distributed software Engineering		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Gain knowledge on project management approaches as well as cost and schedule estimation strategies.
•	Use UML diagrams for analysis and design.
•	Architect and design using architectural styles and design patterns.
•	Understand software testing approaches.
•	Understand the concepts to design advance software engineering concepts.

Reference Books(s):	
1	Ian Somerville, "Software Engineering", 9th edition, 2010, Pearson Education.
2	Roger S, "Software Engineering – A Practitioner's Approach", 7th Edition, Pressman, 2010.
3	Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", Third Edition, Pearson Education, 2005.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19103.1	1	-	-	-	2
CP19103.2	2	3	3	3	2
CP19103.3	1	3	3	3	2
CP19103.4	2	-	3	3	2
CP19103.5	-	-	3	2	2
AVERAGE	1.5	2.3	3.0	2.8	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
PG19101	RESEARCH METHODOLOGY AND IPR	MC	3	0	0	3

Objectives:	
•	To inculcate the importance of research methodology and Intellectual Property Rights. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.
•	To get registration of patents in our country and foreign countries of invention, designs and thesis or theory written. To get knowledge of patents, copy right, trademarks and designs

UNIT-I	FUNDAMENTALS OF RESEARCH METHODOLOGY	9
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations		
UNIT-II	**REVIEW OF LITERATURE AND TECHNICAL WRITING**	**9**
Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal.		
UNIT-III	**INTELLECTUAL PROPERTY RIGHTS**	**9**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright, copyright registration in India Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under Patent Cooperation Treaty.		
UNIT-IV	**PATENT RIGHTS AND RECENT DEVELOPMENTS IN IPR**	**9**
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.		
UNIT-V	**INDUSTRIAL DESIGNS AND GEOGRAPHICAL INDICATIONS**	**9**
Industrial designs and IC Layout design, Registrations of designs, conditions and procedures of industrial designs-Cancellation of Registration, International convention of design- types and functions. Semiconductor Integrated circuits and layout design Act- Geographical indications-potential benefits of Geographical Indications		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Apply knowledge on research problem formulation and analyze research related information
•	Apply IPR concept to important place in growth of individuals & nation.
•	Describe the importance of copyright and industrial designs.
•	Apply patent right to new products developed.
•	Describe the procedure and the tools to get patent copy right for their innovative work.

Reference Books(s):	
1	Neeraj Pandey and Khushdeep D, "Intellectual Property Rights", 1st edition, PHI learning Pvt. Ltd., Delhi, 2014.
2	Uma Sekaran and Roger Bougie, "Research methods for Business", 5th Edition, Wiley India, New Delhi, 2012.
3	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students",2nd edition, Juta Academic, 2001.
4	Ramakrishna B & Anilkumar H S, "Fundamentals of Intellectual Property Rights", 1stEd. Notion Press, 2017.
5	William G Zikmund, Barry J Babin, Jon C. Carr, Atanu Adhikari, Mitch Griffin, "Business Research methods, A South Asian Perspective", 8th Edition, Cengage Learning, New Delhi,2012.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
PG19101.1	3	1	1	3	2
PG19101.2	1	-	1	2	3
PG19101.3	2	2	2	2	3
PG19101.4	2	1	2	3	3
PG19101.5	2	2	3	3	2
AVERAGE	2.0	1.5	1.8	2.6	2.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19111	ADVANCED DATA STRUCTURES LABORATORY	PC	0	0	4	2

Objectives:	
•	To implement iterative and recursive algorithms.
•	To design and implement algorithms using dynamic programming techniques.
•	To design and implement algorithms using backtracking.
•	To design and implement randomized algorithms.
•	To learn to implement shared and concurrent objects.

List of Experiments				
1	Implementation of graph search algorithms.			
2	Implementation and application of network flow and linear programming problems.			
3	Implementation of algorithms using dynamic programming techniques.			
4	Implementation of recursive backtracking algorithms.			
5	Implementation of randomized algorithms.			
6	Implementation of various locking and synchronization mechanisms for concurrent linked lists, concurrent queues and concurrent stacks.			
7	Developing applications involving concurrency.			
		Total Contact Hours	**:**	**60**

Platform Needed:		
HARDWARE	**:**	Personal Computer with Dual Core Processor with 4 GB RAM.
SOFTWARE	**:**	C/C++/Java Compilers

Course Outcomes: On completion of the course, the students will be able to	
•	Design and apply iterative and recursive algorithms.
•	Design and implement algorithms using dynamic programming and recursive backtracking techniques.
•	Design and implement optimization algorithms for specific applications.
•	Design appropriate shared objects and concurrent objects for applications.
•	Implement and apply concurrent linked lists, stacks, and queues.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19111.1	2	3	2	1	1
CP19111.2	2	2	2	2	1
CP19111.3	2	2	2	3	2
CP19111.4	2	2	2	2	2
CP19111.5	3	2	3	3	2
AVERAGE	2	2	2	2	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19112	ADVANCED SOFTWARE ENGINEERING LABORATORY	PC	0	0	4	2

Objectives:	
•	To understand how to develop a project.
•	To determine requirements to develop software.
•	To apply UML modeling Language.
•	To develop correct and robust software products.
•	To understand how to do testing.

List of Experiments				
Students should design a mini project and should apply the following experiments				
A	**Requirements Engineering** 1. Writing Problem Statement 2. Writing Requirement Specification a. SRS b. Use Case			
B	**Planning Project** 1. Plan project with Agile Methodology 2. Do Cost Estimation			
C	**Designing Project** 1. Use Case Diagrams 2. Interaction Diagrams 3. State chart Diagrams and Activity Diagrams 4. Class Diagrams 5. Package Diagrams 6. Component Diagrams and Deployment Diagrams			
D	**Mapping Design to code**			
E	**Testing the Project**			
F	**Documenting the project**			
		Total Contact Hours	**:**	**60**

Platform Needed:		
HARDWARE	**:**	Personal Computer with Dual Core Processor with 8 GB RAM.
SOFTWARE	**:**	IBM Rational Rose/AGRO UML/STAR UML for Design
		Selenium/Junit (any automated testing software) for testing
		Jile Software/Jeera (any Agile planning Software) to do agile planning

Course Outcomes: On completion of the course, the students will be able to	
•	Decide a suitable software model for a project.
•	Elicit requirements.
•	Design a project.
•	Develop and test a product.
•	Apply quality measures.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19112.1	3	-	3	3	2
CP19112.2	3	3	3	3	2
CP19112.3	3	3	3	3	2
CP19112.4	3	-	3	3	2
CP19112.5	3	-	3	3	2
AVERAGE	3.0	2.0	3.0	3.0	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Non Credit course)	Category	L	T	P	C
AC19101	ENGLISH FOR RESEARCH PAPER WRITING	MC	3	0	0	0

Objectives:	
•	To express technical ideas in writing.
•	To plan and organize the research paper.
•	To understand the structure and familiarize the mechanics of organized writing.
•	To improvise academic English and acquire research writing skills.

UNIT-I	INTRODUCTION TO RESEARCH WRITING	9
Research – Types of Research – Selecting the Primary resources – Categorizing secondary sources – Discovering a researchable area and topic – Need Analysis – Research Question–Focusing on the Research Problem–Developing Research Design – Framing the Hypothesis – Identifying the Scope of the Research – Writing – General and Academic Writing.		
UNIT-II	**LANGUAGE OF WRITING**	**9**
Active reading – text mining – use of academic words – jargons – ambiguities – use of expression – use of tense - proper voices – third person narration – phraseology – use of foreign words – use of quotes – interpreting quotes.		
UNIT-III	**THE FORMAT OF WRITING**	**9**
Types of Journals – different formats and styles – IEEE format – Structure – Margins – Text Formatting – Heading and Title – Running Head with Page Numbers – Tables and illustrations – Paper and Printing – Paragraphs – Highlighting – Quotation – Footnotes.		
UNIT-IV	**ORGANISING A RESEARCH PAPER**	**9**
Title- Abstract – Introduction – Literature review – Methodology – Results –Discussion –Conclusion – Appendices – Summarizing– Citation and Bibliography.		
UNIT-V	**PUBLISHING PAPER**	**9**
Finding the Prospective publication or Journal –analyzing the credits – Reviewing – Revising – Plagiarism Check – Proof reading – Preparing the Manuscript– Submitting – Resubmitting – Follow up – Publishing.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Understand the basic structure of research work.
•	Apply proper use of language in writing paper.
•	Comprehend different formats of journal paper.
•	Learn the process of writing a research paper.
•	Know the process of publishing journal paper.

Reference Books(s):	
1	Adrian Wallwork, “English for Writing Research Papers”, Springer Science Business Media, 2nd Edition, 2011.
2	Stephen Howe and Kristina Henrikssion, “Phrasebook for Writing Papers and Research in English”, The Whole World Company Press, Cambridge, 4th Edition 2007
3	The Modern Language Association of America, “MLA Handbook for Writers of Research Papers” 8th Edition, The Modern Language Association of America, 2016
4	Rowena Murray, “The Handbook of Academic Writing: A Fresh Approach”, Sarah Moore Open University Press, 2006.
5	Stephen Bailey: “Academic Writing: A Practical Guide for Students”, Routledge Falmer, 2003
6	Joseph M. Moxley, “Publish, Don't Perish: The Scholar's Guide to Academic Writing and Publishing”, Praeger Publishers, 1992

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
AC19101.1	1	1	1	1	1
AC19101.2	2	2	2	2	2
AC19101.3	3	3	3	3	3
AC19101.4	3	3	3	3	3
AC19101.5	3	3	3	3	3
AVERAGE	2.4	2.4	2.4	2.4	2.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19201	ADVANCED DATABASES	PC	3	0	0	3

Objectives:	
•	To acquire knowledge on parallel and distributed databases and its applications.
•	To study the usage and applications of Object-Oriented database.
•	To understand the principles of intelligent databases.
•	To learn emerging databases such as XML, Cloud and Big Data.
•	To acquire inquisitive attitude towards research topics in databases.

UNIT-I	PARALLEL AND DISTRIBUTED DATABASES	9
Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems– Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Design of Parallel Systems– Distributed Database Concepts – Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Case Studies		
UNIT-II	**OBJECT AND OBJECT RELATIONAL DATABASES**	**9**
Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects – Object Database Standards, Languages and Design: ODMG Model – ODL – OQL – Object Relational and Extended – Relational Systems: Object Relational features in SQL/Oracle – Case Studies.		
UNIT-III	**EMERGING TECHNOLOGIES**	**9**
XML Databases: XML–Related Technologies–XML Schema– XML Query Languages– Storing XML in Databases– XML and SQL– Native XML Databases– Web Databases– Cloud Based Databases: Data Storage Systems on the Cloud– Cloud Storage Architectures–Cloud Data Models– Query Languages		
UNIT-IV	**BIG DATA STORAGE ANALYSIS**	**9**
Big Data introduction: The Hadoop ecosystem– Querying big data with Hive: Introduction, From SQL to HiveQL– Introduction to HIVE e HIVEQL – Using Hive to query Hadoop files.		
UNIT-V	**INTELLIGENT DATABASES**	**9**
Active databases – Deductive Databases – Knowledge bases – Multimedia Databases– Multidimensional Data Structures – Image Databases – Text/Document Databases– Video Databases – Audio Databases – Multimedia Database Design.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Model and represent the real-world data using object-oriented database.
•	Design a semantic based database to meaningful data access.
•	Embed the rule set in the database to implement intelligent databases.
•	Represent the data using XML database for better interoperability.
•	Handle Big data and manipulate using HIVE.

Reference Books(s):	
1	R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson Education, 2007
2	Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", 3rd Edition, Pearson Education, 2007.
3	Henry F Korth, A. Silberschatz, S. Sudharshan, "Database System Concepts", 5th Edition, McGraw Hill, 2006.
4	Simon St. Laurent and Michael Fitzgerald, "XML Pocket Reference", 3rd Edition, O'Reilly, 2012.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19201.1	-	3	-	-	-
CP19201.2	2	-	3	2	-
CP19201.3	2	3	-	2	-
CP19201.4	3	-	-	2	1
CP19201.5	-	-	-	3	2
AVERAGE	2.3	3.0	3.0	2.3	1.5

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19202	NETWORKING TECHNOLOGIES	PC	3	0	0	3

Objectives:	
•	To understand the principles required for network design.
•	To explore various technologies in the wireless domain.
•	To study about 3G and 4G cellular networks.
•	To understand the paradigm of Software defined networks.

UNIT-I	NETWORK DESIGN	9
Advanced multiplexing – CDM, DWDM and OFDM – Shared media networks – Switched networks – End to end semantics – Connectionless, Connection oriented, Wireless Scenarios –Applications, QoS – 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.		
UNIT-II	**WIRELESS NETWORKS**	**9**
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		
UNIT-III	**CELLULAR NETWORKS**	**9**
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		
UNIT-IV	**4G NETWORKS**	**9**
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– Protocol Boosters – Hybrid 4G Wireless Networks Protocols –Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Introduction to 5G		
UNIT-V	**SOFTWARE DEFINED NETWORKS**	**9**
Introduction to SDN – Control and Data Planes – Open Flow –SDN Controllers – General Concepts –VMWare – VLANs – NVGRE –Data Center – Multi Tenant Data Centre – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Identify the components required for designing a network.
•	Design a network at a high-level using different networking technology.
•	Analyze the various protocols of wireless and cellular networks.
•	Discuss the features of 4G and 5G networks.
•	Experiment with software defined networks.

Reference Books(s):	
1	Erik Dahlman, Stefan, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 2013.
2	Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
3	Larry Peterson and B Davie, "Computer Networks: A Systems Approach", 5th edition, Morgan Kauffman, 2011
4	Paul Goransson, C. Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kauffman, 2014.
5	Thomas D. Nadeau and Ken Gray, "SDN Software Defined Networks", O'Reilly, 2013.
6	Ying Dar Lin, Ren Hung Hwang and Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2011.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19202.1	2	-	2	1	-
CP19202.2	2	-	2	1	1
CP19202.3	2	-	2	2	1
CP19202.4	2	-	2	2	1
CP19202.5	2	-	2	2	1
AVERAGE	2	-	2	2	1

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19211	ADVANCED DATABASES LABORATORY	PC	0	0	4	2

Objectives:	
•	To gain knowledge in parallel and distributed data base by experimenting it.
•	To understand and work on object-oriented databases.
•	To represent and work with the database using XML.
•	To learn to work on active database.
•	To study and explore deductive database.

List of Experiments			
1	Create a distributed database with minimum 3 sites for a relation bookstore and perform basic query operation over the schema.		
2	Implement deadlock detection algorithm for distributed database using wait-for graph and test it with 5 transactions.		
3	Consider the application for University Counseling for Engineering Colleges. The college, department and vacancy details are maintained in 3 sites. Students are allocated colleges in these 3 sites simultaneously. Implement this application using parallel database.		
4	Create triggers and assertions for any application		
5	Construct a knowledge database for an application with facts.		
6	Exploring HiveQL Data Definition ii. Exploring HiveQL Data Manipulation iii. Exploring the hive command line interface (CLI)		
7	Design XML Schema for specific database domain		
8	Implement the queries using XQuery and XPath		
	Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course, the students will be able to	
•	Create and work with parallel and distributed database.
•	Experiment on active database.
•	Explore the features of deductive database.
•	Explore HIVEQL and Represent the database using XML and work on it.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19211.1	3	2	-	-	-
CP19211.2	2	1	3	-	2
CP19211.3	2	1	3	-	-
CP19211.4	3	2	-	2	1
CP19211.5	-	2	1	-	2
AVERAGE	2.5	1.6	2.3	2.0	1.7

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Non-Credit course)	Category	L	T	P	C
AC19201	CONSTITUTION OF INDIA	MC	3	0	0	0

Objectives:	
•	To inculcate the values enshrined in the Indian constitution.
•	To create a sense of responsible and active citizenship.
•	To know about Constitutional and Non-Constitutional bodies
•	To understand sacrifices made by the freedom fighters.

UNIT-I	Introduction	9
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Features – Basic Structure – Preamble.		
UNIT-II	**Union Government**	**9**
Union and its territory – Citizenship – Fundamental Rights – Directive Principles of State Policy (DPSP) – Fundamental Duties. Union Government: Executive, Legislature and Judiciary: President – Vice President – Prime Minister – Central Council of Ministers – Cabinet Committees – Parliament: Committees, Forums and Groups – Supreme Court.		
UNIT-III	**State Government & Union Territories**	**9**
State Government: Executive, Legislature and Judiciary–Governor - Chief Minister – State Council of Ministers – State Legislature – High Court – Subordinate Courts –Panchayat Raj – Municipalities–Union Territories –Scheduled and Tribal Areas.		
UNIT-IV	**Relations Between Union and States**	**9**
Relations between Union and States – Services under Union and States. Cooperative Societies – Scheduled and Tribal Areas – Finance, Property, Contracts and Suits – Trade and Commerce within Indian Territory – Tribunals.		
UNIT-V	**Constitutional Bodies and Amendments**	**9**
Introduction to Constitutional & Non-Constitutional Bodies–Elections – Special Provisions relating to certain classes – Languages - Emergency Provisions – Miscellaneous – Amendment of the Constitution – Temporary, Transitional and Special Provisions – Short title, date of commencement, Authoritative text in Hindi and Repeals. Schedules of the Constitution of India – Appendices in the Constitution of India.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to:	
•	Appreciate the philosophical foundations of the Indian Constitution.
•	Understand the functions of the Indian government.
•	Understand and abide the rules of the Indian constitution.
•	Gain knowledge on functions of state Government and Local bodies.
•	Gain Knowledge on constitution functions and role of constitutional bodies and amendments of constitution.

Reference Books(s):	
1	M Lakshmikanth “Indian Polity”, McGraw Hill Education, 5th edition 2017.
2	Durga Das Basu, “Introduction to the Constitution of India “, Lexis Nexis, New Delhi., 21st edition, 2013.
3	Sharma, Brij Kishore, “Introduction to the Constitution of India”, PHI, New Delhi, 7th edition, 2015.
4	Subhash Kashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National Book Trust India, 1994.
5	Mahendra Prasad Singh and Himanshu Roy, “Indian Political System”, Pearson India, 4th edition, 2017.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
AC19201.1	-	-	1	-	2
AC19201.2	-	-	1	-	2
AC19201.3	-	-	1	-	2
AC19201.4	-	-	1	-	2
AC19201.5	-	-	1	-	2
AVERAGE	0	0	1	0	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

PROGRAM ELECTIVES

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19203	MACHINE LEARNING TECHNIQUES	PE	3	0	0	3

Objectives:	
•	To understand the machine learning theory.
•	To implement linear and non-linear learning models.
•	To implement distance-based clustering techniques.
•	To build tree and rule-based models.
•	To apply reinforcement learning techniques.

UNIT-I	**FOUNDATIONS OF LEARNING**	**9**
Components of learning – learning models – geometric models – probabilistic models – logic models – grouping and grading – learning versus design – types of learning – supervised – unsupervised – reinforcement – theory of learning – feasibility of learning – error and noise – training versus testing – theory of generalization – generalization bound – approximation generalization trade off – bias and variance – learning curve.		
UNIT-II	**LINEAR MODELS**	**9**
Linear classification – univariate linear regression – multivariate linear regression – regularized regression – Logistic regression – perceptrons – multilayer neural networks – learning neural networks structures – support vector machines – soft margin SVM – going beyond linearity – generalization and over fitting – regularization – validation.		
UNIT-III	**DISTANCE-BASED MODELS**	**9**
Nearest neighbor models – K-means – clustering around medoids – silhouttes – hierarchical clustering – k-d trees – locality sensitive hashing – non-parametric regression – ensemble learning– bagging and random forests – boosting – meta learning.		
UNIT-IV	**TREE AND RULE MODELS**	**9**
Decision trees – learning decision trees – ranking and probability estimation trees – regression trees – clustering trees – learning ordered rule lists – learning unordered rule lists – descriptive rule learning – association rule mining – first-order rule learning.		
UNIT-V	**REINFORCEMENT LEARNING**	**9**
Passive reinforcement learning – direct utility estimation – adaptive dynamic programming – temporal-difference learning – active reinforcement learning – exploration – learning an action utility function – Generalization in reinforcement learning – policy search – applications in game playing – applications in robot control.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, the students will be able to	
•	Explain theory underlying machine learning.
•	Construct algorithms to learn linear and non-linear models.
•	Implement data clustering algorithms.
•	Construct algorithms to learn tree and rule-based models.
•	Apply reinforcement learning techniques.

Reference Book(s):	
1	Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, "Learning from Data", AMLBook Publishers, 2012.
2	P. Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge University Press, 2012.
3	K. P. Murphy, "Machine Learning: A probabilistic perspective", MIT Press, 2012.
4	C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007
5	D. Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012.
6	M. Mohri, A. Rostamizadeh, and A. Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.
7	T. M. Mitchell, "Machine Learning", McGraw Hill, 1997.
8	S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2009.

CO - PO matrices of course

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PO / CO	PO1	PO2	PO3	PO4	PO5
DS19203.1	1	2	2	1	1
DS19203.2	1	1	2	2	2
DS19203.3	1	1	2	1	1
DS19203.4	1	2	1	2	3
DS19203.5	2	1	2	2	3
AVERAGE	1.2	1.4	1.8	1.6	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P01	WIRELESS SENSOR NETWORKS	PE	3	0	0	3

Objectives:	
•	To provide an overview about sensor networks and emerging technologies.
•	To study about the node and network architecture of sensor nodes and its execution environment.
•	To understand the concepts of communication, MAC, routing protocols.
•	To learn about topology control and clustering in networks with timing synchronization.
•	To study about sensor node platforms and understand the simulation and programming techniques.

UNIT-I	OVERVIEW OF WIRELESS SENSOR NETWORKS	9
Characteristic requirements –TOS, QoS, Fault tolerance, Lifetime, scalability, wide range densities, programmability, maintainability. Required mechanisms – multichip, energy efficient, auto configuration, collaboration, data centric, locality, exploit trade-off. Unique constraints and challenges of sensor networks. Emerging technologies for wireless sensor networks. Advantages of sensor networks – energy advantage – detection advantage. Sensor network applications – Habitat Monitoring- Tracking chemical plumes- Smart transportation.		
UNIT-II	**ARCHITECTURES**	**9**
Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture –Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.		
UNIT-III	**NETWORKING SENSORS**	**9**
Physical Layer and Transceiver Design Considerations, MAC Protocols for WSN, Low Duty Cycle Protocols and Wakeup Concepts – S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols– Energy-Efficient Routing, Geographic Routing.		
UNIT-IV	**INFRASTRUCTURE ESTABLISHMENT**	**9**
Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.		
UNIT-V	**SENSOR NETWORK PLATFORMS AND TOOLS**	
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Get an overview about sensor networks and emerging technologies.
•	Understand node and network architecture of sensor nodes and its execution environment.
•	Understand concepts of MAC, routing protocols and also study about the naming and addressing in WSN.
•	Understand about topology control and clustering in networks with timing synchronization for localization services with sensor tasking and control.
•	Analyze sensor node hardware and software platforms.

Reference Books(s):	
1	Holger Karl & Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.
2	Feng Zhao & Leonidas J. G., “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
3	Kazem Sohraby, Daniel Minoli, & TaiebZnati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007
4	Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P01.1	1	1	2	1	2
CP19P01.2	1	1	3	2	2
CP19P01.3	2	1	3	2	3
CP19P01.4	2	2	3	3	3
CP19P01.5	3	3	3	3	3
AVERAGE	1.8	1.6	2.8	2.2	2.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P02	CLOUD INFRASTRUCTURE	PE	3	0	0	3

Objectives:	
•	To introduce the Cloud Computing Domain with its architecture and Delivery model.
•	To learn the Cloud Enabling Technologies like Virtualization and Infrastructure Management.
•	To learn a variety of management and administrative mechanisms related to the functioning of cloud.
•	To learn the important architectures that enables the cloud to function without disruption.
•	To learn Industry specific tools for cloud automation and container technologies.

UNIT-I	CLOUD FUNDAMENTALS	9
Fundamentals of Cloud computing, Mechanisms, Cloud Computing Architecture, Characteristics, Delivery and Deployment Models. Business Drivers and Technology innovations - Cloud Delivery and Deployment Models. Case Study: Google Cloud Platform, Amazon Web Services and Microsoft Azure Vs OpenStack and CloudStack.		
UNIT-II	**CLOUD ENABLING TECHNOLOGIES**	**9**
Data center technology, Virtualization Technology, Web and Services Technology, Cloud Infrastructure Mechanism: Cloud Storage and Usage Monitor, Resource Replication. Case Study: Xen, KVM, VMWare, and Microsoft Hyper V.		
UNIT-III	**CLOUD AUTOMATION SERVICES AND ADVANCEMENTS**	**9**
Introduction to DevOps, DevOpsTools: Gradle, Git, Jenkins, Kubernetes, Container Technology: Dockers, LXC. Cloud Advancements, Mobile Cloud Computing, Edge Devices and Fog Computing.		
UNIT-IV	**CLOUD COMPUTING MECHANISM**	**9**
Specialized Cloud Mechanism: Load Balancer, SLA Monitor, Pay-per-use Monitor, Audit Monitor, Failover System, Hypervisor, Resource Cluster, Multi Device Broker, State Management Database – Cloud Management Mechanism: Remote Administration System, Resource, SLA and Billing Management System.		
UNIT-V	**ADVANCED CLOUD ARCHITECTURE**	**9**
Elastic resource capacity, Cloud Bursting, Redundant storage, Hypervisor Clustering, Zero Downtime, Dynamic Failure Detection and Recovery, Bare-metal and Rapid provisioning architecture, Geo Replication.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Demonstrate the main concepts of cloud, its characteristics, advantages, key technologies and its various delivery and deployment models.
•	Articulate the strength of virtualization and outline its role in enabling the cloud computing system model.
•	Recognize the scope of Cloud Automation Services and their applications in industry.
•	Illustrate management and administration of Cloud Computing Infrastructure and Data centre.
•	Analyse the issues of cloud like recovery and dynamic failure.

Reference Books(s):	
1	Thomas Erl, ZaighamMahood, Ricardo Puttini, "Cloud Computing, Concept, Technology and Architecture", Prentice Hall, 2013.
2	Kai Hwang, Geoffery C. Fox and Jack J. Dongarra, "Distributed and Cloud Computing: Clusters, Grids, Clouds and the Future of Internet", First Edition, Morgan Kaufman Publisher, an Imprint of Elsevier, 2012.
3	RajkumarBuyya, Christian V, S. ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw-Hill, 2013.
4	ArshdeepBahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", Universities Press, 2014

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P02.1	3	2	3	3	2
CP19P02.2	3	2	2	3	2
CP19P02.3	3	2	3	3	2
CP19P02.4	3	2	3	3	3
CP19P02.5	3	2	3	3	2
AVERAGE	3	2	2.8	3	2.2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P03	DIGITAL FORENSICS	PE	3	0	0	3

Objectives:	
•	To learn about Digital Forensics and Cyber Crime Law.
•	To understand the Environment of Forensics.
•	To learn the process of collecting evidences.
•	To gain working knowledge of analyzing evidences using tools.
•	To learn about other sources of evidences and its future challenges.

UNIT-I	DIGITAL FORENSICS PROCESS	9
Forensic Science, Digital Forensics, Digital Evidence, Digital Forensics Process – Identification, Collection, Examination, Analysis, Presentation Phases. Classification of Cybercrime - Cybercrimes and Cyber Laws in India		
UNIT-II	**FORENSICS ENVIRONMENTS**	**9**
Hardware and Software Environments – Storage Devices, Operating System, File Systems, Metadata, locating evidence in file systems, Password security, Encryption, and Hidden files - Case study – linking the evidence to the user, Data Analysis using forensics tool ILookIX		
UNIT-III	**COLLECTING EVIDENCES**	**9**
Use of Digital Evidence, File Metadata and Correlation with Other Evidence, Technical Complexities of Digital Evidence. Data carving, Date and time problems, Physical Acquisition and Safekeeping of Digital Evidence. Forensic Imaging Processes - Case Study – IXImager, Understanding ASB container		
UNIT-IV	**ANALYZING DIGITAL EVIDENCE**	**9**
Selecting and Analyzing Digital Evidence - Locating digital evidence, categorizing files, eliminating superfluous files, The Event Analysis tool, Cloud Analysis tool, The Lead Analysis tool, Volume Shadow Copy analysis tools, Validating the Evidence. Case study – illustrating the recovery of deleted evidence held in volume shadows.		
UNIT-V	**OTHER SOURCES OF EVIDENCES**	**9**
Windows and Other Operating Systems as Sources of Evidence, Examining Browsers, E-mails, Messaging Systems, and Mobile Phones, Internet and Cloud. Challenges in Digital Forensics – Case study – Volatility		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Identify the need for cybercrime investigations.
•	Use tools to analyze the evidence collected.
•	Collect evidences in proper form.
•	Analyze the evidence through suitable tools.
•	Examine other sources of evidences.

Reference Book(s):	
1	Richard Boddington, “Practical Digital Forensics”, PACKT publishing, 2016
2	André Årnes, “Digital Forensics”, John Wiley & Sons, 2017.
3	Dejey and Murugan, “Cyber Forensics”, Oxford University Press, 2018.
4	Bill Nelson, Amelia Phillips and Christopher Steuart, “Guide to Computer Forensics and Investigations”, Fourth Edition, Cengage Learning, 2010.
5	Dr. Dhananjay, R. Kalbande, Dr. Nilakshi Jain, “Digital Forensic: The Fascinating World of Digital Evidences”. Wiley, 2017.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P03.1	2	1	3	2	2
CP19P03.2	3	2	3	3	2
CP19P03.3	3	1	3	3	2
CP19P03.4	3	2	2	3	3
CP19P03.5	3	3	3	2	1
AVERAGE	2.8	1.8	2.8	2.8	2.2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19204	COMPUTER VISION	PE	3	0	0	3

Objectives:	
•	To review image processing techniques for computer vision.
•	To understand shape and region analysis.
•	To understand Hough Transform and its applications to detect lines, circles, ellipses.
•	To understand three-dimensional image analysis and motions.
•	To study some applications of computer vision algorithms.

UNIT I	IMAGE PROCESSING FOUNDATIONS	9
Introduction–Image Processing Operations– Basic Image filtering operations: Noise Suppression by Gaussian Smoothing– Median Filters– Mode Filters– Rank Order Filters– The Role of Filters in Industrial Applications of Vision– Thresholding- Adaptive Thresholding – Edge detection techniques – corner and interest point detection – mathematical morphology – Some Basic Approaches to Texture Analysis.		
UNIT II	**SHAPES AND REGIONS**	**9**
Binary shape analysis – Connectedness – Object labeling and counting – Size filtering – Distance functions – Skeletons and thinning –Other Measures for Shape Recognition – Boundary tracking procedures – Boundary Pattern Analysis– Centroidal profiles – Problems– Plot- Handling occlusion– Accuracy of boundary length measures.		
UNIT III	**THE HOUGH TRANSFORM**	**9**
Line detection– Application of Hough Transform (HT) for line detection – The Foot-of-normal method – Longitudinal line localization – Final line fitting – Using RANSAC for straight line detection Circle and Ellipse Detection: HT for circular object detection – accurate center location – speed problem – ellipse detection – Case study- Human Iris location – hole detection– Generalized Hough Transform (GHT) – Spatial matched filtering – Use of GHT for Ellipse Detection		
UNIT IV	**3D VISION AND MOTION**	**9**
3-D Vision – Methods for 3D vision – projection schemes – shape from shading – photometric stereo – Surface Smoothness– shape from texture – use of structured lighting– three dimensional object recognition schemes– Image Transformations and Camera Calibration– Motion: Optical Flow– Interpretation– Time-to-Adjacency Analysis– Difficulties– Stereo from Motion– The Kalman Filter.		
UNIT V	**APPLICATION**	**9**
Automated Visual Inspection: Process– Types– Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application- Surveillance–foreground–background separation – particle filters – Chamfer matching – tracking and occlusion – combining views from multiple cameras – human gait analysis Application– In-vehicle vision system: locating roadway – road markings – road signs – locating pedestrians.		
	Total Contact Hours :	**45**

Course Outcomes:	
On completion of the course, the students will be able to	
•	Implement fundamental image processing techniques required for computer vision.
•	Perform shape analysis and able to implement boundary tracking techniques.
•	Apply Hough Transform for line, circle, and ellipse detections.
•	Apply 3D vision techniques and to implement motion related techniques.
•	Develop applications using computer vision techniques.

Reference Books(s):	
1	E. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
2	R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
3	Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012.
4	Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition
5	D. L. Baggio et al., “Mastering OpenCV with Practical Computer Vision Projects”, Packt Publishing, 2012.
6	Jan Erik Solem, “Programming Computer Vision with Python: Tools and algorithms for analyzing images”, O'Reilly Media, 2012.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
DS19204.1	-	2	-	2	1
DS19204.2	-	-	-	-	-
DS19204.3	2	2	2	-	-
DS19204.4	2	-	1	3	3
DS19204.5	1	2	2	3	3
AVERAGE	1.7	2.0	1.7	2.7	2.3

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : “-”

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P04	ADVANCED WIRELESS AND MOBILE NETWORKS	PE	3	0	0	3

Objectives:	
•	To deal about frequency reuse in wireless communication.
•	To study about the various radio propagation models in wireless technology.
•	To provide knowledge about wireless personal area networks.
•	To study about MIMO coding techniques in wireless environment.
•	To study about the Signal Processing recent techniques.

UNIT-I	Wireless Communication	9
Wireless Propagation Mechanisms (Qualitative treatment)– Propagation effects with mobile radio– Channel Classification– Link calculations, –Narrowband and Wideband models. **Wireless Transceivers:** Structure of a wireless communication link– Modulation and demodulation – Quadrature Phase Shift Keying– Differential Quadrature Phase Shift Keying– Offset-Quadrature Phase Shift Keying– Binary Frequency Shift Keying– Minimum Shift Keying–Gaussian Minimum Shift Keying– Power spectrum and Error performance in fading channels.		
UNIT-II	**Recent wireless technologies**	**9**
Recent wireless technologies: Multicarrier modulation– OFDM– MIMO system– diversity multiplexing trade-off– MIMO-OFDM system– smart-antenna– beam forming and MIMO– cognitive radio– software defined radio– communication relays– spectrum sharing. **Advanced Transceiver Schemes**: contention-free multiple access schemes (FDMA TDMA, CDMA, SDMA and Hybrid)– contention-based multiple access schemes (ALOHA and CSMA). Spread Spectrum Systems–Principle, – Power control– Effects of multipath propagation Orthogonal Frequency Division Multiplexing – Principle, –Cyclic Prefix, Transceiver implementation– Second Generation (GSM, IS–95) and Third Generation Wireless Networks and Standards.		
UNIT-III	**Wireless personal area networks**	**9**
Wireless personal area networks (Bluetooth, UWB and ZigBee)– wireless local area networks (IEEE 802.11, network architecture, medium access methods, WLAN standards)– wireless metropolitan area networks (WiMAX). **Ad-hoc wireless networks**: Design Challenges in Ad-hoc wireless networks– concept of cross layer design– security in wireless networks– energy constrained networks. MANET and WSN. Wireless system protocols: mobile network layer protocol (mobile IP, IPv6, dynamic host configuration protocol)– mobile transport layer protocol (traditional TCP, classical TCP improvements)– support for mobility (wireless application protocol).		
UNIT-IV	**MIMO Systems**	**9**
Types of MIMO Systems: Beam forming – spatial multiplexing – basic space time code design principles– orthogonal and quasi orthogonal space time block codes– space time trellis codes – representation of space – performance analysis for space-time trellis codes – comparison of space-time block and trellis codes. **Instructional Activities:** Hours Simulation of minimum of (2) modulation and multiple access technique for wireless communication using related simulation tools.		
UNIT-V	**Fundamentals of Signal Processing**	**9**
Hours Introduction: Basic elements of Digital Signal Processing System– advantages of digital over analog signal processing– Classification of signals: Deterministic vs Random signals –Multi channel and Multi-dimensional signals– Down Sampling–decimation-up sampling– interpolation. **Power spectrum estimation:** Hours Estimation of spectra using the DFT from finite duration signals – non– parametric methods for power spectrum estimation: Welch- Bartlett methods–Parametric methods for power spectrum estimation: Yule-Walker method– Burg method for the ARM parameters– sequential estimation methods.		
	Total Contact Hours :	**45**

Course Outcomes: Upon completion of the course, the students will be able to:	
•	Understand the basics of frequency reuse and handoff in mobile networks.
•	Solve issues related to various propagation models.
•	Identify the types of WPAN and define the scope of personal networks.
•	Implement the MIMO systems and techniques.
•	Gain knowledge on Signal processing techniques for various devices.

Reference Books(s):	
1	Proakis J G and Manolkis D G, "Digital Signal Processing: Principles, Algorithms and Applications", 4th Edition, Prentice Hall of India, 2007.
2	Monson H H, "Statistical Digital Signal Processing and Modeling", Wiley, 2002.
3	Cristi R, "Modern Digital Signal Processing", Thomson Brooks/Cole, 2004.
4	Lokenath D and Firdous A S, "Wavelet Transforms and Their Applications", 2nd Edition, Birkhauser, Springer, 2014.
5	Raghuveer R M, and Ajit S B, "Wavelet Transforms: Introduction to Theory and Applications", Pearson Education, New Delhi, 1998.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P04.1	1	1	1	-	1
CP19P04.2	2	1	2	-	1
CP19P04.3	2	1	1	1	2
CP19P04.4	2	1	2	1	2
CP19P04.5	1	1	1	2	2
AVERAGE	1.6	1.0	1.4	1.3	1.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P05	DATA SCIENCE	PE	3	0	0	3

Objectives:	
•	To understand the basics of data science.
•	To get thorough knowledge in analytical methods.
•	To learn and understand data science packages of python.
•	To learn and apply data science algorithms using R language.
•	To study various visualization techniques.

UNIT-I	INTRODUCTION TO DATA SCIENCE	9
Big Data and Data Science Hype–Characteristics of Big Data– Data Science Life Cycle–Statistical Methods–Probability–Sampling and Sampling Distributions–Statistical Inference–Prediction and Prediction Error–Resampling		
UNIT-II	**ANALYTICAL THEORY AND METHODS**	**9**
Linear Regression–Simple Linear Regression– Multiple Linear Regression–Logistic Regression–Linear Discriminant Analysis–Bayesian Methods –Introduction to Clustering Techniques –K means– Gaussian Mixture Models and Expectations – Maximization – agglomerative clustering – evaluation of clustering – Rand index – mutual information-based scores – Fowlkes – Mallows index – Ensemble Techniques – Bagging & Boosting		
UNIT-III	**DATA SCIENCE USING PYTHON**	**9**
Data science packages–NumPy Basics-Pandas-Data Loading–Data Wrangling-Plotting and Visualization–Data Aggregation and Group Operations – Data Exploration – Visualization using python		
UNIT-IV	**INTRODUCING R LANGUAGE**	**9**
R Basics-R Objects–R Notations– Packages – Indexing Data– Loading Data – Exploratory Data Analysis using R–Statistical Methods for Evaluation using R – Data Science applications–Time Series Forecasting, Text Mining & Sentiment Analysis		
UNIT-V	**DATA VISUALIZATION**	**9**
Data Visualization: Basic Principles– Categorical and Continuous Variables – Exploratory Graphical Analysis – Creating Static Graphs– Animated Visualizations – Loops, GIFs and Videos.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Understand the basics of data science.
•	Acquire knowledge of various analytical methods.
•	Work with data science packages of python.
•	Apply data science algorithms using R language.
•	Obtain knowledge of various visualization techniques.

Reference Books(s):	
1	Cathy O'Neil and Rachel Schutt. “Doing Data Science, Straight Talk from The Frontline”, O'Reilly. 2014.
2	Garrett Grolemund, “Hands on programming with R”, O’Reilly,2014
3	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, “An introduction to statistical learning with application in R”, Springer.
4	Wes McKinney, “Python for Data Analysis”, O'Reilly Media, 2012
5	Sebastian Raschka, “Python Machine Learning”, Packpub.com,2015
6	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, Second Edition, 2007
7	Nathan Yau, “Data Points: Visualization That Means Something”, Wiley, 2013.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P05.1	1	-	2	1	1
CP19P05.2	2	-	2	3	2
CP19P05.3	2	-	3	3	2
CP19P05.4	2	-	3	3	2
CP19P05.5	2	3	2	3	1
AVERAGE	1.8	3.0	2.4	2.6	1.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P06	BIG DATA ANALYTICS	PE	3	0	0	3

Objectives:	
•	To gain factual knowledge regarding data acquisition, data cleansing, and various aspects of data analytics and visualization.
•	To learn the principles of data analytics and its underlying methods and algorithms.
•	To apply the methods of Distributed data storage and processing using Hadoop related tools and Map Reduce Concepts.
•	To understand the necessity of Streaming Data Analysis and its applications.
•	To develop the skills necessary to use related software tools to perform data collection, cleansing, and analytics.

UNIT-I	BIG DATA ANALYTICS	9
Introduction to Big Data Analytics– Data Structures– BI Vs Analytics– Analytic Architecture– Data Analytics Life Cycle– R Language for Data Analytics– Basic Features– Data Import and Export– Descriptive Statistics– Predictive Analytics		
UNIT-II	**ANALYTICAL THEORY**	**9**
Overview of Clustering– Classification and Correlation– K-means– Supervised and Unsupervised Learning– Linear– Logistics and Lasso Regression– Bayesian Modelling– Time Series Analysis, Association Analysis and Cluster Analysis.		
UNIT-III	**HADOOP ECOSYSTEM**	**9**
Hadoop Stack for Big Data– Processing Data with Hadoop– HDFS– Hadoop MapReduce 2.0– Job Scheduling– Shuffle and sort– Hadoop Related Technologies: Hive– Mahout–Zookeeper– HBase and Cassandra.		
UNIT-IV	**STREAMING DATA ANALYTICS**	**9**
Introduction to Streams Concepts – Stream data model and architecture - Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window – Realtime Analytics Platform (RTAP) applications – case studies – real time sentiment analysis, stock market predictions.		
UNIT-V	**ADVANCED TOOLS FOR ANALYTICS**	**9**
Stream Analytics using Apache Spark and Flink, Graph Database using Neo4J– Applications of Spark ML library– In-Memory Databases: VoltDB –SciDB– Data Analytics in Cloud: Tableau– AWS Kinesis and AWS EMR.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Analyze the importance of analytics and identify the features of it.
•	Understand different types of supervised and unsupervised learning algorithms.
•	Examine the implementation techniques for big data analysis.
•	Implement the streaming data sets in stream processors.
•	Apply various tools to execute datasets in real-time.

Reference Books(s):	
1	EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley, 2015.
2	Jen Stirrup, and Ruben Oliva Ramos, "Advanced Analytics with R and Tableau", Packt Publishing Limited, 2017.
3	Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P06.1	3	2	2	1	1
CP19P06.2	2	2	1	3	1
CP19P06.3	1	1	2	3	3
CP19P06.4	1	1	3	3	2
CP19P06.5	2	2	3	3	3
AVERAGE	1.8	1.6	2.2	2.6	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P07	WEB SEARCH & INFORMATION RETRIEVAL	PE	3	0	0	3

Objectives:	
•	To provide with foundation knowledge in information retrieval.
•	To equip with sound skills to solve computational search problems.
•	To understand the working principles of a search engine.

UNIT-I	**INTRODUCTION TO INFORMATION RETRIEVAL**	**9**
Boolean retrieval – The term vocabulary and postings lists– Dictionaries and tolerant retrieval –Index construction – Index compression		
UNIT-II	**EVALUATION AND QUERY EXPANSION**	**9**
Scoring, term weighting and the vector space model – Computing scores in a complete search system – Evaluation in information retrieval – Relevance feedback and query expansion		
UNIT-III	**XML, PROBABILISTIC AND CBIR**	**9**
XML IR – Probabilistic IR– Language IR Crawling – Link Analysis– Content based Image Retrieval		
UNIT-IV	**MULTILINGUAL INFORMATION RETRIEVAL**	**9**
CLIR, MLIR, Matching, Interaction and User Interface, Evaluation –System oriented and User oriented.		
UNIT-V	**PROCESSING LIVE STREAM AND APPLICATION**	**9**
Why Stream–Stream based architecture – Applications like Online advertising fraud detection– health care using the Tools Apache Flink, Kafka, MapR		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, the students will be able to	
•	Use different information retrieval techniques in various application areas.
•	Apply IR principles to locate relevant information large collections of data and analyze performance of retrieval systems when dealing with unmanaged data source.
•	Implement systems for web search.
•	Retrieve the content and the query in language other than English.
•	Implement retrieval from the live data.

Reference Books(s):	
1	Christopher D. Manning Prabhakar Raghavan, HinrichSchütze, "An Introduction to Information Retrieval" Online edition (c) 2009 Cambridge UP, April 2019
2	Carol Peters, Martin Braschler, and Paul Clough, "Multilingual Information Retrieval: From Research to Practice",Springer 2012
3	Andrew G. Psaltis, "Streaming Data Understanding the real-time pipeline", O'Reilly Media, Inc. May 2017
4	VasilikiKalavri, Fabian Hueske, "Stream Processing with Apache Flink",Publisher: O'Reilly Media, Inc.2019
5	Ted Dunning, Ellen Friedman, "Streaming Architecture: New Designs Using Apache Kafka and MapRStreams",1st Edition, 2016

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P07.1	2	2	1	2	1
CP19P07.2	1	2	0	1	1
CP19P07.3	1	1	0	0	0
CP19P07.4	-	2	3	3	3
CP19P07.5	2	2	3	3	3
AVERAGE	1.2	1.8	1.4	1.8	1.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P08	USER INTERFACE DESIGN	PE	3	0	0	3

Objectives:	
•	To learn the foundations of Human Computer Interaction.
•	To be familiar with the design technologies for individuals and persons with disabilities.
•	To be aware of mobile Human Computer interaction.

UNIT-I	COMMUNICATION DESIGN PRINCIPLES	9
Introduction–core principles–effective communication–Intuitive UI–Strategically Un Intuitive UI–Levels of Intuitiveness–Strategically deductive UI–A model for users.		
UNIT-II	**INTERACTION DESIGN**	**9**
Interactive Design basics – process – scenarios – navigation – screen design –Iteration and prototyping. HCI in software process – software life cycle –usability engineering – Prototyping in practice – design rationale. Design rules– principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.		
UNIT-III	**VISUAL DESIGN**	**9**
Introduction – The importance of effective visual design – Working with graphic designers – Layout – Designing for scanning – Typography and text – Color – Affordances – Icons and glyphs – Animations and transitions – Demanding attention.		
UNIT-IV	**WEB INTERFACES**	**9**
Designing Web Interfaces – Drag & Drop– Direct Selection– Contextual Tools–Overlays– Inlays and Virtual Pages– Process Flow– Case Studies.		
UNIT-V	**MOBILE INTERFACE DESIGN**	**9**
Mobile Ecosystem: Platforms–Application frameworks– Types of Mobile Applications: Widgets– Applications– Games– Mobile Information Architecture–Mobile 2.0– Mobile Design: Elements of Mobile Design– Tools.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Understand the structure and models of design principles.
•	Design an interaction-based navigation system.
•	Design visual graphics with various animation and transition.
•	Design an interactive web interface on the basis of models studied.
•	Design UI design examples for Mobile development.

Reference Book(s):	
1	Everett N. McKay, "UI is Communication - How to design intuitive, user-centered interfaces by focusing on effective communication", Morgan Kaufmann (ELSEVIER), 2013.
2	Jeff Johnson, "Designing with the Mind in Mind. Simple Guide to Understanding User Interface Design Guidelines", Morgan Kaufmann, 2014.
3	Brian Fling, "Mobile Design and Development", First Edition, OReilly Media Inc., 2009.
4	Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, OReilly, 2009.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P08.1	1	1	1	1	2
CP19P08.2	-	2	-	1	2
CP19P08.3	1	-	1	2	2
CP19P08.4	1	1	1	1	2
CP19P08.5	1	1	1	2	2
AVERAGE	1.0	1.0	1.0	1.4	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P09	GPU COMPUTING	PE	3	0	0	3

Objectives:	
•	To understand the basics of GPU architectures.
•	To write programs for CUDA programming.
•	To understand the issues in mapping algorithms for GPUs.
•	To introduce different GPU programming issues.
•	To understand the GPU memory and concurrency model.

UNIT-I	GPU ARCHITECTURE	9
History of Supercomputing – Understanding Parallelism with GPU – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling – Memory Handling with CUDA: Shared, Global, Constant, and Texture Memory.		
UNIT-II	**CUDA PROGRAMMING**	**9**
Using CUDA – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition – Memory Considerations – Transfers, Thread Usage – Resource Contentions.		
UNIT-III	**CUDA PROGRAMMING ISSUES**	**9**
Common Problems: CUDA Error Handling – Parallel Programming Issues, Synchronization – Algorithmic Issues – Finding and Avoiding Errors.		
UNIT-IV	**OPENCL BASICS**	**9**
OpenCL Standard – Platform Model – Execution Model – Programming Model – Memory Model – Basic OpenCL Examples.		
UNIT-V	**CONCURRENCY MODEL**	**9**
Commands and Queuing Model – Native and Built-in Kernels – Device side Queuing – Host-side Memory Model – Device-side Memory Model – Dissecting OpenCL on Heterogeneous System.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, students will be able to	
•	Describe GPU Architecture.
•	Write programs using CUDA, identify issues and debug them.
•	Implement efficient algorithms in GPUs for common application kernels.
•	Write simple programs using OpenCL.
•	Understand the memory models of GPU.

Reference Books(s)/Web Link(s):	
1	Shane Cook, CUDA Programming: ―A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012
2	David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, ―Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
3	Nicholas Wilt, ―CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison – Wesley, 2013.
4	Jason Sanders, Edward Kandrot, ―CUDA by Example: An Introduction to General Purpose GPU Programming, Addison – Wesley, 2010.
5	David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors – A Hands-on Approach, Third Edition, Morgan Kaufmann, 2016.
6	http://www.nvidia.com/object/cuda_home_new.html
7	http://www.openCL.org

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P09.1	3	1	3	2	2
CP19P09.2	3	2	3	3	2
CP19P09.3	3	1	3	3	2
CP19P09.4	3	2	3	3	3
CP19P09.5	3	2	3	3	2
AVERAGE	3.0	1.6	3.0	2.8	2.2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P10	QUEUING THEORY AND MODELING	PE	3	0	0	3

Objectives:	
•	To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
•	To analyze the performance of various designs in computer systems and networks.
•	To understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.

UNIT-I	**RANDOM VARIABLES**				**9**
Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.					
UNIT-II	**TWO – DIMENSIONAL RANDOM VARIABLES**				**9**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables.					
UNIT-III	**QUEUEING MODELS**				**9**
Poisson Process–Markovian Queues–Single and Multi-server Models–Little's formula–Machine Interference Model–Steady State analysis –Self Service Queue.					
UNIT-IV	**ADVANCED QUEUEING MODEL**				**9**
Non- Markovian Queues – PollaczekKhintchine Formula – Queues in Series – Open Queueing Networks –Closed Queueing networks.					
UNIT-V	**NETWORK MODELS**				**9**
Network Construction– computation of earliest start time, latest start time, Total, free and independent float time– Computation of optimistic, most likely Pessimistic and expected time.					
		Total Contact Hours	**:**		**45**

Course Outcomes:	
Upon completion of the course, the students will be able to	
•	Have a fundamental Knowledge of the probability concepts.
•	Get exposed to the testing of hypothesis using distributions.
•	Acquire skills in analyzing queuing models.
•	Gain strong knowledge in principles of Queuing theory.
•	Get exposed to Network Models.

Reference Books(s):	
1	Ibe. O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.
2	Gross. D. and Harris. C.M., "Fundamentals of Queueing Theory", Wiley Student edition, 2004.
3	Nita H. Shah., Ravi M. Gor and Hardik Soni, "Operations Research", Prentice Hall India, 2008
4	Donald Gross and Carl M. Harris, "Fundamentals of Queueing theory", 3rd edition, John Wiley and Sons, 2011.
5	Robertazzi, "Computer Networks and Systems: Queueing Theory and Performance Evaluation", 3rd Edition, Springer, 2006.
6	Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
7	Taha. H.A., "Operations Research", 8th Edition, Pearson Education, Asia, 2007

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P10.1	1	1	1	1	2
CP19P10.2	1	1	2	2	2
CP19P10.3	2	1	3	3	3
CP19P10.4	2	2	2	2	1
CP19P10.5	1	1	2	2	1
AVERAGE	1.4	1.2	2.0	2.0	1.8

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P11	PARALLEL ALGORITHMS	PE	3	0	0	3

Objectives:	
•	To familiarize the parallel Architecture.
•	To analysis a parallel Algorithms and Sequences.
•	To understand Probability and Graph Theory Parallel.
•	To develop parallel algorithms for standard problems and applications.
•	To learn parallel programming using OPENMP, OPENCL and CUDA.

UNIT-I	PARALLEL ARCHITECTURES	9
Basic architectures, Multiprocessors, Vector processors, Pipeline, Array, Systolic Array Static Connection Architectures–Linear Array, Ring, Chordal Ring, Mesh, Fat Tree, Hyper Tree, Pyramid, Hypercube, CCC, Butterfly, Dynamic Connection Architecture- Crossbar Switch, Omega Networks, Interconnection Networks Memory Organization, Programming Models in High Performance Computing Architectures		
UNIT-II	**ANALYSIS OF PARALLEL ALGORITHM AND SEQUENECES**	**9**
PRAM model of computation, Basics, Big-O, big-Omega, and big-Theta, Cost Models-Machine-Based Cost Models, RAM Model, PRAM: Parallel Random Access Machine, Language Based Models, Work-Span Model, Scheduling, Recurrences– Some conventions, Tree Method, Brick Method, Substitution Method, Master Method, Sequences– Defining Sequences, Sequence Abstract Data Type, Basic Functions, Tabulate, Map and Filter, Subsequences, Append and Flatten, Update and Inject, Collect, Aggregation by Iteration, Aggregation by Reduction, Aggregation with Scan, Implementation of Sequences- Parametric Implementation, An Array-Based Implementation, Cost of Sequences– Cost Specifications, Array Sequences, Tree Sequences, List Sequences.		
UNIT-III	**PROBABILITY AND GRAPH THEORY**	**9**
Probability Theory, Probability Spaces, Properties of Probability Spaces, Union Bound, Conditional Probability, Law of Total Probability, Independence, Random Variables-Probability Mass Function, Bernoulli, Binomial, and Geometric RVs, Functions of Random Variables, Conditioning, Independence, Expectation- Markov's Inequality, Composing Expectations, Linearity of Expectations, Conditional Expectation; Randomization-Randomized Algorithms, Advantages of Randomization, Disadvantages of Randomization, Analysis of Randomized Algorithms, Order Statistics- The Order Statistics Problem, Randomized Algorithm for Order Statistics, Analysis, Intuitive Analysis, Complete Analysis Graphs: Graphs and their Representation - Graphs and Relations - Applications of Graphs, Graphs Representations, Edge Sets, Adjacency Tables, Adjacency Sequences, Adjacency Matrices, Representing Weighted Graphs, Graph Search - Generic Graph Search, Reachability, Graph-Search Tree, Priority-First Search (PFS), BFS, DFS.		
UNIT-IV	**PARALLEL ALGORITHMS**	**9**
PRAM algorithms for Prefix Sum, Reduction Elementary parallel algorithms – Broadcast, Prefix sums, Searching M, Sorting-Quick Sort, Merge Sort, Odd-even Transposition Sort, Bitonic Merge, Dictionary Operations-Ellis Algorithm Graph Algorithms, Minimum Spanning Trees-Sollin's Algorithms Matrix Multiplication, DFT, FFT		
UNIT-V	**OPENMP, OPENCL AND INTRODUCTION TO CUDA**	**9**
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. **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		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Identify issues in parallel Architecture.
•	Design a parallel algorithms and sequence.
•	Design a probability and graph theory parallel environment.
•	Design and develop shared memory parallel algorithms and applications using OpenMP.
•	Use OpenMP, OpenCL and CUDA programs.

Reference Books(s):	
1	Umut A. Acar, Guy E. Blelloch, "Algorithms: Parallel and Sequential", Feb 2019
2	Peter S. Pacheco, "An introduction to parallel programming‖", Morgan Kaufmann, 2011.
3	Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, © 2007.
4	A. Munshi, B. Gaster, T. G. Mattson, J. Fung, and D. Ginsburg, "OpenCL programming guide‖", Addison Wesley, 2011
5	M. J. Quinn, "Parallel programming in C with MPI and OpenMP‖", Tata McGraw Hill, 2003.
6	Rob Farber, "CUDA application design and development", Morgan Haufmann, 2011.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P11.1	2	2	1	3	3
CP19P11.2	1	1	1	3	3
CP19P11.3	1	1	1	2	2
CP19P11.4	1	1	1	3	3
CP19P11.5	2	1	1	2	2
AVERAGE	1.2	1.2	1.0	2.6	2.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P12	MOBILE APPLICATIONS AND SERVICES	PE	3	0	0	3

Objectives:	
•	To learn the characteristics of mobile applications.
•	To understand the intricacies of UI required by mobile applications.
•	To study about the design aspects of mobile application.
•	To learn development of mobile applications.
•	To understand the web services.

UNIT-I	INTRODUCTION	9
Tools and Basics: Installing Android SDK and Prerequisites – Test Drive–Components of the SDK–Java for Android: Types, Scope, Idioms–Ingredients of an Android Application: Android Components, Component Life Cycles, Application Resources and Context.		
UNIT-II	**APPLICATION WORKSPACES&FRAMEWORK**	**9**
Application Signing – Placing an Application for Distribution–Alternative Distribution– Eclipse for Android – Building a View: Android GUI Architecture –Assembling a Graphical Interface–Fragments and Multiplatform Support: Fragment Life Cycle		
UNIT-III	**APPLICATION DESIGN**	**9**
Drawing 2D and 3D Graphics – Handling and Persisting Data – SQLite – Database Design for Android Applications – Framework for a Well-Behaved Application – Building a User Interface		
UNIT-IV	**APPLICATION DEVELOPMENT**	**9**
Intents and Services – Storing and Retrieving data – Communication via the Web – Notification and Alarms – Graphics and Multimedia – Telephony – Location based services – Packaging and Deployment – Security and Hacking.		
UNIT-V	**WEB SERVICE**	**9**
Developing RESTful Android Applications – Network MVC – Case Study: Dynamically Listing and Caching YouTube Video Content, Stepping Through the Search Application		
	Total Contact Hours :	**45**

Course Outcomes:	
Upon completion of the course, the students will be able to	
•	Design and implement the user interfaces for mobile applications.
•	Design the mobile applications that are aware of the resource constraints of mobile devices.
•	Develop advanced mobile applications that access the databases and the web.
•	Develop useful mobile applications in the current scenario using Google Android and Eclipse simulator.
•	Understand MVC architecture and Search mechanisms in Cloud.

Reference Books(s):	
1	ZigurdMednieks, Laird Dornin, G, Blake Meike and Masumi Nakamura, “Programming Android”, O‟Reilly, 2011.
2	Reto Meier, Wrox Wiley, “Professional Android 2 Application Development”, 2010.
3	Alasdair Allan, “iPhone Programming”, O‟Reilly, 2010.
4	Wei-Meng Lee, “Beginning iPhone SDK Programming with Objective-C”, Wrox Wiley, 2010.
5	Stefan Poslad, “Ubiquitous Computing: Smart Devices, Environments and interactions”, Wiley, 2009.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P12.1	3	2	3	-	-
CP19P12.2	3	3	1	-	-
CP19P12.3	2	-	3	3	-
CP19P12.4	1	3	-	3	-
CP19P12.5	3	3	-	-	3
AVERAGE	2.4	2.2	1.4	1.2	0.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P13	DNA COMPUTING	PE	3	0	0	3

Objectives:	
•	To describe about molecular biology, mechanisms and processes for molecular computing.
•	To construct DNA codes, bounds on DNA block codes and to generate molecules with desired properties.
•	To focus on models those are molecular-state, autonomous and partially programmable.
•	To construct DNA computational models for complex information processing and control tasks.
•	To focus on logical control or manipulation of cellular expression patterns.

UNIT-I	INTRODUCTION TO DNA COMPUTING	9
Molecular Biology– Molecular Structure– Genes– Structure and Biosynthesis– DNA Recombination– Genomes– Gene Expression– Protein Biosynthesis– Proteins–Molecular Structure– Cells and Organisms– Eukaryotes and Prokaryotes– Viruses		
UNIT-II	**WORD DESIGN FOR DNA COMPUTING**	**9**
Distance–Similarity– DNA Languages– Bond-Free Languages– Hybridization Properties– Small DNA Languages– DNA Code Constructions and Bounds– Reverse and Reverse-Complement Codes– Constant GC-Content Codes– Similarity Based Codes–General Selection Model		
UNIT-III	**AUTONOMOUS DNA MODELS**	**9**
Algorithmic Self-Assembly– Self-Assembly– DNA Graphs– Linear Self-Assembly– Tile Assembly– Finite State Automaton Models– Two-State Two-Symbol Automata– Length-Encoding Automata– Sticker Automata– Stochastic Automata		
UNIT-IV	**COMPUTATIONAL DNA MODELS**	**9**
DNA Hairpin Model– Whiplash PCR– Satisfiability– Hamiltonian Paths– Maximum Cliques– Hairpin Structures– Computational Models– Neural Networks– Tic-Tac-Toe Networks– Turing Machines		
UNIT-V	**CELLULAR DNA COMPUTING**	**9**
Models of Gene Assembly– Intramolecular String Model– Intramolecular Graph Model– Intermolecular String Model– Biomolecular Computing– Gene Therapy– Anti-Sense Technology– Cell-Based Finite State Automata– Anti-Sense Finite State Automata– Diagnostic Rules– Diagnosis and Therapy– Computational Genes		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Understand computations with DNA, gene rearrangements, and membrane systems.
•	Analyze and determine the power and limitations of molecular computing.
•	Design and develop molecular computing methods.
•	Analyze genetic code for determining the biological diversity.
•	Model genetic codes using computational methods and genome biology.

Reference Book (s):	
1	Zoya Ignatova, Israel Martınez-Perez, Karl-Heinz Zimmermann, “DNA Computing Models”, 1st edition, Springer 2008
2	JinXiong, “Essential Bioinformatics”, 1st Edition, Cambridge University Press,2011
3	Arthur M Lesk, “Introduction to Bioinformatics”, 1nd Edition, Oxford University Press, 2011
4	Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P13.1	1	1	2	2	1
CP19P13.2	2	1	2	1	2
CP19P13.3	2	2	2	2	1
CP19P13.4	1	2	2	2	1
CP19P13.5	2	1	2	2	2
AVERAGE	1.6	1.4	2.0	1.8	1.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P14	SECURE SOFTWARE DESIGN	PE	3	0	0	3

Objectives:	
•	To know about the threats & Web Applications.
•	To learn about network environment & Conceptual Design.
•	To understand about SDLC & vulnerability.
•	To know about implementation & testing methodologies.
•	To understand about Managing roles & access.

UNIT-I	THREATS	9
Introduction – Tools of the Trade – Fighting Fire – Changing the Design – Threats – Current and Emerging Threats Human Factor – Network – OS Environment – Data Management – Data Centric Threats – Web Application Threats – Client at risk – JavaScript & AJAX – Adobe Flash – ActiveX – Simplify, Restrict and scrub.		
UNIT-II	**ENVIRONMENT**	**9**
Network Environment – Science of secrecy – Eve unleashed – Play It Again, Eve – Eve in the middle – Operating System Environment – Operating System Defence Tactics – Backup and Redundancy – Remote Access Security – Virtualization – Database Environment – Conceptual Design – Logical Design – Physical Design – user interface – web applications and internet.		
UNIT-III	**REQUIREMENTS**	**9**
Programming Languages – Language Barriers – Buffer Bashing – Good Input and Output – Threat down – Development issues – Security Requirements Planning – SDLC – Establishing stakeholders – Gathering requirements – functional & non-functional security – establishing scope – Vulnerability Mapping – Use case construction and extension – sequence diagram and class analysis – activity and state diagrams – data planning – Vulnerability Mapping		
UNIT-IV	**IMPLEMENTATION AND TESTING**	**9**
Development and Implementation – Architecture Decision & Software Sources, Class Security analysis, Attack surface reduction – Application Review and Testing – Static Analysis, Dynamic Analysis, hardening the System – Incorporating SSD with the SDLC – Incident response plan, final security review, Integration tools – Personnel Training – Security Training Delivery methods, Implementing a training solution		
UNIT-V	**BEYOND THE LIMITS**	**9**
Culture of Society – Confidentiality, Integrity & Availability, Security Policy in organization, Enforcing Security Policy – Secure Data Management Modern Threats to database security, Managing Roles & Access, Database Auditing, Backup & Recovery, Data in Cloud Environment – Zero Day and Beyond – Prediction through Penetration, Insider Threat & beyond, Business Continuity Plan.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Explain about threats & understand various Web Applications.
•	Identify various Environment, Virtualization, and Database.
•	Identify vulnerable code in implemented software and describe attack consequences.
•	Compare and contrast testing methodologies.
•	Identify managing roles & access.

Reference Book(s):	
1	Theodor Richardson & Charles NThies, “Secure Software Design”, Jones& Bartlett Learning,2013
2	Gary McGraw, “Software Security: Building Security In”, Addison-Wesley Professional
3	Gary McGraw, “Software Security - Building Security In”, ISBN: 0321356705
4	Mark Merkow, Lakshmikanth Raghavan, “Secure and Resilient Software”, CRC Press, ISBN 9781439826973.
5	Julia H. Allen, Sean J. Barnum Robert J. Ellison, Gary McGraw, Nancy R. Mead, “Software Security Engineering: A Guide for Project Managers”, Pearson Education

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P14.1	-	-	-	-	-
CP19P14.2	-	1	-	-	1
CP19P14.3	1	1	1	2	1
CP19P14.4	-	-	-	1	1
CP19P14.5	-	-	1	-	1
AVERAGE	1.0	1.0	1.0	1.5	1.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P15	DISTRIBUTED DATABASES	PE	3	0	0	3

Objectives:	
•	To acquire knowledge on theoretical and practical aspects of the distributed database technologies.
•	To study the query processing techniques and transaction management in DDBMS.
•	To understand the concepts related to distributed object database design and management.
•	To acquire inquisitive attitude towards emerging database technology.
•	To conceptualize the current trends in distributed databases.

UNIT-I	INTRODUCTION AND DESIGN OF DDBMS	9
Distributed Database System – Design Issues: Distributed Database Design – Distributed Directory Management – Reliability of Distributed DBMS – Data Fragmentation: Horizontal Fragmentation – Vertical Fragmentation – Hybrid Fragmentation – Allocation techniques for DDBMS – Architectures for DDBMS		
UNIT-II	**QUERY PROCESSING & TRANSACTION MANAGEMENT**	**9**
Overview of Query Processing: Query processing problem – Complexity of Relational Algebra operations – Characterization of Query processors – Layers of Query Processing – Introduction to Transaction Management: Definition of Transaction – Properties of Transaction – Types of transaction – Distributed Concurrency Control: Serializability theory – Taxonomy of concurrency control mechanisms – Locking based concurrency control algorithms.		
UNIT-III	**DISTRIBUTED OBJECT DATABASE MANAGEMENT SYSTEMS**	**9**
Fundamentals of Object concepts and Object models – Object distribution design – Architectural issues – Object management – Distributed object storage – Object query processing.		
UNIT-IV	**ENHANCED DATA MODELS FOR ADVANCED APPLICATIONS**	**9**
Parallel Database: Parallel Database System Architectures – Parallel Data Placement – Parallel Query Processing – Multimedia Database – Spatial Database – Web Databases: Web Search – Web Querying – Distributed XML Processing.		
UNIT-V	**CURRENT TRENDS IN DISTRIBUTED DATABASES**	**9**
Data Stream Management: Stream Data Models – Stream Query Languages – Streaming Operators and their Implementation – Load Shedding and Approximation – Stream Mining – Cloud Data Management: Taxonomy of Clouds – Grid Computing – Cloud architectures – Data management in the cloud.		
	Total Contact Hours : 45	

Course Outcomes:	
Upon completion of the course, the students will be able to	
•	Identify the distributed database concepts and its structures.
•	Produce the query processing techniques and transaction management in DDBMS.
•	Describe terms related to distributed object database design and management.
•	Relate the importance and application of emerging database technology.
•	Represent the usage of distributed databases in real time.

Reference Book(s):	
1	M. Tamer Ozsu and Patrick V, “Principles of Distributed Database Systems”, Prentice Hall, Third Edition, 2011.
2	Elmasri &Navathe, “Fundamental of Database Systems”, Pearson Education, Sixth Edition, 2011.
3	Stefano Ceri and GuiseppePelagatti, “Distributed Databases - Principles and Systems”, First Edition, Tata McGraw Hill, 2008.
4	ASilberschatz, Korth and Sudarshan, “Database System Concepts”, Tata McGraw Hill, Sixth Edition, 2011.
5	Stefano Ceri and GuiseppePelagatti, “Distributed Databases - Principles and Systems”, First Edition, Tata McGraw Hill, 2008.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P15.1	1	1	1	1	1
CP19P15.2	1	1	1	1	1
CP19P15.3	1	1	1	2	1
CP19P15.4	1	1	2	2	3
CP19P15.5	2	1	2	2	3
AVERAGE	1.2	1.0	1.4	1.6	1.8

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19P16	INTELLIGENT SYSTEMS	PE	3	0	0	3

Objectives:	
•	To gain good knowledge of basic theoretical foundations of the various common intelligent systems methodologies.
•	To deal with uncertainty.
•	To understand the concepts of Genetic algorithm and fuzzy inference.
•	To understand on the Neural Network concepts.
•	To determine which type of intelligent system methodology would be suitable for a given application.

UNIT-I	INTRODUCTION TO INTELLIGENT SYSTEMS	9
Introduction to knowledge – based intelligent systems – Intelligent machines, or what machines can do? – The history of artificial intelligence, or from the 'Dark Ages' to knowledge-based systems– Rule-based expert systems – Rules as a knowledge representation technique–The main players in the expert system development team–Structure of a rule–based expert system– Fundamental characteristics of an expert system–Forward chaining and backward chaining inference technique–.MEDIA ADVISOR: a demonstration rule-based expert system– Conflict resolution–Advantages and disadvantages of rule-based expert		
UNIT-II	**UNCERTAINITY LOGIC**	**9**
What is uncertainty? – Basic probability theory– Bayesian reasoning–Bias of the Bayesian method–Certainty factors theory and evidential reasoning–Comparison of Bayesian reasoning and certainty factors– Introduction to Fuzzy Logic–Fuzzy sets–Linguistic variables and hedges– Operations of fuzzy sets–Fuzzy rules–Fuzzy inference–Building a fuzzy expert system.		
UNIT-III	**NEURAL NETWORKS**	**9**
How the Brain Works? Neural Networks–Simple computing elements– Network structures Optimal network structure–Perceptron's–What perceptron's can represent? Multilayer Feed–Forward Networks– Back-propagation learning–Back-propagation as gradient descent search –Applications of Neural Networks– Bayesian Methods for Learning Belief Networks Bayesian learning–Belief network learning problems–A comparison of belief networks and neural networks–Boltzman training– Combined back propagation–Cauchy training.		
UNIT-IV	**HYBRID INTELLIGENT SYSTEMS**	**9**
Genetic algorithms –Why genetic algorithms work? – Genetic programming–Introduction or how to combine German mechanics with Italian love– Neural expert systems– Neuro-fuzzy systems–ANFIS: Adaptive Neuro-Fuzzy Inference System–Evolutionary neural networks–Fuzzy evolutionary systems.		
UNIT-V	**LEARNING &KNOWLEDGE ENGINEERING**	**9**
Learning: Learning from Observation– General Model of Learning Agents–Inductive Learning– Learning Decision Trees– Rote Learning– Learning by Advice– Learning in Problem Solving–Explanation based Learning–Knowledge engineering: Introduction–an expert system fora particular problem– a fuzzy expert system working for a problem – a neural network working for a problem.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Gain deep understanding of the basic artificial intelligence techniques.
•	Gain the knowledge to deal with uncertainty.
•	Apply their knowledge to design solutions to different problems.
•	Understand various learning techniques and also to apply them.
•	Design and develop an intelligent system for a selected application.

Reference Book(s):	
1	Michael Negnevitsky, "Artificial Intelligence – A Guide to Intelligent Systems"3rd Edition,Addison Wesley
2	Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 2nd Edition, Pearson Education.
3	Michael Huth and Mark Ryan, "Logic in Computer Science: Modelling and Reasoning about Systems", 2nd Edition, Cambridge University Press, 2004
4	R Beale & T Jackson, "Neural Computing, An Introduction", AdamHilger, 1990.
5	Timothy S. Ross, "Fuzzy Logic with engineering applications", Weily India Pvt. Ltd., 2011.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19P16.1	2	2	1	2	2
CP19P16.2	2	2	2	2	2
CP19P16.3	3	3	3	3	2
CP19P16.4	2	2	2	3	2
CP19P16.5	2	2	2	2	2
AVERAGE	2.2	2.2	2.0	2.4	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19212	CLOUD INFRASTRUCTURE LABORATORY	PE	0	0	4	2

Objectives:	
•	To learn and understand Virtualization and run VMs of different (Oracle virtual box) configuration.
•	To be familiar with current cloud technologies by creating applications and deploying it in public cloud.
•	To learn to set up an enterprise level cloud infrastructure.
•	To design the programming models for distributed cloud management.
•	To understand the issues and solutions by simulating a cloud data centre.

List of Experiments				
1	Create a simple application to understand the concept of PAAS using Google platform cloud and launch it.			
2	Find the procedure to launch a Cloud instance using a Public IaaS cloud like GCP.			
3	Compare the SLA between AWS, GCP, and Microsoft Azure			
4	Setup a Private Cloud by performing the procedure using a Single node OPENSTACK implementation.			
5	Perform Creation, Management and Termination of a CirrOS instance in OPENSTACK.			
6	Show the virtual machine migration based on the certain condition from one node to the other.			
7	Setup a Single Node Hadoop cluster and show all the process through WEB UI.			
8	Show the MAP REDUCE programming model by counting the number of words in a given file.			
9	Implement the procedure to interact with Hadoop API for Accessing HDFS from local file system.			
10	Build a Linux Containers and perform basic operations.			
11	Implement Container technology using DOCKERS			
12	Study the Tools and Technologies for DEVOPS, and install any 2 industry standard tools.			
		Total Contact Hours	**:**	**60**

PLATFORM NEEDED	
Hardware	Systems with Virtualization Enabled, dual core processor with 8 GB RAM
Software	CentOS, VirtualBox, OpenStack, CirrOS, CloudSim.

Course Outcomes: Upon completion of the course, students will be able to	
•	Enterprise and execution of virtual machines and understand the need for resource utilization.
•	Implement the global cloud infrastructure for deploying their applications and SLA.
•	Design and implement a private cloud infrastructure.
•	Design the Map-Reduce concepts.
•	Check the cloud data centre would function using simulator software.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19212.1	3	3	3	3	3
CP19212.2	2	2	2	2	2
CP19212.3	2	2	3	3	2
CP19212.4	3	3	3	3	3
CP19212.5	2	3	3	3	3
AVERAGE	2.4	2.6	2.8	2.8	2.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19213	BIG DATA ANALYTICS LABORATORY	PE	0	0	4	2

Objectives:	
•	To implement MapReduce concept to process big data.
•	To apply linear models to analyze big data.
•	To analyze big data using machine learning techniques.
•	To realize storage of big data using Hbase, MongoDB.
•	To develop big data applications for streaming data using Apache Spark.

List of Experiments				
1	Configure and run Hadoop and HDFS.			
2	Implement word count/frequency programs using MapReduce.			
3	Implement a MapReduce program to process a weather dataset.			
4	Implement Linear and Logistic Regression.			
5	Implement SVM/Decision tree classification techniques.			
6	Implement clustering techniques – Hierarchical and K-Means.			
7	Implement an application that stores big data in Hbase/MongoDB/Pig using Hadoop/R.			
8	Install, Deploy & Configure Apache Spark Cluster.			
9	Run Apache Spark applications using Scala.			
10	Perform Data Visualization using any Online tools like Plot.ly, advanced Excel etc.,			
11	Install and execute Rapid Miner/Tableau and perform data analysis. (use www.data.gov.in for real-time data)			
	Total Contact Hours	**:**	**60**	

PLATFORM NEEDED	
Hardware	Systems with Virtualization Enabled, dual core processor with 8 GB RAM
Software	Hadoop, R package, Spark, Rapid Miner, Tableau.

Course Outcomes: Upon completion of the course, the students will be able to	
•	Process big data using Hadoop framework.
•	Build and apply linear and logistic regression models.
•	Perform data analysis with machine learning methods.
•	Perform graphical data analysis.
•	Create applications for big data analytics.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19213.1	3	1	1	2	3
CP19213.2	3	1	3	2	2
CP19213.3	2	2	2	3	2
CP19213.4	2	2	2	2	2
CP19213.5	3	3	3	3	3
AVERAGE	2.6	1.8	2.2	2.4	2.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19214	WIRELESS SENSOR NETWORKS LABORATORY	PE	0	0	4	2

Objectives:	
•	To deal about basic communication set-up in wired and wireless environment.
•	To code the different techniques to access the mobile devices.
•	To learn analog/digital and modulation/demodulation techniques used in wireless communication.
•	To handle different types of power spectrum density techniques and fading concepts.
•	To learn about digital signal processing techniques using MATLAB.

List of Experiments	
1	Basics of serial communication ports and protocols a. RS232C b. Data/File transfer between two systems (Universal Serial Bus port) c. CAT cable (Any type of cable; hint: NULL Modem concept) (Student have to do solder connect the port with cable)
2	Bluetooth/ShareIT - Transfer a file/messages between two / more mobile device. (by varying distance)
3	Markup language and J2ME a. Introduction to WML events, WML function. b. Design a calculator, mobile phone book using WML Script. c. Create HELLO WORLD application in J2ME. d. Study and Demonstrations of User interface in J2ME. e. Develop a simple App for scheduler using ANDROID developing Tools
4	Configure the access point (wireless modem) with wired server and try to access the server through mobile.
5	Mobile IP, IPv4 and IPv6 subnet masking for subnet
6	Simulate any modulation and Demodulate (AM, FM) multiple access technique for wireless communication using related simulation tools or electronic components (Transistors, Resistance, etc.).
7	Modulation and Demodulation a. To Study Frequency Hopping Spread Spectrum (FHSS) Modulation Technique b. To Study Frequency Hopping Spread Spectrum (FHSS) Demodulation Technique c. Study of Minimum Shift Keying (MSK) Modulation Process d. Study of Minimum Shift Keying (MSK) Demodulation Process
8	Power spectrum and Error performance in fading channels. Plot and compare various values of fading parameters (No. diversity L=1 and diversity L=2). (using MATLAB evaluates Gauss-Kronrod quadrature)
9	MIMO-OFDM system Simulate OFDM modulation & demodulation using MATLAB and 2x2 MIMO error rate (OFDM parameters are based on the 802.11n standard
10	Digital Signal Processing System a. Generate sum of sinusoidal signal (using MATLAB) b. Find frequency response of analog LP/HP filters (using MATLAB)
11	Create a model for discrete-time interpolation and decimation (using MATLAB Simulink). a. Power spectrum density estimation using Yule-Walker method, b. Power spectrum density estimation using Burg method (ARM parameters- sequential estimation methods)
	Total Contact Hours : 60

Course Outcomes: Upon completion of the course, the students will be able to	
•	Find difference between the wired concept/fundamental cellular radio concepts.
•	Code the different techniques to access the mobile devices.
•	Gain sufficient knowledge about analog/digital and modulation/demodulation techniques used in wireless communication.
•	Handle Different types of power spectrum density techniques and fading concepts.
•	Understand various digital signal processing methods.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19214.1	1	2	1	-	-
CP19214.2	2	1	2	-	-
CP19214.3	2	-	2	1	-
CP19214.4	2	1	2	1	1
CP19214.5	1	1	2	1	2
AVERAGE	16	1.3	1.8	1.0	1.5

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory course)	Category	L	T	P	C
CP19215	DIGITAL FORENSICS LABORATORY	PE	0	0	4	2

Objectives:	
•	To understand how cybercrimes are prevented through various methods.
•	To implement and test various tools and procedures for identifying security vulnerabilities.
•	To understand how to develop a firewall and protect a system.
•	To configure and test incidence response mechanisms.

List of Experiments			
1	Analyze the packet structure of IPSec headers and SSL and TLS using Wireshark.		
2	Explore the structure of a file using HEX workshop.		
3	Create an image of your data and perform a through forensics examination and create a report on your findings using FTK imager/ Encase/ProDiscover tool.		
4	Perform Vulnerability Testing and do Bespoke Penetration testing and Web application Testing.		
5	Recover a deleted file content using command prompt and also do it using Stellar phoenix tool.		
6	Perform anti rootkit tool scans for hidden drivers, files, processes, SSDT and stealth objects.		
7	Configure a Firewall in windows or Linux platform or in Android and perform a simple port and IP blocking.		
8	Perform Image Steganography using image forensics tools (GHIRO).		
9	Write a program to perform IP spoofing.		
10	Set up a VPN in Android Mobile and perform Security features.		
11	Configure and test an Incidence Response Automation Tools		
	Total Contact Hours	**:**	**60**

Course Outcomes: Upon completion of the course, the students will be able to	
•	Identify various vulnerabilities in systems.
•	Prevent any attacks in computer infrastructure.
•	Perform a thorough analysis of computer hardware for any viruses or malware.
•	Setup a firewall for his personal devices.
•	Configure various tools and analyze its abilities for protection from attackers.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19215.1	3	2	2	2	3
CP19215.2	3	1	3	2	2
CP19215.3	3	2	2	2	2
CP19215.4	2	1	2	2	2
CP19215.5	3	1	1	3	2
AVERAGE	2.8	1.4	2.0	2.2	2.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19O31	BUSINESS ANALYTICS	OE	3	0	0	3

Objectives:	
•	To understand the role of business analytics within an organization.
•	To analyze data using statistical and data mining techniques.
•	To gain an understanding of how managers use business analytics to formulate and solve business problems.
•	To become familiar with processes needed to develop, report, and analyze business data.
•	To use decision-making tools/Operations research techniques.

UNIT-I	INTRODUCTION	9
Business analytics: Overview of Business analytics– Scope of Business analytics– Business Analytics Process– Relationship of Business Analytics Process and organization – competitive advantages of Business Analytics– Statistical Tools: Statistical Notation– Descriptive Statistical methods– Review of probability distribution and data modelling– sampling and estimation methods overview.		
UNIT-II	**REGRESSION AND VISUALIZATION**	**9**
-Trendiness and Regression Analysis: Modelling Relationships and Trends in Data– simple Linear Regression. – Important Resources– Business Analytics Personnel– Data and models for Business analytics– problem solving– Visualizing and Exploring Data–Business Analytics Technology		
UNIT-III	**ANALYTICAL MODELS**	**9**
Organization Structures of Business analytics–Team management–Management Issues– Designing Information Policy– Outsourcing– Ensuring Data Quality– Measuring contribution of Business analytics– Managing Changes. Descriptive Analytics– predictive analytics– predicative Modelling– Predictive analytics analysis– Data Mining and Methodologies– Prescriptive analytics and its step in the business analytics Process– Prescriptive Modelling–nonlinear Optimization.		
UNIT-IV	**FORECASTING TECHNIQUES**	**9**
Qualitative and Judgmental Forecasting– Statistical Forecasting Models– Forecasting Models for Stationary Time Series– Forecasting Models for Time Series with a Linear Trend– Forecasting Time Series with Seasonality– Regression Forecasting with Casual Variables– Selecting Appropriate Forecasting Models– Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform– New-Product Development Model,–Newsvendor Model– Overbooking Model– Cash Budget Model.		
UNIT-V	**DECISION ANALYSIS**	**9**
Decision Analysis: Formulating Decision Problems– Decision Strategies with the without Outcome Probabilities– Decision Trees– The Value of Information, Utility and Decision Making– Recent Trends in: Embedded and collaborative business intelligence– Visual data recovery– Data Storytelling and Data journalism.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Demonstrate knowledge of data analytics.
•	Think critically in making decisions based on data and deep analytics.
•	Use technical skills in predicative and prescriptive modeling.
•	Translate data into clear, actionable insights.
•	Make decisions using various tools.

Reference Book(s):	
1	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press, 2014.
2	James R Evans, "Business Analytics", Pearson's Education, 2016.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19O31.1	1	-	3	3	2
CP19O31.2	3	3	3	3	2
CP19O31.3	3	1	3	3	2
CP19O31.4	3	2	3	3	1
CP19O31.5	3	3	3	3	3
AVERAGE	2.6	2.3	3.0	3.0	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"