Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds Estd. 1998
An Autonomous Institution
Since 2017

Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Affiliated to Anna University, Chennai; Approved by AICTE ; Accredited by NAAC with Grade 'A++'
Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)
Udumalai Road, Pollachi - 642 003 Tel: 04259-236030/40/50 Fax: 04259-236070 www.mcet.in

Curriculum and Syllabi

M.E. Computer Science and Engineering

Semesters I to IV

(2019 Batch only)

Regulations 2019

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Computer Science and Engineering

Vision

To develop engineers with global employability, entrepreneurship capability, research focus and social responsibility

Mission

- To develop internationally competent engineers in dynamic IT field by providing state-of-art academic environment and industry driven curriculum
- To motivate and guide students to take up higher studies and establish entrepreneurial ventures
- To enrich the department through committed and technically sound faculty team with research focus in thrust areas
- To undertake societal problems and provide solutions through technical innovations and projects in association with the industry, society and professional bodies

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Programme: M.E. Computer Science and Engineering

Programme Educational Objectives (PEOs) - Regulations 2019

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Domain Expertise and Leadership: Exhibit sustained knowledge in the field of Computer Science and Engineering and possess leadership capability in their professional careers.

PEO2. Problem Solving: Design optimal computing solutions for engineering problems to meet the needs of individuals, organizations and society.

PEO3. Lifelong Learning and Research: Engage in lifelong learning and contribute towards independent and collaborative scientific research

Programme Outcomes (POs) - Regulations 2019

On successful completion of the programme the graduates will be able to:

PO1. Scholarship of Knowledge: Acquire in-depth knowledge in Computer Science and Engineering with an ability to discriminate, evaluate, analyse and synthesize knowledge.

PO2. Research Skill: Investigate suitable literature and conduct experiments, apply appropriate research methodologies, techniques and tools to demonstrate higher order skill and contribute to the development of technological knowledge in Computer Science and Engineering.

PO3. Usage of Modern Tools: Develop and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities.

PO4. Communication: Communicate effectively regarding complex engineering activities, write effective reports and design documentation by adhering to appropriate standards and make effective presentations

OBE Coordinator | Programme Coordinator | Head of the Department

Head - OBE

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Programme Specific Outcomes (PSOs) - Regulations 2019

On successful completion of the programme the graduates will be able to:

PSO1. Data Management: Analyze large scale data and provide scalable solutions for real world problems.

PSO2. Computing and Communication: Design and evaluate techniques for secure computing and communication.

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

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Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)
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Programme: M.E Computer Science and Engineering
2019 Regulations
(2019 Batch only)
Curriculum for Semesters I to IV
Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19CPFN1101	Applied Probability and Statistics	3	0	0	3	100	-
19CPCN1101	Data Structures and Algorithms	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – I	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – II	3	0	0	3	100	-
19COFG1101	Research Methodology and IPR	3	0	0	3	100	All
19CPCN2101	Data Structures and Algorithms Laboratory	0	0	4	2	100	-
19CPCN2102	Networks Laboratory	0	0	4	2	100	-
19SHAG1101	English for Research Paper Writing	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19CPCN1201	Data Management and Analytics	3	0	0	3	100	-
19CPCN1202	Object Oriented Software Engineering	3	0	0	3	100	-
19CPCN1203	Modern Operating Systems	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – III	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – IV	3	0	0	3	100	-
19CPCN2201	Data Management and Analytics Laboratory	0	0	4	2	100	-
19CPPN3201	Mini Project with Seminar	0	0	4	2	100	-
19SHAG1201	Teaching and Learning in Engineering	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

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Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
XXXXXXXXXX	Professional Elective – V	3	0	0	3	100	-
XXXXXXXXXX	Open Elective	3	0	0	3	100	-
19CPPN5301	Project – I	0	0	20	10	200	-
Total		**6**	**0**	**20**	**16**	**400**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19CPPN5401	Project – II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 70

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Professional Electives – I

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CPEN1101	Human Computer Interaction	3	0	0	3	100
19CPEN1102	Compiler Design	3	0	0	3	100
19CPEN1103	Digital Media Processing Techniques	3	0	0	3	100

Professional Electives – II

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CPEN1104	Network Design and Management	3	0	0	3	100
19CPEN1105	Embedded Systems	3	0	0	3	100
19CPEN1106	Soft Computing Techniques	3	0	0	3	100

Professional Electives – III

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CPEN1201	Computer Architecture	3	0	0	3	100
19CPEN1202	Cloud Computing and IoT	3	0	0	3	100
19CPEN1203	Parallel Computing	3	0	0	3	100

Professional Electives – IV

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CPEN1204	Security in Computing	3	0	0	3	100
19CPEN1205	Natural Language Processing	3	0	0	3	100
19CPEN1206	Software Project Management	3	0	0	3	100

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Professional Electives – V

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CPEN1301	Information Retrieval	3	0	0	3	100
19CPEN1302	Machine Learning Techniques	3	0	0	3	100
19CPEN1303	Social Network Analysis	3	0	0	3	100

Open Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CPOC1301	Business Analytics	3	0	0	3	100
19CPOC1302	Cyber Security & Computer Forensics	3	0	0	3	100

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Detailed Syllabi for Semesters I to IV

Semester I

Course Code: 19CPFN1101	Course Title: Applied Probability and Statistics		
Course Category: Foundation Courses		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Use the basic concepts of discrete and continuous distributions
2. Calculate the marginal and conditional distributions
3. Compute point estimation
4. Apply hypothesis testing
5. Use the concepts of multivariate techniques and principal component analysis

Unit I Probability Distributions **9 Hours**

Random variables – Moments, Moment generating function – Probability distributions: Binomial, Poisson, Exponential, Erlang and Normal distributions – Functions of one Random variable.

Unit II Two Dimensional Random Variables **9 Hours**

Joint distributions – Marginal and Conditional distributions – Covariance – Correlation-Regression – Functions of two random variables – Central limit theorem.

Unit III Estimation Theory **9 Hours**

Point Estimation: Properties of estimators – Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares.

Unit IV Testing of Hypothesis **9 Hours**

Sampling distributions – Statistical hypothesis – Small sample test: t test for single mean and difference of means – F test - Chi-square test for goodness of fit and independence of attributes – ANOVA: One way and Two way classification – Latin Square Design.

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Unit V **Multivariate Analysis** **9 Hours**

Random vector and Matrices – Mean vectors – Correlation and Covariance matrices – Multivariate normal density and its properties - Principal components – Population principal components – Principal Components from standardized variables.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Use the properties of discrete and continuous distributions to real life Problems	Apply
CO 2: Calculate the marginal and conditional distributions of bivariate random variables	Apply
CO 3: Compute point estimation of parameters and fit a curve to the given data	Apply
CO 4: Apply hypothesis testing to small samples and analysis of variance	Apply
CO 5: Use multivariate techniques in the analysis of data	Apply

Reference Book(s):

R1. Irwin Miller , Marylees Miller, "John E. Freund's Mathematical Statistics with Applications", 7th Edition, Pearson Education Limited, 2014.

R2. Johnson, R.A. Miller and Freund's, "Probability and Statistics for Engineers", Prentice Hall of India Pvt., Ltd., New Delhi, 7th Edition, 2005.

R3. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2012.

R4. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 5th Edition, Pearson Education, Asia, 2002.

R5. Anderson. T.W, "An introduction to Multivariate Statistical Analysis", John Wiley and Sons, 2003.

Web References:

1. https://nptel.ac.in/courses/111105041/1
2. https://nptel.ac.in/courses/103106123/78
3. https://nptel.ac.in/courses/117103018/14

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Course Code: 19CPCN1101	Course Title: Data Structures and Algorithms		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Analyze the time complexity of algorithms
2. Construct balanced tree structures
3. Deploy search data structure
4. Identify the suitable algorithm design technique for problem solving
5. Summarize the concepts of NP-Completeness, Approximation and Randomized Algorithms

Unit I Algorithm Analysis **9 Hours**

Computational Complexity – Asymptotic Notations – Best, Average and Worst Case Analysis – Amortized Complexity. Recursion: Recursive Calls – Types of Recursion.

Unit II Balanced Trees **9 Hours**

AVL Trees - Treaps – Multiway Search Trees: B-Trees – B* Trees – B+ Trees.

Unit III Search Structures **9 Hours**

k-d Trees – R-Trees – Tries – Suffix Trees and Arrays – String Matching: KMP and Boyer Moore algorithms.

Unit IV Algorithm Design Techniques **9 Hours**

Overview of Greedy method, Dynamic Programming, Backtracking, Branch and Bound, Travelling Salesman problem, Knapsack Problem, Flow Shop Scheduling, Vertex Cover problem.

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Unit V **Advanced Algorithm Paradigms** **9 Hours**

Theory of NP Completeness – Decision problems – Satisfiability problem – NP Problems – Cooks Theorem – NP Complete problems. Randomized Algorithms: Primality Testing – Minimum Spanning Trees. Approximation Algorithms: Bin-packing – Polynomial Time Approximation Schemes: 0/1 Knapsack problem.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the time complexity of recursive and non-recursive algorithms	Analyze
CO 2: Construct balanced tree structures for efficient operations on data	Apply
CO 3: Deploy search data structure for efficient range searching and string matching	Apply
CO 4: Identify the suitable algorithm design technique for solving the given problem	Analyze
CO 5: Describe the concepts of NP-Completeness, Approximation and Randomized Algorithms	Understand

Reference Book(s):

R1. Adam Drozdek, "Data Structures and Algorithms in Java", Cengage Learning, 4th Edition, 2013.

R2. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, "Introduction to the Design and Analysis of Algorithms A Strategic Approach", Tata McGraw Hill, 2012.

R3. Charles E. Leiserson, Ronald Rivest, Thomas H. Cormen and Clifford Stein, "Introduction to Algorithms", Prentice Hall India, 2012.

R4. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran "Fundamentals of Computer Algorithms", Universities press, 2nd Edition, 2008.

Web References:

1. URL:http://ww.animatedrecursion.com/
2. URL:http://visualalgo.net
3. https://nptel.ac.in/courses/106102064/Data Structures and Algorithms

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Course Code:19COFG1101	Course Title: Research Methodology and IPR (common to all PG Programmes)		
Course Category: Foundation Courses		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the overview of research methodology
2. Explain the attitude measurements, scales and sampling methods
3. Apply hypotheses testing in research problem
4. Elucidate the research report writing and presentation effectively
5. Apply patent and copyright for their innovative works

Unit I Overview of Research Methodology **9 Hours**

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process

Data collection methods – Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

Unit II Attitude Measurements, Scales and Sampling Methods **9 Hours**

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods – Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method – convenience sampling, judgment sampling, quota sampling.

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Unit III Hypotheses Testing **10 Hours**

Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means – one tailed and two tailed tests)

8 Hours

Unit IV Report Writing and Presentation

Report writing – Types of report, guidelines to review report, typing instructions, oral presentation

Unit V Patenting **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Describe the overview of research methodology	Understand
CO 2: Explain the attitude measurements, scales and sampling methods	Understand
CO 3: Apply hypotheses testing in research problem	Apply
CO 4: Elucidate the research report writing and presentation effectively	Understand
CO 5: Apply patent and copyright for their innovative works	Apply

Reference Book(s):

R1. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

R2. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

R3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications ,2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", Clause 8 Publishing, 2016.

R5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008.

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BOS Chairman

Course Code:19CPCN2101	Course Title: Data Structures and Algorithms Laboratory		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Implement balanced tree structures
2. Implement efficient search on spatial data
3. Implement efficient search on string data
4. Solve graph based problems
5. Solve optimization problems

Area of Experiments:

1. Implementation of recursion for problem solving
2. Implementation of AVL Tree
3. Implementation of Treap
4. Implementation of k-d Tree
5. Implementation of Tries
6. Implementation of String Matching Algorithms

   Problem Solving using suitable algorithm design technique
7. Travelling Salesman Problem
8. Vertex cover problem
9. Minimum spanning tree construction using randomized algorithm
10. Implementation of approximation algorithm for 0/1 Knapsack problem

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Implement various operations on balanced tree structures	Apply
CO 2: Implement appropriate data structure to perform efficient search on spatial data	Apply
CO 3: Implement suitable algorithm to perform search on string data	Apply
CO 4: Solve graph based problems using suitable algorithm design technique	Apply
CO 5: Solve optimization problems using randomized and approximation algorithms	Apply

Reference(s):

R1. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, "Introduction to the Design and Analysis of Algorithms A Strategic Approach", Tata McGraw Hill, 2012.

R2. Adam Drozdek, "Data Structures and Algorithms in Java", Cengage Learning, 4th Edition, 2013.

R3. Data Structures and Algorithms Laboratory Manual

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Course Code:19CPCN2102	Course Title: Networks Laboratory		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Design network applications
2. Design IP LAN and WAN network
3. Implement routing protocols and congestion control techniques
4. Implement network virtualization and management protocols
5. Apply Queuing and Scheduling policies

Area of Experiments:

1. Application development using socket programming
2. Performance analysis of transport layer protocols
3. Implementation of congestion control algorithms
4. Design local area network with IP address configuration
5. Design multi-router network and testing using simulation tools
6. Implementation of Routing protocols
7. Design of network virtualization using simulation tools
8. Demonstration of network management using SNMP
9. Implementation of Queuing and Scheduling policies
10. Analysis of LAN traffic using simulation tools

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Design network applications using appropriate socket programming	Apply
CO 2: Design IP LAN and WAN network using subnetting and IP address configuration	Apply
CO 3: Implement routing protocols and congestion control techniques in multi-router networks.	Apply
CO 4: Implement network virtualization and management protocols using simulation tools	Apply
CO 5: Apply Queuing and Scheduling policies to provide Quality of Service	Apply

Reference(s):

R1. "Cisco Prime Network 3.10 User Guide", Cisco Systems, 2012

R2. Miguel Barreiros, Peter Lundqvist, "QoS Enabled Networks: Tools and Foundations", Second Edition, John Wiley & Sons, 2016

R3. Networks Laboratory Manual, 2019

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Course Code: 19SHAG1101	Course Title: English for Research Paper Writing (common to all PG Programmes)	
Course Category: Audit Courses	Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Total Contact Hours: 30	Max Marks: 100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1.Describe how to improve the writing skills and level of readability

2.Apply research writing skills in each section

3.Explain the skills needed when writing titles

Unit I **Research Plan and Preparatory Tools** **10 Hours**

Plan - Word Order - Break up long sentences - Paragraph and Sentence Structures - Concise and Remove Redundancy - Avoid Ambiguity and Vagueness - Preparation

Unit II **Grammar for Research** **10 Hours**

Expand the vocabulary & phrases – Grammar & punctuation - Ensure the content - Review of the Literature - Conclusions

Unit III **Key Skills for Preparation** **10 Hours**

Clarify Who Did What – Highlight the Findings - Hedge and Criticise - Paraphrase - Check Plagiarism - Sections of a Paper - Abstracts –Introduction - Key skills needed when writing - a Title, an Abstract, an Introduction, a Review of the Literature, Methods, Results, Discussion, Conclusions

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe how to improve the writing skills and level of readability	Understand
CO 2: Apply research writing skills in each section	Apply
CO 3: Use the skills needed when writing titles	Apply

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BOS Chairman

Reference Book(s):

R1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

R2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006

R3. Kumar, Ranjit, "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

Web References:

1. https://writing.wisc.edu/handbook/assignments/planresearchpaper
2. https://libguides.usc.edu/writingguide/grammar
3. https://grammar.yourdictionary.com/writing/how-to-write-a-research-paper.html
4. https://wordvice.com/seminar-how-to-write-an-effective-research-paper

Assessment pattern:

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

- **Students will be finally awarded with three levels based on the score as follows:**

Marks Scored	Levels
70% & above	Good
30- 69%	Average
< 30%	Fair

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Semester I - Electives

Course Code: 19CPEN1101		Course Title: Human Computer Interaction	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the principles and guidelines of HCI for developing effective user interaction
2. Explain the concepts of Mobile Information architecture and User Interface
3. Apply the collections and control flows for Mobiles
4. Implement advanced mobile programming concepts
5. Analyze research directions in computer interaction

Unit I **Design of HCI** **7 Hours**

Principles of HCI – HCI Guidelines – HCI Design – User Interface Layer – User Interface Evaluation.

Unit II **Mobile HCI** **8 Hours**

Mobile Ecosystem – Mobile Applications – Mobile Information Architecture (MIA) – Mobile Design Elements – Mobile User Interface Building and Advances – Universal Design – Best Practices in Mobile UI.

Unit III **Mobile Programming** **10 Hours**

Basic Operators – Strings & Characters – Collection Types – Control Flow – Functions – Closures – Enumerations.

Unit IV **Advanced Controls** **10 Hours**

Classes & Structures – Properties – Methods – Subscripts – Inheritance – Initialization – De-initialization – Automatic Reference Counting – Error Handling.

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Unit V **Applications** **10 Hours**

Speech and Language interfaces and Technologies – Multimedia User Interface Design – Multimodal interfaces – Decision-Support Systems – Online Communities – Privacy, Security, and Trust.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Describe the principles and guidelines of HCI for developing effective user interaction	Understand
CO 2: Explain the concepts of Information architecture and User Interface for Mobile UI	Understand
CO 3: Apply collections and control flows in mobile based programming	Apply
CO 4: Implement advanced programming concepts in mobile application development	Apply
CO 5: Analyze research directions in computer interaction for real time applications	Analyze

Reference Book(s):

R1. Gerard Jounghyun Kim, "Human Computer Interaction: Fundamentals and Practice", CRC Press, 2015.

R2. Brian Fling, "Mobile Design and Development", O'Reilly Media Inc., 2009.

R3. Julie A.Jacko, "The Human Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications", Third Edition, CRC Press, 2012.

R4. "The Swift Programming Language – Swift 3.0.1", Apple Inc – Swift Programming series, 2016.

Web References:

1. https://onlinecourses.nptel.ac.in/noc18_cs23.
2. https://www.interaction-design.org/courses/human-computer-interaction.

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Course Code: 19CPEN1102		Course Title: Compiler Design	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Specify and recognize language tokens
2. Construct parsers for simple grammars
3. Generate intermediate code
4. Deploy code generation techniques
5. Apply code optimization techniques

Unit I Lexical Analysis **9 Hours**

Grammars and Languages – Structure of the Compiler – Applications of Compiler Technology. Lexical Analysis: Input Buffering – Specification of Tokens – Recognition of Tokens – Finite automata – Regular expression to finite automaton – Optimization of DFA based pattern matchers – Lexical Analyzer Generator – LEX.

Unit II Syntax Analysis **9 Hours**

Role of a parser – Context-free grammars – Top-down parsing – Bottom-up parsing – LR parser – Introduction to language for specifying parser – YACC – Implementation of parser using YACC.

Unit III Syntax Directed Translation &Intermediate Code Generation **9 Hours**

Syntax Directed Translation: Syntax-direct definitions – Evaluation Order – Applications and Schemes. Intermediate Code Generation: Intermediate languages – Types and Declarations – Expressions – Type-Checking – Control Flow – Backpatching – Switch statements - Procedures.

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Unit IV **Code Generation** **9 Hours**

Run-time Environments: Storage Organization – Stack Allocation – Access to Non local data – Heap Management – Introduction to Garbage Collection. Code Generation: Issues in designing a code generator – Target machine – Basic blocks and flow graphs – Next-use information – A Simple code generator – Register allocation and assignment – Peephole optimization.

Unit V **Code Optimization** **9 Hours**

Principal sources of optimization – Data Flow Analysis – Optimizing for Parallelism and Locality – Matrix Multiplication – Iteration Spaces – Affine Array Indexes – Data Reuse – Array Data-Dependence Analysis – Finding Synchronization free parallelism.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the working of various phases of the compiler and the specification and recognition of language tokens	Understand
CO2: Construct top-down and bottom-up parsers for simple grammars	Apply
CO3: Apply Syntax directed translation schemes for the generation of intermediate code	Apply
CO4: Deploy run time memory management and code generation techniques	Apply
CO5: Apply optimization strategies to improve the code generated by compilers	Apply

Reference Book(s):

R1. Alfred V Aho, Monica S Lam, Ravi Sethi, Jeffrey D Ullman, "Compilers - Principles, Techniques and Tools", Second Edition, Addison- Wesley, 2006.

R2. Kenneth.C.Louden, "Compiler Construction Principles and Practice", Vikas publishing House, 2003.

R3. Andrew.W.Appel, "Modern Compiler Implementation in Java", Second Edition, Cambridge University Press, 2002.

Web References:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-035-computer-language-engineering/
2. https://nptel.ac.in/courses/106104123/

Passed in Board of Studies meeting

BOS Convener

Approved in Academic Council meeting

BOS Chairman

Course Code: 19CPEN1103		Course Title: Digital Media Processing Techniques	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the theoretical foundation for image processing methods
2. Use various categories of filters to enhance and restore images
3. Choose various color transformation models for different processing techniques
4. Analyse an image by detecting the isolated points, edge and boundary parameters
5. Identify appropriate motion models and perform segmentation for video processing

Unit I Introduction **9 Hours**

Steps in Digital Image processing – Elements of visual perception, Image Sensing and Acquisition, Image Sampling and Quantization, Basic relationships between pixels: neighborhood, adjacency, connectivity, distance measures – Image Transforms: DFT, DCT, Hadamard, Haar and Karhunen-Loeve.

Unit II Image Enhancement and Restoration **9 Hours**

Gray level transformations – histogram equalization and specifications – smoothing filters: linear and Non-linear – pixel-domain sharpening filters: first and second derivative, frequency domain filters: low-pass and high-pass – Model of Image Degradation/Restoration Process-Noise Models.

Unit III Color Image and Multi Resolution Processing **9 Hours**

Color fundamentals – Color models – RGB, YUV, HSI; Color transformation: formulation, color complements, color slicing, tone and color corrections – Color image smoothing and sharpening – Color image Segmentation- Wavelet Transform and Multi-resolution Processing.

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Unit IV **Image Compression and Segmentation** **9 Hours**

Image Compression: Redundancies, Image compression standards, Lossy and Loss-less predictive coding-Image Segmentation: Detection of isolated points, Line, edge linking and boundary – Thresholding: global and adaptive – Region based segmentation.

Unit V **Video Processing** **9 Hours**

Digital Video and its applications – 2D Apparent Motion Models and its Estimation – Video Compression standards: MPEG-1, MPEG-2 and H.26X – Video Segmentation: Change detection, Motion segmentation and tracking.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the theoretical foundation for image processing methods	Understand
CO2: Use various categories of filters to enhance and restore images	Apply
CO3: Choose various color transformation models for different processing techniques on color images	Apply
CO4: Analyse an image by detecting the isolated points, edge and boundary parameters	Analyze
CO5: Identify appropriate motion models and perform segmentation for video processing	Apply

Reference Book(s):

R1. R.C. Gonzalez and R.E. Woods, "Digital Image Processing", Pearson Education, 3rd Edition, 2013.

R2. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India 2003.

R3. Murat Tekalp , "Digital Video Processing", Second Edition, Prentice Hall, 2015.

R4. Milan Sonka , "Digital Image Processing and Computer Vision", Thomson publication, 2nd Edition,2007.

Web References:

1. https://www.coursera.org/learn/digital
2. http://www.wavelet.org/

Passed in Board of Studies meeting

BOS Convener

Approved in Academic Council meeting

BOS Chairman

Course Code: 19CPEN1104	Course Title: Network Design and Management		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Differentiate the working of various TCP congestion control techniques
2. Design wired/ wireless network with suitable IP addressing
3. Compare the performance of a network
4. Analyze various tools and advanced queuing policies
5. Analyze the quality of service

Unit I Reliable Services **9 Hours**

Packet Switched Network – Congestion Issues and TCP – Managing Congestion – Measuring Network Congestion – Source Based Congestion Control Mechanisms – Congestion Control for Wireless and Multimedia Networks.

Unit II Internetworking **9 Hours**

Internet Addressing – IPv4 and IPv6 Addressing scheme – IPv6 Transition – Datagram Delivery – Error and Control Messages: ICMPv6 – DHCP – Routing Protocols: Distance Vector, Link State Routing – Mobility and Mobile IP.

Unit III Virtualization and Management **9 Hours**

Network Virtualization – Virtual Private Networks – Tunneling and Encapsulation – Network Address Translation – Overlay Networks – Software Defined Networks – Architecture – Open flow Technology. Network Management – Architecture – MIB for IPv6 – SNMP and Security.

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Unit IV **Queuing and Scheduling** **9 Hours**

QoS Tools – Challenges – Classifiers – Policing and Shaping – Queuing and Scheduling – Queuing Disciplines – Advanced Queuing Concepts – Random Early Discard.

Unit V **Quality of Service** **9 Hours**

Case Studies – QoS in Virtual Private LAN Service: Classes of Service – Admission Control – Queues and Schedules; QoS in Data Center – Traffic Model – Causes of Congestion; IP RAN and Mobile Backhaul QoS – Network Components and Traffic in 2G/3G and LTE Networks.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Differentiate the working of various TCP congestion control techniques in wired and wireless networks	Apply
CO 2: Design wired/ wireless network with suitable IP addressing using appropriate routing protocol	Apply
CO 3: Compare the performance of a network after applying virtualization concepts and network management protocols	Analyze
CO 4: Analyze various tools and advanced queuing policies used for improving quality of service in a network	Analyze
CO 5: Analyze the quality of service offered in various real time applications	Analyze

Reference Book(s):

R1. Christos N Houmkozlis, George A Rovithakis, "End-to-End Adaptive Congestion Control in TCP/IP Networks", CRC Press, 2012.

R2. Douglas E. Comer, "Internetworking with TCP/IP: Principles, Protocol and Architecture Volume I", 6th Edition, Pearson Education, 2014.

R3. Miguel Barreiros, Peter Lundqvist, "QoS Enabled Networks: Tools and Foundations", 2nd Edition, John Wiley & Sons, 2016.

R4. James F. Kurose, Keith W. Ross, "Computer Networking – A top down Approach Featuring the Internet", 7th Edition, Pearson Education, 2016.

Web References:

1. https://onlinecourses.nptel.ac.in/noc18_cs38/preview
2. https://web.cs.dal.ca/~zincir/cs6706.html

Passed in Board of Studies meeting

BOS Convener

Approved in Academic Council meeting

BOS Chairman

Course Code: 19CPEN1105		Course Title: Embedded Systems	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Explain the basic characteristics and design
2. Describe the Embedded processor and component interfacing
3. Design the networks for embedded systems
4. Describe the real time characteristics
5. Analyze the system architecture

Unit I Introduction **9 Hours**

Embedded Computers, Characteristics of Embedded Computing Applications, Challenges in system design, Process – Requirements, Specification, Architectural Design, System Integration, Formalism for System Design – Structural and Behavioral Description, Design Example: Model Train Controller, ARM processor and memory organization.

Unit II Embedded Processor **9 Hours**

Data operations, Flow of Control, SHARC processor – Memory organization, Data operations, Flow of Control, parallelism with instructions, CPU Bus configuration, ARM and SHARC Bus, Memory and Input/output devices, Component interfacing, design with microprocessor development, debugging, Design Example : Alarm Clock. Hybrid Architecture.

Unit III Networks **9 Hours**

Distributed Embedded Architecture – Hardware and Software Architectures, Networks for Embedded systems – I2C, CAN Bus, SHARC link supports, Ethernet, Network-Based design – Communication Analysis, System performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

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Unit IV **Real-Time Characteristics** **9 Hours**

Clock driven approach, weighted round robin approach, Priority driven approach, Dynamic Versus Static systems, Effective release times and deadlines, Optimality of the Earliest deadline first (EDF) algorithm, Challenges in validating timing constraints in priority driven systems, Off-line Versus On-line scheduling.

Unit V **System Design Techniques** **9 Hours**

Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design, Quality Assurance, Design Example: Telephone PBX – System Architecture, Ink jet printer- Hardware Design and Software Design, Personal Digital Assistants, Set-top Boxes.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic characteristics and design of Embedded System	Understand
CO2: Describe the Embedded processor and component interfacing with an example	Understand
CO3: Design the networks for embedded systems with a real time example	Apply
CO4: Describe the real time characteristics of the embedded system	Understand
CO5: Analyze the system architecture using existing product design	Analyze

Reference Book(s):

R1. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman Publishers, Second edition 2008.

R2. Jane.W.S. Liu, "Real-Time systems", Pearson Education Asia, 2001.

R3. Rajkamal "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill, Second edition 2008.

R4. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons, 2001.

Web References:

1. https://developer.arm.com/ip-products/processors/classic-processors
2. https://www.analog.com/en/products/processors-dsp/dsp/sharc.html
3. https://microcontrollerslab.com/embedded-systems-basics/

Passed in Board of Studies meeting

BOS Convener

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BOS Chairman

Course Code: 19CPEN1106	Course Title: Soft Computing Techniques		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3 : 0 : 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the concept of Soft Computing
2. Apply fuzzy logic and reasoning approaches
3. Analyze various learning techniques and architectures
4. Describe generic scheme of evolutionary algorithm
5. Develop hybrid intelligent system

Unit I Introduction to Soft Computing **9 Hours**

Intelligent system – Knowledge based system-Experts system – Knowledge representation processing – Soft computing – Machine Learning basics.

Unit II Fuzzy Logic **9 Hours**

Fundamentals of Fuzzy logic system-Fuzzy set-Fuzzy operation – Fuzzy resolution Fuzzy relations-Composition and inference – Fuzzy Decision Making – Fuzzy logic control.

Unit III Neural Network **9 Hours**

Machine Learning Using Neural Network, Adaptive Networks – Feed forward Networks – Supervised Learning Neural Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures – Advances in Neural networks.

Unit IV Evolutionary Computing **9 Hours**

Evolutionary Computing: The Origins – Evolutionary Algorithm-Components of Evolutionary Algorithms-Representation, Mutation, and Recombination. – Fitness, Selection, and Population Management – Popular Evolutionary Algorithm.

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Unit V **Genetic Algorithm** **9 Hours**

Genetic algorithm and Optimization – Genetic algorithm operators – Integration of genetic algorithm with Neural network & Fuzzy logic – Applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe the concept of Soft Computing for building intelligent Systems	Understand
CO 2: Apply fuzzy logic and reasoning approaches to solve various engineering problems	Apply
CO 3: Analyze various learning techniques and architectures using Neural Network	Analyze
CO 4: Describe the generic scheme of evolutionary algorithm for problem-solving	Understand
CO 5: Develop hybrid intelligent systems for solving optimization problems	Apply

Reference Book(s):

R1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2003.

R2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition, Wiley, 2010.

R3. Simon Haykin, "Neural Networks and Learning Machines", Third Edition, Prentice Hall, 2009.

R4. Fakhreddine O. Karray, "Soft Computing and Intelligent Systems Design: Theory, Tools and Applications", Pearson Education India, 2004.

R5. A.E. Eiben J.E. Smith, "Introduction to Evolutionary Computing", Natural Computing Series, Springer, New York, 2015.

Web References:

1. https://nptel.ac.in/courses/106105173/
2. https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-641j-introduction-to-neural-networks-spring-2005/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/lecture-videos/lecture-13-learning-genetic-algorithms/

Passed in Board of Studies meeting

BOS Convener

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BOS Chairman

Semester II

Course Code: 19CPCN1201		Course Title: Data Management and Analytics	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the Data management architecture for data analytics in engineering
2. Choose different data models for performing analytics
3. Apply the concepts of Hadoop / HDFS for various operations
4. Compare map reduce and YARN for all features
5. Explore various analytics platforms such as Mahout, MLBase and R

Unit I Data Management **9 Hours**

The Age of Information- Information Revolution – Big data dimensions and characteristics – 4 V's of Big Data – Structured, Semi-structured, and Unstructured Data -Information pioneered Product- Big Data Management Architecture – Applications of Big Data Analytics and Case Studies.

Unit II Big Data Analytics **9 Hours**

Introduction – The role of statistics in Engineering: The Engineering Method and Statistical Thinking – Collecting Engineering Data – Mechanistic and Empirical Models – Probability and Probability Models - Analytics Revolution for big data.

Unit III Hadoop and HDFS **9 Hours**

Hadoop: Data Storage and Analysis, Comparison with other Systems: RDBMS, Grid Computing, Volunteer Computing – Hadoop Releases – HDFS: Design and Concepts, CLI, File Systems and Interfaces, Data Flow, Hadoop Archives – Hadoop I/O.

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Unit IV **MapReduce & Yarn** **9 Hours**

MapReduce: Analysis with Hadoop, Scaling Out, Hadoop Streaming, Hadoop Pipes – Classic vs YARN MapReduce: Anatomy of Job Run, Failures, Scheduling, Shuffle and Sort, Task Execution – Types and Formats, Features, Apache MRUnit.

Unit V **Data Analytics with Large Datasets** **9 Hours**

Machine Learning with Large Datasets: Mahout- Building a data classification system with MAHOUT, MLBase – Distributed Machine learning, Statistical Analysis for massive datasets: Using R for large datasets- strategies for dealing with large datasets, Google Big Query: Building Big Data Dashboard.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the Data management architecture for data analytics in engineering with case studies	Understand
CO2: Choose different data models for performing analytics in engineering data	Apply
CO3: Apply the concepts of Hadoop / HDFS for various file system operations	Apply
CO4: Compare map reduce and YARN for all features and internal processes	Apply
CO5: Explore various analytics platforms such as Mahout, MLBase and R for large datasets	Apply

Reference Book(s):

R1. Nitin Upadhyay "Big Data Management and Analytics", Cengage India, 1st Edition, 2018.

R2. Douglas C. Montgomery, George C. Runger , "Applied Statistics and Probability for Engineers", John Wiley & Sons, 7th Edition, 2018.

R3. Tom White, "Hadoop: The Definitive Guide", O'Reilly Publication and Yahoo!Press, 3rd Edition, 2012

R4. Michael Manoochehri, "Data Just Right: Introduction to Large-scale Data & Analytics", Addison-Wesley, 1st Edition, 2013.

Web References:

1. The Apache Software Foundation, "Apache™ Hadoop® URL: http://hadoop.apache.org/
2. The Apache Software Foundation, "Apache MRUnit™ URL: http://mrunit.apache.org/
3. AMPLab, "Software | AMPLab - UC Berkeley URL:https://amplab.cs.berkeley.edu/software/

Passed in Board of Studies meeting

BOS Convener

Approved in Academic Council meeting

BOS Chairman

Course Code: 19CPCN1202	Course Title: Object Oriented Software Engineering		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Characterize the essence of object-oriented software processes and outline the usage of modeling language
2. Analyze the requirements of the software
3. Apply the design concepts and object design for software development
4. Describe the principles of Software Testing and its strategies
5. Analyze the need for Software Configuration Management

Unit I **Software Engineering** **9 Hours**

Software Related problems – Software Engineering concepts – Development activities – Modelling: Concepts – Modelling with UML – Project Organization & Communication: Concepts and Activities – Case Study: ARENA.

Unit II **Requirement Analysis** **9 Hours**

Requirements Elicitation – Activities – Managing requirements elicitation – Analysis: Analysis overview – Concepts – Activities and managing analysis – Case Study: ARENA.

Unit III **System Design** **9 Hours**

Design overview – Concepts – Activities – Addressing design goals and managing system design - Object Design: Object reuse – its activities & managing reuse – Interface specification concepts & its activities – Case Study: ARENA.

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BOS Chairman

Unit IV Testing **9 Hours**

Testing concepts: Faults – Erroneous States and Failures – Test cases – Test Stubs and Drivers – Corrections – Testing Activities: Component Inspection – Usability Testing – Unit Testing – Integration Testing and System Testing – Managing Testing.

Unit V Software Configuration Management **9 Hours**

Aircraft Example – Overview of Configuration Management – Configuration Management concepts – SCM Activities: SCI – Promotion Management – Release Management – Branch Management – Variant Management – Change Management and Managing Configuration Management.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Characterize the essence of object-oriented software processes and outline the usage of general purpose modeling language in the field of software Engineering	Understand
CO2: Analyze the functional requirements for an Object Oriented system	Analyze
CO3: Apply OO Design concepts, processes, languages, databases, user interfaces, frameworks, and design patterns	Apply
CO4: Describe the principles of Software Testing and the strategies for generating system test cases	Understand
CO5: Analyze the need for Configuration Management and gain awareness on SCM activities	Analyze

Reference Book(s):

R1. Bernd Bruegge and Allen H. Dutoit, "Object-Oriented Software Engineering: Using UML, Patterns and Java", 3rd Edition, Pearson Education Asia, 2010.

R2. Timothy C. Lethbridge and Robert Laganiere, "Object-Oriented Software Engineering: Practical Software Development using UML and Java", McGraw-Hill Higher education, 2004.

R3. Stephen R Schach, "An Introduction to Object Oriented Systems Analysis and Design with UML and the Unified Process", Tata McGraw-Hill, 2008.

R4. Roger Pressman and Bruce Maxim , "Software Engineering: A Practitioner's Approach", 8th Edition, Tata McGraw-Hill, 2014.

Web References:

1. https://online.stanford.edu/courses/cs108-object-oriented-systems-design.
2. https://onlinecourses.nptel.ac.in/noc16_cs19/preview.

Passed in Board of Studies meeting

BOS Convener

Approved in Academic Council meeting

BOS Chairman

Course Code: 19CPCN1203		Course Title: Modern Operating Systems	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Demonstrate the communication and synchronization issues between processes
2. Apply various resource management techniques for Distributed systems
3. Design of fault-tolerant systems using various failure recovery models and commit protocols
4. Describe the different features of real time systems and mobile operating systems
5. Summarize the basic concepts of various operating systems in different environments

Unit I **Distributed Operating System** **9 Hours**

Distributed Computing System Models – Design Issues in Distributed Operating System – Distributed Computing Environment – Communication Primitives – Synchronization: Clock Synchronization-Event ordering – Mutual Exclusion – Deadlock Handling – Election Algorithms.

Unit II **Distributed Resource Management** **9 Hours**

Distributed File Systems – Design Issues – Distributed Shared Memory – Algorithms for Implementing Distributed Shared memory – Memory Coherence protocols – Distributed Scheduling: Issues in Load Distributing – Components – Load Distribution Algorithms – Task Migration.

Unit III **Failure Recovery and Fault Tolerance** **9 Hours**

Classification of Failures – Error recovery – Recovery in concurrent systems – Check pointing and recovery – Fault tolerance: Issues – Commit protocols – Voting protocols: Static – dynamic – Failure resilient processes – reliable communication.

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BOS Chairman

Unit IV **Real Time and Mobile Operating Systems** **9 Hours**

Basic model of Real Time Systems – Characteristics – Applications of RTOS – Real Time Task Scheduling – Handling Resource Sharing – Mobile OS : Architecture and SDK Framework – Media Layer – Services Layer – Core OS Layer – File System.

Unit V **Case Studies** **9 Hours**

Linux system : Design Principles – Kernel Modules – Process Management & scheduling – Memory Management – I/O Management – File System – Inter process communication – Network structure – Security – Mobile OS : Android.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Identify the communication and synchronization issues between processes in a distributed environment	Apply
CO 2: Apply various resource management techniques for distributed systems using DFS and DSM	Apply
CO 3: Design of fault-tolerant systems using various failure recovery models and commits protocols in distributed systems	Apply
CO 4: Describe the different features of real time systems and mobile operating systems	Understand
CO 5: Summarize the basic concepts of various operating systems in different environments	Understand

Reference Book(s):

R1. Pradeep K.Sinha, "Distributed Operating Systems: Concepts and Design", PHI Learning Pvt. Ltd., Reprint 2012.

R2. Mukesh Singhal, Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems: Distributed, Database, and Multiprocessor Operating Systems", Tata McGraw-Hill, Reprint 2008.

R3. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.

R4. Neil Smyth, "Android 4.2 App Development Essentials", Payload media, 2013.

R5. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", 7th Edition, John Wiley & Sons, 2004.

Web References:

1. Distributed Systems –NPTEL Videos - https://nptel.ac.in/courses/106106168/10
2. Android OS Materials: https://www.techotopia.com/index.php/Android_4_App_Development_Essentials

Passed in Board of Studies meeting

BOS Convener

Approved in Academic Council meeting

BOS Chairman

Course Code: 19CPCN2201	Course Title: Data Management and Analytics Laboratory		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Implement data processing and data analytics functions using R
2. Implement programs using statistical and probability models for data processing
3. Create Map Reduce programs for data processing
4. Deploy Map Reduce programs for data analytics
5. Develop data analysis and classification packages

Area of Experiments:

Develop analytics models for any application using the following experiments

1. Implementation of data processing techniques using R.
2. Implementation of data analytics functions using R.
3. Simple Programs using R to process probability models.
4. Simple Programs using R to process empirical models.
5. Running HDFS commands for data processing.
6. Running HDFS commands for data processing with different Interfaces.
7. Programs using Map Reduce algorithms for data processing.
8. Programs using Map Reduce algorithms for data analytics applications.
9. Classification and data analysis using MAHOUT.
10. Classification and data analysis using MLBASE.

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BOS Chairman

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Implement data processing and data analytics functions using R	Apply
CO2: Implement programs using statistical and probability models for data processing with various interfaces	Apply
CO3: Create Map Reduce programs for data processing	Apply
CO4: Deploy Map Reduce programs for data analytics using large data sets	Apply
CO5: Develop data analysis and classification packages using MAHOUT and MLBASE	Apply

Reference(s):

R1. Tom White, "Hadoop: The Definitive Guide", O'Reilly Publication and Yahoo!Press, 3rd Edition, 2012.

R2. The Apache Software Foundation, "Apache MRUnit™ URL: http://mrunit.apache.org/

R3. The Apache Software Foundation, "Apache™ Hadoop® URL: http://hadoop.apache.org/

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BOS Convener

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BOS Chairman

Course Code: 19SHAG1201	Course Title: Teaching and Learning in Engineering (Common to all PG Programmes)	
Course Category: Humanities	Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Total Contact Hours: 30	Max Marks: 100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Use Outcome based approach in teaching courses
2. Conduct lecture/practical/tutorial sessions using active learning methods
3. Conduct higher order assessments using rubrics

Unit I **Outcome Based Approach** **10 Hours**

Outcome based Education – Need & Approach – Washington accord – Graduate attributes – Learning outcomes – Blooms Taxonomy

Unit II **Active Learning Methods** **10 Hours**

Design and Delivery plan for lectures/practical/tutorial sessions – Need for Active learning methods – Active learning strategies – Benefits of Active learning Methods

Unit III **Assessments** **10 Hours**

Assessments – types of assessments-need for rubrics, Types of rubrics – Assessment using rubrics

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use outcome based approach in teaching courses in engineering programmes	Apply
CO 2: Conduct lecture/practical/tutorial sessions using active learning methods	Apply
CO 3: Conduct higher order assessments using rubrics	Apply

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BOS Chairman

Reference Book(s):

R1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.

R2. Dr. William G. Spady, Wajid Hussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.

R3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc

Web References:

1. cid.buu.ac.th/information/Eric_Soulsby_Assessment_Notes.pdf
2. www4.ncsu.edu/unity/lockers/users/f/felder/public/.../Active/Active-learning.pdf
3. https://tomprof.stanford.edu/posting/1491 -Common Active Learning Mistakes

Assessment pattern:

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

- **Students will be finally awarded with three levels based on the score as follows:**

Marks Scored	Levels
70% & above	Good
30- 69%	Average
< 30%	Fair

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BOS Chairman

Semester II - Electives

Course Code: 19CPEN1201		Course Title: Computer Architecture	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the principles and design of Instruction Set Architectures
2. Apply the various Optimization techniques
3. Summarize the various aspects of Instruction level parallelism
4. Illustrate the significant aspects of Data level parallelism
5. Describe advanced topics like thread level parallelism, embedded systems and interconnection systems

Unit I **Fundamentals of Computer Design** **9 Hours**

Classes of Computers – Defining Computer Architecture – Trends – Dependability – Measuring, Reporting, and Summarizing Performance – Quantitative Principles of Computer Design – Instruction Set Principles and Examples – Classifying Instruction Set Architectures – Memory Addressing – Type and Size of Operands – Operations in the Instruction Set – Instructions for Control Flow – Encoding an Instruction Set.

Unit II **Memory Hierarchy Design** **9 Hours**

Introduction – Cache Performance – Six Basic Cache Optimizations – Virtual Memory – Protection and Examples of Virtual Memory -Advanced Optimizations of Cache Performance – Memory Technology and Optimizations.

Unit III **Instruction-Level Parallelism** **9 Hours**

Pipelining Concepts – Pipeline Hazards – Implementation of Pipelining – ILP : Concepts and Challenges – Basic Compiler Techniques for Exposing ILP – Advanced branch Prediction –

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Dynamic Scheduling – Hardware-Based Speculation – Exploiting ILP – Advanced Techniques for Instruction Delivery and Speculation – Limitations of ILP.

Unit IV Data-Level Parallelism **9 Hours**

Vector Architecture – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units –Detecting and Enhancing Loop-level parallelism – Warehouse Scale Computers: Programming Models, Workloads and Architecture – Physical Infrastructure and costs.

Unit V Thread-Level Parallelism **9 Hours**

Centralized Shared Memory Architectures – Performance of Symmetric Shared Memory Multiprocessors – Distributed Shared Memory and Directory Based Coherence – Synchronization – Models of Memory Consistency – Case Study: Multi-core Processors and their Performance – Storage Systems – Embedded Systems – Interconnection Networks.

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Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Describe the principles and design of Instruction Set Architectures in computer	Understand
CO 2: Apply the various Optimization techniques used in memory technologies	Apply
CO 3: Summarize the various aspects of Instruction level parallelism using Pipelining	Understand
CO 4: Illustrate the significant aspects of Data level parallelism of Vector Architecture	Apply
CO 5: Describe advanced topics like thread level parallelism, embedded systems and interconnection systems used in parallel computing	Understand

Reference Book(s):

R1. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann, 5th Edition, 2012.

R2. Richard Y. Kain, "Advanced Computer Architecture - A Systems Design Approach", Prentice Hall, 2011.

R3. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture", Tata McGraw-Hill, 2nd Edition, 2010.

Web References:

1. https://nptel.ac.in/courses/106105033/
2. https://www.cse.iitm.ac.in/course_details.php

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Course Code: 19CPEN1202		Course Title: Cloud Computing and IoT	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Network Design and Management

Course Objectives

The course is intended to:

1. Analyze the evolutionary changes that have occurred in parallel, distributed and Cloud Computing
2. Apply the design principles, architectures and enabling technologies
3. Interpret the genesis and impact of IoT architectures
4. Analyze various IOT Protocols and methods
5. Illustrate different applications of IoT

Unit I **Cloud Computing and Models** **9 Hours**

Distributed System Models and Enabling Technologies – Cloud Computing: Cloud Types – Characteristics – Measuring Cloud Value and cloud computing cost- Cloud Architecture: Cloud Computing Stack – Cloud Services: IaaS – PaaS – SaaS.

Unit II **Cloud Infrastructure** **9 Hours**

Data-Centre Design and Interconnection Networks – Architectural Design of Compute and Storage Clouds – Public Cloud platforms – Inter Cloud Resource Management.

Unit III **Introduction To IoT** **9 Hours**

Genesis of IoT, Digitization, Impact, Convergence of IT and IoT, IoT Challenges, Network Architecture and Design, Comparing IoT Architectures, Core IoT Functional Stack, Data Management.

Unit IV **IoT Networks & Protocols** **9 Hours**

Sensors, Actuators, and Smart Objects – Sensor Networks – Connecting Smart Objects – Communication Criteria – IoT Access Technologies – IoT Network Layer – Business Case for

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IP – Optimizing IP for IoT – Profiles and Compliances – Application Protocols for IoT – Transport Layer – IoT Application Transport Methods – Securing IoT.

Unit V Application **9 Hours**

Manufacturing – Smart and Connected Cities – Transportation – Mining – Public Safety – Home automation – Agriculture – productivity applications – Structural Health Monitoring.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the evolutionary changes that have occurred in parallel, distributed and Cloud Computing with real time examples	Understand
CO 2: Apply the design principles, architectures and enabling technologies for cloud infrastructure	Apply
CO 3: Interpret the genesis and impact of IoT architectures with its application	Analyze
CO 4: Analyze various IOT Protocols and methods for secure communication	Understand
CO 5: Illustrate different applications of IoT in real time scenario	Apply

Reference Book(s):

R1. Barrie Sosinsky, "Cloud Computing Bible", Wiley Publishing, 2011

R2. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012

R3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Pearson Education, 2017.

R4. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things -Key Applications and Protocols", 2nd Edition, Wiley, 2012.

Web References:

1. Cloud Computing, https://nptel.ac.in/courses/106105167
2. Cloud Courses, https://www.udemy.com/topic/cloud-computing
3. Introduction to Internet of Things, https://nptel.ac.in/courses/106105166
4. Internet of Things Protocols and Standards https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

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Course Code: 19CPEN1203	Course Title: Parallel Computing		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3 : 0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe various parallel computing hardware and software architectures
2. Analyze various parallel algorithms
3. Explain the message passing paradigm for shared processors
4. Develop a programming models using OpenMP
5. Develop a programming models for GPU processors using CUDA

Unit I **Parallel Hardware and Parallel Software** **9 Hours**

Need for Parallel Computing – Concurrency in computing – Von Neumann Architecture and modifications – Parallel Hardware – Parallel Software.

Unit II **Parallel Algorithm Design** **9 Hours**

Task / Channel Model – Foster's Design Methodology – Examples – Adding Data Input – Performance Analysis – Speedup and Efficiency – Metrics and Laws.

Unit III **Message Passing Paradigm** **9 Hours**

MPI programming – MPI communicators – Single Program Multiple Data programs – Communication – Message matching – MPI I/O – Collective communication – Performance evaluation of MPI programs.

Unit IV **Shared Memory Programming with Openmp** **9 Hours**

OpenMP programming – Scope of variables – Reduction clause – Loops in OpenMP – Scheduling loops – Synchronization – Producer-Consumer problem – Cache issues – Thread safety in OpenMP.

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Unit V **Shared Memory Programming with Cuda** **9 Hours**

Introduction to GPU – Understanding Parallelism with GPUs – Anatomy of CUDA Programming - CUDA Parallelism Model – CUDA Grid, Blocks and Threads – Memory Handling with CUDA – Multi-CPU and Multi – GPU Solutions – Case Study: Matrix multiplication.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the working principles of parallel computing hardware and software architectures	Understand
CO2: Design and analyze parallel algorithms	Apply
CO3: Develop parallel programs using the message passing paradigm	Apply
CO4: Develop Shared Memory programs using OpenMP	Apply
CO5: Use common architectures and programming models for GPU processors	Apply

Reference Book(s):

R1. Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann, 2011.

R2. M. J. Quinn, "Parallel programming in C with MPI and OpenMP", Tata McGraw Hill, 2003.

R3. Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufman, 2012.

Web References:

1. https://www.cs.usfca.edu/~peter/ipp/
2. https://computing.llnl.gov/tutorials/parallel_comp/
3. https://onlinecourses.nptel.ac.in/noc17_cs39/preview

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Course Code: 19CPEN1204	Course Title: Security in Computing		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Summarize the basic concepts in Cryptography and symmetric ciphers
2. Apply the working of Public Key Encryption and Hash Functions
3. Summarize various types of database security
4. Describe issues related to Administering Security
5. Explain legal and ethical issues in computer security

Unit I **Symmetric Ciphers** **9 Hours**

Introduction – Security Attacks – Security Services – Security Mechanisms – Symmetric Ciphers: Classical Encryption Techniques – Block Ciphers and the Data Encryption Standard – Advanced Encryption Standard.

Unit II **Public Key Encryption and Hash Functions** **9 Hours**

Asymmetric Ciphers: Mathematical Concepts – Public-Key Cryptography and RSA – Other Public-Key Cryptosystems – Message Authentication and Hash Functions: Authentication Requirements – Authentication Functions – Message Authentication Codes – Hash Functions – Security of Hash Functions and MACs.

Unit III **Program, Database and Data Mining Security** **9 Hours**

Secure Programs – Non-malicious Program Errors – Viruses and Other Malicious Code – Targeted Malicious Code – Controls Against Program Threats – Database Security Requirements – Reliability and Integrity – Sensitive Data – Inference – Multilevel Databases – Proposals for Multilevel Security – Data Mining.

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Unit IV **Security in Networks and Administering Security** **9 Hours**

Network Concepts – Threats in Networks – Network Security Controls – Firewalls – Security Planning – Risk Analysis – Organizational Security Policies – Physical Security.

Unit V **Issues in Computer Security** **9 Hours**

Privacy Concepts – Privacy Principles and Policies – Authentication and Privacy – Privacy on the Web – E-mail Security – Impacts on Emerging Technologies – Protecting Programs and Data – Information and the Law – Rights of Employees and Employers – Redress for Software Failures – Computer Crime – Ethical Issues in Computer Security.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the basic concepts in Cryptography and symmetric ciphers for secure communication using single key	Apply
CO 2: Apply the working of Public Key Encryption and Hash Functions secure communication using public and private key	Apply
CO 3: Summarize various types of security provided in maintaining a secure Database	Understand
CO 4: Describe issues related to security while administering the networks	Understand
CO 5: Explain legal and ethical issues in computer security and privacy in computing	Understand

Reference Books:

R1. William Stallings, "Cryptography and Network Security", Fifth Edition, Prentice Hall, 2010.

R2. Charles.P.Pfleeger and Shari Lawrence Pfleeger, "Security in Computing", Fourth Edition, Pearson Education, 2007.

R3. Behrouz A Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", Second Edition, Tata McGraw Hill Education Pvt Ltd Publication, 2010.

R4. Marjie T. Britz, "Computer Forensics and Cyber Crime-An Introduction", Third Edition, Pearson Education, 2013.

R5. Bernard L. Menezes, "Network Security and Cryptography", Cengage Learning India, 2010.

Web References:

1. https://nptel.ac.in/courses/106105031/
2. williamstallings.com/ComputerSecurity/

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Course Code: 19CPEN1205	Course Title: Natural Language Processing		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Perform word and sentence recognition
2. Identify POS tags for words
3. Perform syntax analysis and construct parse trees
4. Determine word sense, semantic role and similarity
5. Develop NLP applications

Unit I Language Modeling **8 Hours**

Knowledge in Speech and Language Processing – Ambiguity – Regular Expressions – Finite State Automata – Morphology – Finite State Transducers – Word and Sentence Tokenization – Detecting and Correcting Spelling Errors – Minimum Edit Distance.

Unit II Word Level Analysis **10 Hours**

N-grams – Unsmoothed N-grams – Perplexity – Smoothing – Word Classes – Part-of-Speech Tagging – Rule-based, Stochastic and Transformation based tagging – Evaluation and issues in PoS tagging – Markov chains – Hidden Markov Model – Forward, Viterbi, Forward-Backward algorithms.

Unit III Syntax Analysis **10 Hours**

Context-Free Grammars – Grammar rules – Treebanks - Dependency Grammars – Parsing as Search – Ambiguity – Dynamic Programming parsing – Partial parsing – Probabilistic CFG – Probabilistic CKY parsing – Probabilistic Lexicalized CFGs.

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Unit IV **Semantics** **8 Hours**

First Order Logic – Description Logics – Syntax-driven semantic analysis – Word Senses – Relations between Senses – Semantic roles – Word Sense Disambiguation: Supervised, Dictionary & Thesaurus methods – Word Similarity: Thesaurus and Distributional methods.

Unit V **Pragmatics and Applications** **9 Hours**

Discourse segmentation – Text Coherence – Reference, Anaphora and Co-reference resolution – Named Entity Recognition – Relation Detection and Classification – Information Retrieval – Factoid Question Answering – Summarization.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Construct Finite state automata and transducers for word recognition	Apply
CO2: Identify n-grams and Parts of Speech tags for sentences	Apply
CO3: Perform syntax analysis using appropriate parsing algorithms	Apply
CO4: Determine word sense and similarity between words using suitable methods	Apply
CO5: Implement NLP techniques for Information Extraction and retrieval	Apply

Reference Book(s):

R1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2008.

R2. U. S. Tiwary and Tanveer Siddiqui, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.

R3. Richard M Reese, "Natural Language Processing with Java", Packt Publishing, 2015.

Web References:

1. https://nptel.ac.in/courses/106101007/
2. https://nlp.stanford.edu/software/

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Course Code: 19CPEN1206	Course Title: Software Project Management		
Course Category: Professional Elective		Course Level: Mastery	
L:T: P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Describe the fundamental concepts in Project Management
2. Identify appropriate project tools, template and process
3. Design, adapt and deploy project life cycle
4. Analyze the benefits of Agile and Extreme Project Management
5. Explain the project organizational contribution

Unit I **Project Management** **9 Hours**

Project – Understanding the Scope Triangle – Envisioning the Scope Triangle as a System in Balance – Managing the Creeps - Applying the Scope Triangle – The Importance of Classifying Projects – Fundamentals of Project Management – Process Groups – Knowledge Areas – Scoping a Project.

Unit II **Project Management Process** **9 Hours**

Tools, Templates and Processes: Planning, Launching, Monitoring and Control, Closing Project activities – Installing Project Deliverables – Documenting the Project – Conducting the Post Implementation Audit – Final Report.

Unit III **Project Management Life Cycle** **9 Hours**

Project Management Landscape – Traditional Project Management: Linear Project Management Life Cycle, Incremental Project Management Life Cycle – Critical chain Project Management.

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Unit IV **Agile and Extreme Project Management** **9 Hours**

Agile Project Management – Iterative Project Management Life Cycle – Adaptive Project Management Life Cycle – Adapting and Integrating the APM Toolkit – Extreme Project Management – Extreme Project Management Life Cycle – Emertxe Project Management – Using the Tools, Templates, and Processes for Maximum xPM Effectiveness.

Unit V **Project Management Infrastructure** **9 Hours**

Project Support Office – Naming – Establishing Mission – Framing Objectives – Exploring support functions – Organizational Structure – Organizational Placement – Need for PSO – Establishing PSO – Challenges of implementing PSO - Project Portfolio Management – PPM Life Cycle – Roles and Responsibilities – Project submission – Agile PPM.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Describe the fundamental concepts in managing projects with real time examples	Understand
CO 2: Identify appropriate tools, template and process for managing a project	Apply
CO 3: Design, adapt and deploy project life cycle based on changing characteristics of a project	Apply
CO 4: Analyze the benefits of Agile and Extreme Project Management using tools, templates and processes	Analyze
CO 5: Explain the organizational contribution for the success of a project	Understand

Reference Book(s):

R1. Robert K. Wysoki, "Effective Project Management- Traditional, Agile, Extreme", 7th Edition, Wiley, 2013.

R2. Bob Hughes, Mikecotterell, "Software Project Management", 3rd Edition, Tata McGraw Hill, 2011.

R3. Gopalaswamy Ramesh, "Managing Global Projects", Tata McGraw Hill, 2006.

R4. Murali Chemuturi, Thomas M. Cagley, "Mastering Software project Management: Best Practices, Tools and Techniques", J. Ross publishing, 2010.

R5. Pankaj Jalote, "Software Project Management in Practice", Pearson Education, 2002.

Web References:

1. https://agilemanifesto.org/
2. https://www.atlassian.com/agile
3. https://www.projectmanager.com/software

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Semester III - Electives

Course Code: 19CPEN1301	Course Title: Information Retrieval		
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Evaluate the efficiency of various IR models
2. Explain the stages involved in Query processing systems
3. Apply text processing operations and searching
4. Develop a data model for multimedia retrieval
5. Describe the architecture of a Search Engine

Unit I Introduction **9 Hours**

Basic Concepts – Retrieval Process – Modeling – Classic Information Retrieval – Set Theoretic, Algebraic and Probabilistic Models – Structured Text Retrieval Models – Retrieval Evaluation.

Unit II Querying **9 Hours**

Languages – Key word based Querying – Pattern Matching – Structural Queries – Query Operations – User Relevance Feedback – Local and Global Analysis – Text and Multimedia languages.

Unit III Text Operations And User Interface **9 Hours**

Document Preprocessing – Clustering – Text Compression - Indexing and Searching – Inverted files – Boolean Queries – Sequential searching – User Interface and Visualization – Access Process – Query Specification – Context – User relevance Judgment.

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Unit IV **Multimedia Information Retrieval** **9 Hours**

Data Models – Query Languages – Spatial Access Methods – Generic Approach – One Dimensional Time Series – Two Dimensional Color Images – Feature Extraction.

Unit V **Web Searching And Applications** **9 Hours**

Searching the Web – Characterizing the Web – Search Engines–Crawling – Browsing – Link Analysis – Page Ranking – Parallel Information Retrieval – Distributed Information Retrieval.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the principles of various Information Retrieval models	Understand
CO2: Design query processing systems with relevance feedback mechanisms	Apply
CO3: Apply text processing operations, construct text indices and design effective user interfaces	Apply
CO4: Develop systems for searching and retrieving multimedia data	Apply
CO5: Design prototype Search Engines	Apply

Reference Book(s):

R1. Ricardo Baeza-Yates, BerthierRibeiro-Neto, "Modern Information Retrieval", Second Edition, ACM Press Books, 2011

R2. Christopher D. Manning, PrabhakarRaghavan, HinrichSchutze, "Introduction to Information Retrieval",First South Asian Edition, Cambridge University Press, 2012

R3. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval Implementing and Evaluating Search Engines", The MIT Press, Cambridge, 2010

Web References:

1. Information Retrieval and web search, URL: http://web.stanford.edu/class/cs276/
2. Information Retrieval, URL: https://www.gla.ac.uk/schools/computing/research/researchoverview/informationretrieval
3. Information Retrieval, URL: http://cse.iitkgp.ac.in/~pawang/courses/IR18.html

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Course Code:19CPEN1302	Course Title:Machine Learning Techniques		
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Explain the working of supervised learning systems
2. Apply parametric and non-parametric techniques
3. Develop multilayer perceptron networks
4. Apply neural network and deep learning algorithms
5. Evaluate the performance of classifiers and combine multiple learners

Unit I Supervised Learning **9 Hours**

Machine Learning – Paradigms and Applications – Supervised Learning –Learning from Examples – VC Dimension – Probably Approximately Correct Learning – Handling Noise – Learning Multiple Classes – Regression – Model Selection and Generalization.

Unit II Parametric And Non-Parametric Methods **9Hours**

Maximum Likelihood Estimation – Bayes Estimator – Parametric Classification and Regression – Dimensionality Reduction: Principal Component Analysis, Factor Analysis, Expectation Maximization – Density Estimation – Generalization to Multi-variate data – Non-parametric Classification and Regression.

Unit III Multilayer Perceptrons And Kernel Machines **9 Hours**

Linear Discrimination – Generalizing the Linear model – Geometry of Linear Discriminant – Multilayer Perceptrons – Perceptron Learning – Universal Approximators – Back propagation Algorithm – Training – Temporal networks – Kernel Machines: Separating Hyperplanes – Kernels – Regression.

Unit IV Deep Learning Networks **9 Hours**

Fundamentals of Deep Networks - Architectural Principles – Building blocks – Convolutional Neural Networks (CNN) – Recurrent Neural Networks (RNN).

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Unit V **Classification Assessment And Multiple Learners** **9 Hours**

Assessing Classification Algorithms: Cross Validation and Re-sampling – Error measurement – Hypothesis Testing – Performance Assessment – Comparison of Algorithms – Combining Multiple Learners: Voting – Bagging – Boosting.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the working of supervised learning systems for machine learning	Understand
CO2: Apply parametric and non-parametric techniques for classification and regression	Apply
CO3: Develop multilayer perceptron networks for solving classification problems	Apply
CO4: Implement neural network and deep learning algorithms for classification and prediction	Apply
CO5: Evaluate the performance of classifiers and combine multiple learners for choosing the best algorithm	Analyze

Reference Book(s):

R1. EthemAlpaydin, "Introduction to Machine Learning", Second Edition, MIT Press, 2014.

R2. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly, 2017.

R3. Peter Harrington, "Machine Learning in Action", Wiley India Pvt Ltd, 2012.

Web References:

1. Introduction to Machine Larning, URL: https://swayam.gov.in/nd1_noc20_cs29/preview
2. ML Repository, URL: http://www.ics.uci.edu/mlearn/MLRepository.html
3. Machine Learning Tutorialfor Beginners, URL: https://www.kaggle.com/kanncaa1/machine-learning-tutorial-for-beginners

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Course Code:19CPEN1303	Course Title:Social Network Analysis		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3 : 0 : 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Data Management and Analytics

Course Objectives

The course is intended to:

1. Explain various notations and graph terminology
2. Illustrate various models and relationship in social network
3. Analyze dynamic changes in social network
4. Apply mining tools and methods
5. Apply social network approach

Unit I Introduction **9 Hours**

Overview of Networks –Graph – Paths and Connectivity – Distance and Breadth – First Search –Network Datasets – Triadic Closure –Strength of Weak Ties – Network Structure in Large – Scale Data –Social Media – Passive Engagement – Closure – Structural Holes – – Social Capital –Betweenness Measures – Graph Partitioning.

Unit II Models And Algorithms **9Hours**

Homophily –Selection and Social Influence – Affiliation – Spatial Model of Segregation – Positive and Negative Relationships –Link Analysis using Hubs and Authorities – PageRank – Applying Link Analysis in Modern Web Search – Spectral Analysis – Random Walks – and Web Search.

Unit III Social Network Dynamics **9 Hours**

Power Laws and Rich –Get-Richer Phenomena –Cascading Behavior in Networks – The Small –World Phenomenon – Epidemics – Branching Processes –SIR Epidemic Model – SIS Epidemic Model.

Unit IV Visualization And Mining **9Hours**

Visualizing social networks –Data mining methods for social media –Text mining in social networks – Keyword Search – Classification Algorithms.

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Unit V Applications **9 Hours**

Real Time Emotion Classification of Tweets –A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments –Explaining Scientific and Technical Emergence Forecasting –Social Network Analysis for Biometric Template Protection.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain various notations and graph terminology used in social network	Understand
CO2: Illustrate various models and relationship in social network using Link Analysis Algorithm	Apply
CO3: Analyze social network dynamics in cascading behavior and spread of information	Analyze
CO4: Apply mining tools and methods for data visualization	Apply
CO5: Apply social network approach in real time applications	Apply

Reference Book(s):

R1. David Easley and Jon Kleinberg , "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.

R2. Charu.C.Aggarwal, "Social Network Data Analytics", Springer, 2011.

R3. Przemyslaw Kazienko, Nitesh Chawla, "Applications of Social Media and Social Network Analysis", Springer,2015.

R4. GuandongXu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and Applications", Springer, 2012.

Web References:

1. Social Networks, URL: https://nptel.ac.in/courses/106106169/
2. Collaborative Innovation Networks, URL: https://ocw.mit.edu/courses/sloan-school-of-management/15-599-workshop-in-it-collaborative-innovation-networks-fall-2011/lecture-notes/MIT15_599F11_lec04.pdf
3. Social Network Analysis, URL: https://www.edx.org/course/social-network-analysis-sna-utarlingtonx-link-la-snax

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Open Electives

Course Code:19CPOC1301	Course Title:Business Analytics		
Course Category: Open Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Describe the role of business analytics
2. Demonstrate and Visualize models
3. Analyze data using data mining techniques
4. Select forecasting techniques and models
5. Formulate and solve business problems to support managerial decision making

Unit I **Business Analytics & Statistical Tools** **9 Hours**

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 modeling, sampling and estimation methods overview.

Unit II **Trendiness & Regression Analysis** **9 Hours**

Modeling 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 **Analytics & Modeling** **9 Hours**

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 Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

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Unit IV **Forecasting Techniques** **9 Hours**

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 Hours**

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Visual data recovery, Data Storytelling and Data journalism.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Describe the role of business analytics within an organization	Understand
CO2. Demonstrate and Visualize the trends in data and models	Apply
CO3. Analyze data using data mining techniques and understand relationships between the underlying business processes	Apply
CO4.Select forecasting techniques and models for Risk analysis	Analyze
CO5. Formulate and solve business problems to support managerial decision making by the managers for business analytics	Apply

Reference Book(s):

R1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press, 2014

R2. James Evans, "Business Analytics", Pearson Education, 2013

Web References:

1. Business Analytics and Data mining, URL: https://nptel.ac.in/courses/110107092/
2. Business Analysis Modeling, URL: https://www.udemy.com/visual-modeling-master-class/
3. Data Analysis - A Practical Introduction, URL: https://www.edx.org/course/data-analysis-a-practical-introduction-for-absolute-beginners-2

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Course Code:19CPOC1302	Course Title:Cyber Security & Computer Forensics		
Course Category: Open Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Outline the cyber security metrics and frameworks
2. Examine the cyber security issues
3. Discuss cyber hacking and cyber crime
4. Identify the computer forensics knowledge requirement
5. Examine network and mobile forensics

Unit I **Cyber security Objectives And Guidance** **9 Hours**

Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks:E-Commerce Systems, Industrial Control Systems, Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers- Cyber Security Management – Catalog Approach.

Unit II **Cyber Security Issues** **9 Hours**

Cyber Governance Issues: Net Neutrality ,Internet Names and Numbers, Copyright and Trademarks, Email and Messaging - Cyber User Issues: Malvertising, Impersonation, Appropriate Use, Cyber Crime, Geolocation,Privacy - Cyber Conflict Issues: Intellectual, property Theft, Cyber Espionage, Cyber Sabotage, Cyber Welfare.

Unit III **Cyber Hacking And Cyber Crime** **9 Hours**

Culture of Hackers - Types of Hacking - Cracking, Phreaking and Hacking - International Initiatives to Prevent and Control Cyber Hacking - Modes of Cyber Fraud - Cyber Pornography- Prevention and Control of Cyber Pornography - Computer Crime – Cyberspace Against Economy - Cyber Warfare - Legal Protection against Cyber Crime - Cyber Crime Preventive Methods.

Unit IV **Computer Forensics Requirements** **9 Hours**

Scope of computer forensics - Types of Evidence - Investigator skills - History of Computer Forensics, Common Computer Forensic Techniques - Law Enforcement Training – Acquiring Evidence in a Computer Forensics Lab.

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Unit V **Network And Mobile Forensics** **9 Hours**

Network Forensics: Tools, Networking Devices, Understanding the OSI Model, Advanced Persistent Threats, Investigating a Network Attack- Mobile Forensics: Cellular Network, Handset Specifications, Mobile Operating Systems, Standard Operating Procedures for Handling Handset Evidence, Handset Forensics – Case study on MAC forensics.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Outline the cyber security metrics and frameworks for cyber decision making	Understand
CO 2: Examine the cyber governance and user issues faced by decision makers	Apply
CO 3: Discuss cyber hacking and cybercrime of digital era.	Understand
CO 4: Identify the knowledge requirement for computer forensics investigation	Apply
CO 5: Examine network and mobile forensic techniques for cyber-crime investigation	Apply

Reference Book(s):

R1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss, "Cyber Security Policy Guidebook", John Wiley & Sons, 2012.

R2. National Cyber Safety and Security Standards, Govt. of India, "National Cyber Crime Reference Handbook", 2014.

R3. Darren R. Hayes, "A Practical Guide to Computer Forensics Investigations", Pearson, 2014.

Web References:

1. Cyber Security, URL: https://www.sans.org/course/introduction-cyber-security
2. Fundamentals of cyber security, URL: http://www.cyberaces.org/courses/
3. A Guide to Computer Forensics, URL: https://forensiccontrol.com/resources/beginners-guide-computer-forensics/

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