Rashtreeya Sikshana Samithi Trust

R.V. College of Engineering

(An Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Computer Science and Engineering

Master of Technology (M.Tech.)
in
Computer Science and Engineering

Scheme and Syllabus of
Autonomous System w.e.f 2018

R. V. College of Engineering, Bengaluru – 59

(An Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Computer Science and Engineering

Vision: To achieve leadership in the field of Computer Science and Engineering by strengthening fundamentals and facilitating interdisciplinary sustainable research to meet the ever growing needs of the society.

Mission:

- To evolve continually as a center of excellence in quality education in computers and allied fields.
- To develop state-of-the-art infrastructure and create environment capable for interdisciplinary research and skill enhancement.
- To collaborate with industries and institutions at national and international levels to enhance research in emerging areas.
- To develop professionals having social concern to become leaders in top-notch industries and/or become entrepreneurs with good ethics.

Program Outcomes (PO)
The graduates of M. Tech. in Computer Science and Engineering (CSE) Program will be able to:

PO1 Independently carry out research and development work to solve practical problems related to Computer Science and Engineering domain.

PO2 Write and present a substantial technical report/document.

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

PO4 Acquire knowledge to evaluate, analyze complex problems by applying principles of Mathematics, Computer Science and Engineering with a global perspective.

PO5 Explore, select, learn and model applications through use of state-of-art tools.

PO6 Recognize opportunities and contribute synergistically towards solving engineering problems effectively, individually and in teams, to accomplish a common goal and exhibit professional ethics, competence and to engage in lifelong learning.

Program Specific Criteria for M.Tech in Computer Science and Engineering

Professional Bodies: IEEE-CS, ACM

The M.Tech in Computer Science and Engineering curriculum is designed to enable the students to (a) analyze the problem by applying design concepts, implement the solution, interpret and visualize the results using modern tools (b) acquire breadth and depth wise knowledge in computer science domain (c) be proficient in Mathematics and Statistics, Humanities, Ethics and Professional Practice, Computer Architecture, Analysis of Algorithms, Advances in Operating Systems, Computer Networks and Computer Security courses along with elective courses (d) critically think and solve problems, communicate with focus on team work.

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Department of Computer Science and Engineering

M. Tech. in Computer Science and Engineering

Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION			Total Credits
				Lecture L	Tutorial T	Practical P	
1.	18 MAT 11B	Probability Theory and Linear Algebra	MT	3	1	0	4
2.	18 MCE 12	Advances in Algorithms and Applications	CS	3	1	1	5
3.	18 MCE 13	Data Science	CS	3	1	1	5
4.	18 MCE 14x	Elective-1	CS	4	0	0	4
5.	18 MCE 15x	Elective-2	CS	4	0	0	4
6.	18 HSS 16	Professional Skills Development	HSS	0	0	0	0
			Total	**17**	**3**	**2**	**22**

LIST OF ELECTIVE COURSES

Elective 1	
18 MCE 141	Computer Network Technologies
18 MCE 142	Data Preparation and Analysis
18 MCE 143 / 18 MCN 143	Applied Cryptography
Elective 2	
18 MCE 151 / 18 MCN 151	Cloud Computing Technology
18 MCE 152 / 18 MMD 152 / 18 MCM 152	Intelligent Systems
18 MCE 153 / 18 MCN 153	Wireless Network Security

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Department of Computer Science and Engineering

M. Tech. in Computer Science and Engineering

Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION			Total Credits
				Lecture L	Tutorial T	Practical P	
1.	18 MCE 21	Big Data Analytics	CS	3	1	1	5
2.	18 MCE 22	Parallel Computer Architecture	CS	3	1	0	4
3.	18 IEM 23	Research Methodology	IEM	3	0	0	3
4.	18 MCE 24x	Elective-3	CS	4	0	0	4
5.	18 MCE 25x	Elective-4	CS	4	0	0	4
6.	18 GXX 26x	Global Elective	CS	3	0	0	3
7.	18 MCE 27	Minor Project	CS	0	0	2	2
			Total	**20**	**2**	**3**	**25**

LIST OF ELECTIVE COURSES

Elective 3	
18 MCE 241	Wireless and Mobile Networks
18 MCE 242	Natural Language Processing
18 MCE 243 / 18 MCN 243	Cloud Security
Elective 4	
18 MCE 251 / 18 MCN 251	Internet of Things and Applications
18 MCE 252 / 18 MCS 252	Deep Learning
18 MCE 253 / 18 MCN 253	Security Engineering
Global Elective	
18 GCS 261	Business Analytics
18 GCV 262	Industrial & Occupational Health And Safety
18 GIM 263	Modeling Using Linear Programing
18 GIM 264	Project Management
18 GCH 265	Energy Management
18 GME 266	Industry 4.0
18 GME 267	Advanced Materials

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Department of Computer Science and Engineering
M. Tech. in Computer Science and Engineering

THIRD SEMESTER							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**			**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	
1	18 MCE 31	Operating System Design	CS	4	1	0	5
2	18 MCE 32x	Elective-5	CS	4	0	0	4
3	18 MCE 33	Internship	CS	0	0	5	5
4	18 MCE 34	Dissertation Phase I	CS	0	0	5	5
		Total		**8**	**1**	**10**	**19**

LIST OF ELECTIVE COURSES

Elective 5	
18 MCE 321 / 18 MCN 321	Software Defined Systems
18 MCE 322	Web Analytics and Development
18 MCE 323 / 18 MCN 323	Cyber Security

FOURTH SEMSESTER							
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**			**Credits**
				L	**T**	**P**	
1	18 MCE 41	Dissertation Phase II	CS	0	0	20	20
2	18 MCE 42	Technical Seminar	CS	0	0	2	2
		Total		**0**	**0**	**22**	**22**

FIRST SEMESTER

PROBABILITY THEORY AND LINEAR ALGEBRA						
Course Code	**:**	**18MAT11B**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **09 Hrs**

Matrices and Vector spaces :
Geometry of system of linear equations, vector spaces and subspaces, linear independence, basis and dimension, four fundamental subspaces, Rank-Nullity theorem(without proof), linear transformations.

Unit – II **09 Hrs**

Orthogonality and Projections of vectors:
Orthogonal Vectors and subspaces, projections and least squares, orthogonal bases and Gram-Schmidt orthogonalization, Computation of Eigen values and Eigen vectors, diagonalization of a matrix, Singular Value Decomposition.

Unit – III **10 Hrs**

Random Variables:
Definition of random variables, continuous and discrete random variables, Cumulative distribution Function, probability density and mass functions, properties, Expectation, Moments, Central moments, Characteristic functions.

Unit – IV **10 Hrs**

Discrete and Continuous Distributions:
Binomial, Poisson, Exponential, Gaussian distributions.
Multiple Random variables:
Joint PMFs and PDFs, Marginal density function, Statistical Independence, Correlation and Covariance functions, Transformation of random variables, Central limit theorem (statement only).

Unit – V **09 Hrs**

Random Processes:
Introduction, Classification of Random Processes, Stationary and Independence, Auto correlation function and properties, Cross correlation, Cross covariance functions. Markov processes, Calculating transition and state probability in Markov chain.

Expected Course Outcomes:
After completion of the course, the students should have acquired the ability to:

- CO1: Demonstrate the understanding of fundamentals of matrix theory, probability theory and random process.
- CO2: Analyze and solve problems on matrix analysis, probability distributions and joint distributions.
- CO3: Apply the properties of auto correlation function, rank, diagonalization of matrix, verify Rank - Nullity theorem and moments.
- CO4: Estimate Orthogonality of vector spaces, Cumulative distribution function and characteristic function. Recognize problems which involve these concepts in Engineering applications.

Reference Books:	
1.	T. Veerarajan, Probability, Statistics and Random Processes, 3rd Edition, Tata McGraw Hill Education Private Limited, 2008, ISBN:978-0-07-066925-3.
2.	Scott. L. Miller and Donald. G. Childers, "Probability and Random Processes With Applications to Signal Processing and Communications", Elsevier Academic Press, 2nd Edition, 2012, ISBN 9780121726515.
3.	Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, 4th Edition, 2006, ISBN 97809802327.
4.	Seymour Lipschutz and Marc Lipson, Schaum's Outline of Linear Algebra, 5th Edition, McGraw Hill Education, 2012, ISBN-9780071794565.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

ADVANCES IN ALGORITHMS AND APPLICATIONS (Theory and Practice)			
Course Code:	**18MCE12**		**CIE Marks: 100+50**
Hrs/week	**L:T:P**	**3:2:2**	**SEE Marks: 100+50**
Credits:	**5**		**SEE: 3 Hrs**

Unit – I	**07 Hrs**
Analysis techniques: Growth of functions: Asymptotic notation, Standard notations and common functions, Substitution method for solving recurrences, Recursion tree method for solving recurrences, Master theorem. **Sorting in Linear Time** Lower bounds for sorting , Counting sort, Radix sort, Bucket sort	
Unit – II	**08 Hrs**
Advanced Design and Analysis Technique Matrix-chain multiplication, Longest common subsequence. An activity-selection problem, Elements of the greedy strategy **Amortized Analysis** Aggregate analysis, The accounting method , The potential method	
Unit – III	**07 Hrs**
Graph Algorithms Bellman-Ford Algorithm, Shortest paths in a DAG, Johnson's Algorithm for sparse graphs. **Maximum Flow:** Flow networks, Ford Fulkerson method and Maximum Bipartite Matching	
Unit – IV	**07 Hrs**
Advanced Data structures Structure of Fibonacci heaps, Mergeable-heap operations, Decreasing a key and deleting a node, Disjoint-set operations, Linked-list representation of disjoint sets, Disjoint-set forests. **String Matching Algorithms:** Naïve algorithm, Rabin-Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm	
Unit – V	**07 Hrs**
Multithreaded Algorithms The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort	

Unit – VI (Lab Component)	**2 Hrs/Week**

Solve case studies by applying relevant algorithms and calculate complexity.

For example:

1. Applied example of graph Algorithm
2. Real world applications of Advanced Data Structures
3. Real applications of Maximum Flow
4. String matching algorithms

Sample Experiment:

1. Write code for an appropriate algorithm to find maximal matching.

Six reporters Asif (A), Becky (B), Chris (C), David (D), Emma (E) and Fred (F), are to be assigned to six news stories Business (1), Crime (2), Financial (3), Foreign(4), Local (5) and Sport (6). The table shows possible allocations of reporters to news stories. For example, Chris can be assigned to any one of stories 1, 2 or 4.

	1	2	3	4	5	6
A					✓	
B	✓			✓		
C	✓	✓		✓		
D					✓	
E			✓		✓	✓
F				✓		

2. The table shows the tasks involved in a project with their durations and immediate predecessors.

Task	Duration (Days)	Immediate predecessors
A	2	
B	4	
C	5	A,B
D	3	B
E	6	C
F	3	C
G	8	D
H	2	D,F

Find minimum duration of this project.

Course Outcome: At the end of the course the student will be able to: CO1: Explore the fundamentals in the area of algorithms by analysing various types of algorithms. CO2: Analyze algorithms for time and space complexity for various applications CO3: Apply appropriate mathematical techniques to construct robust algorithms. CO4: Demonstrate the ability to critically analyze and apply suitable algorithm for any given problem.		
REFERENCE BOOKS:		
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms; Columbia University", 3rd Edition, 2009, ISBN: 978-0262033848	
2.	Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Addison-Wesley, 3rd Edition, 2007, ISBN: 978-0132847377	
3.	Kozen DC, "The design and analysis of algorithms", Springer Science & Business Media, 2012, ISBN: 978-0387976877	
4.	Kenneth A. Berman, Jerome L. Paul,"Algorithms", Cengage Learning, 2002. ISBN: 978-8131505212	

Scheme of Continuous Internal Evaluation (CIE) for Theory 100 marks:
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Scheme of Semester End Examination (SEE) for Theory 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

Scheme of Continuous Internal Evaluation (CIE) for Practical 50 Marks:
CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 30 marks. One test will be conducted for 20 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Practical 50 Marks:
SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks is 50.

DATA SCIENCE (Theory and Practice)						
Course Code	**:**	**18MCE13**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P**	**3:2:2**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction to Data mining and machine learning: Describing structural patterns, Machine learning, Data mining, Simple examples, Fielded applications, Machine learning and statistics, Generalization as search, Enumerating the concept space, Bias.	
Unit – II	**08 Hrs**
The data science process: The roles in a Data Science project, Project roles, Stages of a data science project, Defining the goal, Data collection and management, Modelling, Model evaluation and critique, Presentation and documentation, Model deployment and maintenance, setting expectations, Determining lower and upper bounds on model performance, Choosing and evaluating models. Mapping problems to machine learning tasks, Solving classification problems, Solving scoring, Working without known targets, Problem-to-method mapping, Evaluating models, Evaluating classification models, Evaluating scoring, Evaluating probability models, Evaluating ranking models, Evaluating clustering models, Validating models.	
Unit – III	**07 Hrs**
Output knowledge representation: Decision trees, association rule mining: Association rule mining, Apriori Algorithm, Statistical modeling, Divide-and-conquer: Constructing decision trees.	
Unit – IV	**07 Hrs**
Linear Models: Linear regression, logistic regression, Extending linear models, Instance-based learning, Bayesian Networks, Combining multiple models.	
Unit-V	**07 Hrs**
K-Nearest Neighbors, Support Vector Machines Maximal Margin Classifier, Support Vector Classifiers, Classification with Non-linear Decision Boundaries, Unsupervised Learning: Principal Components Analysis, clustering methods: k means, hierarchical clustering.	
UNIT-VI (Lab Component)	**2 Hrs/week**

Using Open source tools(R/Python) design and execute for a given large dataset:

1. Principal Components Analysis
2. Decision Trees: Fitting Classification and Regression Trees, Bagging and Random Forests, Boosting.
3. Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, and K-Nearest Neighbors.
4. Support Vector Machines: Support Vector Classifier, ROC Curves, SVM with Multiple Classes
5. Clustering: K-Means and Hierarchical Clustering

Course Outcomes:

After going through this course the student will be able to:

CO1: Explore and apply Machine Learning Techniques to real world problems.
CO2: Evaluate different mathematical models to construct algorithms.
CO3: Analyze and infer the strength and weakness of different machine learning models
CO4: Implement suitable supervised and unsupervised machine learning algorithms for various applications.

References:

1.	Ian H. Witten & Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, 2nd edition, Elsevier Morgan Kaufmann Publishers, 2005, ISBN: 0-12-088407-0
2.	Nina Zumel and John Mount, “Practical data science with R”, Manning Publications, March 2014, ISBN 9781617291562
3.	Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, ISSN 1431-875X,ISBN 978-1-4614-7137-0 ISBN 978-1-4614-7138-7 (eBook), DOI 10.1007/978-1-4614-7138-7,2015,Springer Publication.
4.	Jiawei Han and Micheline Kamber: Data Mining – Concepts and Techniques, Third Edition, Morgan Kaufmann, 2006, ISBN 1-55860-901-6

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Scheme of Semester End Examination (SEE) for Theory 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

Scheme of Continuous Internal Evaluation (CIE) for Practical 50 Marks:

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 30 marks. One test will be conducted for 20 marks. The total marks for CIE (Practical) will be for 50 marks

Scheme of Semester End Examination (SEE) for Practical 50 Marks:

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks is 50.

COMPUTER NETWORK TECHNOLOGIES (Elective-1)						
Course Code	**:**	**18MCE141**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Foundations and Internetworking

Network Architecture- layering & Protocols, Internet Architecture, Implementing Network Software-Application Programming Interface (sockets), High Speed Networks, Ethernet and multiple access networks (802.3), Wireless-802.11/Wi-Fi, Bluetooth(802.15.1), Cell Phone Technologies.Switching and Bridging, Datagrams, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches.

Unit – II	**09 Hrs**

Internetworking

Internetworking, Service Model, Global Addresses, Special IP addresses, Datagram Forwarding in IP, Subnetting and classless addressing-Classless Inter-domain Routing(CIDR), Address Translation(ARP), Host Configuration(DHCP), Error Reporting(ICMP), Routing, Routing Information Protocol(RIP), Routing for mobile hosts, Open Shortest Path First(OSPF), Switch Basics-Ports, Fabrics, Routing Networks through Banyan Network.

Unit – III	**10 Hrs**

Advanced Internetworking

Router Implementation, Network Address Translation(NAT), The Global Internet-Routing Areas, Interdomain Routing(BGP), IP Version 6(IPv6), extension headers, Multiprotocol Label Switching(MPLS)-Destination Based forwarding, Explicit Routing, Virtual Private Networks and Tunnels, Routing among Mobile Devices- Challenges for Mobile Networking, Routing to Mobile Hosts(MobileIP), Mobility in IPv6.

Unit – IV	**09 Hrs**

End-to-End Protocols

Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Sliding Window Revisited, Triggering Transmission-Silly Window Syndrome, Nagle's Algorithm, Adaptive Retransmission-Karn/Partridge Algorithm, Jacobson Karels Algorithm, Record Boundaries, TCP Extensions, Real-time Protocols

Unit – V	**10 Hrs**

Congestion Control/Avoidance and Applications

Queuing Disciplines-FIFO, Fair Queuing, TCP Congestion Control-Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery, Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. Network Management: Network Management System; Simple Network Management Protocol (SNMP) - concept, management components, SMI, MIB, SNMP messages, *features of SNMPv3*. What Next: Internet of Things, Cloud Computing, The Future Internet, Deployment of IPv6

Course Outcomes:

After going through this course the student will be able to:

CO1: Gain knowledge on networking research by studying a combination of functionalities and services of networking.

CO2: Analyze different protocols used in each layer and emerging themes in networking research.

CO3: Design various protocols and algorithms in different layers that facilitates effective communication mechanisms.

CO4: Apply emerging networking topics and solve the challenges in interfacing various protocols in real world.

Reference Books:

	1.	Larry Peterson and Bruce S Davis "Computer Networks: A System Approach", 5th edition, Elsevier, 2014, ISBN-13:978-0123850591, ISBN-10:0123850592.
2.		Behrouz A. Forouzan, "Data Communications and Networking", 5th Edition, Tata McGraw Hill, 2013,ISBN: 9781259064753
3.		S.Keshava, "An Engineering Approach to Computer Networking", 1st edition, Pearson Education, ISBN-13: 978-0-201-63442-6
4.		Andrew S Tanenbaum, Computer Networks, 5th edition, Pearson, 2011, ISBN-9788-177-58-1652.

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Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

Data Preparation and Analysis (Elective-1)						
Course Code	**:**	**18MCE142**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**
Data Objects and Attribute Types: Attributes, Nominal Attributes, Binary Attributes, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes. **Basic Statistical Descriptions of Data:** Measuring the Central Tendency: Mean, Median, and Mode , Measuring the Dispersion of Data: Range, Quartiles, Variance, Standard Deviation, and Inter quartile Range, Graphic Displays of Basic Statistical Descriptions of Data	
Unit – II	**09 Hrs**
Measuring Data Similarity and Dissimilarity: Data Matrix versus Dissimilarity Matrix, Proximity Measures for Nominal Attributes, Proximity Measures for Binary Attributes, Dissimilarity of Numeric Data: Minkowski Distance, Proximity Measures for Ordinal Attributes, Dissimilarity for Attributes of Mixed Types, Cosine Similarity.	
Unit – III	**09 Hrs**
Data Preprocessing: An Overview, Data Quality: Need of Preprocessing the Data, Major Tasks in Data Preprocessing. **Data Cleaning:** Missing Values, Noisy Data, Data Cleaning as a Process. **Data Integration:** Entity Identification Problem, Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Resolution. **Data Reduction:** Overview of Data Reduction Strategies, Wavelet Transforms, Principal Components Analysis, Attribute Subset Selection, Regression and Log-Linear Models: Parametric, Data Reduction, Histograms, Clustering, Sampling, Data Cube Aggregation.	
Unit – IV	**09 Hrs**
Data Transformation and Data Discretization: Data Transformation Strategies Overview, Data Transformation by Normalization, Discretization by Binning, Discretization by Histogram Analysis, Discretization by Cluster, Decision Tree, and Correlation Analyses, Concept Hierarchy Generation for Nominal Data. **Data Visualization:** Pixel-Oriented Visualization Techniques, Geometric Projection Visualization Techniques, Icon-Based Visualization Techniques, Hierarchical Visualization Techniques, Visualizing Complex Data and Relations.	
Unit – V	**10 Hrs**
Mining Complex Data Types: Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences, Mining Graphs and Networks, Mining Other Kinds of Data. **Other Methodologies of Data Mining:** Statistical Data Mining, Views on Data Mining	

Foundations, Visual and Audio Data Mining. **Data Mining Applications:** Data Mining for Financial Data Analysis , Data Mining for Retail and Telecommunication Industries, Data Mining in Science and Engineering, Data Mining for Intrusion Detection and Prevention, Data Mining and Recommender Systems, Data Mining and Society**:** Ubiquitous and Invisible Data Mining, Privacy, Security, and Social Impacts of Data Mining
Course Outcomes: After going through this course the student will be able to: CO1: Explore the data of various domains, for preprocessing CO2: Analyze the various techniques of data cleaning performing data analysis. CO3: Apply various techniques for data extraction from dataset CO4: Visualize the data using different tools for getting better insight.

References:

1	Jiawei Han and Micheline Kamber: Data Mining – Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2006, ISBN 1-55860-901-6
2	Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Pearson Education, 2007, ISBN 9788131714720
3	Insight into Data Mining, Theory & Practice by K. P. Soman, Shyam Diwakar, V. Ajay, PHI – 2006, ISBN: 978-81-203-2897-6
4	Ian H Witten & Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, 2nd edition, Elsevier Morgan Kaufmann Publishers, 2005, ISBN: 0-12-088407-0

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APPLIED CRYPTOGRAPHY (Elective-1)						
Course Code	**:**	**18MCE143/18MCN143**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**
Overview of Cryptography: Introduction, Information security and cryptography: Background on functions: Functions (1-1, one-way, trapdoor one-way), Permutations, and Involutions. Basic terminology and concepts, Symmetric-key encryption: Overview of block ciphers and stream ciphers, Substitution ciphers and transposition ciphers, Composition of ciphers, Stream ciphers, The key space. Classes of attacks and security models: Attacks on encryption schemes, Attacks on protocols, Models for evaluating security, Perspective for computational security.	
Unit – II	**09 Hrs**
Mathematical Background: Probability: Basic definitions, Conditional probability, Random variables, Binomial distribution, Birthday attacks and Random mappings. Information theory: Entropy, Mutual information. Number theory: The integers, Algorithms in Z, The integers modulo n, Algorithms in Zn, Legendre and Jacobi symbols, Blum integers. Abstract Algebra: Groups, Rings, Fields, Polynomial rings, Vector spaces.	
Unit – III	**09 Hrs**
Stream Ciphers: Introduction: Classification, Feedback shift registers: Linear feedback shift registers, Linear complexity, Berlekamp-Massey algorithm, Nonlinear feedback shift registers. Stream ciphers based on LFSRs: Nonlinear combination generators, Nonlinear filter generators, Clock-controlled generators. Other stream ciphers: SEAL.	
Unit – IV	**09 Hrs**
Block Ciphers: Introduction and overview, Background and general concepts: Introduction to block ciphers, Modes of operation, Exhaustive key search and multiple encryption. Classical ciphers and historical development: Transposition ciphers (background), Substitution ciphers (background), Polyalphabetic substitutions and Vigenere ciphers (historical). Polyalphabetic cipher machines and rotors (historical), Cryptanalysis of classical ciphers (historical).	
Unit – V	**10 Hrs**
Identification and Entity Authentication: Introduction, Passwords (weak authentication), Challenge-response identification (strong authentication), Customized and zero-knowledge identification protocols: Overview of zero-knowledge concepts, Feige-Fiat-Shamir identification protocol, GQ identification protocol, Schnorr identification protocol, Comparison: Fiat-Shamir, GQ, and Schnorr, Attacks on identification protocols.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Analyze background on functions, composition of ciphers and attacks on encryption schemes. CO2: Evaluate mathematical background on cryptographic functions. CO3: Identify stream cipher and block cipher algorithms and functionalities. CO4: Evaluate identification and Entity authentication schemes.	
Reference Books:	
1	Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, “HANDBOOK of APPLIED CRYPTOGRAPHY” CRC Press, Taylor and Francis Group, ISBN-13: 978-0-84-938523-0.
2	Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C", 2nd Edition, ISBN:0-471-22357-3.
3	William Stallings, "Cryptography and Network Security", 6th Edition, ISBN-13: 978-0-13-335469-0.
4	Niels Ferguson, Bruce Schneier, Tadayoshi Kohno “Cryptography Engineering: Design Principles and Practical Applications” 2010, Wiley. ISBN: 978-0-470-47424-2.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

CLOUD COMPUTING TECHNOLOGY (Elective-2)						
Course Code	**:**	**18MCE151/18MCN151**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Introduction, Cloud Infrastructure

Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Major challenges faced by cloud computing; Cloud Infrastructure: Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Service- and compliance-level agreements, User experience and software licensing. Exercises and problems

Unit – II	**09 Hrs**

Cloud Computing: Application Paradigms

Challenges of cloud computing, Existing Cloud Applications and New Application Opportunities, Workflows: coordination of multiple activities, Coordination based on a state machine model: The ZooKeeper, The MapReduce Programming model, A case study: The Grep TheWeb application, HPC on cloud, Biology research

Unit – III	**09 Hrs**

Cloud Resource Virtualization.

Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and para virtualization, Hardware support for virtualization, Case Study: Xen a VMM based para virtualization, Optimization of network virtualization, The darker side of virtualization, Exercises and problems.

Unit – IV	**10 Hrs.**

Cloud Resource Management and Scheduling

Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers; Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Exercises and problems.

Unit – V	**09 Hrs**

Cloud Security, Cloud Application Development

Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to

launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis. Exercises and problems. Amazon Simple Notification services.

Latest topics:
Google messaging, Android Cloud to Device messaging, Isolation mechanisms for data privacy in cloud, Capability-oriented methodology to build private clouds.

Course Outcomes:
After going through this course the student will be able to:

CO1: Explain industry relevance of cloud computing and its intricacies, in terms of various challenges, vulnerabilities, SLAs, virtualization, resource management and scheduling, etc.
CO2: Examine some of the application paradigms, and Illustrate security aspects for building cloud-based applications.
CO3: Conduct a research study pertaining to various issues of cloud computing.
CO4: Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service on that.

Reference Books:

1.	Dan C Marinescu: Cloud Computing Theory and Practice. Elsevier (MK), 1st edition, 2013, ISBN: 9780124046276.
2.	Kai Hwang, Geoffery C.Fox, Jack J Dongarra: Distributed Computing and Cloud Computing, from parallel processing to internet of things. Elsevier(MK), 1st edition, 2012, ISBN: 978-0-12-385880-1
3.	Rajkumar Buyya, James Broberg, Andrzej Goscinski: Cloud Computing Principles and Paradigms, Willey, 1st Edition, 2014, ISBN: 978-0-470-88799-8.
4.	John W Rittinghouse, James F Ransome: Cloud Computing Implementation, Management and Security, CRC Press, 1st Edition, 2013, ISBN: 978-1-4398-0680-7.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

INTELLIGENT SYSTEMS
(Elective-2)
(Common to CSE-CNE, MECH-MD, MECH-CIM)

Course Code	**:**	**18MCE152 / 18MMD152/18MCM152**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **09 Hrs**

Overview of Artificial Intelligence: Artificial Intelligence and its Application areas;
Knowledge Representation and Search: The Predicate Calculus :The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor;
Structures and strategies for state space search: Introduction, Structures for state space search ,Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/Or Graphs;

Unit – II **09 Hrs**

Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues.
Control and Implementation of State Space Search: Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving.

Unit – III **09 Hrs**

Other Knowledge Representation Techniques: Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs.
Knowledge Intensive Problem Solving : Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems
Planning: Introduction to Planning, Algorithms as State-Space Search, Planning graphs.

Unit – IV **09 Hrs**

Automated Reasoning: Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving;
Uncertain Knowledge and Reasoning:
Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes' Rule and its use.
Representing Knowledge in Uncertain Domain:
Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network

Unit-V	**10 Hrs**
Introduction to Learning: Forms of Learning: Supervised learning, Unsupervised Learning, Semi-Supervised and Reinforcement Learning; Parametric Models & Non-Parametric Models, Classification and Regression problems **Artificial Neural Networks:** ANN Structures, Single Layer feed-forward neural networks, Multi-Layer feed-forward neural networks, Learning in multilayer networks, networks. **Artificial Intelligence Current Trends :** The Science of Intelligent Systems, AI: Current Challenges and Future Directions;	

Course Outcome:

At the end of this course graduates will be able to:

CO1. Explore various Artificial Intelligence problem solving techniques.

CO2. Identify and describe the different AI approaches such as Knowledge representation, Search strategies, learning techniques to solve uncertain imprecise, stochastic and nondeterministic nature in AI problems.

CO3. Apply the AI techniques to solve various AI problems.

CO4. Analyze and compare the relative challenges pertaining to design of Intelligent Systems.

Reference Books

1.	George F Luger, “Artificial Intelligence – Structures and Strategies for Complex problem Solving”, 6th Edition, Pearson Publication, 2009, ISBN-10: 0-321-54589-3, ISBN-13: 978-0-321-54589-3
2.	Stuart Russel, Peter Norvig, “Artificial Intelligence A Modern Approach”, 3rd Edition, Pearson Publication, 2015, ISBN-13: 978-93-325-4351-5
3.	Elaine Rich, Kevin Knight, “Artificial Intelligence”, 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709, ISBN-13: 978-0070087705
4.	Grosan, Crina, Abraham, Ajith, "Intelligent Systems-A Modern Approach", Springer-Verlag Berlin Heidelberg 2011, ISBN 9783642269394, 2011.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

WIRELESS NETWORKS SECURITY (Elective-2)						
Course Code	**:**	**18MCE153/18MCN153**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Graduates shall be able to

1. Explore the principles of wireless networks security technology
2. Illustrate the secure design of wireless network with various protocols
3. Analyze and choose the suitable wireless security technology based on requirements.
4. Investigate the upcoming security trends and threats in the wireless applications

Unit – I	**09 Hrs**

Overview of wireless network security technology: Wireless network security fundamentals, Types of wireless network security Technology, Elements of wireless security, Available solutions and policies for wireless security, Perspectives- prevalence and issues for wireless security, Inverted security model

Unit – II	**09 Hrs**

Designing wireless network security: Wireless network security design issues , Cost justification and consideration –hitting where it hurts, assess your vulnerable point, security as Insurance, consequences of breach, Standard design issues- switches, flexible IP address assignment, router filtering, bandwidth management, firewalls and NAT, VLAN, VPN, Remote access security, third party solutions

Unit – III	**09 Hrs**

Installing and deploying wireless network security: Testing techniques- Phase I to IV, Internetworking Wireless Security - Operation modes of Performance Enhancing Proxy (PEP), Adaptive usage of PEPs over a Radio Access Network (RAN), Problems of PEP with IPSec, Problems of Interworking between PEP and IPSec, Solutions, Installation and Deployment

Unit – IV	**10 Hrs**

Security in Wireless Networks and Devices: Introduction, Cellular Wireless Communication Network Infrastructure , Development of Cellular Technology, Limited and Fixed Wireless Communication Networks , Wireless LAN (WLAN) or Wireless Fidelity (Wi-Fi) , WLAN (Wi-Fi) Technology, Mobile IP and Wireless Application Protocol, Standards for Wireless Networks , The IEEE 802.11, Bluetooth, Security in Wireless Networks, WLANs Security Concerns,
*Best Practices for Wi-Fi Security

Unit – V	**09 Hrs**

Security in Sensor Networks : Introduction , The Growth of Sensor Networks, Design Factors in Sensor Networks , Routing , Power Consumption, Fault Tolerance, Scalability , Product Costs, Nature of Hardware Deployed , Topology of Sensor Networks, Transmission Media, Security in

Sensor Networks, Security Challenges, Sensor Network Vulnerabilities and Attacks, Securing Sensor Networks *Security Mechanisms and Best Practices for Sensor Networks, Trends in Sensor Network Security Research
Course Outcomes: After going through this course the student will be able to: **CO1:** Explore the existing threats in wireless networks and security issues **CO2:** Design suitable security in wireless networks depending on context **CO3:** Analyze the wireless installation and deployment techniques in real-world networks **CO4:** Improve the security and energy management issues for the wireless devices
Reference Books:

1.	John R.Vacca, "Guide to Wireless Network security", 1st edition, 2006, Springer Publishers, ISBN 978-0-387-29845-0
2.	Joseph Migga Kizza, "A Guide to Computer Network Security", Springer, 2009, ISBN: 978-1-84800-916-5
3.	William Stallings, Cryptography and Network Security,4th edition, November 16, 2005, ISBN 13: 9780131873162
4*	Technical Journal papers and manuals.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

SECOND SEMESTER

BIG DATA ANALYTICS (Theory and Practice)						
Course Code	**:**	**18MCE21**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L: T: P**	**3:2:2**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **08 Hrs**

INTRODUCTION TO NoSQL and BIG DATA
Classification of Digital Data: Structured, Semi-Structured and Unstructured data.

NoSQL: Where is it used?, What is it?, Types of NoSQL Databases, Why NoSQL?, Advantages of NoSQL, SQL versus NoSQL, NewSQL, Comparison of SQL, NoSQL and NewSQL,

Elasticsearch: Talking to Elastic Search: Document Oriented, Finding your feet, Life inside Cluster: Scale Horizontally, Coping with Failure, Data-in Data-out: Document Metadata, Indexing a document, Retrieving a document.
Introduction to Big Data: Distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications.

Unit – II — **07 Hrs**

HADOOP ARCHITECTURE
Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read, NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance.

Unit – III — **07 Hrs**

HADOOP ECOSYSTEM AND YARN
Hadoop ecosystem components - SPARK, FLUME, Hadoop 2.0 New Features- NameNode High Availability, HDFS Federation, MRv2, YARN

Unit – IV — **07 Hrs**

Real-Time Applications in the Real World
Using HBase for Implementing Real-Time Applications- Using HBase as a Picture Management System Using Specialized Real-Time Hadoop Query Systems Apache Drill, Using Hadoop-Based Event-Processing Systems HFlame, Storm

Unit-V — **07 Hrs**

HIVE AND HIVEQL, HBASE
Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating. HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper

UNIT-VI (Lab Component)	**2 Hrs/Week**

Exercise 1 --- Elastic Search

Build a platform to manage published journal papers:
Each journal document can have various attributes like,

1. Name
2. List of Author
3. Abstract
4. Content
5. Name of conference where the paper is published
6. Name of the journal where paper is published
7. Date of publication
8. List of references
9. Subject

An Author can have various attributes like

1. Name
2. Contact
3. University
4. Department
5. Designation

There are two types of users in the system

1. Author
2. Normal User

Authors are those who have published one or more papers. Author needs to register into the platform and upload his or her paper with the description fields as above. The system will store these details about the paper and also the paper document. It will parse the document to extract the “Abstract”, “Reference” and other keywords from the documents and store it.

“Normal Users” will also have to register to the platform. Once they login they can do the following

1. They can list all the papers based on various attributes
2. They can search the papers based on keywords in abstract, contents, tags etc

Exercise 2 --- HDFS
Start by reviewing HDFS. You will find that its composition is similar to your local Linux file system. You will use the hadoop fs command when interacting with HDFS.
1. Review the commands available for the Hadoop Distributed File System:
2. Copy file foo.txt from local disk to the user’s directory in HDFS

3. Get a directory listing of the user's home directory in HDFS
4. Get a directory listing of the HDFS root directory
5. Display the contents of the HDFS file user/fred/bar.txt
6. Move that file to the local disk, named as baz.txt
7. Create a directory called input under the user's home directory
8. Delete the directory input old and all its contents
9. Verify the copy by listing the directory contents in HDFS:

Exercise 3 --- MapReduce (Programs)

Using movie lens data

1. List all the movies and the number of ratings
2. List all the users and the number of ratings they have done for a movie
3. List all the Movie IDs which have been rated (Movie Id with at least one user rating it)
4. List all the Users who have rated the movies (Users who have rated at least one movie)
5. List of all the User with the max, min, average ratings they have given against any movie
6. List all the Movies with the max, min, average ratings given by any user

Exercise 4 – Extract facts using Hive

Hive allows for the manipulation of data in HDFS using a variant of SQL. This makes it excellent for transforming and consolidating data for load into a relational database. In this exercise you will use HiveQL to filter and aggregate click data to build facts about user's movie preferences. The query results will be saved in a staging table used to populate the Oracle Database. The moveapp_log_json table contains an activity column. Activity states are as follows:

1. RATE_MOVIE
2. COMPLETED_MOVIE
3. PAUSE_MOVIE
4. START_MOVIE
5. BROWSE_MOVIE
6. LIST_MOVIE
7. SEARCH_MOVIE
8. LOGIN
9. LOGOUT
10. INCOMPLETE_MOVIE

```
hive> SELECT * FROM movieapp_log_json LIMIT 5;
hive> drop table movieapp_log_json;
hive> CREATE EXTERNAL TABLE movieapp_log_json (
custId INT,
movieId INT,
genreId INT,
time STRING,
recommended STRING,
activity INT,
rating INT,
price FLOAT)
```

ROW FORMAT SERDE 'org.apache.hadoop.hive.contrib.serde2.JsonSerde'
LOCATION '/user/oracle/moviework/applog/'
hive> SELECT * FROM movieapp_log_json LIMIT 20;
hive> SELECT MIN(time), MAX(time) FROM movieapp_log_json
1. PURCHASE_MOVIE
Hive maps queries into Map Reduce jobs, simplifying the process of querying large datasets in HDFS. HiveQL statements can be mapped to phases of the Map Reduce framework. As illustrated in the following figure, selection and transformation operations occur in map tasks, while aggregation is handled by reducers. Join operations are flexible: they can be performed in the reducer or mappers depending on the size of the leftmost table.
1. Write a query to select only those clicks which correspond to starting, browsing, completing, or purchasing movies. Use a CASE statement to transform the RECOMMENDED column into integers where 'Y' is 1 and 'N' is 0. Also, ensure GENREID is not null. Only include the first 25 rows.
2. Write a query to select the customer ID, movie ID, recommended state and most recent rating for each movie.
3. Load the results of the previous two queries into a staging table. First, create the staging table:
4. Next, load the results of the queries into the staging table.

Exercise 5 - Extract sessions using Pig
While the SQL semantics of HiveQL are useful for aggregation and projection, some analysis is better described as the flow of data through a series of sequential operations. For these situations, Pig Latin provides a convenient way of implementing data flows over data stored in HDFS. Pig Latin statements are translated into a sequence of Map Reduce jobs on the execution of any STORE or DUMP command. Job construction is optimized to exploit as much parallelism as possible, and much like Hive, temporary storage is used to hold intermediate results. As with Hive, aggregation occurs largely in the reduce tasks. Map tasks handle Pig's FOREACH and LOAD, and GENERATE statements. The EXPLAIN command will show the execution plan for any Pig Latin script. As of Pig 0.10, the ILLUSTRATE command will provide sample results for each stage of the execution plan. In this exercise you will learn basic Pig Latin semantics and about the fundamental types in Pig Latin, Data Bags and Tuples.
1. Start the Grunt shell and execute the following statements to set up a dataflow with the click stream data. Note: Pig Latin statements are assembled into Map Reduce jobs which are launched at execution of a DUMP or STORE statement.
2. Group the log sample by movie and dump the resulting bag.
3. Add a GROUP BY statement to the sessionize.pig script to process the click stream data into user sessions.

Course Outcomes:
After going through this course the student will be able to:
CO1: Explore and apply the Big Data analytic techniques for business applications.
CO2: Apply non-relational databases, the techniques for storing and processing large volumes of structured and unstructured data, as well as streaming data.
CO3: Analyze methods and algorithms, to compare and evaluate them with respect to time and space requirements, make appropriate design choices when solving problems.

CO4: Develop and implement efficient big data solutions for various application areas using NoSQL database, Elastic Search and Emerging technologies.	
Reference Books:	
1	Judith Hurwitz, Alan Nugent,Fern Halper, Marcia Kaufman, "Big data for dummies", Wiley Publications, 1st edition, 2013, ISBN: 978-1-118-50422-2
2	Clinton Gormley, Zachary Tong, Elasticsearch – The Definitive Guide , O'Reilly Media, Inc. 1st edition, 2015. ISBN: 978-1-449-35854-9.
3	Tom White, "HADOOP: The definitive Guide", 4th edition, O Reilly, 2015, ISBN-13: 978-1-4493-610-7
4	Chris Eaton, Dirk deroos et al. , "Understanding Big data: Analytics for Enterprise Class Hadoop and Streaming Data", 1st edition, Tata McGraw Hill, 2015, ISBN 13: 978-9339221270

Scheme of Continuous Internal Evaluation (CIE) for Theory 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for Theory 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

Scheme of Continuous Internal Evaluation (CIE) for Practical 50 Marks:
CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 30 marks. One test will be conducted for 20 marks. The total marks for CIE (Practical) will be for 50 marks

Scheme of Semester End Examination (SEE) for Practical 50 Marks:
SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks is 50.

PARALLEL COMPUTER ARCHITECTURE						
Course Code	**:**	**18MCE22**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:2:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**07 Hrs**
Fundamentals of computer design: Introduction; Classes computers; Defining computer architecture; Trends in Technology; Trends in power in Integrated Circuits; Trends in cost; Dependability, Measuring, reporting and summarizing Performance attributes; Quantitative Principles of computer design						
Unit – II						**07 Hrs**
Introduction to Parallel Programming: Motivation, Scope of Parallel Computing, Principles of Parallel Algorithm design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for containing Interaction Overheads, Parallel Algorithms Models using Open MP.						
Unit – III						**08 Hrs**
Programming Using the Using Message Passing Paradigm: Principles of Message Passing Programming, Building Blocks, MPI, Topologies and Embedding, Overlapping Communication with computation, Collective Communication and computation operations, Groups and Communicators.						
Unit – IV						**07 Hrs**
Data-Level Parallelism in Vector, SIMD, and GPU Architectures: Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Mobile versus Server GPUs and Tesla versus Core i7.						

Unit-V	07 Hrs
***Heterogeneous Computing** Heterogeneous Programming using Open ACC: Introduction, Execution Model, Memory Model, Features **Case Study**: Vector dot product, Matrix multiplication, Graph algorithms, and molecular dynamics.	
Course Outcome: At the end of this course graduates will be able to: **CO1:** Explore the fundamental concepts of parallel computer architecture. **CO2:** Analyze the performance of parallel programming. **CO3:** Design parallel computing constructs for solving complex problems. **CO4:** Demonstrate parallel computing concepts for suitable applications.	

Reference Books

1.		John L Hennessy, David A Patterson, "Computer Architecture: A Quantitative Approach", Elsevier, 5th Edition; 2011, ISBN: 9780123838728.
2.		Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar : "Introduction to Parallel Computing", 2nd edition, Pearson Education, 2007
3.		Rob Farber, Parallel Programming with Open ACC, 1st edition, 2016, ISBN : 9780124103979
	4*	http://hpac.rwth-aachen.de/people/springer/openacc_seminar.pdf

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

RESEARCH METHODOLOGY						
Course Code	**:**	**18 IEM 23**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Overview of Research: Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.	
Unit – II	**08 Hrs**
Data and data collection: Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **Sampling Methods:** Probability sampling and Non-probability sampling	
Unit – III	**07 Hrs**
Processing and analysis of Data: Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools	
Unit – IV	**07 Hrs**
Advanced statistical analyses: Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.	
Unit-V	**07 Hrs**

Essentials of Report writing and Ethical issues: Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism. **Case studies:** Discussion of case studies specific to the domain area of specialization
Course Outcomes: After going through this course the student will be able to CO1: Explain the principles and concepts of research types, data types and analysis procedures. CO2: Apply appropriate method for data collection and analyze the data using statistical principles. CO3: Present research output in a structured report as per the technical and ethical standards. CO4: Create research design for a given engineering and management problem situation.
Reference Books:
1. Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

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CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

WIRELESS AND MOBILE NETWORKS (Elective-3)						
Course Code	**:**	**18MCE241**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:1:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Fundamentals of Wireless Communication: Advantages, Limitations and Applications, Wireless Media, Infrared Modulation Techniques, Spread spectrum: DSSS and FHSS, Diversity techniques, MIMO, Channel specifications- Duplexing, Multiple access technique: FDMA, TDMA,CDMA, CSMA,OFDMA fundamentals, Frequency Spectrum, Radio and Infrared Frequency Spectrum, Wireless Local Loop (WLL): User requirements of WLL systems, WLL system architecture	
Unit – II	**07 Hrs**
Fundamentals of cellular communications: Introduction, Cellular systems, Hexagonal cell geometry, Channel assignment strategies, Handoff strategies, Interference and System Capacity [Design problems], Co channel interference ratio, Frequency Reuse, Cellular system design in worst case scenario with omnidirectional antenna, Co-channel interference reduction, Directional antennas in seven cell reuse pattern, Cell splitting	
Unit – III	**07 Hrs**
Wireless Local Area Network (WLAN): Network components, Design requirements, WLAN architecture, Standards, WLAN Protocols- Physical Layer and MAC Layer, IEEE 802.11p, Security (WPA), Latest developments of IEEE 802.11 standards	
Unit – IV	**07 Hrs**

Wireless Personal Area Network (WPAN): Network architecture and components, WPAN technologies and protocols, Application software; ZigBee (802.15.4): Stack architecture, Components, Topologies, Applications; Bluetooth (802.15.1): Protocol stack, Link types, security aspects, Network connection establishment, error correction and topology; LR-WPAN (IEEE 802.15.4)		
Unit-V		**08 Hrs**
Security in Wireless Systems: Needs, Privacy definitions, Privacy requirements, Theft resistance, Radio System and Physical requirements, Law enforcement requirements, IEEE 802.11 Security. Wi-Fi Protected Access (WPA),Economies of Wireless Network, Economic Benefits, Economics of Wireless industry,*Wireless data forecast, charging issues		
Course Outcome: At the end of this course graduates will be able to: **CO1:** Explore the existing wireless networks and connectivity issues **CO2:** Analyze the range of signals and path loss models for real world scenarios **CO3:** Evaluate the security and energy management issues for wireless devices **CO4:** Design suitable wireless network for various applications		
Reference Books		
1.		Dr. Sunil Kumar S. Manvi & Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Network concepts and protocols", John Wiley India Pvt. Ltd, 1st edition, 2010, *ISBN* 13: 9788126520695.
2.		Vijay K.Garg, "Wireless Communications and Networking", Morgan Kaufmann Publishers, 2009, Indian Reprint ISBN: 978-81-312-1889-1
3.		Theodore S Rappaport, "Wireless Communications, Principles and Practice", 2nd Edition, Pearson Education Asia, 2009, ISBN: 9780133755367
4 *		Technical Journals, White papers

Open ended Lab experiments

1. Explore the scanning tools such as Wi-Fi Scanner, Aircrack, Kismet
2. Using QualNet simulator, design wireless networks such as IEEE 802.11, IEEE 802.15.5, UMTS
3. Review the features of LTE simulator and ONE (Opportunistic Network Environment)

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

NATURAL LANGUAGE PROCESSING (Elective-3)						
Course Code	**:**	**18MCE242**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:1:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):
Students shall be able to

1. Demonstrate sensitivity to linguistic phenomena and an ability to model them with formal grammars.
2. Train and evaluate empirical NLP systems.
3. Manipulate probabilities, construct statistical models over strings and trees, and estimate parameters using supervised and unsupervised training methods.
4. Design, implement, and analyse NLP algorithms

Unit – I	**07 Hrs**
Overview and Language Modeling: Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications -Information Retrieval. Language Modeling: Various Grammar- based Language Models - Statistical Language Model	
Unit – II	**07 Hrs**
Word Level and Syntactic Analysis: Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency-Parsing-Probabilistic Parsing.	
Unit – III	**07 Hrs**

Hidden Markov and Maximum Entropy Models
Markov Chains, The Hidden Markov Model, Computing Likelihood: The forward algorithm, Decoding: The Viterbi algorithm, Training Hidden Markov models
Speech Recognition
Speech Recognition Architecture, Applying Hidden Markov models to speech

Unit – IV	**07 Hrs**

Machine Translation
Introduction, Problems in machine translation, Characteristics of Indian languages, machine Translation approaches, Direct machine translation, Rule based machine translation, corpus based machine translation
NLP Applications
Information extraction, Machine Translation, Natural Language Generation, Discourse processing

Unit – V	**08 Hrs**

Information Retrieval and Lexical Resources: Information Retrieval: Design features of Information Retrieval Systems-Classical, Non classical, Alternative Models of Information Retrieval valuation Lexical Resources: WordNet, FrameNet, Stemmers, POS Tagger

Case Study: Learning to classify text using NLTK- Supervised classification, Choosing the right features, Document classification, parts of speech tagging, Exploiting context, Evaluation, Accuracy, Precision and Recall, Confusion matrix, Cross- validation

Course Outcomes:
After going through this course the student will be able to:
CO1: Comprehend and compare different natural language processing models.
CO2: Analyse spelling errors and error detection techniques.
CO3: Extract dependency, semantics and relations from the text.
CO4: Differentiate various information retrieval models.

Reference Books

1	Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, OUP India, 2008, ISBN : 9780195692327
2	Daniel Jurafsky and James H Martin, “Speech and Language Processing”, 2nd edition, Pearson Education, 2009
3	Steven Bird, Ewan Klein, Edward Loper, “Natural Language Processing with Python,” Publisher: O'Reilly Media, June 2009, ISBN : 9780596516499
4	Alexander Clark, Chris Fox, Shalom Lappin, “The Handbook of computational linguistics and Natural Language processing”, 2010, Wiley Blackwell.

Open ended experiments / Tutorial Questions

1. Forming Sentences-1
2. Forming Sentences-2
3. Tokens and Types
4. Heap's Law

5. Dictionary Generation
6. Coarse-grained POS Tagging
7. Fine-grained POS Tagging
8. Chunking
9. Context Free Grammar

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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

CLOUD SECURITY (Elective-3)						
Course Code	**:**	**18MCE243/18MCN243**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:1:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**07 Hrs**
Introduction to cloud computing and security-A brief primer on security, architecture, defense in depth, cloud is driving broad changes. Securing the cloud: architecture-requirements, patterns and architectural elements, cloud security architecture, key strategies for secure operations						
Unit – II						**08 Hrs**
Securing the cloud: data security-overview of data security in cloud computing, data encryption: applications and limits, sensitive data categorization, cloud storage, cloud lock-in Securing cloud : key strategies and best practises- Overall strategy, security controls						
Unit – III						**07 Hrs**

Security criteria: Building an internal cloud, Security Criteria-private clouds: selecting an external cloud provide-Selecting CSP,-overview of assurance, over view of risks, security criteria, Evaluating clouds security: An information security framework- evaluation cloud security, checklist for evaluating cloud security

Unit – IV	**07 Hrs**

Identity and access management Trust Boundaries, IAM Challenges, IAM Definitions ,IAM Architecture and Practice , Getting Ready for the Cloud 80 Relevant IAM Standards and Protocols for Cloud Services , IAM Practices in the Cloud, Cloud Authorization Management , Security Management in the Cloud, Security Management Standards , Security Management in the Cloud,

Unit – V	**07 Hrs**

Privacy: Privacy, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing , Legal and Regulatory Implications , U.S. Laws and Regulations , International Laws and Regulations, Audit and compliance, Internal Policy Compliance, Governance, Risk, and Compliance (GRC) Illustrative Control Objectives for Cloud Computing

Course Outcomes:

After going through this course the student will be able to:

CO1. Explore compliance and security issues that arise from cloud computing architectures intended for delivering Cloud based enterprise IT services and business applications.

CO2. Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services.

CO3. Illustrate the concepts and guiding principles for designing and implementing appropriate safeguards and countermeasures for Cloud based IT services

CO4. Design security architectures that assure secure isolation of physical and logical infrastructures of network and storage, comprehensive data protection at all layers, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates.

Reference Books:

1	Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'Reilly Media; 1st edition, 2009, ISBN: 0596802765
2	Vic (J.R.) Winkler, Securing the Cloud: Cloud Computer Security Techniques and Tactics", **Imprint:** Syngress, 1st edition, 2011, **ISBN:** 9781597495929
3	Ronald L. Krutz, Russell Dean Vine**, "**Cloud Security: A Comprehensive Guide to Secure Cloud Computing**"**, 1st edition, 2010, ISBN-13: 978-0470589878, 2010, ISBN-10: 0470589876
4	John Rittinghouse, James Ransome, "Cloud Computing: Implementation, Management, and Security", 1st edition, 2009, ISBN-13: 978-1439806807, ISBN-10: 1439806802

Open ended experiments / Tutorial Questions

1. Cloud authentication and authorization techniques
2. Cloud identity and access management
3. Cloud key management

4. Cloud auditing
5. Credential management
6. Cloud DoS protection
7. Cloud traffic hijacking protection
8. Identifying malicious insider, malilcious agent, malicious tenant
9. Virtualization attacks
10. Trust management and assurance
11. Resource Access Control schemes
12. Cloud data encryption and access
13. Cloud data integrity

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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

INTERNET OF THINGS AND APPLICATIONS (Elective-4)						
Course Code	**:**	**18MCE251/18MCN251**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**09 Hrs**
FUNDAMENTAL IOT MECHANISM AND KEY TECHNOLOGIES-Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards Overview and Approaches, IETF IPv6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M,Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Lowpower WPAN, Zigbee IP(ZIP), IPSO						
Unit – II						**10 Hrs**

LAYER ½ CONNECTIVITY: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M,Layer 3 Connectivity :IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities,IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6,Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.

Unit – III	**09 Hrs**

Application Protocols- Common Protocols, Web service protocols, MQ telemetry transport for sensor networks (MQTT-S), ZigBee compact application protocol (CAP) , Service discovery ,Simple Network Management Protocol(SNMP) ,Real-time transport and sessions , Industry-specific protocols.

Unit – IV	**09 Hrs**

Wireless Embedded Internet- 6LoWPAN, 6LoWPAN history and standardization ,Relation of 6LoWPAN to other trends , Applications of 6LoWPAN , Example: facility management , The 6LoWPAN Architecture , 6LoWPAN Introduction ,The protocol stack, Link layers for 6LoWPAN, Addressing , Header format , Bootstrapping , Mesh topologies , Internet integration

Unit – V	**09 Hrs**

***The evolution of computing models towards edge computing**-Shared and central resources versus exclusive and local computation , IoT disrupts the cloud, characteristics of the new computing model , Blueprint of edge computing intelligence Trend drivers and state of the art for edge intelligence Industry needs, Hardware evolution, Software evolution, Architecture

Course Outcomes:

After going through this course the student will be able to

CO1: Acquire knowledge of different use cases of IoT in real time scenarios
CO2: Explain key technologies for connectivity and communications in IoT
CO3: Examine different application protocols and their roles in IoT
CO4: Propose IoT-enabled applications for building smart spaces and services with security features, resource management and edge computing.

Reference Books:

1.	Daniel Minoli, ”Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications”, student edition ,Wiley, 2013. ISBN: 978-1-118-47347-4.
2.	Zach Shelby Sensinode , Carsten Bormann”, 6LoWPAN: The Wireless Embedded Internet”, 1st Edition, John Wiley & Sons Ltd, 2009 , ISBN 9780470747995
3.	ArshdeepBahga, Vijay Madisetti, ”Internet of Things: A Hands on Approach” , 1st Edition, Universities Press., 2015, ISBN, : 978-81-7371-954-7
4*	www.iec.ch/whitepaper/pdf/IEC_WP_Edge_Intelligence.pdf

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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

Deep Learning (Elective-4)		
Course Code:18MCE252/18MCS252		**CIE Marks: 100**
Hrs/Week: L:T:P	**4:0:0**	**SEE Marks: 100**
Credits: 4		**SEE Duration: 3Hrs**
UNIT-I		
Deep Feedforward Networks: Multilayer Perceptron, Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation Algorithm		**08 Hrs**
UNIT-II		
Convolutional Networks: Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the basic convolution function, Structured Outputs, Data types, Efficient Convolution Algorithms, Random or Unsupervised features, The Neuroscientific basis for convolutional networks		**10 Hrs**
UNIT-III		
Sequence Modeling: Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, Echo State Networks, The Long Short-Term Memory and Other Gated RNNs		**10 Hrs**
UNIT-IV		
Autoencoders: Undercomplete Autoencoders, Regularized Autoencoders, Representational Power, Layer Size and Depth, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders		**08 Hrs**
UNIT-V		
Structured Probabilistic Models For Deep Learning: The challenge of unstructured modelling, Using graphs to describe model structure: Directed, Undirected, Partition function, Energy-based models, Factor graphs; Sampling from graphical models, Advantages of structured modelling, learning about dependencies, Inference and approximate inference, The deep learning approach to structured probabilistic models		**10 Hrs**
Course Outcomes: After completing the course, the students will be able to: CO1 Describe basic concepts of neural network, its applications and various learning models CO2 Acquire the knowledge on Recurrent, Recursive Nets and Auto-encoder models CO3 Analyze different Network Architectures, learning tasks, Convolutional networks CO4 Evaluate and compare the solutions by various Neural Network approaches for a given problem.		
Reference Books		

1.	Ian Good Fellow, YoshuaBengio and Aaron Courville,"Deep Learning (Adaptive Computation and Machine Learning Series)",MIT Press (3 January 2017), ISBN-13: 978-0262035613.
2.	Simon Haykin, "Neural Networks – A Comprehensive Foundation", Second Edition, PHI, 2005.
3.	Gunjan Goswami,"Introduction to Artificial Neural Networks", S.K. Kataria & Sons; 2012 Edition, ISBN-13: 978-9350142967.
4.	Nikhil Buduma,"Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", by O'Reilly Publications, 2016 Edition, ISBN-13: 978-1491925614.

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Scheme of Semester End Examination (SEE) for 100 marks:
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SECURITY ENGINEERING
(Elective-4)

Course Code	**:**	**18MCE253/18MCN253**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Graduates shall be able to:

1. Gain knowledge on security Engineering.
2. Acquire knowledge of password attacks and phishing counter measures.
3. Analyse access control mechanisms.
4. Identify network attack and relevant defence mechanism.
5. Evaluate exploiting the Edge for security threat.

Unit – I	**09 Hrs**

What Is Security Engineering: Introduction, A framework, Examples. Usability and Psychology: Introduction, Attacks Based on Psychology: Pretexting, Phishing, Insights from Psychology Research, What the Brain Does Better Than Computer.

Unit – II	**09 Hrs**

Passwords: Difficulties with Reliable Password Entry, Difficulties with Remembering the Password, Naive Password Choice, User Abilities and Training, Social-Engineering Attacks, Trusted Path, Phishing Countermeasures, The Future of Phishing, System Issues, Attacks on Password Entry.

Unit – III	**09 Hrs**

Access Control: Introduction, Operating System Access Controls, Groups and Roles, Access Control Lists, Unix Operating System Security, Apple's OS/X, Windows — Basic Architecture, Capabilities, Windows — Added Features, Middleware, Database Access Controls, General Middleware Issues, ORBs and Policy Languages, Sandboxing and Proof-Carrying Code, Virtualization, Trusted Computing.

Unit – IV	**09 Hrs**

Network Attack and Defense: Introduction, Vulnerabilities in Network Protocols, Attacks on Local Networks, Attacks Using Internet Protocols and Mechanisms. Trojans, Viruses,

Worms and Rootkits, Defense Against Network Attack, Filtering: Firewalls, Spam Filters, Censor ware and Wiretaps, Intrusion Detection.	
Unit – V	**10 Hrs**
The Bleeding Edge: Introduction, Computer Games, Types of Cheating, Aimbots and Other Unauthorized Software, Virtual Worlds, Virtual Economies, Web Applications e Bay, Google. Social Networking Sites, Privacy Technology: Anonymous Email — The Dining Cryptographers and Mixes, Anonymous Web Browsing — Tor, Confidential and Anonymous Phone Calls, Email Encryption, Steganography and Forensics Countermeasures.	
Course Outcomes: After going through this course the student will be able to: CO1: Analyze attacks based on psychology, attacks on network and defense mechanisms CO2: Identify password attacks and phishing counter measures. CO3: Evaluate issues related to access control mechanisms. CO4: Analyze exploiting the computing edge and countermeasures.	

Reference Books:

1	Rose Anderson, “Security Engineering”, 2nd Edition, Wiley 2012, ISBN-10: 1111138214.
2	William Stallings, "Cryptography and Network Security", 6th Edition, ISBN-13: 978-0-13-335469-0.
3	Joseph MiggaKizza, Computer Network Security, Springer International Edition, 2009, ISBN 978-1-84800-916-5.
4	Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C", 2nd Edition, ISBN: 0-471-22357-3.

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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

BUSINESS ANALYTICS (Global Elective)						
Course Code	**:**	**18GCS261**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Graduates shall be able to

1. Formulate and solve business problems to support managerial decision making.
2. Explore the concepts, processes needed to develop, report, and analyze business data.
3. Use data mining techniques concepts to identify specific patterns in the data
4. Interpret data appropriately and solve problems from various sectors such as manufacturing, service, retail, software, banking and finance.

Unit – I	**07 Hrs**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

Unit – II	**07 Hrs**

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit – III	**08 Hrs**

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

Unit – IV	**07 Hrs**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Unit-V	**07 Hrs**
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	

Course Outcome:

At the end of this course graduates will be able to:

CO1. Explore the concepts, data and models for Business Analytics.

CO2. Analyze various techniques for modelling and prediction.

CO3. Design the clear and actionable insights by translating data.

CO4. Formulate decision problems to solve business applications

Reference Books

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications FT Press Analytics, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2. Evan Stubs , "The Value of Business Analytics: Identifying the Path to Profitability ", John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st edition 2014
3. James Evans, "Business Analytics", Pearsons Education 2nd edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4. Gary Cokins and Lawrence Maisel, "Predictive Business Analytics Forward Looking Capabilities to Improve Business", Wiley; 1st edition, 2013.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

INDUSTRIAL & OCCUPATIONAL HEALTH AND SAFETY (Global Elective)						
Course Code	**:**	**18GCV262**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**03**		**SEE Duration**	**:**	**3Hrs**

UNIT – I	**07Hrs**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT – II	**08Hrs**

Occupational health and safety: Introduction, Occupational health: a definition, Interaction between work and health, Interaction between work and health, Health hazards, Unemployment, Health, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Accident factors. Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT – III	**08Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids: Introduction, Glycol Ethers (Cellosolve, Methyl Cellosolve, and Butyl Cellosolve) Esters: (Ethyl, Butyl, Amyl, and Cellosolve Acetates), Ketones (Acetone, Methyl Ethyl ketone, and Methyl Isobutyl Ketone), Aromatics (Toluene, Benzene, Xylene, Phenol, Styrene and Isocyanates), Polyaromatics (Chlorinated Compounds), Halogenated Hydrocarbons (Trichloroethylene, Trichloroethylene, Trichloroethane, Perchloroethylene, Methylene Chloride, Chloroform and Fluorocarbons), Alkyl Nitrites (Dimethylformamide), Aldehydes (Formaldehyde).Gases: Introduction, Boron (Boron Trichloride, Diborane and Boron Tribromide), Metal Hydrides (Arsine and Germane), Asphyxiants (Simple Asphyxiants, Carbon Monoxide and Cyanides), Silicon (Silane, Dichlorosilane, Trichlorosilane and Chlorosilane), Phosphine,

Phosgene, Nitrogen Oxides and Ozone. Metals and Metallic Compounds: Introduction, Lead, Gallium, Indium and Antimony, Cadmium, Yttrium, Silver, Beryllium, Platinum, Gold, Tantalum, Mercury, Nickel, Arsenic, Tellurium, Tin, Barium, Cobalt. Particulates and Fibers: Introduction, Resin Dust, Fibrous Glass, Silica, Portland Cement, Mica. Acids, Alkalies and Oxidizers: Introduction, Sulfuric Acid, Chromium Acids, Hydrogen Fluoride (Hydrofluoric Acid), Sodium Hydroxide, Hydrogen Peroxide.General Manufacturing Materials: Epoxy Resin Systems, Flux Fumes, Cutting Fluids, Nonacid etches, Fluoride Compounds, Phosphorus Compounds, Hexamethly Disilazane, Chemical Combined Effects, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents: Electromagnetic and particulate Radiation, Microwave and Radio Frequency Radiation, Particulate Radiation, Infrared Radiation, Laser Radiation, Ultraviolet Radiation, X-Radiation, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.

UNIT – IV	**07Hrs**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – V	**07Hrs**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components,
over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps,
iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Expected Course Outcomes:
After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books:

	1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2.		Maintenance Engineering, H. P. Garg, S. Chand and Company, New Delhi, 2009.
3.		WILL BE PROVIDED
4.		Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

MODELING USING LINEAR PROGRAMMING
(Global Elective)

Course Code	**:**	**18GIM263**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **7 Hrs**

Linear Programming: Introduction to Linear Programming problem
Simplex methods: Variants of Simplex Algorithm – Use of Artificial Variables

Unit – II — **7 Hrs**

Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method
Duality: Primal-Dual relationships, Economic interpretation of duality

Unit – III — **7 Hrs**

Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality

Unit – IV — **8 Hrs**

Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.

Unit-V — **7 Hrs**

Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).

Course Outcomes:
After going through this course the student will be able to:
CO1: Explain the various Linear Programming models and their areas of application.
CO2: Formulate and solve problems using Linear Programming methods.
CO3: Develop models for real life problems using Linear Programming techniques.
CO4: Analyze solutions obtained through Linear Programming techniques.

Reference Books:

1.	Taha H A, Operation Research An Introduction, PHI, 8th Edition, 2009, ISBN: 0130488089.
2.	Philips, Ravindran and Solberg - Principles of Operations Research – Theory and Practice, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0

3.	Hiller, Liberman, Nag, Basu, Introduction to Operation Research, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7
4.	J K Sharma, Operations Research Theory and Application, Pearson Education Pvt Ltd, 4th Edition, 2009, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

PROJECT MANAGEMENT (Global Elective)						
Course Code	**:**	**18GIM264**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**7 Hrs**
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	
Unit – II	**7 Hrs**
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	
Unit – III	**8 Hrs**
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	
Unit – IV	**7Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	
Unit-V	**7 Hrs**
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain project planning activities that accurately forecast project costs, timelines, and quality.

CO2: Evaluate the budget and cost analysis of project feasibility.

CO3: Analyze the concepts, tools and techniques for managing projects.
CO4: Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations

Reference Books:

1. Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.
2. Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
3. Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4. Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

ENERGY MANAGEMENT (Global Elective)			
Course Code:	**18GCH265**	**CIE Marks: 100**	
Hrs/Week: L:T:P	**3:0:0**	**SEE Marks: 100**	
Credits:	**3**	**SEE Duration: 3 Hrs**	
Unit – I			**08 Hrs**
Energy conservation: Principles of energy conservation and energy audit, types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat recuperators- classification, liquid/gas and gas/liquid heat exchangers			
Unit – II			**07 Hrs**
Wet Biomass gasifiers: Introduction, Classification of feedstock for biogas generation. Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages, Biogas from aquatic weed.			
Unit – III			**08 Hrs**
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers. Pyrolysis.			
Unit – IV			**08 Hrs**
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear,turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications			
Unit – V			**08 Hrs**
Alternative liquid fuels: Introduction. Ethanol production: Raw materials, Pre-treatment, Conversion processes, Fermentation systems. Methanol production: Raw materials, Gasification of wood, Gas purification and shift conversion, Synthesis, Gasification equipment.			

Course Outcomes:
After completion of the course student will be able to:

1. Understand the use alternate fuels for energy conversion
2. Develop a scheme for energy audit
3. Evaluate the factors affecting biomass energy conversion
4. Design a biogas plant for wet and dry feed

Reference Books:

1	Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
4	C. S. Solanki, Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009, ISBN:9788120343863

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

INDUSTRY 4.0 (Global Elective)						
Course Code	**:**	**18GME266**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**03**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**10 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture, Industry 4.0, Characteristics of Industry 4.0, The Value Chain, Industry 4.0 Design Principles.	
Unit – III	**10 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing, Predicting Drilling Efficiency, Estimation of Manufacturing Cost of Jet Engine, Components, Techniques Used for Predictive Analytics, Forecast Accuracy Calculation Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics, Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications.	
Unit – IV	**10 Hrs**

Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing, Application Areas of Additive Manufacturing, Impact of Additive Manufacturing Techniques on Society

Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software.

Unit – V	**10 Hrs**

Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training.

Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward.

A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.

Course Outcomes:

After going through this course the student will be able to:

CO1: Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals

CO2: Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services

CO3: Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits

CO4: Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1. Alasdair Gilchrist “INDUSTRY 4.0 THE INDUSTRIAL INTERNET OF THINGS” Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2. Alp Ustundag • Emre Cevikcan “Industry 4.0: Managing The Digital Transformation”, Springer, 2018 ISBN 978-3-319-57869-9
3. Ovidiu Vermesan and Peer Friess “ Designing the industry - Internet of things connecting the physical, digital and virtual worlds” Rivers Publishers, 2016 ISBN 978-87-93379-81-7

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

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Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

ADVANCED MATERIALS (Global Elective)						
Course Code	**:**	**18GME267**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**6 Hrs**
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials	
Unit – II	**8 Hrs**
Non Metallic Materials: Classification of n on metallic materials, Rubber : Properties, processing and applications.Plastics : Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications. Optical fibers : Properties and applications. Composites : Properties and applications.	
Unit – III	**8 Hrs**
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	
Unit – IV	**8 Hrs**
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	
Unit – V	**6 Hrs**

Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials
Course Outcomes: After going through this course the student will be able to CO1: Describe metallic and non-metallic materials CO2: Explain preparation of high strength Materials CO3:Integrate knowledge of different types of advanced engineering Materials CO4: Analyse problem and find appropriate solution for use of materials.

Reference Books:

1.	Donald R. Askeland, and Pradeep P. Fulay, The Science & Engineering of Materials, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2.	Gregory L. Timp, Nanotechnologym 1999th Edition Springer, 1999 ISBN-13: 978-0387983349
3.	Dr. VD Kodgire and Dr. S V Kodgire, Material Science and Metallurgym 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4.	N Bhatnagar, T S Srivatsan, " Processing and Fabrication of Advanced Materials", 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit.

MINOR PROJECT						
Course Code	**:**	**18MCE27**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P**	**0:0:4**	**SEE Marks**	**:**	**50**
Credits	**:**	**2**		**SEE Duration**	**:**	**30 min**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes:

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.

CO2: Communicate the solutions through presentations and technical reports.

CO3: Apply resource managements skills for projects

CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members: guide, two senior faculty members and Head of the Department.

Phase	Activity	Weightage
I	Synopsis submission, Preliminary seminar for the approval of selected topic and Objectives formulation	20%
II	Mid-term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

****Phase wise rubrics to be prepared by the respective departments**

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.