Silicon Institute of Technology
| An Autonomous Institute |

Curriculum Structure and Detailed Syllabus

Master of Technology in Computer Science & Engineering

Department of Computer Science & Engineering
Silicon Institute of Technology
Silicon Hills, Patia, Bhubaneswar - 751024

Effective from Academic Year 2020-21
Version: 1.21 (Build: 05-05-2021)

Approval History

ACM#	Date	Resolutions
AC-1	14/08/2018	The curriculum & detailed syllabus of 1st Year, as proposed by the Board of Studies, is provisionally approved by the Academic Council.
AC-2	11/05/2019	The curriculum & detailed syllabus up to 2nd Year, as proposed by the Board of Studies, is approved by the Academic Council.
AC-4	18/08/2020	The amendments to the curriculum, as proposed by the Board of Studies, are approved by the Academic Council.

Program Outcomes

Program Outcomes (POs) form a set of individually assessable outcomes that are the components indicative of the post-graduate's potential to acquire competence to practice at the appropriate level. The following POs have been defined for the M.Tech programmes in line with NBA, so that the outcomes can be assessed in a similar manner to UG Engineering programmes:

PO1. Develop an understanding of the theoretical foundations and the limits of computing.

PO2. Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.

PO3. Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.

PO4. Develop understanding and insight of advanced computing techniques and use of advanced tools.

PO5. Explore ideas and undertake original research at the cutting edge of computer science and its related areas.

PO6. Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.

PO7. Understand the impact of IT related solutions in an economic, social and environment context.

PO8. Understand intellectual property rights and overall professional & ethical responsibility.

PO9. Communicate effectively in a technically sound manner with a wide range of audience.

PO10. Continue to learn independently and engage in life-long learning.

Program Educational Objectives (PEOs)

PEO1. Exhibit analytical & problem solving skills to develop efficient algorithms and effective computational systems & solutions under realistic constraints for betterment of society, mankind, and environment.

PEO2. Adapt to technological advancements and acquire skills to engage in professional practice in industry or academics, individually or in a well coordinated team with integrity and ethics.

PEO3. Conduct independent research in specialized domains of Computer Science & Engineering and pursue higher studies with life-long learning.

Program Specific Outcomes (PSOs)

PSO1. Analyze, solve, and create algorithms for computational problems and develop efficient solutions.

PSO2. Apply principles & practices of Computer Science for finding solutions to real life problems.

PSO3. Engage as a computer science professional in industry, higher studies, research & development, academics, or entrepreneurship.

Course Types & Definitions

L	Lecture
T	Tutorial
P	Practical / Sessional
WCH	Weekly Contact Hours
BS	Basic Sciences
HS	Humanities & Social Sciences (including Management)
ES	Engineering Sciences
PC	Professional Core
PE	Professional Elective
OE	Open Elective
MC	Mandatory Course
CC	Compulsory Course
AC	Audit Course
PJ	Project Work
VV	Viva Voce

Contents

Part I

1st Year M. Tech. (CSE)

Curriculum Structure

Semester I									
Type	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY									
PC	18MS1T01	Mathematical Foundations for CS	3	0	0	3	0	0
PC	18MS1T02	Advanced Data Structures & Algorithms	3	0	0	3	0	0
PE	18MS2T**	Professional Elective-I	3	0	0	3	0	0
PE	18MS2T**	Professional Elective-II	3	0	0	3	0	0
CC	18MS1T05	Research Methodology & IPR	2	0	0	2	0	0
AC	18MS8T06	Stress Management by Yoga	2	0	0	0	0	0
PRACTICAL									
PC	18MS1L01	Advanced Data Structures & Algorithms Lab	0	0	4	0	0	2
PE	18MS2L**	Professional Elective-I Lab	0	0	2	0	0	1
PE	18MS2L**	Professional Elective-II Lab	0	0	2	0	0	1
		SUB-TOTAL	**16**	**0**	**8**	**14**	**0**	**4**
		TOTAL	**24**			**18**		

List of Electives

Code (T)	Elective # and Subjects	Code (L)	Labs of Elective Subjects
Professional Elective-I		***Professional Elective-I Lab***	
18MS2T07	Statistical Inference	18MS2L07	Statistical Inference Lab
18MS2T04	Wireless Sensor Networks	18MS2L04	Wireless Sensor Networks Lab
18MS2T17	IoT Enterprise Networks	18MS2L17	IoT Enterprise Networks Lab
Professional Elective-II		***Professional Elective-II Lab***	
18MS2T08	Cloud Computing	18MS2L08	Cloud Computing Lab
18MS2T09	Distributed Database Systems	18MS2L09	Distributed Database Systems Lab
18MS2T10	Cryptography & Security	18MS2L10	Cryptography & Security Lab

Semester II									
Type	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY									
PC	18MS1T07	Advanced Algorithms	3	0	0	3	0	0
PC	18MS1T08	Soft Computing	3	0	0	3	0	0
PE	18MS2T**	Professional Elective-III	3	0	0	3	0	0
PE	18MS2T**	Professional Elective-IV	3	0	0	3	0	0
AC	18MS8T11	English for Research Paper Writing	2	0	0	0	0	0
PRACTICAL									
PC	18MS1L03	Advanced Algorithms & Soft Computing Lab	0	0	4	0	0	2
PE	18MS2L**	Professional Elective-III Lab	0	0	2	0	0	1
PE	18MS2L**	Professional Elective-IV Lab	0	0	2	0	0	1
PJ	18MS6L05	Mini Project & Seminar	0	0	4	0	0	2
		SUB-TOTAL	**14**	**0**	**12**	**12**	**0**	**6**
		TOTAL	**26**			**18**		

List of Electives

Code (T)	Elective # and Subjects	Code (L)	Labs of Elective Subjects
Professional Elective-III		***Professional Elective-III Lab***	
18MS2T03	Machine Learning	18MS2L03	Machine Learning Lab
18MS2T14	Secure Software Design & Enterprise Computing	18MS2L14	Secure Software Design & Enterprise Computing Lab
18MS2T15	Advanced Wireless & Mobile Networks	18MS2L15	Advanced Wireless & Mobile Networks Lab
Professional Elective-IV		***Professional Elective-IV Lab***	
18MS2T05	Intelligent Systems	18MS2L05	Intelligent Systems Lab
18MS2T18	High Performance Computing	18MS2L18	High Performance Computing Lab
18MS2T19	Digital Forensics	18MS2L19	Digital Forensics Lab

Type	Code	Mathematical Foundations for CS	L-T-P	Credits	Marks
PC	18MS1T01		3-0-0	3	100

Objectives	The objective of this course is to impart knowledge to the students in Linear Algebra, Probability theory and Graph theory to build the necessary mathematical foundation required for other Computer Science subjects.
Pre-Requisites	Knowledge of set theory and matrix algebra is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Vector Spaces, subspaces, linear independence, basis, dimension, linear transformation, perpendicular vectors and orthogonal subspaces, innerproduct and projection, least square approximation, orthogonal basis.	**10 Hours**
Module-2	Eigen vectors and Eigen values, Hermitian, skew Hermitian and unitary matrices, digitalization of a matrix.	**6 Hours**
Module-3	Positive definite matrices, singular value decomposition and pseudo inverse of a matrix.	**6 Hours**
Module-4	Basics of Graphs (vertex, degree, paths, cycles, Euler and Hamiltonian Circuits), Trees, spanning trees, Matching, Maximum matching, Min-Max Theorems.	**12 Hours**
Module-5	Independent sets and covers; cuts and maximum flow, planarity and coloring.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. G. Strang, ***Linear Algebra and Applications***, 4th Edition, Wellesley Cambridge Press, 2005.
T2. D. B. West, ***Introduction to Graph Theory***, 2nd Edition, Pearson Education, 2001.

Reference Books:

R1. B. N. Datta, ***Numerical Linear Algebra and Applications***, 2nd Edition, PHI Learning, 2010.
R2. J. W. Demmel, ***Applied Numerical Linear Algebra***, 1st Edition, University Press, 2017.
R3. G. Chartrand and P. Zahang, ***Introduction to Graph Theory***, McGraw-Hill Education, 2017.

Online Resources:

1. https://www.khanacademy.org/math/linear-algebra
2. http://discrete.openmathbooks.org/dmoi2/ch_graphtheory.html

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand projection in a linear space and to apply the concepts to different approximation problems.
CO2	Obtain the singular value decomposition of a matrix and apply the same to obtain the minimum distance solution.
CO3	Apply singular value decomposition to obtain the pseudo inverse of a matrix.
CO4	Understand the concepts of matching & cover in graphs used for optimization problems.
CO5	Optimize network flow using graph theory models.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1		1					1	2	1	3
CO2	2	2	2		1					1	2	1	3
CO3	2	2	2		2					2	2	1	1
CO4	2	2	2		2					2	3	1	3
CO5	2	2	2		2					2	2	1	3

Type	Code	Advanced Data Structures & Algorithms	L-T-P	Credits	Marks
PC	18MS1T02		3-0-0	3	100

Objectives	The objective of this course is to familiarize students with advanced paradigms and data structure used to solve algorithmic problems. Students should also understand the necessary mathematical abstraction to solve problems. They should be able to come up with analysis of efficiency and proofs of correctness.
Pre-Requisites	Knowledge of UG level course in Data Structures and Algorithms are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	**9 Hours**
Module-2	Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists. Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees.	**9 Hours**
Module-3	Sorting: Lower Bound for sorting, Shellsort, Indirect Sorting, Count Sort, Bucket Sort and Radix Sort, External Sorting.	**8 Hours**
Module-4	Text Processing: String Operations, Brute-Force Pattern Matching, Boyer-Moore Algorithm, Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, Ukkonen's Algorithm for suffix tree construction, applications of Suffix Tree.	**9 Hours**
Module-5	Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.	**9 Hours**
	Total	**44 Hours**

Text Books:

T1. M. A. Weiss, ***Data Structures and Algorithm Analysis in C++***, 3rd Edition, Pearson, 2007.
T2. M. T. Goodrich and R. Tamassia, ***Algorithm Design and Applications***, 1st Edition, John Wiley, 2014.

Reference Books:

R1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, ***Introduction to Algorithms***, 3rd Edition, Prentice Hall India, 2010.
R2. J. Kleinberg and E. Tardos, ***Algorithm Design***, 1st Edition, Pearson, 2014.
R3. D. Gusfield, ***Algorithms on Strings, Trees, and Sequences***, 1st Edition, Kindle, 2005.

Online Resources:

1. https://www.tutorialspoint.com/data_structures_algorithms/index.htm
2. https://www.geeksforgeeks.org/category/advanced-data-structure

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the implementation of dictionaries and apply various hashing techniques in real life applications.
CO2	Analyse and compare various operations of Skip Lists, Red-Black Trees, B-trees and Splay trees.
CO3	Compare various comparison and non-comparison based sorting techniques.
CO4	Apply text processing data structures and algorithms in real life applications and compare various pattern matching algorithms.
CO5	Identify suitable data structures and develop algorithms for computational geometry problems.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	1	2					1	3	3	3
CO2	3	2	2	1	1					1	3	2	3
CO3	3	2	2	1	1					1	3	1	2
CO4	3	3	2	1	1					1	3	2	2
CO5	3	2	2	1	3					1	3	3	2

Type	Code	Statistical Inference	L-T-P	Credits	Marks
PE	18MS2T07		3-0-0	3	100

Objectives	The objective of this course is to learn statistical techniques to analyse samples of data from a population and infer meaningful information out of that.
Pre-Requisites	Knowledge of probability, basic statistics, and optimization are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Normal Distribution and Distributions Derived from it: Normal distribution, multidimensional normal distribution, χ^2, t, and F distribution, The sample Mean and the Sample Variance, Survey Sampling: Population parameters, Sample random Sampling - The Expectation and variance of the Sample Mean, Estimation of the Population Variance, The Normal Approximation to the Sampling Distribution of $\bar{\chi}$, Estimation of a Ratio.	**9 Hours**
Module-2	Estimation of Parameters and Fitting of Probability Distributions: Fitting the Poisson Distribution to Emissions of Alpha Particles, Parameter Estimation, The Method of Moments, The Method of Maximum Likelihood, Maximum Likelihood Estimates of Multinomial Cell Probabilities, Large sample theory for maximum likelihood estimates, Confidence intervals from Maximum likelihood estimates, The Bayesian Approach to Parameter Estimation – Further Remarks on priors, Large Sample Normal Approximation to the Posterior, computational Aspects, Efficiency and the Camer-Rao Lower Bound- An Example- The Negative Bionomial Distribution, Sufficiency – A factorization Theorem, The Rao-Blackwell Theorem.	**10 Hours**
Module-3	Testing Hypotheses and Assessing goodness of Fit : Introduction, The Neyman-Person Paradigm- Specification of the Significance Level and the concept of a p-value, The Null Hypothesis, Uniformly Most Powerful Tests, The Duality of Confidence Intervals and Hypothesis Tests, Generalized Likelihood Ratio Test, Likelihood Ratio tests for the Multinomial Distribution, Probability Plots, Tests for Normality. Summarizing Data : Comparison of Location Estimates, Estimating Variability of Location Estimates by the Bootstrap, Measures of Dispersion, Boxplots, Exploring Relationship with Scatterplots.	**9 Hours**

Cont'd...

Module-#	Topics	Hours
Module-4	Comparing Two Samples : Introduction, comparing two independent samples - Methods Based on the Normal Distribution, Power, A Nonparametric Method-the Mann Whitney Test, Bayesian Approach, Comparing Paired Samples, Methods Based on the Normal Distribution, A Nonparametric Method-The Signed Rank Test, An Example-Measuring Mercury Levels in Fish, Experimental Design – Mammary Artery Ligation, The Placebo Effect, The Lanarkshire Milk Experiment, The Portacaval Shunt, FD & C Red No. 40, Further Remarks on Randomization, Observational Studies, Confounding and Bias in Graduate Admission, Fishing Expeditions. The Analysis of Variance: Introduction, The One-Way Layout- Normal Theory: the F Test, The Problem of Multiple Comparisons, a Nonparametric Method-The Kruskal Wallis Test, The Two-Way Layout- Additive Parameterization, Normal theory for the Two-Way Layout, Randomized Block Designs, A Nonparametric Method-Friedman's Test.	**10 Hours**
Module-5	The Analysis of Categorical Data: Introduction, Fisher's Exact Test, The Chi-square Test of Homogeneity, The Chi-square Test of Independence, Matched Pairs Designs, Odds Ratios, Linear Least Square: Introduction, Simple Linear Regression – Statistical Properties of the Estimated Slope and Intercept, Accessing the Fit, Correlation and Regression.	**7 Hours**
	Total	**45 Hours**

Text Books:

T1. J. A. Rice, ***Mathematical Statistics and Data Analytics***, 3rd Edition, Thomson, 2006.

Reference Books:

R1. L. Wasserman, ***All of Statistics***, 1st Edition, Springer, 2004.

Online Resources:

1. https://www.coursera.org/learn/statistical-inference: Statistical inference course by Brian Caffo, PhD, Professor, Biostatistics, Johns Hopkins University.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Use the normal distribution and distributions derived from it.
CO2	Estimate the parameters of probability distributions using maximum likelihood and Bayesian approach.
CO3	Develop understanding of Testing Hypotheses and use it for examining the validity of inferences obtained from computational models.
CO4	Develop understanding of Comparing of Two Samples and analysis of variance and use them for computing the performance of different models.
CO5	Analyze categorical data and linear regression along with statistical signification of the coefficient in the regression equation.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.

Cont'd...

PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	1					2	3	2	2
CO2	3	3	2	2	1					2	3	2	2
CO3	3	3	2	2	1					2	3	2	2
CO4	3	3	2	2	1					2	3	3	2
CO5	3	3	2	2	1					2	2	3	2

Type	Code	Wireless Sensor Networks	L-T-P	Credits	Marks
PE	18MS2T04		3-0-0	3	100

Objectives	The objective of this course is to offer an overview of the unique design challenges presented by wireless sensor networks, and a practical introduction to wireless sensor network programming at various levels.
Pre-Requisites	Knowledge of computer networks and wireless communication are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction and overview of wireless sensor networks, basic overview of the technology, applications and motivation of wireless sensor networks; Taxonomy of wireless sensor network technology, traditional layered stack, cross-layer designs, sensor network architecture.	**8 Hours**
Module-2	Sensor node technology: Hardware and software, wireless network trends, wireless transmission technology and systems, radio technology primer, available wireless technologies; Medium Access Control protocols for WSNs: Fundamentals of MAC Protocols, Sensor-MAC, Case study, IEEE 802.15.4 LR-WPANs Standard, Case study, MAC protocols analysis using Markov Chain.	**10 Hours**
Module-3	Routing protocols for wireless sensor networks, data dissemination and gathering, routing challenges and design issues in wireless sensor networks, routing strategies in wireless sensor networks, transport control protocols for wireless sensor networks, transport protocol design Issues, Resource aware routing, data-centric, geographic routing, opportunistic routing.	**10 Hours**
Module-4	Wireless sensor networks middleware: Principles, middleware architecture, existing middleware, network management for wireless sensor networks, network management requirements, traditional network management models, network management design issues, Security issues of wireless sensor networks, possible attacks, countermeasures, Static and dynamic key distribution.	**8 Hours**
Module-5	Operating systems for WSN: Operating system design issues, examples of operating systems, TinyOS, Mate, MagnetOS, MANTIS, OSPM,EYES OS, SenOS, EMERALDS, PicOS.	**8 Hours**
	Total	**44 Hours**

Text Books:

T1. W. Dargie and C. Poellabauer, ***Fundamentals of Wireless Sensor Networks: Theory and Practice***, 1st Edition, Wiley, 2010.

T2. K. Sohraby, D. Minoli, and T. Znati, ***Wireless Sensor Networks: Technology, Protocols, and Applications***, 1st Edition, Wiley Interscience, 2007.

Reference Books:

R1. T. Hara, V. I. Zadorozhny, and E. Buchmann, ***Wireless Sensor Network: Technologies for the Information Explosion Era***, 1st Edition, Springer, 2010.
R2. B. Krishnamachari, ***Networking Wireless Sensors***, 1st Edition, Cambridge University Press, 2005.

Online Resources:

1. http://nptel.ac.in/courses/114106035/37: Introduction to wireless sensor networks
2. http://www.csd.uoc.gr/~hy539/lectures/20140408_hy439_sensor_nets_part1.pdf: Introduction to wireless sensor networks, networking aspects
3. https://onlinelibrary.wiley.com/doi/book/10.1002/0470095121: Protocols and Architectures for Wireless Sensor Networks

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Explore the different types of wireless networks with architecture and its supporting protocols.
CO2	Investigate the hardware, software for wireless sensor network and MAC layer protocols to address media accessing.
CO3	Analyze the Network & Transport layer protocols to address issues like addressing, route optimization, handover, and reliability in wireless networks.
CO4	Identify challenges and latest research results in wireless sensor networks in relation to industrial and societal aspects.
CO5	Classify Operating systems for wireless sensor networks and design.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1								3	1	
CO2	2	3	2				1				2	2	2
CO3	2	3	2	2			2				2	1	3
CO4	2	2	3	2			3			2	2		3
CO5	1	1	1							2	3	1	

Type	Code	IoT Enterprise Networks	L-T-P	Credits	Marks
PE	18MS2T17		3-0-0	3	100

Objectives	The objectives of this course are to learn the latest microcontrollers with application development, envisage product ideas for the future of various devices connected to the Internet, analyze data from various sources in real-time and take necessary actions in an intelligent fashion.
Pre-Requisites	Basic knowledge of computer networks, sensor networks, micro-processor and micro-conrollers are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on designing for IoT & real-life applications.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Overview of IoT: Definition, evolution, IoT architectures- SOA-based architecture, API-oriented architecture, IoT data management and analytics, communication protocols, IoT applications, security aspects.	**9 Hours**
Module-2	Physical Design of IoT: Things in IoT, IoT protocols, logical design of IoT- functional blocks, communication models, communication APIs, enabling technologies- wireless sensor networks, communication protocols, embedded systems, IoT levels & deployment templates.	**8 Hours**
Module-3	Resource Management in IoT: Clustering, Synchronisation and Software Agents, data synchronisation, clustering for scalability, clustering principles in IoT architecture, software agents for object representation, data synchronization; Autonomy and Agility in Collaborative Production Environments: Fundamental concepts of agility and autonomy, enabling autonomy and agility by IoT.	**9 Hours**
Module-4	Web of Things: Web of Things vs. Internet of Things- architecture standardization for WoT platform, middleware for WoT, WoT portals and business intelligence; Cloud of Things: Grid/SOA and cloud computing-cloud standards, Cloud of Things architecture; Development of schemes for the applications of IoT in real-time scenarios; design of business intelligence and information security for WoT.	**9 Hours**
Module-5	Case Studies: Applied Internet of Things, Internet of vehicles and applications, cloud based smart facilities management with various case studies.	**8 Hours**
	Total	**43 Hours**

Text Books:

T1. R. Buyya and A. V. Dastjerdi, ***Internet of Things Principle and Paradigms***, Elsevier, 2016.
T2. A. Bahga and V. Audisetti, ***Internet of Things - A Hands on Approach***, University Press, 2014.
T3. D. Uckelmann, M. Harrison, and F. Michahelles, ***Architecting the Internet of Things***, Springer, 2014.

Reference Books:

R1. J. Holler, V. Tsiatsis, C. Mulligan, S. Karnouskos, S. Avesand, and D. Boyle, ***From Machine-to-Machine to the Internet of Things***, 1st Edition, Elsevier, 2014.
R2. F. DaCoasta, ***Rethinking the Internet of Things: A Scalable Approach to Connecting Everyone***, Apress, 2013.

Online Resources:

1. https://iot-analytics.com/: Online repository for IoT analytics topics.
2. http://www.steves-internet-guide.com/internet-of-things/: IoT fundamentals for beginners.
3. https://www.ibm.com/internet-of-things: IBM Watson IoT platform

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the vision of IoT from a global context.
CO2	Determine the Market perspective of IoT.
CO3	Develop systems using the devices, gateways with data management for IoT.
CO4	Gain insight to and build systems using state of the art architectures for IoT.
CO5	Apply IoT in industrial and commercial automation with real-world design constraints.

Program Outcomes Relevant to the Course:

PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1			3	3	1					1	2	2	1
CO2				2	2					1	2	2	3
CO3			3	3	2					1	3	3	2
CO4			3	2						1	3	3	3
CO5			3	3	1					2	2	3	3

Type	Code	Cloud Computing	L-T-P	Credits	Marks
PE	18MS2T08		3-0-0	3	100

Objectives	The objective of this course is to introduce the students to fundamental concepts of cloud computing, its architecture, different models, privacy and security provisioning issues and methods, auditing and performance analysis of different application specific models deployed in a cloud.
Pre-Requisites	Knowledge of computer networks, client-server concepts, and server side programming are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Overview of Computing Paradigm: P2P, Grid, Cluster, Distributed, Utility, and Cloud Computing; Evolution of computing, adopting cloud computing in business; Introduction to cloud computing: NIST Model, properties, characteristics, benefits, role of open standards.	**9 Hours**
Module-2	Cloud Computing Architecture: The cloud computing stack (Client/Server, Protocols, Web services), Service Models (XaaS): IaaS, PaaS, SaaS; Deployment Models: Public, Private, Hybrid, Community; Platform as a Service: Overview of PaaS, Service Oriented Architecture (SOA); cloud platform and management, computation and storage; Case Study: Google App Engine, Microsoft Azure, SalesForce.com - platform and use for public.	**9 Hours**
Module-3	Infrastructure as a Service: IaaS definition, Introduction to Virtualization, Hypervisors, Machine Image, Virtual Machine; Resource Virtualization of server, storage, network; Case Study: Amazon EC2- Renting, EC2 Compute Unit, platforms and storage, pricing, Customer Service Provisioning; Eucalyptus.	**9 Hours**
Module-4	Software as a Service: Introduction to SaaS, Web services, Web 2.0, Web OS, Case Study on SaaS; Service Management: Service Level Agreements, Billing & Accounting, Comparing Scaling Hardware- Traditional vs. Cloud, Economics of Scaling, Managing Data- Database & Data Stores in Cloud, large scale data processing.	**9 Hours**
Module-5	Cloud Security: Infrastructure Security, Network level, Host level, Application Level, Data Security, Identity and Access Management, Access Control, Trust, Reputation, Risk; Authentication: Client access in Cloud, Cloud contracting model, commercial and business considerations, Service level maintenance in Infrastructure, Network, Host and Application; Case Study: Eucalyptus, Microsoft Azure, Amazon EC2.	**9 Hours**
	Total	**44 Hours**

Text Books:

T1. R. Buyya, J. Broberg, and A. Goscinski, ***Cloud Computing: Principles and Paradigms***, 2nd Edition, Wiley, 2011.
T2. G. Shroff, ***Enterprise Cloud Computing - Technology, Architecture, Applications***, University Press, 2010.
T3. R. L. Krutz and R. D. Vines, ***Cloud Security: A Comprehensive Guide to Secure Cloud Computing***, Wiley-India, 2010.

Reference Books:

R1. B. Sosinsky, ***Cloud Computing Bible***, Wiley-India, 2010.
R2. N. Antonopoulos and J. Gilam, ***Cloud Computing: Principles, Systems and Applications***, Springer, 2012.
R3. T. Mather, S. Kumaraswamy, and S. Latif, ***Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance***, 1st Edition, O'Reilly Media, 2009.
R4. A. T. Velte, T. J. Velte, and R. Elsenpeter, ***Cloud Computing: A Practical Approach***, Tata McGraw-Hill, 2010.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc17_cs23/preview: by Prof. S. K. Ghosh, IIT Kharagpur.
2. https://www.coursera.org/learn/cloud-computing: Prof. I. Gupta, Dept. of CS, University of Illinois at Urbana-Champaign.
3. http://web.mit.edu/6.897/www/readings.html: by Prof. H. Balakrishnan, MIT.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Learn different types of computing paradigms, differentiate between them, acquire knowledge on cloud standards and their various application areas.
CO2	Visualise cloud computing architecture, service models, deployment models, service platforms with respect to computation and storage.
CO3	Get an insight about virtualization of machine, resources, servers, storage, Network, with a case study of Amazon EC2, pricing model, service provisioning.
CO4	Acquire knowledge on Software as a Service, service level agreement, how to manage data, large scale processing in cloud environment.
CO5	Understand infrastructure, network, host, application, data, identity level security in cloud computing security models and commercial & business reliability models from different case studies of popular cloud service providers.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO10	Continue to learn independently and engage in life-long learning.

P.T.O

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3				1	1		1		1	1
CO2	3	2	3	1			1	1		1		2	1
CO3	3	3	3	2			3	2		1	1		1
CO4	3	3	3	3			3	3		1	1	1	1
CO5	3	2	3	3			3	2		3	1	1	2

Type	Code	Distributed Database Systems	L-T-P	Credits	Marks
PE	18MS2T09		3-0-0	3	100

Objectives	The objective of this course is to introduce the fundamental concepts and issues of managing large volume of shared data in a parallel and distributed environment, and to provide insight into related research problems.
Pre-Requisites	Knowledge of database management systems is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Distributed data processing, What is a DDBS, Advantages and disadvantages, Problem areas, Overview of database and computer network concepts, DDBMS Architecture, Transparencies in a DDBMS; Global directory issues.	**8 Hours**
Module-2	Distributed Database Design: Alternative design strategies, distributed design issues, fragmentation, data allocation; Semantics Data Control: View management, Data security, Semantic Integrity Control; Query Processing Issues: Objectives of query processing, characterization of query processors, layers of query processing, query decomposition, localization of distributed data.	**10 Hours**
Module-3	Distributed Query Optimization: Factors governing query optimization, centralized query optimization, ordering of fragment queries, distributed query optimization algorithms; Transaction Management: Concept & goals, characteristics of transactions, taxonomy of transaction models; Concurrency Control: Concurrency control in centralized database systems, concurrency control in DDBSs, distributed concurrency control algorithms, deadlock management.	**10 Hours**
Module-4	Reliability: Reliability issues in DDBSs, types of failures, reliability techniques, commit protocols, recovery protocols.	**8 Hours**
Module-5	Parallel Database Systems: Parallel architectures, parallel query processing and optimization, load balancing; Advanced Topics: Mobile databases, distributed object management, multi-databases.	**9 Hours**
	Total	**45 Hours**

Text Books:

T1. S. Ceri and G. Pelagatti, ***Distributed Databases: Principles and Systems***, 2nd Edition, McGraw-Hill Computer Science Series, 2008.

Reference Books:

R1. M. T. Ozsu and P. Valduriez, ***Principles of Distributed Database Systems***, Prentice-Hall, 1991.
R2. D. Bell and J. Grimson, ***Distributed Database Systems***, Addison-Wesley, 1992.

Online Resources:

1. https://www.tutorialspoint.com/distributed_dbms
2. https://www.tutorialride.com/distributed-databases/distributed-databases-tutorial.htm

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand distributed database management system and its components.
CO2	Analyze how database implementation is affected by different levels of data and process distribution.
CO3	Apply transaction management principles in a distributed environment.
CO4	Understand the importance of reliability and recovery from failures.
CO5	Identify the effect of distributed database environment on database design.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	1	1		1					1	2	3	3
CO2	1	2	1	1	2					1	2	2	3
CO3	2	1	1	2	1					1	2	3	3
CO4	1	1	2		1					1	3	2	2
CO5	1	1	3	2	1					3	1	1	2

Type	Code	Cryptography & Security	L-T-P	Credits	Marks
PE	18MS2T10		3-0-0	3	100

Objectives	The objective of this course is to introduce the concept of security, types of attacks, encryption and authentication techniques and their application to OS security, Network Security and Web security.
Pre-Requisites	Knowledge of linear algebra, algorithms, programming, databases, computer networks, and general web technologies are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Security: Need for security, Security approaches, Principles of Security, Types of attacks; Encryption Techniques: Plaintext, Cipher text, Substitution & Transposition Techniques, Encryption & Decryption, Key range & Size.	**8 Hours**
Module-2	Symmetric Key Cryptography: Algorithm types & modes, AES and its analysis, differential & linear cryptanalysis; Asymmetric Key Cryptography: Trapdoor one way function, RSA and its analysis, Elliptic Curve Arithmetic, ECC operations, applications of ECC in asymmetric key cryptography.	**10 Hours**
Module-3	Cryptographic Hash Functions: Random oracle model, SHA-512, MD5, Pseudo-random number generation using Hash function; Message Authentication Code: HMAC, digital signature; User Authentication Mechanism: Authentication basics, passwords, authentication tokens, certificate based & biometric authentication.	**9 Hours**
Module-4	Network and Web Security: Network security attacks, Denial of Service, Distributed Denial of Service (Botnet), Intrusion Detection & Prevention Systems, Firewall, browser attacks, obtaining user or website data, web attack targeting users, E-mail attacks and security.	**9 Hours**
Module-5	Operating System and Database Security: Security in operating systems, security in designing the operating system, buffer overflow attacks, Rootkits, Malwares, security requirements of database, database security, reliability and integrity.	**9 Hours**
	Total	**45 Hours**

Text Books:

T1. D. R. Stinson, ***Cryptography: Theory and Practice***, 3rd Edition, CRC press, 2005.
T2. C. P. Pfleeger, S. L. Pfleeger, and J. Margulies, ***Security in Computing***, 5th Edition, PHI, 2015.

Reference Books:

R1. W. Stallings, ***Cryptography and Network Security: Principles and Practice***, 6th Edition, Pearson, 2014.

R2. B. A. Forouzan and D. Mukhopadhaya, ***Cryptography and Network Security***, 2nd Edition, McGraw-Hill, 2010.
R3. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, ***Handbook of Applied Cryptography***, 1st Edition, CRC press, 1996.
R4. B. Schneier, ***Applied Cryptography: Protocols, Algorithms, and Source Code in C***, 2nd Edition, Wiley, 2007.

Online Resources:
1. https://www.cs.bgu.ac.il/~dsec121/wiki.files/j21.pdf: A Survey of Web Security.
2. http://www.uky.edu/~dsianita/390/firewall1.pdf: Network Security - A Simple Guide to Firewalls.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the basics of security and issues related to encryption/decryption techniques.
CO2	Analyze the concepts of symmetric and asymmetric key cryptography with AES, RSA and ECC.
CO3	Apply cryptographic hash functions in authentication and digital signatures.
CO4	Analyze the security issues in computer network and web and their mitigation.
CO5	Investigate and mitigate the security vulnerabilities in operating system & database system.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	2						1	1		
CO2	3	2	2	2	2					1	3		2
CO3	3	3	2	2	2					1	2	1	2
CO4	1	2	3	2	2		2			1	3	1	2
CO5	1	2	3	2	2		2			2	2	1	3

Type	Code	Research Methodology & IPR	L-T-P	Credits	Marks
CC	18MS1T05		2-0-0	2	100

Objectives	The objective of this course is to introduce students to the principles and practices involved in conducting scientific research. The course is designed to cover three broad areas - The Scientific Method and Hypothesis Testing, Review of Literature and writing Technical Reports, and the elements of Intellectual Property Rights (IPR).
Pre-Requisites	Basic knowledge of probability & statistics will be helpful.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to research, its significance and meaning; Types of research - fundamental, pure, theoretical, applied and experimental; Identification of the research problem and formulation of hypothesis; Research design and errors in research, error analysis; The Scientific Method as the established way of doing research; Data collection, measurement and scaling techniques.	**8 Hours**
Module-2	Meaning and need for hypothesis, types of hypothesis, functions and characteristics of a good hypothesis; Statistical Testing of Hypothesis - T-test, Chi-squared test; Sampling methods, types of sampling, probability and non-probability sampling; One-sample and Two-sample tests. Correlation and Regression analysis.	**8 Hours**
Module-3	Literature - types and review; Literature survey using the web, search engines; Journal, report and thesis writing; Types of reports, structure of the research report and presentation of results.	**8 Hours**
Module-4	Code of ethics in research - Intellectual Property Rights; Details of Patents, Copyrights, Trademarks and Trade Secrets.	**6 Hours**
	Total	**30 Hours**

Text Books:

T1. C. R. Kothari & G. Garg, ***Research Methodology: Methods and Techniques***, 2nd Edition, New Age International Publishers, 2004.
T2. D. Chawla & N.Sodhi, ***Research Methodology: Concepts and Cases***, 2nd Edition, Vikas Publishing, 2016.

Reference Books:

R1. E. L. Lehman & J. P. Romano, ***Testing Statistical Hypothesis***, 3rd Edition, Springer, 2008.
R2. R. Panneerselvam, ***Research Methodology***, 2nd Edition, Prentice Hall India, 2013.

P.T.O

Online Resources:

1. http://nptel.ac.in/courses/107108011: NPTEL Course.
2. https://ocw.mit.edu/courses/sloan-school-of-management/15-347-doctoral-seminar-in-research-methods-i-fall-2004/readings/: MIT Open Courseware (MIT-OCW).

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Disseminate the scientific method as a structured way of conducing scientific research.
CO2	Apply statistical principles for conducting hypothesis testing.
CO3	Conduct effective review of literature and write technical reports.
CO4	Acquire knowledge of the various intellectual property rights.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	1	1					1	1	1	2
CO2	2	2	1	1	1					1		1	1
CO3					3				2	1		1	2
CO4								3		1		1	2

Type	Code	Stress Management by Yoga	L-T-P	Credits	Marks
AC	18MS8T06		2-0-0	0	100

Objectives	To impart skills in students for control of mind, body and soul, enhance self-awareness, improve self-awareness, focus, and concentration, bring together physical and mental wellness, manage stress and anxiety, achieve perfect equilibrium and harmony, and promote self-healing.
Pre-Requisites	There are no pre-requisites for this course.
Teaching Scheme	Regular practice classes conducted under supervision of the qualified Yoga teacher with necessary explanation and demonstration for each session.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Yoga, Pranayama, Mudra, Bandha and Chakra.	**6 Hours**
Module-2	Pawanmuktasana Part 1, various Asanas in standing posture.	**6 Hours**
Module-3	Surya Namaskar set and its benefits.	**6 Hours**
Module-4	Various Asanas in sitting posture.	**6 Hours**
Module-5	Asanas in sleeping posture and various relaxation Asanas.	**6 Hours**
	Total	**30 Hours**

Text Books:

T1. E. F. Bryant, ***The Yoga Sutras of Patanjali***, 1st Edition, North Point Press, 2009.

Reference Books:

R1. Swami Satyananda Saraswati, ***Asana Pranayama Mudra Bandha***, 4th Edition, Yoga Publication Trust, Munger (Bihar), India, 2008.

Online Resources: *There are a number of online resources available for this subject. The student is advised to search on the Internet and locate the required study materials as per advise of the teacher.*

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Promote positive health, prevent stress related health problems and rehabilitation through Yoga.
CO2	Achieve integral approach of Yoga Therapy to common ailments.
CO3	Develop skills to adopt Yoga practices for health and general well-being.
CO4	Develop of overall personality through control of body, mind and soul.
CO5	Enhance scientific attitude and team spirit for creative and constructive endeavors.

P.T.O

Program Outcomes Relevant to the Course:

PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						1			3	2		2	1
CO2										3		1	1
CO3						2			3	3		2	2
CO4									3	3	1	2	2
CO5						2			2	3	1	2	3

Type	Code	Advanced Data Structures & Algorithms Lab	L-T-P	Credits	Marks
PC	18MS1L01		0-0-4	2	100

Objectives	The objective of this course is to implement advanced data structures such as Dictionary, Skip List, Red Black Trees, Suffix Trees, Tries and various algorithms related to Sorting, Text Processing and Computational Geometry.
Pre-Requisites	Knowledge of UG level Data Structures and Algorithms with proficiency in any one programming language such as C, C++, Java etc., are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1, 2	Insertion Sort, Quick Sort, Merge Sort
3	Heap Sort
4, 5	Binary Search Tree
6	Dictionary Abstract Data Type
7, 8	Hashing
9, 10	Skip Lists
11, 12	Red Black Tree
13, 14	B-Tree, Splay Tree
15, 16	Shell Sort, Bucket Sort
17, 18	Count Sort, Radix Sort
19, 20	Brute-Force Pattern Matching, Boyer-Moore Algorithm
21, 22	Knuth-Morris-Pratt Algorithm
23	Construction of Suffix Tries
24, 25	One Dimensional Range Searching, Two Dimensional Range Searching
26, 27	Priority Search Tree and Priority Range Trees
28	Quad Trees and k-D Trees

Text Books:

T1. M. A. Weiss, ***Data Structures and Algorithm Analysis in C++***, 3rd Edition, Pearson, 2007.
T2. M. T. Goodrich and R. Tamassia, ***Algorithm Design and Applications***, 1st Edition, John Wiley, 2014.

Reference Books:

R1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, ***Introduction to Algorithms***, 3rd Edition, Prentice Hall India, 2010.
R2. J. Kleinberg and E. Tardos, ***Algorithm Design***, 1st Edition, Pearson, 2014.
R3. D. Gusfield, ***Algorithms on Strings, Trees, and Sequences***, 1st Edition, Kindle, 2005.

Online Resources:

1. https://www.tutorialspoint.com/data_structures_algorithms/index.htm
2. https://www.geeksforgeeks.org/category/advanced-data-structure

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Develop computer programs to implement various advanced data structures like Dictionary, Skip List, Red Black Trees, Tries etc.
CO2	Compare various comparison and non-comparison based sorting algorithms by implementing them.
CO3	Implement the general operation in various types of trees like BST, B Tree, Red Black Tree, Splay Tree etc.
CO4	Develop applications related to text processing using various pattern matching algorithms.
CO5	Apply suitable data structures and algorithms to develop applications of computational geometry Problems.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	1	2					1	3	3	3
CO2	3	2	2	1	1					1	3	2	3
CO3	3	2	2	1	1					1	3	1	2
CO4	3	3	2	1	1					1	3	2	2
CO5	3	2	2	1	3					1	3	3	2

Type	Code	Statistical Inference Lab	L-T-P	Credits	Marks
PE	18MS2L07		0-0-2	1	100

Objectives	The objective of this course is to give the students hands-on exposure to analyze the given sample data for inferring meaningful information for whole population.
Pre-Requisites	Knowledge of Statistics, Numerical analysis, and basic programming skills in a programming language like C/C++/Java/MATLAB etc., are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1, 2	Introduction to R Programming and writing simple programs using R.
3, 4	Fitting data (one or more dimensions) using different distribution and visualizing.
5	Parameter estimation using maximum likelihood method.
6	Parameter estimation using Bayesian approach.
7, 8	Formulation of null hypothesis, computation of confidence interval and p-value.
9	Likelihood ratio test for multinomial distribution and obtaining probability plots.
10	Drawing boxplots, scatterplots, etc., and estimating measures of central tendency and dispersion.
11	Comparing two samples of data sets using various techniques.
12	Use of F-test and analysis of variance for multiple comparisons.
13	Analysis of categorical data using Fisher's test.
14	Fitting of data set to linear regression and interpret the coefficients.

Text Books:

T1. J. A. Rice, ***Mathematical Statistics and Data Analytics***, 3rd Edition, Cengage, 2013.

Reference Books:

R1. N. Matloff, ***The Art of R Programming - A Tour of Statistical Software Design***, 1st Edition, No Starch Press, 2011.
R2. L. Wasserman, ***All of Statistics***, 1st Edition, Springer, 2004.

Online Resources:

1. https://www.coursera.org/learn/statistical-inference: Statistical inference course by Brian Caffo, PhD, Professor, Biostatistics, Johns Hopkins University.

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Study and use the normal distribution and distributions derived from it.
CO2	Estimate the parameters of probability distributions using maximum likelihood and Bayesian approach.
CO3	Develop understanding of Testing Hypotheses and use it for examining the validity of inferences obtained from computational models.
CO4	Develop understanding of Comparing of Two Samples and analysis of variance and use them for computing the performance of different models.
CO5	Learn methodology to analyze categorical data and linear regression along with statistical signification of the coefficient in the regression equation.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	1					2	2	3	2
CO2	2	2	2	2	1					2	3	3	1
CO3	3	3	2	2	1					2	2	3	2
CO4	3	3	2	2	1					2	2	3	2
CO5	3	3	2	2	1					2	2	3	1

Type	Code	Wireless Sensor Networks Lab	L-T-P	Credits	Marks
PE	18MS2L04		0-0-2	1	100

Objectives	The objective of this course are to enable the students to apply the concepts and protocols of wireless sensor networks, differentiate between the underlying designs, implement and evaluate existing techniques and experiment with new ideas for solving various design issues.
Pre-Requisites	Knowledge of shell scripts, computer networks, wireless communication, and proficiency in programming are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Implementation aspects of Wireless sensor network applications and its simulation.
2	Network Simulator installation of wireless sensor network.
3	Write TCL script for transmission between mobile nodes.
4	Write TCL script for sensor nodes with different parameters.
5	Generate TCL script for UDP and CBR traffic in WSN nodes.
6	Generate TCL script for TCP and CBR traffic in WSN nodes.
7	Implementation of routing protocol in NS2 for AODV protocol.
8	Implementation of routing protocol in NS2 for DSR protocol
9	Implementation of routing protocol in NS2 for TORA protocol.
10	Simulation of MAC protocol in NS2 for T-MAC protocol.
11	Simulation of MAC Protocol in NS2 for S-MCA protocol.
12	Implementation of Energy Efficiency protocol in NS2 for LEACH protocol.
13	Implementation of Content routing protocol in NS2 for DD protocol.
14	Implementation of Content routing protocol in NS2 for SPIN protocol.

Text Books:

T1. P. Beltowski and W. Kocjan, ***Tcl 8.5 Network Programming***, 2nd Edition, Packt Publishing, 2010.
T2. K. Sohraby, D. Minoli, and T.Znati, ***Wireless Sensor Networks: Technology, Protocols, and Applications***, 1st Edition, Wiley Interscience, 2007.

Reference Books:

R1. T. Issariyakul and E.Hossain, ***Introduction to Network Simulator NS2***, 2nd Edition, Springer, 2012.
R2. I. F. Akyildiz and M. C. Vuran, ***Wireless Sensor Networks***, 1st Edition, John Wiley & Sons, 2010.

Online Resources:

1. http://www.crcpress.com/Wireless-Sensor-Networks-Current-Status-and-Future-Trends/author/p/book/9781138199873

2. http://www.wiziq.com/tutorials/ns2: Tutorials for Network Programming with NS2

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Implement the fundamental concepts of Wireless sensor networks and its application.
CO2	Analyze network using UDP and TCP protocols.
CO3	Implement and evaluate performance of routing protocols.
CO4	Analyze the performance of various MAC protocols.
CO5	Implement the various energy-conscious models.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2			2						2	2	
CO2	3	2	1	1	2		2				2	2	2
CO3	2	3	1	1	2		1				2	2	1
CO4	2	2	2	1	3		1				2		1
CO5	2	2	2	3	3		2				1	1	

Type	Code	IoT Enterprise Networks Lab	L-T-P	Credits	Marks
PE	18MS2L17		0-0-2	1	100

Objectives	The objective of this course is to give the students hands on practice on latest microcontrollers & IoT Kits with application development and implement real world project ideas with various devices connected.
Pre-Requisites	Knowledge of computer networks, sensor networks, microprocessor and microcontrollers, and proficiency in programming are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of hardware assembly and programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Quad Store(TM) - Super Starter Kit for Arduino Uno R3 (Beginner's Kit).
2	Quad Store(TM) - Ultimate Kit for Arduino Uno R3 (Professional Kit).
3	Quad Store(TM) - 37 in 1 Sensor Modules Kit for Arduino Uno R3, Mega 2560, Raspberry Pi with box.
4	HC-05 Wireless Bluetooth Host Serial Transceiver Module Slave and Master RS232 for Arduino.
5	NodeMcu WiFi Development Board - ESP8266.
6	4 Channel 5 V Relay Module with Optocoupler.
7	Complete Starter Kit for Raspberry Pi 3 Model B+, Official Case and PSU Included.
8	Amazon Echo Dot for Voice Control.
9	Sonoff Wifi Switch 10A 2200W For Home Automation Android & IOS Support. Smart Wifi Wireless Switch.
10	HTC Instrument DM-97 3 3/4 Digital Multimeter4000 Counts, Capacitance, Frequency, Temperature.
11	Amicikart 60W Soldering Iron Kit With Temperature Control Iron, Desoldering Pump, Soldering Wire, Tweezers, Stand And 5 Extra Bits.

Text Books:

T1. A. Bahga and V. Audisetti, ***Internet of Things: A Hands on Approach***, 1st Edition, University Press, 2015.

Reference Books:

R1. D. Uckelmann, M. Harrison, and F. Michahelles, ***Architecting the Internet of Things***, Springer, 2011.

Online Resources:

1. https://opensourceforu.com/2016/10/programming-raspberry-pi-with-python/: Raspberry Pi programming
2. https://www.arduino.cc/en/Tutorial/ArduinoToBreadboard: Arduino board programming

3. https://www.arduino.cc/en/Guide/ArduinoMega2560: Arduino Atmega programming

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the vision of IoT from a global context.
CO2	Determine the Market perspective of IoT.
CO3	Develop systems using the devices, gateways with data management for IoT.
CO4	Gain insight to and build systems using state of the art architectures for IoT.
CO5	Apply IoT in industrial and commercial automation with real-world design constraints.

Program Outcomes Relevant to the Course:

PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1			3	3	1					1	2	2	1
CO2				2	2					1	2	2	3
CO3			3	3	2					1	3	3	2
CO4			3	2						1	3	3	3
CO5			3	3	1					2	2	3	3

Type	Code	Cloud Computing Lab	L-T-P	Credits	Marks
PE	18MS2L08		0-0-2	1	100

Objectives	The objective of this course is to visualize cloud architecture, its functions & working principles, to create and execute virtual machines on open source OS platforms, install and investigate security features in the cloud, and implement different applications in the cloud environment with case studies.
Pre-Requisites	Knowledge of computer organization, data structure, Java programming, and Internet technologies are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Virtualization in Cloud by using KVM and VMware or Oracle's Virtual Box and Guest O.S.
2	Installation and Configuration of Hadoop.
3	Create an Application using Hadoop MapReduce. (Ex.: Similarity word count during searching).
4	Implementation of Infrastructure as a Service with OpenStack with the technology – Quanta Plus / Aptana / Kompozer.
5	Study and implement SaaS by installing of ownCloud (an Open source) and using it for accessing files through a web interface.
6	Implementation of identity management by simulating it by using OpenStack.
7	Write program for web feed by using PHP and HTML.
9	Study and implementation of Single-Sing-On by installing and using JOSSO.
9	Securing Servers in Cloud by using security feature of ownCloud.
10	User Management in Cloud with ownCloud.
11	Case study: PaaS (FaceBook, Google App Engine).
12	Case study on Amazon Web Services (AWS).
13	Case study on Microsoft Azure.
14	Project assignments based on real life problems by using open source cloud platforms.

Text Books:

T1. G. Shroff, ***Enterprise Cloud Computing***, 1st Edition, Cambridge University Press, 2010.
T2. R. Krutz and R. D. Vines, ***Cloud Security***, Wiley India, 2010.
T3. A. Patawar, ***Getting Started with ownCloud***, Packt Publishing Ltd, 2013.

P.T.O

Reference Books:

R1. A. T. Velte, T. J. Velte, and R. Elsenpeter, ***Cloud Computing: A Practical Approach***, 1st Edition, McGraw Hill, 2009.
R2. A. Srinivasan and J. Suresh, ***Cloud Computing: A Practical Approach for Learning and Implementation***, 1st Edition, Pearson, 2014.

Online Resources:

1. http://www.openstack.org: All materials related to OpenStack for private and public clouds.
2. https://owncloud.org: Open Source Content Collaboration Platform in the world

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Exhibit the implementation knowledge by installation, application and exploration of Oracle's Virtual Box, Hadoop, MapReduce etc.
CO2	Create various applications in Cloud Environment using Hadpoop MapReduce.
CO3	Implement IaaS and Identity using OpenStack and SaaS, user management by using the Open Source cloud platform ownCloud.
CO4	Explore the real-life cloud environment such as Microsoft Azure, AWS, JOSSO with HTML, PHP and server side programming.
CO5	Acquire overall knowledge on Cloud Computing, develop team spirit and can design and develop models for real-life societal problems through working in a project.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	3		2	1			1	2	2	1
CO2	2	2	3	3		2	2			1	1	3	1
CO3	3	3	3	3		2	2			2	1	2	1
CO4	3	2	3	3		2	2			2	3	2	2
CO5	3	3	3	3		3	3			2	1	3	3

Type	Code	Distributed Database Systems Lab	L-T-P	Credits	Marks
PE	18MS2L09		0-0-2	1	100

Objectives	The objective of this course is to enhance database handling, data manipulation and data processing skills in distributed environments through SQL & PL/SQL and help developing data-centric distributed applications.
Pre-Requisites	Knowledge of database systems is required and topics taught in the theory classes are essential to execute the assignments.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of implementation assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Designing a Distributed Database for Bookstore.
2	Implementation of Deadlock Detection Algorithm for distributed database using wait-for graph.
3, 4	Creating a Object Oriented Database – Extended Entity Relationship (EER) model.
5	Designing a Parallel Database for University Counseling of Engineering students.
6, 7	Implementation of Parallel Join and Parallel Sort over parallel databases.
8	Active Database – Implementation of Triggers and Assertions for Bank Database.
9,10	Deductive Database – Constructing Knowledge Database for Kinship Domain (Family Relations).
11	Study and Working of WEKA Tool.
12	Query Processing – Implementation of an Efficient Query Optimizer.

Text Books:

T1. I. Bayross, ***SQL, PL/SQL: The Programming Language of Oracle***, 4th Edition, BPB Publications, 2010.

Reference Books:

R1. B. Pribyl and S. Feuerstein, ***Oracle SQL PL/SQL Programming***, 6th Edition, O'Reilly Media, 2014.

Online Resources:

1. https://www.w3schools.com/sql/
2. https://www.tutorialspoint.com/sql/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Develop and write SQL queries for a distributed database.
CO2	Implement Deadlock Detection Algorithm for Distributed Database using Wait-for Graph to check for Deadlock.
CO3	Design an Enhanced Entity Relationship model and write Object Query Language (OQL) to manage the database.

Cont'd...

CO4	Implement parallel join and parallel sort algorithms.
CO5	Study and work with WEKA tool.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2							2	2	3	3
CO2		3	2		3					2	3	3	2
CO3	1	2					1			2	2	3	2
CO4	2	2	2							2	3	3	3
CO5		3	3		3					2	2	3	2

Type	Code	Cryptography & Security Lab	L-T-P	Credits	Marks
PE	18MS2L10		0-0-2	1	100

Objectives	The objective of the course is to give the students hands-on experience on implementing different ciphers (algorithms) and simulation of some cryptographic protocols. The laboratory experiments shall cover some of the topics covered in the theory classes.
Pre-Requisites	Good knowledge of C/C++ programming in Linux environment and topics taught in the theory classes are essential to execute the assignments.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Implementation of Caesar, Multiplicative, Affine ciphers.
2	Implementation of Playfair, Vigenere cipher.
3	Implementation of Hill ciphers.
4	Implementation of AES algorithms.
5	Implementation of RSA algorithms.
6	Implementation of ECC algorithms-I.
7	Implementation of ECC algorithms-II.
8	Implementation of Cryptographic Hash functions-I.
9	Implementation of Cryptographic Hash functions-II.
10	Implementation of Digital Signature Algorithm(DSA).
11	Implementation of Elliptic Curve Digital Signature Algorithm(ECDSA).
12	Demonstration of Security Attacks-I.
13	Demonstration of Security Attacks-II.
14	Demonstration of Security Attacks-III.

Text Books:

T1. D. R. Stinson, ***Cryptography: Theory and Practice***, 3rd Edition, CRC press, 2005.
T2. C. P. Pfleeger, S. L. Pfleeger, and J. Margulies, ***Security in Computing***, 5th Edition, PHI, 2015.

Reference Books:

R1. W. Stallings, ***Cryptography and Network Security: Principles and Practice***, 6th Edition, Pearson, 2014.
R2. B. A. Forouzan and D. Mukhopadhaya, ***Cryptography and Network Security***, 2nd Edition, McGraw-Hill, 2010.
R3. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, ***Handbook of Applied Cryptography***, 1st Edition, CRC press, 1996.
R4. B. Schneier, ***Applied Cryptography: Protocols, Algorithms, and Source Code in C***, 2nd Edition, Wiley, 2007.

Online Resources:

1. https://www.cs.bgu.ac.il/~dsec121/wiki.files/j21.pdf: A Survey of Web Security.
2. http://www.uky.edu/~dsianita/390/firewall1.pdf: Network Security - A Simple Guide to Firewalls.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Implement some traditional encryption/decryption techniques.
CO2	Simulate symmetric and asymmetric key algorithms like AES, RSA and ECC.
CO3	Generate message digest using cryptographic hash functions.
CO4	Implement digital signature schemes.
CO5	Demonstrate the simulation of various types of attacks.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2						1		
CO2	2	3	2	2	2						3		1
CO3	2	2	3	2	2						2	1	1
CO4	2	2	3	2	2						3	1	1
CO5	1	2	3	3	3		2				2	1	1

Type	Code	Advanced Algorithms	L-T-P	Credits	Marks
PC	18MS1T07		3-0-0	3	100

Objectives	The objective of this course is to introduce the advanced methods of designing and analyzing algorithms, paradigms and data structures used to solve different classes of problems, and recent developments in algorithms.
Pre-Requisites	Knowledge of data structures and algorithms are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Sorting: Review of various sorting algorithms. Graph: Definitions and elementary algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.	**8 Hours**
Module-2	Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path. Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson method to compute maximum flow, Edmond-Karp maximum-flow algorithm.	**10 Hours**
Module-3	Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer multiplication algorithm	**10 Hours**
Module-4	NP-completeness: Examples, proof of NP-hardness and NP-completeness. Approximation algorithms: Introduction, Greedy Approximation Algorithms. Dynamic Programming and Weakly Polynomial-Time Algorithms. Vertex cover, TSP.	**8 Hours**
Module-5	Parallel Algorithms: Introduction, Models, speedup and efficiency, Some basic techniques. Parallel algorithms and their parallel time and processors complexity. PRAM. Pointer Jumping and Parallel Prefix. Tree Contraction. Divide and Conquer. Randomized symmetry breaking. Maximal independent set.	**8 Hours**
	Total	**44 Hours**

Text Books:

T1. T. H. Cormenn, C. E. Leiserson, R.L. Rivest, and C. Stein, ***Introduction to Algorithms***, 3rd Edition, PHI, 2013.

T2. J. Kleinberg and E. Tardos, ***Algorithm Design***, 1st Edition, Pearson, 2005.
T3. M. J. Quinn, ***Designing Efficient Algorithms for Parallel Computer***, 1st Edition, McGraw-Hill, 1987.

Reference Books:

R1. A. V. Aho, J. E. Hopcroft, and J. D. Ullman, ***The Design and Analysis of Computer Algorithms***, 1st Edition, Addison-Wesley, 1976.
R2. S. G. Akl, ***Design and Analysis of Parallel Algorithms***, 1st Edition, Prentice-Hall, 1989.

Online Resources:

1. http://www.nptelvideos.in/2012/11/design-analysis-of-algorithms.html: Explanation of NP complete and approximation algorithm.
2. http://cse.iitkgp.ac.in/~debdeep/courses_iitkgp/PAlgo/Autumn16-17/: Reference material on parallel algorithm.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the various graph algorithms and apply it in real life application.
CO2	Understand graph matching and flow network techniques.
CO3	Analyze randomized algorithms and Fast Fourier Transform algorithm.
CO4	Analyze NP-complete problems and develop approximation algorithm for many real life problem.
CO5	Formulate and develop parallel algorithms, and explore the fundamental of parallel architecture.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	1	1					1	3	2	1
CO2	3	2	1	2	2					1	3	2	1
CO3	3	2	1	2	1					1	2	2	1
CO4	3	3	1	2	1					2	3	2	2
CO5	3	2	1	2	1					1	3	2	1

Type	Code	Soft Computing	L-T-P	Credits	Marks
PC	18MS1T08		3-0-0	3	100

Objectives	The objectives of this course is to introduce the fundamentals of non-traditional computing techniques and approaches to solve hard real-world problems using artificial neural networks, fuzzy systems and nature inspired computing, and derivative based & multi-objective optimization along with different aspects of hybridization with some case studies.
Pre-Requisites	Knowledge of Linear Algebra, algorithm design, and data structures are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Fuzzy Set Theory: fuzzy sets, basic definition and terminology, Set-Theoretic operations, Membership Function Formulation and Parameterization, T-norm, T-conorm; Fuzzy Rules and Fuzzy Reasoning: Extension Principle and Fuzzy Relations, Fuzzy if-then rules, Fuzzy reasoning; Fuzzy Inference Systems: Mamdani Fuzzy models, Sugeno Fuzzy models, Tsukamoto Fuzzy models.	**10 Hours**
Module-2	Derivative based Optimization: Local optima and global optima, constrained optimization, optimality conditions and matrix calculus, Gradient descent and stochastic gradient descent, Newton's method and Quasi-Newton methods (BFGS, L-BFGS), Linear Optimization, Duality, and Convex optimization, Conjugate Gradient.	**6 Hours**
Module-3	Neural Networks: Model of a neuron, LMS, Perceptron, MLP and Back propagation algorithm, heuristics for improving performance of BPA, Higher order convergence methods for BPA (Newton method, conjugradient method, LM, BFGS); Radial Basis Function Networks, Self-Organizing Maps.	**9 Hours**
Module-4	Nature Inspired Computing: Simulated Annealing, Genetic Algorithm, Differential Evolution, Ant & Bee Algorithm, Particle Swarm Optimization, Firefly algorithm, Cuckoo Search, Bat Algorithm, Harmony Search, Flower algorithm.	**10 Hours**
Module-5	Hybrid Methods: Adaptive Neuro-Fuzzy Inference Systems, Neuro genetic Systems, GA Fuzzy systems.	**6 Hours**
Module-6	Multi-Objective Optimization: Pareto Optimality, Weighted Sum Method, Utility Method, The ε-Constraint Method, Metaheuristic Approaches, NSGA-II.	**8 Hours**
	Total	**45 Hours**

P.T.O

Text Books:

T1. J. S. R. Jang, C.-T, Sun, and E. Mizutani, ***Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence***, 1st Edition, Pearson Education, 2015.
T2. S. Boyd and L. Vandenberghe, ***Convex Optimization***, Cambridge University Press, 2004.
T3. S. Haykin, ***Neural Networks: A Comprehensive Foundation***, 2nd Edition, Pearson Education.
T4. X. -S. Yang, ***Nature-Inspired Optimization Algorithms***, 1st Edition, Elsevier Publication, 2014.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Apply fuzzy logic and fuzzy inference system concept to design automation system for real life problems.
CO2	Grasp the concepts of derivative based optimization and to use it to solve problems.
CO3	Use the concepts of Artificial Neural Network (ANN) to solve real life engineering and societal problems.
CO4	Apply the concepts of different nature inspired computing techniques to solve engineering problems.
CO5	Envisage the need of hybridization, and to develop hybrid models for solving complex problems.
CO6	Identify the multi-objective aspects of real life problems and apply different techniques to solve it.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	2	3					3	3	3	1
CO2	3	3	1	1	1					2	3	3	1
CO3	3	3	3	2	3					2	3	3	2
CO4	3	3	3	2	3					3	3	3	2
CO5	3	3	3	2	3					3	3	3	2
CO6	3	3	3	2	3					3	3	3	2

Type	Code	Machine Learning	L-T-P	Credits	Marks
PE	18MS2T03		3-0-0	3	100

Objectives	The objective of this course is to learn patterns and concepts by analyzing data using various machine learning algorithms and feature extraction techniques with a modern outlook focusing on recent advances in this domain.
Pre-Requisites	Knowledge of Engineering Optimization and Matrix Theory are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Subset selection, Ridge regression, Linear Discriminant Analysis, Logistic regression, generative models for discrete data (Bayesian concept learning, Naïve Bayes classifier).	**11 Hours**
Module-2	Dimensionality Reduction: Factor analysis, Principal Components, Kernel PCA, Independent Component analysis, ISOMAP, LLE, Feature Selection.	**7 Hours**
Module-3	Model Assessment and Selection: Bias, Variance and model complexity, Bias-variance trade off, Optimization of the training error rate, Estimate of In-sample prediction error, Bayesian approach and BIC, Cross-validation, Bootstrap methods, conditional or expected test error.	**9 Hours**
Module-4	Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees, Boosting methods-exponential loss and AdaBoost, Random forests and analysis, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data).	**8 Hours**
Module-5	Support Vector Machines (SVM), K-nearest Neighbor and Cluster Analysis: Basis expansion and regularization, Kernel smoothing methods, SVM for classification, SVM for regression, K-nearest Neighbor classifiers (Image Scene Classification), Cluster analysis, Gaussian mixtures and selection.	**9 Hours**
	Total	**44 Hours**

Text Books:

T1. T. Hastie, R. Tibshirani, J. Friedman, ***The Elements of Statistical Learning: Data Mining, Inference and Prediction***, 2nd Edition, Springer Verlag, 2009.
T2. K. P. Murphy, ***Machine Learning: A Probabilistic Perspective***, 4th Edition, MIT Press, 2012.

Reference Books:

R1. C. Bishop, ***Pattern Recognition and Machine Learning***, Springer, 2007.
R2. T. Mitchel, ***Machine Learning***, McGraw-Hill Science, 1997.

R3. G. James, D. Witten, T. Hastie, and R. Tibshirani, ***An Introduction to Statistical Learning with Applications in R***, Springer, 2013.
R4. L. Wasserman, ***All of Statistics***, 1st Edition, Springer, 2004.

Online Resources:

1. https://github.com/josephmisiti/awesome-machine-learning: An exhaustive index of machine learning concepts and programming materials.
2. http://mlss.cc/: Machine Learning Summer School Study Material.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Formulate and solve machine learning problems using linear models of regression and classification.
CO2	Develop understanding of unsupervised learning models of dimensionality reduction and factor analysis.
CO3	Analyze the building blocks of probabilistic model assessment and selection.
CO4	Understand theoretical principles of additive models, trees and boosting with examples.
CO5	Apply the tools in cluster analysis, support vector machines and K-nearest neighbors.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	2				1	3	3	2
CO2	3	3	3	1	2	2				1	3	3	2
CO3	3	3	3	3	3	2				1	3	2	2
CO4	3	3	3	3	3	2				2	3	3	2
CO5	3	3	3	3	3	2				3	3	3	2

Type	Code	Secure Software Design & Enterprise Computing	L-T-P	Credits	Marks
PE	18MS2T14		3-0-0	3	100

Objectives	The objective of this course is to introduce challenges of software systems from security perspective, to address design and implementation issues critical to producing secure software systems, and the intricacies of secured software design for confidentiality, privacy, integrity, and availability.
Pre-Requisites	Fundamentals of software engineering and general computer security is required. Knowledge of cryptography and network/internet security is desirable.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on secured software design activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Defining computer security, the principles of secure software, trusted computing base, etc, threat modeling, advanced techniques for mapping security requirements into design specifications. Secure software implementation, deployment and ongoing management.	**9 Hours**
Module-2	Software design and an introduction to hierarchical design representations. Difference between high-level and detailed design. Handling security with high-level design. General Design Notions. Security concerns designs at multiple levels of abstraction, design patterns, quality assurance activities and strategies that support early vulnerability detection, trust models, security architecture & design reviews.	**9 Hours**
Module-3	Software Assurance Model, identify project security risks & selecting risk management strategies, risk management framework, security best practices, known security flaws, architectural risk analysis, security testing & reliability, Penn testing, Risk-Based security testing, Abuse cases, Operational testing, Introduction to reliability engineering, software reliability, Software Reliability approaches, Software reliability modeling.	**9 Hours**
Module-4	Software Security in Enterprise Business: Identification and authentication, Enterprise Information Security, Symmetric and asymmetric cryptography, public key cryptography, data encryption standards, DES, AES, algorithms for hashes and message digests; Authentication: authentication schemes, access control models, Kerberos protocol, public key infrastructure (PKI), protocols specially designed for e-commerce and web applications, firewalls and VPNs; Management issues: technologies and systems, information security management in enterprises.	**9 Hours**

Cont'd...

Module-#	Topics	Hours
Module-5	Security development frameworks. Security issues associated with the development and deployment of information systems, including Internet-based e-commerce, e-business, and e-service systems, as well as the technologies required to develop secure information systems for enterprises, policies and regulations essential to the security of enterprise information systems.	**9 Hours**
	Total	**45 Hours**

Text Books:

T1. W. Stallings, ***Cryptography and Network Security: Principles and Practice***, 6th Edition, Pearson, 2013.
T2. C. Kaufman, R. Perlman, and M. Speciner, ***Network Security: Private Communication in a Public World***, 2nd Edition, Pearson, 2016.
T3. C. P. Pfleeger and S. L. Pfleeger, ***Security in Computing***, 5th Edition, Pearson Education, 2018.
T4. M. Merkow, and J. Breithaupt, ***Information Security: Principles and Practices***, 2nd Edition, Pearson IT Certification, 2014.

Reference Books:

R1. G. McGraw, ***Software Security: Building Security In***, Addison-Wesley Professional, 2006.

Online Resources:

1. https://www.dwheeler.com/secure-class/: by David A. Wheeler
2. https://www.coursera.org/lecture/software-design-threats-mitigations/secure-software-design-is-good-software-design-dXAT3: by Albert Glock

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand various aspects and principles of software security.
CO2	Devise security models for implementing at the design level.
CO3	Identify and analyze the risks associated with s/w engineering and use relevant models to mitigate the risks.
CO4	Understand the various security algorithms to implement for secured computing and computer networks.
CO5	Explain different security frameworks for different types of systems including electronic systems.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.

Cont'd...

PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	2	1	1	1	2	1		1	1	2	1
CO2	2	3	1	1		1	1			2	1	2	1
CO3	2	2	1	1						1	1	2	2
CO4	3	2	3	2		1				1	2	3	3
CO5	2	2	2	1	1	1	2			2	1	2	2

Type	Code	Advanced Wireless & Mobile Networks	L-T-P	Credits	Marks
PE	18MS2T15		3-0-0	3	100

Objectives	The objectives of this course are to get familiar with the wireless/mobile market and future needs & challenges, understand the key concepts of wireless networks, standards, technologies and their basic operations; learn to design and analyze various MAC protocols.
Pre-Requisites	Knowledge of computer networking and basic concepts of wireless & mobile networks are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction: Wireless networking trends, Physical Layer concepts, Multiple Access technologies-SDMA, FDMA, TDMA, CDMA, Spread Spectrum, frequency reuse, radio propagation and modeling; Challenges in Mobile Computing: Constrained resources, bandwidth, energy; WLANs: IEEE 802.11 WLANs, Physical & MAC layer, 802.11 MAC Modes (DCF & PCF), IEEE 802.11 standards, architecture & protocols, Infrastructure vs. Ad hoc Modes, hidden node & exposed terminal problems, fading effects in indoor & outdoor WLANs, deployment issues.	**10 Hours**
Module-2	Wireless Cellular Networks: 1G, 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over wireless networks, cellular architecture, frequency reuse, channel assignment strategies, handoff strategies, interference and system capacity, improving radio coverage and capacity in cellular systems.	**8 Hours**
Module-3	WiMAX: Physical layer, media access control, mobility and networking, IEEE 802.22, Wireless Regional Area Networks, IEEE 802.21 media independent handover, overview; Wireless Sensor Networks: Introduction, application, physical, MAC layer and network layer, power management, Tiny OS overview.	**10 Hours**
Module-4	Wireless PANs: Bluetooth and ZigBee, introduction to wireless sensors; Advanced Topics: IEEE 802.11x and IEEE 802.11i standards, introduction to Vehicular Ad hoc Networks.	**8 Hours**
Module-5	Protection and Security in Wireless and Mobile Networks: Security in wireless networks, vulnerabilities, security techniques, Wi-Fi security, DoS in wireless communication.	**8 Hours**
	Total	**44 Hours**

Text Books:

T1. Y. B. Lin and I. Chlamtac, ***Wireless and Mobile Network Architectures***, 1st Edition, Wiley, 2000.
T2. J. Schiller, ***Mobile Communications***, 2nd Edition, Pearson Education, 2008.
T3. W. Stallings, ***Wireless Communications and Networks***, 2nd Edition, Pearson Education, 2009.

Reference Books:

R1. R. Pandya, ***Mobile and Personal Communications Systems and Services***, IEEE Press, 2005.
R2. I. Stojmenic (Ed.), ***Handbook of Wireless Networks and Mobile Computing***, Wiley, 2002.

Online Resources:

1. https://nptel.ac.in/courses/117102062/: by Dr. Ranjan Bose, IIT Delhi.
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-452-principles-of-wireless-communications-spring-2006/download-course-materials/: MIT Open Courseware
3. http://nptel.ac.in/courses/106105160/21: Introduction to Wireless Sensor Networks Part-I

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Acquire knowledge on multiple access technologies, spectrum reuse in wireless medium, WLAN standards and deployment challenges.
CO2	Design and develop models for channel allocation, handoff to improve the performance of network with respect to its coverage and capability for 2G, 3G and 4G technologies.
CO3	Demonstrate WiMAX functionalities and deploy Wireless Sensor Network with limitations of resource and power supply.
CO4	Integrate WPAN and IEEE 802.11x standards for industrial applications such as Vehicular ad hoc network, unmanned vehicles by assembling Bluetooth and ZigBee interfaces.
CO5	Visualise security breaches, find solution to protect the data during access to a server and transmission in wireless medium.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	1	1		1			1	3	3	3
CO2	2	3	3	3	2		2			1	3	3	3
CO3	3	2	3	3	3		2			2	3	3	3
CO4	3	3	3	3	3		3			2	3	3	3
CO5	3	3	3	3	3		3			2	2	3	3

Type	Code	Intelligent Systems	L-T-P	Credits	Marks
PE	18MS2T05		3-0-0	3	100

Objectives	This course is a study of systems that exhibit intelligent attributes. It covers solving problems by searching, Game playing, solving constraint satisfaction problems, Logical agents, knowledge representation and probabilistic reasoning.
Pre-Requisites	Knowledge of data structures and algorithm design are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Artificial Intelligence and intelligent agents, Solving Problems by Searching: Problem-Solving Agents, Searching for solutions, Uninformed search strategies (Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening, Bidirectional search), Informed (Heuristic) search strategies (Greedy best-first search, A* search, Memory-bounded heuristic search).	**10 Hours**
Module-2	Adversarial Search: Games, optimal decisions in games, alpha-beta pruning. Constraint Satisfaction Problems: Defining Constraint Satisfaction Problems, Constraint Propagation, Backtracking.	**8 Hours**
Module-3	Logical Agents: Knowledge-Based Agents, the Wumpus World, Logic, Propositional Logic, Propositional Theorem Proving. First-Order Logic, Inference in First-Order Logic: Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining.	**9 Hours**
Module-4	Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information, the Internet Shopping World.	**9 Hours**
Module-5	Quantifying Uncertainty: Acting under Uncertainty, Inference Using Full Joint Distributions, Independence. Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, the Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks.	**9 Hours**
	Total	**45 Hours**

Text Books:

T1. S. Russell and P. Norvig, ***Artificial Intelligence: A Modern Approach***, 3rd Edition, Pearson Education India, 2015.

Reference Books:

R1. N. J. Nilsson, ***Artificial Intelligence: A New Synthesis***, Morgan-Kaufmann, 2003.

R2. G. F. Luger and W. A. Stubblefield, ***Artificial Intelligence: Structures and Strategies for Complex Problem Solving***, 6th Edition, Addison Wesley, 2008.

Online Resources:

1. http://www.princeton.edu/~stengel/MAE345.html: Online reference material Robotics and Intelligent Systems from Princeton University, New Jersy, USA
2. http://nptel.ac.in/courses/108104049/: Online reference material from IIT Kanpur (NPTEL – E-Learning Courses from IIT & IISc)

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Explore different techniques to solve artificial intelligence problems by searching.
CO2	Grasp the concepts of adversarial search and constraint satisfaction problems.
CO3	Conceive the concepts of logical agents and inference in First-Order Logic.
CO4	Explore the concepts of knowledge representation and reasoning.
CO5	Envisage the need of quantifying uncertainty and probabilistic reasoning.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	2					2	3	2	3
CO2	2	2	2	2	2					2	3	2	3
CO3	3	3	2	2	3					2	3	2	3
CO4	3	2	2	2	3					2	3	2	3
CO5	2	3	3	2	3					2	3	2	3

Type	Code	High Performance Computing	L-T-P	Credits	Marks
PE	18MS2T18		3-0-0	3	100

Objectives	The objective of this course is to introduce the students to broad and deep knowledge of contemporary computer architecture issues and techniques for building high performance scalable multithreaded and multiprocessor systems.
Pre-Requisites	Knowledge of basic computer organization and architecture is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Review of basic computer organization and architecture, trends in technology, dependability, measuring, reporting and summarizing performance, quantitative principles of computer design, Amdahl's Law, Instruction Set, CISC and RISC processors.	**8 Hours**
Module-2	Pipelining: Basic concepts, instructions and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards,super-scalar, super-pipelined and VLIW processor architectures.	**9 Hours**
Module-3	Instruction-level parallelism using software approaches, dynamic instruction scheduling, scoreboard, tomasulo, branch prediction techniques, superscalar techniques, speculative execution, review of modern processors, Pentium Processor: IA 32 and P6 micro architectures, ARM processor.	**10 Hours**
Module-4	Basic concept of hierarchical memory organization, main memories, cache memory design and implementation, virtual memory design and implementation, secondary memory technology.	**7 Hours**
Module-5	Multiprocessor architecture: taxonomy of parallel architectures, centralized shared-memory architecture: synchronization, memory consistency, cache coherence problem, interconnections networks, multi-core architecture, distributed shared-memory architecture.	**10 Hours**
	Total	**44 Hours**

Text Books:

T1. J. L. Hennessy and D. A. Patterson, ***Computer Architecture: A Quantitative Approach***, 2nd Edition, Morgan Kaufmann, 2010.
T2. D. A. Patterson and J. L. Hennessy, ***Computer Organization & Design: The Hardware/Software Interface***, Morgan Kaufmann, 2011.
T3. K. Hwang, ***Advanced Computer Architecture: Parallelism, Scalability, Programmability***, McGraw-Hill, 2008.

P.T.O

Reference Books:

R1. K. Hwang and F. A. Briggs, ***Computer Architecture and Parallel Processing***, McGraw-Hill, 2012.
R2. B. Parhami, ***Computer Architecture***, Oxford University Press, 2005.

Online Resources:

1. http://www.eecs.berkeley.edu/~pattrsn
2. http://www-inst.eecs.berkeley.edu/~cs252
3. http://www.cs.berkeley.edu/~culler/courses/cs252-s05/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Apply concepts of computer architecture, identify and quantify different parameters used to measure and report the performance of a system.
CO2	Describe basics of pipelining with the influence of hazards on its performance and implement principles of pipelining to design super scalar and super pipelining architectures.
CO3	Analyze and describe advanced hardware and software based techniques for exploiting instruction level parallelism and discuss the modern processors.
CO4	Analyze, describe and justify the storage and memory hierarchy, multilevel cache design and various cache optimization techniques.
CO5	Examine needs to switch from uni-processor to multi-processor architecture. Analyze and compare different multiprocessor architectures and their interconnection networks.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2					1	3		3
CO2	3	3	2	3	2		1			1	2		1
CO3	3	2	2	3	2		1			1	3	1	1
CO4	2	3	3	2	2		1			1	2	1	2
CO5	3	3	3	2	2		1			1	2	1	3

Type	Code	Digital Forensics	L-T-P	Credits	Marks
PE	18MS2T19		3-0-0	3	100

Objectives	The objective of this course is to provides an in-depth study of computer forensics, knowledge required to investigate, detect and prevent digital crimes, digital forensics legislations, forensics processes and procedures, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics.
Pre-Requisites	Knowledge of computer networks, network security, and idea on cybercrime and information warfare are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Digital Forensics Science: Forensics science, computer forensics, and digital forensics. Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber-criminalistics area, holistic approach to cyber-forensics.	**9 Hours**
Module-2	Cyber Crime Scene Analysis: Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, discuss the importance of understanding what court documents would be required for a criminal investigation.	**8 Hours**
Module-3	Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, explain what the normal case would look like, define who should be notified of a crime, parts of gathering evidence, define and apply probable cause.	**9 Hours**
Module-4	Computer Forensics: Prepare a case, begin an investigation, understand computer forensics workstations and software, conduct an investigation, complete a case, critique a case; Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data.	**9 Hours**
Module-5	Mobile Forensics: Mobile forensics techniques and tools; Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008; Recent Trends in Mobile Forensics: technique and methods to search and seizure, electronic evidences.	**10 Hours**
	Total	**45 Hours**

Text Books:

T1. B. Nelson, A. Phillips, F Enfinger, C Steuart, ***Guide to Computer Forensics and Investigations***, 4th Edition, Course Technology, 2010.

Reference Books:

R1. J. Sammons, ***The Basics of Digital Forensics***, 2nd Edition, Elsevier, 2014.
R2. J. Vacca, ***Computer Forensics: Computer Crime Scene Investigation***, 2nd Edition, Laxmi Publications, 2005.

Online Resources:

1. http://www.cftco.com/: Computer Forensic Training Center Online
2. http://www.computerforensicsworld.com/: Computer Forensics World
3. http://www.computer-forensic.com/: Computer Forensic Services
4. http://www.digitalforensicsmagazine.com/: Digital Forensic Magazine
5. http://www.jdfsl.org/: The Journal of Digital Forensics, Security and Law
6. http://www.tandf.co.uk/15567281: Journal of Digital Forensic Practice
7. http://www.usdoj.gov/criminal/cybercrime/searching.html: DOJ Cybercrime and IP Section
8. http://www.ojp.usdoj.gov/nij/pubs-sum/187736.htm: Electronic Crime Scene Investigation
9. http://nij.ncjrs.org/publications/pubs_db.asp: Related Publications

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand relevant legislation and codes of ethics.
CO2	Investigate computer forensics and digital detective and various processes, policies and procedures data acquisition and validation, e-discovery tools.
CO3	Analyze E-discovery, guidelines and standards, E-evidence, tools and environment.
CO4	Apply the underlying principles of Email, web and network forensics to handle real life problems.
CO5	Use IT Acts and apply mobile forensics techniques.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	3		1		1		2	2	1	1
CO2	1	2	1	3		1		1		1	2		1
CO3	1	1	1	3		1		1		1	1		1
CO4	1	1	2	3		1		1		2	1		1
CO5	1	2	1	2		1		1		2	1		1

Type	Code	English for Research Paper Writing	L-T-P	Credits	Marks
AC	18MS8T11		2-0-0	0	100

Objectives	The objective of this course is to give learners an exposure to different aspects of research related technical writing and to help them write such matter effectively through practice.
Pre-Requisites	Basic knowledge of English grammar and the ability to read and write using the English language.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on technical writing activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Technical Communication: Differentiating between general and technical writing, purpose of writing, plain English, mechanics of writing, elements of style. Essentials of English Grammar: basic word order, tense forms, reported speech, use of passives, conditionals, concord, clauses, common errors.	**9 Hours**
Module-2	Elements of Writing: Process writing, developing an effective paragraph, qualities of a paragraph, structuring a paragraph, types of essays, writing reports.	**5 Hours**
Module-3	Key Reading Skills: sub-skills of reading, local and global comprehension, types of technical texts, critical analysis of technical texts, note-making, the purpose and importance of literature review, evaluating literature.	**5 Hours**
Module-4	Developing Writing Skills: writing abstracts, technical letters, project reports, elements of proposal writing.	**6 Hours**
Module-5	Research and Writing: The research paper as a form of communication, Writing a review of Literature, developing a hypothesis, formulating a thesis statement, plagiarism issues.	**3 Hours**
	Total	**28 Hours**

Text Books:

T1. C. Ellison, ***McGraw-Hill's Concise Guide to Writing Research Papers***, McGraw-Hills, 2010.
T2. A. Wallwork, ***English for Writing Research Papers***, Springer, 2011.
T3. R. A. Day, ***How to Write and Publish a Scientific Paper***, 7th Edition, Greenwood, 2011.

Reference Books:

R1. R. Goldbort, ***Writing for Science***, Yale University Press, 2006.
R2. N. J. Higham, ***Handbook of Writing for the Mathematical Sciences***, 2nd Edition, SIAN, 1998.
R3. C. R. Kothari & G. Garg, ***Research Methodology: Methods and Techniques***, 2nd Edition, New Age International Publishers, 2014.

P.T.O

Online Resources:

1. https://msu.edu/course/be/485/bewritingguideV2.0.pdf: Michigan State University Press, USA, Technical Writing Guide, 2007.
2. http://web.mit.edu/me-ugoffice/communication/technical-writing.pdf: Sentence Structure of Technical Writing, Nicole Kelley, MIT, USA, 2006.
3. http://www.inf.ed.ac.uk/teaching/courses/pi/2017_2018/slides/Technical-Writing-Basics.pdf: Notes from Pocketbook of Technical Writing for Engineers and Scientists by Leo Finkelstein, NY, 2007.
4. https://www.shs-conferences.org/articles/shsconf/pdf/2016/04/shsconf_erpa2016_01090.pdf: A need analysis of technical writing skill of engineering students in India, JCK Evangeline & K. Ganesh, DOI: 10.1051/ shsconf/20162601090, 2016

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the importance and application of technical communication and apply essentials of English grammar to make research writing effective.
CO2	Apply the elements of technical writing to produce effective research papers.
CO3	Develop critical reading and analysis skills of technical research papers and texts.
CO4	Develop the ability to write technical articles and effectively present the ideas.
CO5	Develop research acumen by understanding the key skills of research.

Program Outcomes Relevant to the Course:

PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						3	1	1	3	3	1	2	3
CO2						3			3	3	1	2	3
CO3						3	1	1	3	3	2	2	3
CO4						2		1	3	3	2	2	3
CO5						2	1	3	3	3	2	2	3

Type	Code	Advanced Algorithms & Soft Computing Lab	L-T-P	Credits	Marks
PC	18MS1L03		0-0-4	2	100

Objectives	The objective of this course is to give hands on exposure to implementation of different algorithms and develop intelligent machines for solving real world problems.
Pre-Requisites	Good knowledge of programming languages and data structures is required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
	Advanced Algorithms
1	Performance comparison of various sorting algorithms.
2	Graph traversal algorithm (BFS and DFS)
3	Single source shortest path (Dijkstra Algorithm)
4	Minimum spanning tree (Prims and Kruskal)
5	Graph matching using Edmond's Blossom algorithm
6	maximum-flow algorithm (Edmond-Karp)
7	Integer multiplication algorithm (Schonhage-Strassen)
8	Approximation algorithms for TSP and vertex cover.
	Soft Computing
9	Mamdani Fuzzy models, Sugeno Fuzzy models, Tsukamoto Fuzzy models
10	Single Layer Perceptron and Multi Layer Perceptron training with back propagation algorithm
11	Genetic Algorithm, Differential Evolution, Particle Swarm Optimization, etc
12	Multi-Objective Optimization with Weighted Sum Method, NSGA-II etc.

Text Books:

T1. T. H. Cormen, C. E. Leiserson, R.L. Rivest, and C. Stein, ***Introduction to Algorithms***, 3rd Edition, Prentice Hall India, 2013.
T2. J. Kleinberg and E. Tardos, ***Algorithm Design***, 1st Edition, Pearson Education, 2005.
T3. J. -S. R. Jang, C. -T, Sun, and E. Mizutani, ***Neuro-Fuzzy And Soft Computing: A Computational Approach to Learning and Machine Intelligence***, 3rd Edition, Pearson Education, 2004.
T4. S. Haykin, ***Neural Networks: A Comprehensive Foundation***, 2nd Edition, Pearson Education, 2010.
T5. X. -S. Yang, ***Nature-Inspired Optimization Algorithms***, 1st Edition, Elsevier Publications, 2014.

Reference Books:

R1. S. V. Kartalopoulos, ***Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications***, IEEE Press, Prentice Hall India, 2014.
R2. T. J. Ross, ***Fuzzy Logic with Engineering Applications***, 3rd Edition, John Wiley & Sons, 2009.

R3. M. Mitchell, ***An Introduction to Genetic Algorithms***, Prentice-Hall, 1998.
R4. M. T. Goodrich and R. Tamassia, ***Algorithms Design***, 1st Edition, John Wiley, 2014.
R5. R. Sedgewick and K. Wayne, ***Algorithms***, 4th Edition, Addison-Wesley, 2011.

Online Resources:

1. https://www.csail.mit.edu/research: MIT CS AI Lab
2. http://www.doc.gold.ac.uk/~mas01ds/dssc/: Data Science and Soft Computing Lab, Goldsmith University of London
3. http://sci2s.ugr.es/otherCourses/FutureDirectionsSC: Soft computing and Intelligent Information Systems, University of Granada
4. https://sites.google.com/site/softcomputinglaboratory/Home: Soft Computing Laboratory, Department of Mechanical Engineering, IIT Khargarpur

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the concept of designing an algorithm.
CO2	Justify Algorithm as a Technology in problem solving by considering various algorithmic approaches for the same problem.
CO3	Learn advanced tree and graph applications.
CO4	Identify and describe soft computing techniques and their roles in building intelligent machines.
CO5	Apply soft computing tools to solve variety of optimization problems in Data Mining, Text Analytics, and Image Processing.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	1	1					1	2		
CO2	3	2	1	1	1					1	3	1	2
CO3	3	2	2	2	2					1	3	1	2
CO4	2	2	2	2	2					1	1	1	3
CO5	3	2	2	2	2					1	3	2	3

Type	Code	Machine Learning Lab	L-T-P	Credits	Marks
PE	18MS2L03		0-0-2	1	100

Objectives	The objective of this course are to learn how to extract features that can be used for machine learning applications, help students to experimentally compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
Pre-Requisites	Knowledge of Engineering Optimization and Matrix Theory along with proficiency in a computer programming language are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Overview of Scikit-Learn
2	Experiment demonstrating simple and multiple linear regression
3	Experiment on binary classification using Logistic regression
4	Application of Linear discreminant analysis
5	Program on Ridge regression
6	Experiment on Cross-validation and boot strap
7	Program on Fitting classification and regression trees
8	Program on K-nearest neighbors
9	Experiment on Principal component analysis
10	Program demonstrating K-means clustering
11	Implementation of Perceptron Learning
12	Implementation of Deep Neural Network with Backpropagation

Text Books:

T1. T. Hastie, R. Tibshirani, J. Friedman, ***The Elements of Statistical Learning: Data Mining, Inference and Prediction***, 2nd Edition, Springer Verlag, 2009.
T2. C. Bishop, ***Pattern Recognition and Machine Learning***, Springer, 2007.

Reference Books:

R1. K. P. Murphy, ***Machine Learning: A Probabilistic Perspective***, 4th Edition, MIT Press, 2012.
R2. H. Daumé III, ***A Course in Machine Learning***, Free e-Book, 2015.
R3. T. Mitchel, ***Machine Learning***, McGraw-Hill Science, 1997.
R4. S. Shalev-Shwartz and S. Ben-David, ***Understanding Machine Learning: From Theory to Algorithms***, Cambridge University Press, 2014.

P.T.O

Online Resources:

1. http://mlss.cc/: Machine Learning Summer School Study Material.
2. https://github.com/josephmisiti/awesome-machine-learning: An exhaustive index of machine learning concepts and programming materials.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Become familiar with different Machine Learning toolkits.
CO2	Apply basic machine learning algorithms for predictive modeling.
CO3	Compare and contrast pros and cons of various machine learning techniques.
CO4	Extract meaningful data using non-statistical modeling with special emphasis on real world applications.
CO5	Implement recent advances in the field of machine learning, especially deep learning.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	1	3	2					1	3	3	2
CO2	2	2	2	3	2		2			2	3	3	2
CO3	3	3	3	3	2		2			2	3	3	2
CO4	3	3	3	3	3		2			3	3	3	2
CO5	3	3	3	3	3		2			3	3	3	2

Type	Code	Secure Software Design & Enterprise Computing Lab	L-T-P	Credits	Marks
PE	18MS2L14		0-0-2	1	100

Objectives	The objective of this course is to study the different threats, vulnerabilities and controls for a software system and implement some of the widely used algorithms for software security.
Pre-Requisites	Good programming skill preferably in languages like C/C++ is required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1, 2	Study of Network Security fundamentals - Ethical Hacking, Social Engineering practices
3	Study of System threat attacks - Denial of Services.
4	Study of Sniffing and Spoofing attacks.
5	Study of techniques uses for web based password capturing.
6	Study of Different attacks causes by Virus and Trojans.
7	Study of Anti-Intrusion Technique – Honey pot.
8	Study of Symmetric Encryption Scheme – RC4.
9	Implementation of S-DES algorithm for data encryption.
10	Implementation of Asymmetric Encryption Scheme – RSA.
11	Study of IP based Authentication.
12	Design a security model for an enterprise.

Text Books:

T1. A. Kahate, ***Cryptography and Network Security***, Tata McGraw-Hill, 2013.
T2. W. Stallings, ***Cryptography and Network Security: Principles and Practice***, 6th Edition, Pearson, 2013.

Reference Books:

R1. G. McGraw, ***Software Security: Building Security In***, Addison-Wesley Professional, 2006.

Online Resources:

1. https://www.dwheeler.com/secure-class/: by David A. Wheeler
2. https://www.coursera.org/lecture/software-design-threats-mitigations/secure-software-design-is-good-software-design-dXAT3: by Albert Glock
3. https://www.garykessler.net/library/crypto.html: Overview of Cryptography by Gary C. Kessler

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the various aspects and principles of software security.
CO2	Compare different types of threats and attacks.
CO3	Identify and analyze the different anti-intrusion techniques.
CO4	Implement the various security algorithms to be implemented for secured computing and computer networks.
CO5	Develop a security model for any enterprise based on its threats and vulnerabilities.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	1	1	1			2				1	1	2
CO2	1	2	2	1			1				1	1	2
CO3	1	2	3	1			1				2	1	2
CO4	1	2	2	2			2				3	3	3
CO5	1	2	3	2		2	3				2	3	2

Type	Code	Advanced Wireless & Mobile Networks Lab	L-T-P	Credits	Marks
PE	18MS2L15		0-0-2	1	100

Objectives	The objective of the course is to develop systems engineering skills in the field of wireless communications, gain first-hand practical skills involving wireless and mobile applications.
Pre-Requisites	Knowledge of programming using C++ or Python and socket programming is required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Demonstration of multiple access concepts such as FDMA, TDMA and CDMA.
2	Simulation of communication mechanisms in WLAN.
3	Channel assignment strategies such as Reserved Channel Allocation, Queuing Scheme and Sub-rating scheme in wireless medium.
4	Flow control, Error control mechanism between sender and receiver.
5	Congestion control in the network.
6	Implementation of proactive routing protocols in ad hoc networks.
7	Implementation of reactive routing protocols in ad hoc networks.
8	Implementation of hybrid routing protocols and comparative analysis between different types of protocols with respect to their network parameters.
9	Preparation of test-bed with RaspberryPi or Arduino for workable model of WSN devices.
10	Implementation of Security protocols for Wi-Fi environment.
11	Implementation of Symmetric Key Cryptography protocols in wireless communication.
12	Implementation of Asymmetric Key Cryptography protocols in wireless medium.

Text Books:

T1. Y. B. Lin and I. Chlamtac, ***Wireless and Mobile Network Architectures***, 1st Edition, Wiley, 2000.
T2. J. Schiller, ***Mobile Communications***, 2nd Edition, Pearson Education, 2008.
T3. W. Stallings, ***Wireless Communications and Networks***, 2nd Edition, Pearson Education, 2009.

Reference Books:

R1. L. Cassell and A. Gauld, ***Python Projects***, Wrox Publication, 2014.
R2. I. Stojmenic (Ed.), ***Handbook of Wireless Networks and Mobile Computing***, Wiley, 2002.

Online Resources:

1. https://www.nsnam.org/: Open source simulator for wired, wireless, sensor and ad hoc network related protocols; requires C++ and Python as pre-requisite for better understanding.

2. https://www.gnuradio.org/doc/doxygen/index.html: Open source simulator for implementation of radio ecosystem; requires knowledge of C++ and Python.

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the concepts of multiplexing and implement multi-access mechanisms.
CO2	Exhibit the handoff detection and channel assignment procedures through simulation or implementation.
CO3	Obtain insight on flow control, error control and congestion control algorithms and implement using NS3 or gnuradio simulator.
CO4	Simulate various routing protocols by NS3 and learn to integrate IoT devices in the Internet using RPi.
CO5	Acquire knowledge on different protection and security mechanisms and implement them for wireless and mobile communication environments.

Program Outcomes Relevant to the Course:

PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1		3	2	2		1	1			2	3	2	2
CO2		3	2	2		1	2			2	3	2	2
CO3		2	2	3		2	1			1	3	3	2
CO4		2	2	3		3	3			2	3	3	3
CO5		3	3	2		2	3			2	3	3	3

Type	Code	Intelligent Systems Lab	L-T-P	Credits	Marks
PE	18MS2T05		0-0-2	1	100

Objectives	The objective of this course is to motivate and prepare the students to appreciate and implement intelligent systems and conduct research projects through advanced courses in related areas.
Pre-Requisites	Knowledge of data structure, database management systems, and strong logical ability, and proficiency in programming are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Heuristic search: Tic-Tac-Toe
2	Heuristic search: Water Jug Problem
3	Heuristic search: Missionaries and Cannibals
4	Heuristic search: Blocks World Problem
5	8 Queens Problem
6	Depth First Search (DFS)
7	Breadth First Search (BFS)
8	Best First Search
9	A* Algorithm
10	Adversarial Search: Optimal decision in games
11	Constraint satisfaction problems: Backtracking
12	Reasoning Systems for categories
13	Bayesian Networks: Exact inference
14	Bayesian Networks: Approximate inference

Text Books:

T1. I. Bratko, ***Prolog Programming***, Prentice Hall India, 2002.
T2. M. T. Jones, ***Artificial Intelligence Application Programming***, 2nd Edition, DreamTech, 2006.
T3. E. Charniak, C. K. Riesbeck, D. V. McDermott, and J. R. Meehan, ***Artificial Intelligence Programming***, 2nd Edition, Amazon Kindle, 2014.

Reference Books:

R1. P. Joshi, ***Artificial Intelligence with Python***, Packt Publishing, 2017.
R2. S. J. Russell and P. Norvig, ***Artificial Intelligence: A Modern Approach***, 3rd Edition, Prentice-Hall, 2010.

Online Resources:

1. https://www.csail.mit.edu/: MIT Computer Science and Artificial Intelligence Lab
2. https://www.expertsystem.com: Multi disciplinary industry solutions, World

3. https://www.eecs.umich.edu/eecs: University of Michigan AI Lab
4. https://onlinelibrary.wiley.com/journal/14680394: Expert System Wiley online library

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Solve problems by applying AI techniques to different complex problems using LISP, PROLOG.
CO2	Represent difficult real life problems in a state space and solve those using AI techniques.
CO3	Apply various AI methods like searching and game playing to solve real world applications.
CO4	Build inference engines by applying knowledge representation and Logic.
CO5	Obtain understanding of planning, Bayes networks, NLP and concepts of cognitive computing.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	1	2		2					3	2	3
CO2	3	3	1	2		2					3	2	3
CO3	3	3	2	3		2					3	2	3
CO4	2	3	2	2		2					3	2	3
CO5	2	3	2	2		2					3	2	3

Type	Code	High Performance Computing Lab	L-T-P	Credits	Marks
PE	18MS2L18		0-0-2	1	100

Objectives	The objectives of this course are to enable the students to build & model applications to simulate real programs running on modern processors using set of tools that model a virtual computer system, and design & analyze advanced techniques to enhance computing performance.
Pre-Requisites	Knowledge of advanced computer architecture, Linux, C/C++ programming languages are required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to Simple Scalar and its installation; Testing the GCC Cross-compiler for SimpleScalar Processor Simulator.
2	Execution of C programs in Simplescalar.
3	Run some benchmarks programs (anagram, compress, go and gcc) using sim-profile in alpha ISA and analyze the output.
4	Compare the PISA and Alpha ISA by executing the same benchmarks sim-profile and analyze the output by plot.
5	Implement Pipelining on ALPHA-ISA using sim-outorder simulator and analyze the outcome.
6	Implement Super Scalar pipelining for various configurations on ALPHA-ISA and PISA-ISA using sim-outorder simulator.
7	Investigate the effects of various branch prediction schemes and CPI/IPC for ALPHA benchmarks using sim-bpred simulator.
8	Study of sim-cache simulator to perform cache simulation with various configurations. Plot the results of the simulations.
9	Investigate the performance of unified cache and split cache by executing test-math program.
10	Write C/C++ programs (Matrix Multiplication without loop, with loop and using function) using ALPHA/PISA compiler to benchmark computer systems.
11	Modify the C/C++ source code in sim-cache.c file to add a third-level data and instruction cache.
12, 13	Project Work (may be group activity).

Text Books:

T1. J. L. Hennessy and D. A. Patterson, ***Computer Architecture: A Quantitative Approach***, 5th Edition, Morgan Kaufmann, 2012.

Reference Books:

R1. D. A. Patterson and J. L. Hennessy, ***Computer Organization & Design***, 3rd Edition, Morgan Kaufmann, 2005.

Online Resources:

1. http://www.simplescalar.com/docs/simple_tutorial_v2.pdf
2. http://www.ecs.umass.edu/ece/koren/architecture/Simplescalar/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Implement concepts of computer architecture running different benchmark programs like ALPHA/PISA ISA.
CO2	Analyze different techniques for achieving ILP.
CO3	Implement advanced techniques to achieve ILP and enhance performance of processor.
CO4	Demonstrate the basic memory hierarchy techniques.
CO5	Simulate and analyze various multiprocessor systems.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2				1	2		1
CO2	3	3	3	3	2	2				1	2		2
CO3	3	3	3	3	2	2				1	2	1	1
CO4	2	3	3	3	2	1				1	2	1	2
CO5	1	1	1	2	2	1				1	2	1	1

Type	Code	Digital Forensics Lab	L-T-P	Credits	Marks
PE	18MS2L19		0-0-2	1	100

Objectives	The objective of this course is to enable the students conduct hand on investigation and performing digital forensic analysis using various digital forensics tools and formulate the findings.
Pre-Requisites	Knowledge of operating systems (Linux, DOS, Windows) is required.
Teaching Scheme	Regular laboratory experiments executed by the students under supervision of the teacher. Experiments shall comprise of various forensic investigation, analysis, and evidence gathering activities.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to legal issues, context, and digital forensics; Disk Imaging and Cloning
2	Analysis: disk structure, file systems (NTFS, EXT 2/3, HFS), and physical system
3	Search Word Filtering from Unallocated, Slack and Swap Space
4	Unix File Recovery – Data Unit Level
5	File Recovery: Meta Data Layer
6	File Recovery: Data Layer Revisited
7, 8	Analysis Techniques: Keyword Searches, Timelines, Hidden Data
9	Data Mining For Digital Forensics
10	Network devices: routers, switches
11	Analysis of cell Phones, Tablet, Ipad, Pdas, Etc. Cell Phones
12	Evidence: Collection, Preservation, Testimony

Text Books:

T1. C. Altheide and H. Carvey, ***Digital Forensics with Open Source Tools***, 3rd Edition, Elsiviers, 2011.
T2. M. McDougal, ***Live Forensics on a Windows System***, WFT, 2006.

Reference Books:

R1. J. Sammons, ***The Basics of Digital Forensics***, 2nd Edition, Elsevier, 2014.
R2. J. Vacca, ***Computer Forensics: Computer Crime Scene Investigation***, 2nd Edition, Laxmi Publications, 2005.

Online Resources:

1. http://users.erols.com/gmgarner/forensics/userdump.exe
2. http://www.scanwith.com/download/Fport.htm: For fport.exe
3. http://www.foundstone.com/knowledge/proddesc/fport.html/psloggedon.exe
4. http://www.sysinternals.com/Utilities/PsLoggedOn.htmlp/slist.exe
5. http://www.sysinternals.com/Utilities/PsList.html: For kill.exe, auditpol.exe, dumpel.exe
6. http://www.petri.co.il/download_free_reskit_tools.htm/ntlast.exe
7. http://www.foundstone.com/resources/proddesc/ntlast.htm

8. http://www.foolmoon.net/downloads/Live_Forensics_Using_WFT.pdf: Digital Forensics of the Physical Memory by M. Burdach
9. http://www.forensicfocus.com/index.php?name=Content&pid=57: Windows Live Incident Response Volatile Data Collection: Non- Disruptive User & System Memory Forensic Acquisition
10. http://web.archive.org/web/20040405032635/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Demonstrate Disk Imaging and Cloning.
CO2	Simulate different techniques for File Recovery.
CO3	Implement various analysis techniques like, Keyword Searches, Timelines, Hidden Data.
CO4	Apply Data Mining algorithms for Digital Forensics.
CO5	Simulate forensics issues of network and mobile devices.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2						1		1
CO2	2	3	1	2	1						1		1
CO3	2	2	2	2	1						2		1
CO4	2	1	2	2	2						1	1	1
CO5	1	1	3	2	2						1		1

Part II

2nd Year M. Tech. (CSE)

Curriculum Structure

Semester III									
Type	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY									
PE	18MS2T**	Professional Elective-V	3	0	0	3	0	0
OE	18MA3T**	Open Elective	3	0	0	3	0	0
PRACTICAL									
PJ	18MS7L01	Thesis (Part - I) & Seminar	0	0	20	0	0	10
		SUB-TOTAL	**6**	**0**	**20**	**6**	**0**	**10**
		TOTAL	**26**			**16**		

List of Electives

Code	Elective # and Subjects
	Professional Elective - V
18MS2T20	Big Data Analytics
18MS2T12	Advanced Machine Learning
18MS2T22	Computational Biology
18MS2T23	Natural Language Processing
	Open Elective
18MA3T01	Business Analytics
18MA3T02	Industrial Safety
18MA3T03	Operations Research
18MA3T04	Cost Management of Engineering Projects
18MA3T05	Composite Materials
18MA3T06	Waste to Energy

Semester IV								
Type	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
PRACTICAL								
PJ	18MS7L02	Thesis (Part-II) & Seminar	0	0	32	0	0	16
		SUB-TOTAL	**0**	**0**	**32**	**0**	**0**	**16**
		TOTAL	**32**			**16**		

Type	Code	Big Data Analytics	L-T-P	Credits	Marks
PE	18MS2T20		3-0-0	3	100

Objectives	The objective of this course is to learn about importance & use cases of big data, big data analytics with emphasis on map-reduce programming paradigm and related tools, processing and storage requirements of unstructured data using Hadoop ecosystem components, and process of running higher level machine learning algorithms on underlying big data infrastructure.
Pre-Requisites	Knowledge of data structures, programming in Java, and database systems are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction to Big Data**: Definition, Characteristics and evolution, Challenges specific to big data, Sources of big data, Types of big data; Traditional business intelligence vs. big data, Role and importance of big data analytics.	**4 Hours**
Module-2	**Unstructured Data and NoSQL Database Systems**: Aggregate data models, Key-value and document stores, Graph databases, Schemaless databases; Sharding, Replication and Relaxed consistency; Overview of Cassandra, data types and CRUD operations in Cassandra; Basics of MongoDB, MongoDB Query Language.	**10 Hours**
Module-3	**Overview of Hadoop**: RDBMS vs. Hadoop, Architecture and use cases, HDFS design and goals, Block replication and Replication factor, File operations in HDFS, Functioning of Hadoop, Managing applications with YARN, Advantages of YARN.	**9 Hours**
Module-4	**Introduction to MapReduce Programming**: Mappers and Reducers, Phases of MapReduce process, Concepts of combiner and partitioner, Searching and sorting, Word count and Recommender examples.	**9 Hours**
Module-5	**Hadoop Ecosystem**: Introduction to Hive, Features of Hive, Hive data types and query language; Overview to Pig, Pig use cases, Pig data types, Pig Latin, Pig vs. Hive; Basics of Spark, Spark clusters, Batch processing vs. processing of streaming data in Spark, Features and applications of Spark ML library.	**10 Hours**
	Total	**42 Hours**

Text Books:

T1. S. Acharya, S. Chellappan, ***Big Data Analytics***, 1st Edition, Wiley, 2015.
T2. T. White, ***Hadoop: The Definitive Guide***, 3rd Edition, O'Reilly Media, 2012.

Reference Books:

R1. C. Eaton, D. Deroos, T. Deutsch, and G. Lapis, ***Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data***, 1st Edition, McGraw-Hill, 2012.
R2. E. Capriolo, D. Wampler, and J. Rutherglen, ***Programming Hive***, 1st Edition, O'Reilly Media, 2012.
R3. A. Gates, ***Programming Pig***, 1st Edition, O'Reilly Media, 2011.

Online Resources:

1. https://nptel.ac.in/courses/106104189/
2. https://nptel.ac.in/courses/106104135/45
3. http://www.coreservlets.com/hadoop-tutorial/
4. https://cognitiveclass.ai/learn/big-data/
5. https://ocw.mit.edu/resources/res-ll-005-d4m-signal-processing-on-databases-fall-2012/class-videos/mathematics-for-big-data-and-machine-learning/
6. http://work.caltech.edu/telecourse

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the role of big data and its use cases in modern business environments.
CO2	Understand the nature, requirements and operations of unstructured data.
CO3	Learn about data access and processing on a distributed file system using Hadoop.
CO4	Design solutions to big data problems using MapReduce programming paradigm.
CO5	Become familiar with additional components of Hadoop ecosystem, Hive, Pig and Spark.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1				2	1	1	1
CO2	3	3	3	2	1	1				2	3	1	1
CO3	2	3	3	1	1	2				1	2	1	1
CO4	1	3	3	3	1	3				1	3	2	2
CO5	1	3	3	3	2	3			1	1	2	1	2

Type	Code	Advanced Machine Learning	L-T-P	Credits	Marks
PE	18MS2T12		3-0-0	3	100

Objectives	The objective of this course is to learn patterns and information from data by designing and analyzing various advanced machine learning algorithms and techniques with a modern outlook focusing on recent advances.
Pre-Requisites	Knowledge of Engineering Optimization and Matrix Theory are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Gaussian discreminent analysis, Inference in jointly Gaussian distributions, Bayesian statistics, Baysian linear and logistic regression.	**9 Hours**
Module-2	General linear models and exponential family. Mixture models and EM algorithm, Sparse linear models, Review of SVM, Multiclass SVM, kernels for building generative models, Multiple kernels, kernels for strings, trees, and graphs. Gaussian Processes.	**9 Hours**
Module-3	Graphical models- Directed Graphical models (Bayesian networks), Markov and Hidden Markov Models, Markov Random fields, Conditional Random fields.	**9 Hours**
Module-4	Exact inference for graphical models, Variational inference, Monte Carlo inference, MCMC inference, Learning undirected Gaussian graphical models.	**9 Hours**
Module-5	Reinforcement learning and control- MDP, Bellman equations, value iterations and policy iteration, Linear quadratic regulation, LQG,Q-learning Value function approximation, Policy search, Reinforce POMDPs.	**8 Hours**
	Total	**44 Hours**

Text Books:

T1. K. P. Murphy, ***Machine Learning – A Probabilistic Perspective***, MIT Press, 2012.
T2. T. Mitchel, ***Machine Learning***, McGraw-Hill Science, 1997.

Reference Books:

R1. C. Bishop, ***Pattern Recogntion and Machine Learning***, Springer, 2007.
R2. D. Koller and N. Friedman, ***Probalistic Graphical Models: Principles and Techniques***, MIT Press, 2009.
R3. D. Barber, ***Bayesian Reasoning and Machine Learning***, Cambridge University Press, 2012.

Online Resources:

1. http://cs229.stanford.edu/: Machine Learning
2. https://work.caltech.edu/telecourse.html: Learning from Data (Machine learning course)

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Use the building blocks of probabilistic Bayesan learning and logistic regression.
CO2	Understand theoretical principles of EM algorithm and SVM and their applications.
CO3	Develop understanding of Markov and Hidden Markov Models, Markov Random fields and Conditional Random fields.
CO4	Study and use the building blocks of exact inference, Variational inference, Monte Carlo inference and MCMC inference.
CO5	Apply reinforcement learning and control using various methods and tools.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	1	1					2	3	3	2
CO2	2	3	2	2	1					2	3	3	3
CO3	3	2	2	2	1					2	3	2	2
CO4	2	3	2	2	1					2	3	2	2
CO5	3	3	2	2	1					2	2	2	2

Type	Code	Computational Biology	L-T-P	Credits	Marks
PE	18MS2T22		3-0-0	3	100

Objectives	The objective of this course is to learn mapping of biological problems as computational problems, solve them using machine learning algorithms, analyze characteristics of Genes and Proteins using statistical and computational tools, understand Biological data and databases, and use different tools for analysis of biological sequences.
Pre-Requisites	Knowledge of design and analysis of algorithms is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Basic Concepts of Molecular Biology**: Cellular Architecture, Nuclecic Acid (RNA & DNA), DNA Replication, Repair and Recombination, Transcription, Translation, Genetic Code, Gene Expression, Protein structure and function, Molecular biology tools; Statistical Methods: Estimation, Hypothesis Testing, Random Walks, Markov Models (HMM).	**8 Hours**
Module-2	**Suffix Trees**: Definition and examples, Ukkonen's linear-time suffix tree algorithm, Applications – Exact string matching, LCS of two strings, Recognizing DNA contamination, Pair-wise Sequence Alignment (Global, Local), Dynamic Programming approach, Edit distance, Dynamic programming calculation of Edit distance, Gaps.	**10 Hours**
Module-3	**HMM for Pair-wise & Multiple Sequence Alignment**: Need of MSA, Family and Super Family representation, Multiple sequence comparisons for structural inferences, Multiple alignments with sum-of-pairs, Consensus objective functions, Database searching for similar sequences (FASTA, BLAST), PAM, BLOSOM substitution matrices.	**9 Hours**
Module-4	**Sequencing**: Sequencing by Hybridididization, Shortest common super string, Algorithms for overlap multigraph, Fragment Assembly, Protein Sequencing.	**6 Hours**
Module-5	Motif Prediction, Gene prediction, Introduction to protein structure prediction.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. D. Gusfield, ***Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology***, 1st Edition, Cambridge University Press, 1997.
T2. J. C. Setubal and J. Meidanis, ***Introduction to Computational Molecular Biology***, 1st Edition, PWS Publishing Co., 1997.
T3. N. C. Jones, P. A. Pevzner, S. Istrail, and M. S. Waterman, ***An Introduction to Bioinformatics Algorithms (Computational Molecular Biology)***, 1st Edition, MIT Press, 2004.

Reference Books:

R1. W. J. Ewens and G. R. Grant, ***Statistical Methods in Bioinformatics: An Introduction***, 2nd Edition, Springer Science & Business Media, 2006.
R2. R. Durbin, S. R. Eddy, A. Krogh, and G. Mitchison, ***Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids***, 1st Edition, Cambridge University Press, 1998.
R3. R. C. Deonier, S. Tavaré, and M. S. Waterman, ***Computational Genome Analysis: An Introduction***, 1st Edition, Springer Science & Business Media, 2005.
R4. D. E. Krane and M. L. Raymer, ***Fundamental Concepts of Bioinformatics***, 1st Edition, Pearson Education India, 2003.

Online Resources:

1. https://nptel.ac.in/courses/102106065/
2. https://nptel.ac.in/courses/102106068/
3. http://pages.cs.wisc.edu/~bsettles/ibs08/lectures/01-intro.pdf
4. https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the basic concepts of Molecular Biology and concept of some statistical methods such as Hypothesis Testing and Hidden Markov Model.
CO2	Apply Ukkonen's suffix tree algorithm and Dynamic programming method for string matching and sequence alignment respectively.
CO3	Become familiar with different algorithms/tools such as HMM, Sum of Pairs, BLAST for pair-wise and multiple sequence alignment.
CO4	Apply DNA/Protein sequencing problems using various approaches and apply it to identify certain genetic disorders.
CO5	Apply Motif/Gene prediction algorithms for computational drug design.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	1	1	2	1					1	2	2	1
CO2	3	2	1	2	1					1	3	2	1
CO3	3	3	2	3	1					1	2	3	1
CO4	3	2	2	2	1					1	3	3	1
CO5	3	2	2	2	1					1	3	3	1

Type	Code	Natural Language Processing	L-T-P	Credits	Marks
PE	18MS2T23		3-0-0	3	100

Objectives	The objective is to enable the students understand how natural languages are processed by computers to design different human computer interactive systems through natural language processing interfaces.
Pre-Requisites	Knowledge on English grammar rules, Regular Expressions, and Automata Theory is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Natural Language Processing: Need for processing natural languages, issues and processing complexities, Overview of phases of natural language processing; Language Modeling: Various types of languages and its modelling, Grammar based language models, Statistical modelling, n-gram model.	**8 Hours**
Module-2	Word Level Analysis: Regular expressions, Finite state automata, Morphological parsing, Spelling error detection & correction, Part of speech tagging; Syntactic Analysis: Phrase and sentence level constructions; Parsing: Top-down parsing, Bottom-up parsing, A basic top-down parser, the Earley parser, the CYK Parser, Probabilistic parsing.	**10 Hours**
Module-3	Semantic Analysis: Meaning representation, Meaning structure of languages, WordNet, Internal structure of words, Ambiguity, Word sense disambiguation, Information retrieval.	**9 Hours**
Module-4	Discourse Analysis: Context-based word sense disambiguation approaches, Anaphora resolution, Discourse structure; Natural Language Generation: Architecture of language generators, Surface realization, Discourse planning, Template-based, phrase-based and feature-based natural language generation, Knowledge-based approaches.	**9 Hours**
Module-5	Advanced Applications of NLP: Machine Translation System, Text to Speech system, Speech to Text System, Question Answering System, Text Summarization.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. D. Jurafsky and J. H. Martin, ***Speech and Language Processing - An Introduction to Language Processing, Computational Linguistics, and Speech Recognition***, 2nd Edition, Pearson Education, 2003.

T2. T. Siddiqui and U. S. Tiwary, ***Natural Language Processing and Information Retrieval***, 1st Edition, Oxford University Press, 2008.

Reference Books:

R1. J. Allen, ***Natural Language Understanding***, 2nd Edition, Pearson Education, 2008.
R2. C. D. Manning and H. Schütze, ***Foundations of Statistical Natural Language Processing***, 2nd Edition, MIT Press, 2000.

Online Resources:

1. https://nptel.ac.in/courses/106105158/
2. https://blog.algorithmia.com/introduction-natural-language-processing-nlp
3. http://www.nltk.org: Natural Language Toolkit
4. https://towardsdatascience.com/gentle-start-to-natural-language-processing-using-python-6e46c07addf3: Natural Language Processing using Python

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand how natural languages are processed by machine to develop different human computer Interactive systems through natural language interface.
CO2	Apply the knowledge to address various issues in morphological, syntactic, semantic, and pragmatic level for designing NLP applications in different languages.
CO3	Analyze different models and algorithms for wide range of natural language processing tasks.
CO4	Compare, contrast, and evaluate various NLP algorithms, tools, and techniques available and enhance or develop new models.
CO5	Acquire necessary knowledge & skills for designing NLP based software to address different real life problems.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	1			1	2	2	2
CO2	3	3	2	3	2	2	2			2	3	3	3
CO3	3	2	2	2	2	2	2			2	3	3	3
CO4	3	3	3	3	3	3	3			3	3	3	3
CO5	3	3	3	3	3	3	3			3	3	3	3

Type	Code	Business Analytics	L-T-P	Credits	Marks
OE	18MA3T01		3-0-0	3	100

Objectives	The objective of this course is to gain understanding of the role of business analytics within an organization, formulation of decision making problems and solving those problems through statistical and data mining techniques.
Pre-Requisites	Basic knowledge of Statistics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities and real-life applications.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction to Business Analytics**: Evolution and scope of business analytics, Relationship of business analytics and organization, Competitive advantages of business analytics, Overview of problem formulation, data collection, model selection and problem solving	**5 Hours**
Module-2	**Data Exploration**: Visualizing data, Measures of location, dispersion and association, Summarization of grouped and categorical data	**5 Hours**
Module-3	**Descriptive Analytics**: Common probability distributions, Sampling and parameter estimation, Confidence intervals, Hypothesis testing, Analysis of variance.	**12 Hours**
Module-4	**Predictive Analytics**: Regression analysis, Forecasting models for stationary time series and time series with linear trend, Data classification using k-nearest neighbor, logistic regression and association rule mining.	**12 Hours**
Module-5	**Prescriptive Analytics**: Formulating decision problems, Creating decision strategies, Using decision trees and linear optimization, Developing information policy, Ensuring data quality, Measuring contribution of business analytics.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. M. J. Schniederjans, D. G. Schniederjans, and C. M. Starkey, ***Business Analytics: Principles, Concepts, and Applications***, 1st Edition, Pearson FT Press, 2014.
T2. J. Evans, ***Business Analytics***, 2nd Edition, Pearson Education, 2016.

Reference Books:

R1. J. Cadle, M. Eva, K. Hindle, D. Paul, C. Rollason, P. Turner, and D. Yeates, ***Business Analysis***, 3rd Edition, BCS, The Chartered Institute for IT, 2014.
R2. W. Winston, ***Business Analytics: Data Analysis & Decision Making***, 5th Edition, South-Western College Publishing, 2014.
R3. R. Bartlett, ***A Practitioner's Guide To Business Analytics: Using Data Analysis Tools To Improve Your Organization's Decision Making And Strategy***, 1st Edition, McGraw-Hill Professional, 2013.

Online Resources:

1. https://nptel.ac.in/courses/110105089/
2. https://nptel.ac.in/courses/110107092/
3. http://mgencer.com/files/BA/BA464-index.html: Business Analytics Lecture Notes

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Demonstrate broader knowledge of the role and importance of data analytics.
CO2	Explore and visualize data.
CO3	Fit data to specific distributions, estimate parameters and test their hypotheses.
CO4	Demonstrate the ability to use technical skills in predictive analytics.
CO5	Translate data into clear, actionable insights using prescriptive modeling.

Program Outcomes Relevant to the Course:

PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1				1	2					1	1	2	
CO2					2	1	2			2	1	2	1
CO3					2	2		1		1	2	1	1
CO4				2	2	2	1			1	1	1	1
CO5				2	2	2	1			1	1	1	1

Type	Code	Industrial Safety	L-T-P	Credits	Marks
OE	18MA3T02		3-0-0	3	100

Objectives	The objective of this course is to provide knowledge of safety, risk management, laws, hazard analysis & assessment, and topics pertinent to industrial operations and workplace safety.
Pre-Requisites	Basic ideas of industrial safety and regulations would be helpful.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on case studies & real-world examples.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction to Industrial Safety**: Definition, safety policy, organizational safety, accident, causes, types, results and control; Safety concerning wash rooms, drinking water, electrical safety; Cleanliness, pressure vessels, safety color codes, fire prevention and firefighting, equipment and methods.	**8 Hours**
Module-2	**Fundamentals of Maintenance Engineering**: Definition and aim of maintenance engineering; Primary and secondary functions and responsibility of maintenance department; Types of maintenance and applications of tools used for maintenance, Maintenance costs, Service life of equipment, Periodic inspection-concept, cleaning and repairing schemes, repair complexities and its use, definition, need, steps and advantages of preventive maintenance, Steps/procedures for periodic and preventive maintenance.	**8 Hours**
Module-3	**Wear & Corrosion and their Prevention**: Wear – types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general layouts; Corrosion – definition, principle and factors affecting corrosion, Types of corrosion, corrosion prevention methods.	**8 Hours**
Module-4	**Hazard, Risk Issues and Hazard Assessment**: Introduction to hazards, hazard monitoring-risk issue, Hazard assessment, procedure, methodology; Safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), Hazard analysis (HAZAN), hazard operability studies (HAZOP), Types of Hazards, causes and preventive steps/procedures.	**9 Hours**
Module-5	**Regulations for Health, Safety and Environment**: Factories act and rules -– Workmen's Compensation Act; Indian Explosives Act – Gas cylinder rules -– SMPV (Static and Mobile Pressure Vessels) Act – Indian Petroleum Act and Rules; Environmental Protection Act (EPA); Manufacture, Storage and Import of Hazardous Chemical rules 1989, Indian Electricity Act and Rules, Overview of OSHA (US), OHSAS 18000 and ISO 14000 (India); Representative case studies.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. R. K. Jain and S. S. Rao, ***Industrial Safety, Health and Environment Management Systems***, 4th Edition, Khanna Publishers, 2017.

Reference Books:

R1. L. M. Deshmukh, ***Industrial Safety Management***, 1st Edition, Tata McGraw-Hill, 2005.
R2. A. Gupta, ***Industrial Safety and Environment***, 1st Edition, Laxmi Publications, 2006.
R3. R. C. Mishra and K. Pathak, ***Maintenance Engineering and Management***, 2nd Edition, Prentice-Hall India, 2012.
R4. H. P. Garg, ***Industrial Maintenance***, 4th Edition, S. Chand & Co., 2012.

Online Resources:

1. https://nptel.ac.in/courses/110105094/
2. https://nptel.ac.in/courses/112107143/40
3. https://nptel.ac.in/courses/103106071/
4. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-863j-system-safety-spring-2016/lecture-notes/MIT16_863JS16_LecNotes7.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Apply concepts of safety policies used to prevent accidents and recognize hazards.
CO2	Understand fundamentals of maintenance engineering and applications.
CO3	Apply concepts regarding wear, corrosion and their prevention in industrial settings.
CO4	Understand hazards, risk issues and hazard assessment methods.
CO5	Become familiar with regulations for health, safety and environment.

Program Outcomes Relevant to the Course:

PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						1	1		1	1		1	1
CO2						2	1		2	2		1	1
CO3						1	1		1	1	1	2	2
CO4						2	1		2	2	1	2	2
CO5						2	1		2	2	1	2	2

Type	Code	Operations Research	L-T-P	Credits	Marks
OE	18MA3T03		3-0-0	3	100

Objectives	The objective of this course is to know the methods to optimize the processes, algorithms, solve large-scale industrial optimization problems, and implement the solution processes.
Pre-Requisites	Basic concepts of multivariable functions, maxima & minima, matrices, probability theory and capability of understanding algorithmic computation are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Concept of OR, Formulation of Linear Programming models, Graphical Solution, Simplex technique, Solution of artificial variables of LPP.	**8 Hours**
Module-2	Revised Simplex method, Duality theory, Dual Simplex method, Sensitivity Analysis, Integer Programming.	**8 Hours**
Module-3	Non-linear programming problem: Lagrange's method , Kuhn Tucker condition, Quadratic Programming problem, Dynamic Programming: Forward and Backward Recursion, Knapsack/cargo loading model, solution by Bellman's Optimality principle.	**10 Hours**
Module-4	Game theory: Two Person Zero sum game, Games with and without Saddle point, graphical method and LPP model, Scheduling a project with CPM, Scheduling a project with PERT, Time-cost trade offs.	**8 Hours**
Module-5	Queuing model, Birth and death process, Single Server Models, Multi Server Models, non-exponential models; Deterministic Inventory model, continuous and periodic review models.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. H. A. Taha, ***Operations Research: An Introduction***, 8th Edition, Pearson Education, 2007.
T2. F. S. Hiller and G. J. Lieberman, ***Introduction to Operations Research***, 7th Edition, McGraw-Hill Education, 2001.

Reference Books:

R1. K. Swarup, P. K. Gupta, and M. Mohan, ***Operations Research***, 9th Edition, S. Chand & Sons, 2008.
R2. J. K. Sharma, ***Operations Research Theory and Application***, 5th Edition, MacMillan India, 2013.
R3. W. L. Winston, ***Operations Research Application and Algorithm***, 4th Edition, Cengage Learning, 2004.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/111105039/
2. https://nptel.ac.in/courses/108104112/
3. https://nptel.ac.in/courses/111105100/
4. https://nptel.ac.in/courses/105108127/
5. https://nptel.ac.in/courses/106108056/
6. https://nptel.ac.in/courses/108103108/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand and apply simplex method to solve a linear programming problem.
CO2	Apply post optimal analysis methods of a LPP.
CO3	Apply dynamic programming methods to solve problems.
CO4	Understand and apply the concepts of game theory and network analysis in decision making.
CO5	Understand and use queuing and inventory models.

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO2	Apply existing models, techniques, algorithms, data structures, etc. for efficiently solving problems.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO4	Develop understanding and insight of advanced computing techniques and use of advanced tools.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	2	2	3						2	1	1
CO2	3	1	3	3	3						2	1	1
CO3	2	2	3	2	3						3	2	1
CO4	3	2	3	2	3						3	2	1
CO5	3	2	3	2	3						3	2	1

Type	Code	Cost Management of Engineering Projects	L-T-P	Credits	Marks
OE	18MA3T04		3-0-0	3	100

Objectives	The objective of this course is to provide knowledge of cost estimation, cost control, pricing, break-even analysis & budget preparation for engineering projects, and introduce use of quantitative methods, model formulation & applications for solving business decision problems.
Pre-Requisites	Basic knowledge in Mathematics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Objectives of a Costing System; Inventory valuation and control; Creation of a Database for operational control; Provision of data for Decision-Making.	**7 Hours**
Module-2	Project: meaning, different types, why to manage, cost overruns centres; Various Stages of Project Execution: conception to commissioning; Project execution as conglomeration of technical and nontechnical activities; Detailed Engineering activities; Pre project execution main clearances and documents Project team: Role of each member; Importance Project site: Data required with significance; Project contracts, Types and contents; Project execution, Project cost control, Bar charts and Network diagrams, Project commissioning: mechanical and process.	**8 Hours**
Module-3	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis; Various decision-making problems; Standard Costing and Variance Analysis.	**9 Hours**
Module-4	Pricing strategies: Pareto Analysis, Target costing, Life Cycle costing, Costing of service sector, Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints; Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis; Budgetary Control, Flexible Budgets, Performance budgets, Zero-based budgets; Measurement of Divisional profitability pricing decisions including transfer pricing.	**10 Hours**
Module-5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. J. Lal, ***Advanced Management Accounting: Text, Problems and Cases***, 4th Edition, S. Chand Publication, 2016.
T2. A. K. Bhattacharya, ***Principles & Practices of Cost Accounting***, 3rd Edition, PHI, 2010.
T3. N. D. Vohra, ***Quantitative Techniques in Management***, 3rd Edition, Tata McGraw-Hill, 2007.

Reference Books:

R1. C. T. Horngren, S. M. Datar, and M. V. Rajan, ***Cost Accounting: A Managerial Emphasis***, 14th Edition, Prentice Hall of India, 2011.
R2. M. C. Shukla, T. S. Grewal, and M. P. Gupta, ***Cost Accounting: Texts and Problems***, 1st Edition, S Chand & Company, 2007.
R3. R. Panneerselvam, ***Production and Operations Management***, 3rd Edition, PHI, 2012.
R4. M. Y. Khan and P. K. Jain, ***Management Accounting***, 7th Edition, McGraw-Hill Education, 2017.

Online Resources:

1. https://www.scribd.com/doc/78419405/Strategic-Cost-Analysis
2. https://www.accountingtools.com/articles/what-is-inventory-valuation.html
3. http://www.umsl.edu/~sauterv/analysis/488_f02_papers/ProjMgmt.html
4. http://cost-edu.blogspot.com/p/basic-cost-concepts.html
5. https://www.imanet.org.cn/uploads/resource/2015-11/1447060485-6834.pdf
6. http://www.interventions.org/pertcpm/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand the concept of cost accounting and its application in evaluating engineering project.
CO2	Execute the project as per the plan and control the project execution cost.
CO3	Asses how cost-volume-profit is related and uses CVP analysis as a planning and decision making aid.
CO4	Price the products based on different pricing technique.
CO5	Understand the mathematical tools that are needed to solve optimization problems.

Program Outcomes Relevant to the Course:

PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						1			1	1	1	1	1
CO2								1		1			1
CO3						1		1		1		1	1
CO4						1			1	1		2	1
CO5								1	1	1		1	1

Type	Code	Composite Materials	L-T-P	Credits	Marks
OE	18MA3T05		3-0-0	3	100

Objectives	The objective of this course is to classify, manufacturing, physical & mechanical properties and applications of a range of composite materials, and understand the mechanisms of composite deformation and fracture.
Pre-Requisites	Knowledge on materials science, metallurgy and mechanics of solids is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Definition, Classification and Characteristics of Composite materials, Advantages and application of composites, Functional requirements of reinforcement and matrix, Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance, Properties (mechanical, transport, thermal, etc.).	**8 Hours**
Module-2	**Reinforcements**: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers; Properties and applications of whiskers, particle reinforcements, Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures, Isostrain and Isostress conditions.	**8 Hours**
Module-3	**Manufacturing of Metal Matrix Composites**: Casting -– Solid State diffusion technique, Cladding – Hot isostatic pressing, Properties and applications; Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration — Liquid phase sintering; Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving, Properties and applications.	**9 Hours**
Module-4	**Manufacturing of Polymer Matrix Composites**: Preparation of moulding compounds and prepregs (hand layup method, Autoclave method, Filament winding method, Compression moulding, Reaction injection moulding), Properties and applications.	**8 Hours**
Module-5	**Failure of Composites**: Fracture modes in composites, Laminar Failure Criteria – strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure, Laminate first play failure-insight strength; Laminate strength – ply discount truncated maximum strain criterion, stress concentrations.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. W. D. Callister and D. G. Rethwisch, ***Materials Science and Engineering - An introduction***, 10th Edition, Wiley, 2014.
T2. K. K. Chawla, ***Composite Materials: Science and Engineering***, 3rd Edition, Springer, 2012.

Reference Books:

R1. R. F. Gibson, ***Principles of Composite Materials Mechanics***, 2nd Edition, CRC Press, 2007.
R2. B. Harris, ***Engineering Composite Materials***, 2nd Edition, Institute of Metals, 1999.
R3. R. W. Cahn, ***Material Science and Technology, Vol 13 -– Composites***, VCH, West Germany.

Online Resources:

1. https://nptel.ac.in/downloads/112104168/
2. http://www.issp.ac.ru/ebooks/books/open/Composites_and_Their_Properties.pdf
3. https://nptel.ac.in/courses/Webcourse-contents/IIScBANG/Composite%20Materials/pdf/Lecture_Notes/LNm7.pdf
4. https://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Composite%20Materials/pdf/Teacher_Slides/mod2.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Classify and know the properties & applications of composite materials.
CO2	Identify various reinforcing agents and mechanical behavior of composites.
CO3	Know the various manufacturing techniques used in development of metal matrix composites and their applications.
CO4	Recognize the various manufacturing techniques used in development of polymer matrix composites and their applications.
CO5	Understand the various fracture and failures modes of composite materials.

Program Outcomes Relevant to the Course:

PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO8	Understand intellectual property rights and overall professional & ethical responsibility.
PO9	Communicate effectively in a technically sound manner with a wide range of audience.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						1		1	1	1	1		
CO2						1		1	1	1		1	1
CO3						1		1	1	1	1		1
CO4						1		1	1	1		1	1
CO5						1		1	1	1	1	1	1

Type	Code	Waste to Energy	L-T-P	Credits	Marks
OE	18MA3T06		3-0-0	3	100

Objectives	The objective of the course is to provide exposure to working principles of waste to energy schemes, their implementation & current practices, and understand the energy conversion technologies of biomass resources.
Pre-Requisites	Knowledge of engineering chemistry, engineering Physics, Thermodynamics environmental science, basic electrical engineering.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on recent trends & technologies.

Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Energy from Waste: Classification of waste as fuel, Agro based, Forest residue, Industrial waste, MSW, Introduction to Conversion devices, Incinerators, gasifiers, digestors.	**6 Hours**
Module-2	Biomass Pyrolysis: Pyrolysis types, Manufacture, yields and application of charcoal, Manufacture of pyrolytic oils and gases, Biomass Thermo chemical conversion, Direct combustion.	**6 Hours**
Module-3	Biomass Gasification: Fixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers, Gasifier Design, construction and operation, Gasifier burner arrangement for thermal heating, Gasifier engine arrangement, Equilibrium and kinetic consideration in gasifier operation.	**9 Hours**
Module-4	Biomass Combustion: Biomass stoves, Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation of all the above biomass combustors.	**7 Hours**
Module-5	Biogas: Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy systems, Design and constructional features, Biomass resources and their classification, biochemical conversion, anaerobic digestion, Types of biogas Plants, Applications.	**8 Hours**
Module-6	Bioenergy & Biofuels: Alcohol production from biomass (ethanol), Bio diesel production, Urban waste to energy conversion, Biomass energy programme in India; Urban waste to energy conversion.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. A. V. Desai, ***Non Conventional Energy***, Wiley Eastern Ltd., 2011.
T2. K. C. Khandelwal and S. S. Mahdi, ***Biogas Technology: A Practical Hand Book***, Tata McGraw-Hill, 1989.
T3. P. Shilpkar and D. Shilpkar, ***Handbook Of Biogas Technology***, Agrotech Publishing, 2009.
T4. C. Y. W. Brobby and E. B. Hagan, ***Biomass Conversion and Technology***, Wiley-Blackwell, 1996.
T5. H. S. Mukunda, ***Understanding Clean Energy and Fuels from Biomass***, Wiley, 2011.

Reference Books:

R1. R. P. Overend, T. Milne, and L. Mudge, ***Fundamentals of Thermochemical Biomass Energy***, Springer, 2011.
R2. V. C. Nelson and K. L. Starcher, ***Introduction to Bioenergy (Energy and the Environment)***, 1st Edition, CRC Press, 2016.

Online Resources:

1. https://nptel.ac.in/downloads/112104168/
2. http://www.issp.ac.ru/ebooks/books/open/Composites_and_Their_Properties.pdf
3. https://nptel.ac.in/courses/Webcourse-contents/IIScBANG/Composite%20Materials/pdf/Lecture_Notes/LNm7.pdf
4. https://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Composite%20Materials/pdf/Teacher_Slides/mod2.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Understand biomass based resources.
CO2	Understand thermo chemical conversion process of biomass.
CO3	Understand the applications of biomass combustion process in energy conversion.
CO4	Study the design, analysis of biochemical conversion process of biomass.
CO5	Study the design of anaerobic energy conversion system for biomass.
CO6	Study the design of biomass energy conversion to biofuels (biodiesel, gasohol).

Program Outcomes Relevant to the Course:

PO1	Develop an understanding of the theoretical foundations and the limits of computing.
PO3	Design, develop and evaluate new computer based systems for novel applications which meet the desired needs of industry and society.
PO5	Explore ideas and undertake original research at the cutting edge of computer science and its related areas.
PO6	Function effectively as an individual or as a part of a multi-disciplinary team to accomplish defined goals.
PO7	Understand the impact of IT related solutions in an economic, social and environment context.
PO10	Continue to learn independently and engage in life-long learning.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1		1			2					2	1	
CO2	1		1			2					1	1	
CO3	1		1			2					1	1	1
CO4	1		1		1	2	2			1	2		1
CO5	1		1		1	2	2			1	2	1	1
CO6	1		1		1	2	2			1	1	1	1