DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Scheme of Instruction
and
Syllabi of

B.E (CSE) - VII & VIII- SEMESTERS

2021-2022

AICTE MODEL CURRICULUM

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
OSMANIA UNIVERSITY
HYDERABAD – 500 007, TELANGANA

SCHEME OF NSTRUCTION
BE (COMPUTER SCIENCE & ENGINEERING)
VII SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P/D	Contact Hours/ Week	CIE	SEE	
Theory Courses									
1	**Professional Elective-IV**		3	0	0	3	30	70	3
	PE701CS	Advanced Cloud Computing							
	PE702CS	Storage Systems							
	PE703CS	Data Mining							
	PE704CS	Number Theory and Cryptography							
2	**Professional Elective-V**		3	0	0	3	30	70	3
	PE711CS	Scalable Architectures for Large Applications							
	PE712CS	Principles of Data Intensive Systems							
	PE713CS	Natural Language Processing							
	PE714CS	Principles of Secure Coding							
3	**Professional Elective-VI**								
	PE721CS	Mining Massive Datasets	3	0	0	3	30	70	3
	PE722CS	Deep Learning							
	PE723CS	Mobile & Wireless Network Security							
4	**Open Elective-II**		3	0	0	3	30	70	3
	OE701BM	Micro Electro-Mechanical Systems							
	OE702CE	Green Building Technology							
	OE703CS	Information Security							
	OE704CS	Data base Management Systems							
	OE705EC	Embedded Systems							
	OE706EC	Verilog HDL							
	OE707EC	Satellite Communication and Applications							
	OE708EE	Optimization Techniques							
	OE709EE	Non-Conventional Energy Sources							
	OE710ME	Startup Entrepreneurship							
	OE711ME	Nano Technology							
Practicals									
5	PW 751CS	Major Project Phase - I	0	0	6	12	50	-	2
6	PW 961 CS	Summer Internship	-	-	-	-	50	-	-
Total			**12**	**0**	**6**	**24**	**220**	**280**	**14**

L : Lectures T : Tutorials P : Practicals
CIE : Continuous Internal Evaluation SEE : Semester End Examination

PE701CS

ADVANCED CLOUD COMPUTING

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- Explain the core concepts of the cloud computing paradigm.
- Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost.
- Discuss system, network and storage virtualization and outline their role in enabling the cloud
- computing system model.
- Identify the problems of scale and management in big data and discuss various storage abstractions.
- Explain the main execution flow, scheduling and fault tolerance concepts in various cloud programming models. Recall and contrast different cloud programming models (Map Reduce, Spark, Graph Lab, Spark Streaming and Samza).

Course Outcomes:

After completion of course, students will be able to:

1. Understand the basic concepts of cloud computing paradigm, characteristics, advantages and challenges posed by various models and services in cloud computing.
2. Explain system virtualization, networking and storage and outline its role in enabling cloud computing system models.
3. Apply the basic concepts of cloud infrastructure to obtain power balance, efficiency and costs to be applied to tough, elastic and cost-effective cloud applications.
4. Being responsible for the work in his area of expertise independently. Working together to be able to make the most of their potential.

UNIT –I

Introduction: Definition and evolution of Cloud Computing Enabling Technologies, Service and Deployment Models. Popular Cloud Stacks and Use Cases, Benefits, Risks, and Challenges of Cloud Computing Economic Models and SLAs, Topics in Cloud Security

UNIT-II

Cloud Infrastructure: Historical Perspective of Data Centers, Datacenter Components: IT Equipment and Facilities, Design Considerations: Requirements, Power, Efficiency & Redundancy, Power Calculations, PUE and Challenges in Cloud Data Centers, Cloud Management and Cloud Software Deployment Considerations

UNIT- III

Virtualization: Virtualization (CPU, Memory, I/O), Case Study: Amazon EC2 Software Defined Networks (SDN) Software Defined Storage(SDS) .

UNIT- IV

Introduction to Storage Systems: Cloud Storage Concepts Distributed File Systems (HDFS,Ceph FS), Cloud Databases (HBase, MongoDB, Cassandra, DynamoDB), Cloud Object Storage (AmazonS3,OpenStackSwift,Ceph).

UNIT-V

Programming Models: Distributed Programming for the Cloud Data-Parallel Analytics with Hadoop Map Reduce (YARN); Iterative Data-Parallel Iterative Analytics (Spark); Graph-Parallel Analytics with GraphLab2.0(Power Graph); Stream Processing (Samza).

Suggested Readings:

1. David E.Y. Sarna, "*Implementing and Developing Cloud Computing Applications*" , CRC Press, 2018.

2. Igor Faynberg, Kui-Lan Lu, and DorSkuler, "*Cloud Computing: Business Trends and Technologies*", Wiley, 2015.

3. Jan Kunigk, Ian Buss, Paul Wilkinson& Lars George, "*Architecting Modern Data Platforms*" George.O'reilly, 2019.

PE702CS

STORAGE SYSTEMS

Instruction: 3 Periods per week | Duration of SEE: 3 hours
CIE: 30 Marks | SEE: 70 Marks
Credits: 3

Course Objectives:

- To introduce the students about different storage environments.
- To Understand Data Center Environment, Data Protection Policies, Intelligent Storage Systems, and Storage Technologies.

Course Outcomes:

After completion of course, students will be able to:

1. To describe the performance profiles and behaviors of current and emerging storage technologies;
2. Analyze information availability and its measurement.
3. Apply the File Systems and Network File Sharing.
4. Identify the key architectural characteristics of Fast Data application architectures,

UNIT –I

Introduction to storage systems: Storage, Processing, Networking, Naming and Storing, Storage File Systems. Storage media, Storage access Mechanisms, Storage protocols- Access Architecture, Hard Disks, SCSI.

UNIT -II

Communication Protocols for Networked Storage: Fiber Channel Protocol (FCP), 10Gb Ethernet, iSCSI, TCP, NFS, NFSv2, NFSv3, NFSv4, CIFS. Types of Storage Devices and Systems, Long- term Storage, USB Storage, Tiering, Mobile, Personal, Organizational type storage, Parallel, Cloud, Web-scale Storage.

UNIT- III

Storage Interfaces and Device Drivers: Storage interfaces, User memory –CPU interactions, Spinlock, concurrency, Block-layer Design, FAT, TFAT, F2FS, LFS, FTL. Storage Reliability, Performance, Security.

UNIT- IV

Design Factors: CAP Theorem, POSIX, NFS, Zookeeper, ACID Vs BASE. Theoretical Foundations- Consistency& Commit Problems, Paxos, Group Communication Problem, Message Ordering, Ordering Models, Orderings in File systems, semantics of highly scalable file systems.

UNIT- V

Highly scalable Distributed File System Sharing Stateful streaming state, Data Driven Micro-services, State and Micro-services.

Deployment environments for Fast Data Applications, Application containerization, resource scheduling, Apache Mesos, Kubernetes, Cloud Deployments.

Suggested Readings:

1. *"Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments"*, EMC Educational Services, 2nd Edition, 2012.

2. Gerard Maas, Stavros Kontopoulos, Sean Glover, *"Designing Fast Data Application Architectures*", O'Reilly Media, Inc., June 2018.

PE703CS

DATA MINING

Instruction: 3 Periods per week | Duration of SEE: 3 hours
CIE: 30 Marks | SEE: 70 Marks
Credits: 3

Course Objectives:

- To introduce the basic concepts of data Mining and its applications
- To understand different data mining like classification, clustering and Frequent Pattern mining
- To introduce current trends in data mining

Course Outcomes:
After completion of course, Student will be able to:

1. Apply the data mining concepts for preprocessing
2. Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on a given data set
3. Define and apply metrics to measure the performance of various data mining algorithms

UNIT-I
Introduction: Importance of Data Mining, Major issues in Data Mining, Getting to know your data: Data objects and attributed types. Basic statistical descriptions of data. Data visualization, Measuring data similarity and dissimilarity.

UNIT-II
Mining frequent patterns, Associations and correlations: Basic concepts and methods, Frequent Item set Mining Methods, Pattern evaluation methods.

UNIT-III
Classification: Basic concepts, Decision tree induction, Bayes classification methods, Advance methods, Bayesian Belief Network, Classification by back propagation, Support vector machines.

UNIT-IV
Cluster Analysis: Concepts and Methods: Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of Clustering.

UNIT-V
Data Mining Trends and Research Frontiers: Mining Complex Data Types, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining trends.

Suggested Readings:

1. Jiawei Han, Micheline Kamber, Jin Pei, "*Data Mining: Concepts & Techniques*", 3rd Edition., Morgon Kauffman, 2011.
2. Vikram Pudi, P.Radha Krishna, "*Data Mining"*, Oxford University Press, 1st Edition, 2009.
3. Pang-Ning Tan, Michael Steinbach, Vipin Kumar," *Introduction to Data Mining"*, Pearson Education, 2008.

PE704CS

NUMBER THEORY AND CRYPTOGRAPHY

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- Understand the significant aspects of Number Theory
- Comprehend secret and public key cryptography
- Learn hash functions and digital signatures
- Study the digital signatures and smart cards
- Comprehend the applications of network applications

Course Outcomes:

After completion of course, Students will be able to

1. Explain the fundamentals of Number Theory
2. Elaborate the concepts secret and public key cryptography
3. Elucidate the hash functions digital signatures
4. Describe the digital signatures and smart cards
5. Explain the applications of network security

UNIT-I

Introduction to Number Theory: Euclidean algorithm, Modular arithmetic, Prime numbers, Fermat's and Euler's theorem, Testing for Primality, The Chinese Remainder theorem, Discrete Logarithms

Computer and Network Security concepts: security attacks, security services and security mechanisms, security design principles and model for network security.

UNIT-II

Secret Key Cryptography: DES, Double and Triple DES, AES, Block cipher Modes: ECB, CBC, CFB, and CTR; XTS-AES mode of operation.

Public Key Cryptography: RSA, ECC, Diffie-Hellman Key Exchange

UNIT-III

Integrity, Authentication and Non-Repudiation: Hash Function (MD5, SHA-1), Message Authentication Code (MAC), **Digital Signature**: Introduction and using RSA and DSA schemes

Authentication: Principles, Using symmetric key: Kerberos and using Asymmetric key

UNIT-IV

Key Management and Distribution: Digital Certificates, Certifying Authorities, Public-key infrastructure.

Email Security: PGP and PEM-S/MIME

UNIT-V

Web Security Protocols (SSL), IPSec, Secure Electronic Transaction (SET), **System Security** using Firewalls and VPN

Suggested Readings:

1. William Stallings, "*Cryptography and Network Security, Principles and Practice*", 7th Edition, Pearson, 2017.

2. Behrouz A Forouzan, "*Cryptography and Network Security*", TMH, 2009.

PE711CS

SCALABLE ARCHITECTURES FOR LARGE APPLICATIONS

Instruction: 3 Periods per week | Duration of SEE: 3 hours
CIE: 30 Marks | SEE: 70 Marks
Credits: 3

Course Objectives:

- To introduce the idea of difference between implementing Machine learning algorithms and large scale Machine Learning.
- To understand and implement the specific libraries useful for Running ML applications using Spark.
- To learn the importance of processing using streaming data

Course Outcomes:

After completion of course, students will be able to:

1. Build architectures suitable for scaling across different kinds of applications
2. Understand and suggest the mechanisms in building scalable systems

UNIT –I

Introduction to Scalable applications, Challenges with running applications using Machine Learning with scaling, Algorithms for Large scale Learning, Overview of Hadoop and Current Big Data Systems.

UNIT- II

How Programming for Data Flow Differs, Basic Spark, Working with Vectors and Matrices in Spark, Brief tour of Spark ML, Beyond parallelization , Practical Big Data.

UNIT - III

Anatomy of Fast Data Applications, SMACK Stack – Functional Decomposition , Message Backbone- Understanding messaging requirements, Data ingestion, Fast data& low latency, Message Delivery Semantics, Distributing Messages.

UNIT - IV

Compute Engines- Micro Batch Processing, One-at-a time Processing, Choice of processing engine, Storage as the Fast Data Borders, The message backbone as Transition Point

UNIT V

Sharing Stateful Streaming State, Data Driven Micro-services, State and Micro-services.
Deployment environments for Fast Data Applications, Application containerization, resource scheduling, Apache Mesos, Kubernetes, Cloud Deployments.

Suggested Readings:

1. Jan Kunigk, Ian Buss, Paul Wilkinson & Lars George," *Architecting Modern Data Platforms*", O'reilly, 2019.
2. Gerard Maas, Stavros Kontopoulos, Sean Glover , "*Designing Fast Data Application Architectures*" , O'Reilly Media, Inc., *June 2018.*
3. Bill Chambers, Matei Zaharia "*Spark- The definitive Guide*" , O'Reilly Media, Inc., *June 2019.*

PE712CS

PRINCIPLES OF DATA INTENSIVE SYSTEMS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:
Students will learn:

- To understand the challenge of building large and scalable database systems.
- To learn the importance of enduring principles in the face of rapidly changing technologies.
- To learn Replication, Partitioning , Transactions of distributed data.
- To deal with Transactions and failure recovery, concurrency of the query processing.
- To know to handle the streaming data

Course Outcomes:
Students will be able to:

1. Apply concepts for data systems availability and operationally robust.
2. Analyse the requirements and technologies for scalable Architectures
3. Apply appropriate technology and tools application architecture.

UNIT-I
Reliable, Scalable, and Maintainable Applications, Data models and query languages

UNIT-II
Storage engines, Encoding and Evolution

UNIT-III
Distributed Data- Replication, Partitioning , Transactions

UNIT-IV
Trouble with Distributed systems, Consistency and Consensus

UNIT-V
Derived Data- Batch Processing, Stream Processing, The future of Data Systems

Suggested Readings:

1. Martin Kleppmann, "*Designing Data- intensive Applications*", O'Reilly 2017.

2. Tomasz Wiktorski, "*Data-intensive Systems: Principles and Fundamentals using Hadoop and Spark*", Springer 2019.

PE713CSE

NATURAL LANGUAGE PROCESSING

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce to basic concepts of Natural Language processing
- To understand morphological processing, and syntactic parsing methods
- To learn probabilistic NLP and classification of text using Python's NLTK Library.

Course Outcomes:

At the end of the course the student will be able to:

1. To write Python programs to manipulate and analyze language data
2. To understand key concepts from NLP and linguistics to describe and analyze language
3. To apply the appropriate data structures and algorithms in NLP
4. To classify texts using machine learning

UNIT-I

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language Understanding

Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet

UNIT -II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings.

Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation Based Tagging, How to Determine the Category of a Word

UNIT -III

Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers

Extracting Information from Text: Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction.

UNIT -IV

Analyzing Sentence Structure:

Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar, Dependencies and Dependency Grammar, Grammar Development, Building Feature-Based Grammars .

UNIT -V

NLP Applications: Topic modeling, Text classification, Sentiment analysis, Word sense disambiguation,

Speech recognition and speech to text, Text to speech, Language detection and translation

Suggested Readings:

1. Steven Bird, Ewan Klein, and Edward Lope, " *Natural Language Processing with Python*", O'Reily, 2009.

2. Akshay Kulkarni, Adarsha Shivananda, " *Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python*", Apress, 2019.

PE714CS

PRINCIPLES OF SECURE CODING

Instruction: 3 Periods per week
Duration of SEE: 3 hours
CIE: 30 Marks
SEE: 70 Marks
Credits: 3

Course Objectives:

- To understand the various security attacks
- To learn how to recognize to coding errors
- To understand techniques for developing a secure application.

Course Outcomes:

On successful completion of this course, students will be able to:

1. To understand various attacks like DoS, buffer overflow, web specific, database specific, web-spoofing attacks.
2. To demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications.
3. To identify the nature of the threats to software and incorporate secure coding practices throughout the planning and development of the product.

UNIT- I

Introduction: Security, CIA Triad, Viruses, Trojans, and Worms in a Nutshell, Security Concepts-exploit, threat, vulnerability, risk, attack. Malware Terminology: Rootkits, Trapdoors, Botnets, Key loggers, Honeypots. Active and Passive Security Attacks. IP Spoofing, Tear drop, DoS, DDoS, XSS, SQL injection, Man in middle Attack, Format String attack. Types of Security Vulnerabilities-buffer overflows, Invalidated input, race conditions, access-control problems, weaknesses in authentication , authorization, or cryptographic practices. Access Control Problems.

UNIT-II

Need for secure systems: Proactive Security development process, Secure Software Development Cycle(S-SDLC),Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code – Best Practices SD3(Secure by design, default and deployment), Security principles and Secure Product Development Timeline.

UNIT- III

Threat modeling process and its benefits: Identifying the Threats by Using Attack Trees, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization
Secure Coding Techniques: Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks. Security Issues in C Language: String Handling, Avoiding Integer Overflows and Underflows and Type Conversion Issues- Memory Management Issues, Code Injection Attacks.

UNIT-IV

Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check, Time of Use and its protection mechanisms. Validating Input and Inter process Communication, Securing Signal Handlers and File Operations. XSS scripting attack and its types – Persistent and Non persistent attack XSS Counter measures and Bypassing the XSS Filters.

UNIT- V

Testing Secure Applications: Security code overview, secure software installation. The Role of the Security Tester, Building the Security Test Plan. Testing HTTP-Based Applications, Testing File-Based Applications

Suggested Reading:

1. Michael Howard and David LeBlanc," *Writing Secure Code*" , Microsoft Press, 2nd Edition, 2004.
2. Jason Deckard, "*Buffer Overflow Attacks: Detect, Exploit, Prevent ",* Syngress, 1st Edition, 2005.
3. Frank Swiderski and Window Snyder, "*Threat Modeling*", Microsoft Professional, 1st Edition, 2004.

PE721CS

MINING MASSIVE DATASETS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To understand the basic concepts, principles, and techniques in data mining
- To learn the classical data mining algorithms
- To perform systematic analyze the real world data mining problems
- To model data mining problems and evaluate, visualize and communicate statistical models
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Course Outcomes : After completion of course, students will be able to:

1. To identify the Similarity search, streaming data, clustering, and graph mining.
2. To develop a research project relevant to Mining Massive Datasets and produce a report describing the project's background, methods, results, and conclusions.

UNIT- I

Data Mining – Modeling, Statistical limits on Data Mining, Importance of Words in Documents, Hash Functions, indexe.s

Map Reduce and the New Software Stack – Distributed File systems, Map Reduce, Algorithms using Map Reduce, Extensions to Map Reduce, The Communication Cost Model, Complexity ‘theory For Map Reduce.

UNIT-II

Finding Similar Items – Applications of Set similarity, Shingling of Documents, Similarities Preserving Summaries of Sets, Locality Sensitive Hashing for Documents, Distance Measures, theory of locality-sensitive functions, LSH families for Other Distance Measures, Applications of LSH, Methods for High Degrees of Similarity.

UNIT-III

Mining Data Streams – The Stream Data Model, Sampling Data in a stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in a Window, Decaying Windows.

Link Analysis -Page Rank, Efficient Computation of Page Rank, Topic Sensitive Page Rank, Link Spam, Hubs and Authorities

UNIT-IV

Frequent Itemsets- Market- Basket Model, A-Priori Algorithm, Handling Larger Datasets in Main Memory, Limited –Pass Algorithm , Counting Frequent Items in a Stream,

Clustering – Introduction, Hierarchical Clustering, K-Means Clustering, CURE Algorithm, Clustering in Non- Euclidean Spaces, Clustering for Streams and Parallelism

Advertising on the Web- Issues in online Algorithms, The matching Problem, The Adwords Problem, Adwords implementation.

UNIT-V

Mining Social Network Graphs – Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, Partitioning of Graphs, Finding Overlapping Communities, Simrank, Counting Triangles, Neighborhood Properties of Graphs.

Dimensionality Reduction – Eigen values and Eigen vectors of Symmetric Matrices, Principal Component Analysis, Singular Value Decomposition, CUR decomposition.

Suggested Readings:

1. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, "*Mining of Massive Datasets*", 2019.

PE722CS

DEEP LEARNING

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives :

- To understand complexity of Deep Learning algorithms and their limitations
- To understand modern notions in data analysis oriented computing;
- To apply Deep Learning algorithms in practical applications
- To perform experiments in Deep Learning using real-world data.

Course Outcomes:

The student will be able to

1. Understand the concepts of TensorFlow, its main functions, operations and the execution pipeline
2. Implement deep learning algorithms, understand neural networks and traverse the layers of data abstraction.
3. Learn topics such as convolutional neural networks, recurrent neural networks, training deep networks and high-level interfaces
4. Build deep learning models in TensorFlow and interpret the results
5. Understand the language and fundamental concepts of artificial neural networks

UNIT-I

Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.

Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT-II

Multilayer Perceptrons:

Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT-III

Introduction to Convolutional Neural Networks

Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters,

Modern Convolutional Neural Networks

Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet).

UNIT-IV

Recurrent Neural Networks: Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through Time**.**

Modern Recurrent Neural Networks: Gated Recurrent Units (GRU), Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence, Beam Search.

UNIT-V

Auto Encoders : Types of Auto Encoders and its applications

Generative Adversarial Networks: Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks

Suggested Readings:

1 Goodfellow, I., Bengio,Y., and Courville, A., "*Deep Learning"*, MIT Press, 2016.

2 Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "*Dive into Deep Learning",* 2020.

PE723CS

MOBILE AND WIRELESS NETWORK SECURITY

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To conceptualize the wireless terrain idiosyncrasies in terms of security and privacy;
- To impart state-of-the-art technologies of wireless network security;
- To analyze the various categories of threats, vulnerabilities, countermeasures in the area of wireless and mobile networking;
- To familiarize students with the issues and technologies involved in designing a wireless system that is robust against attacks.

Course Outcomes :

After completion of course, students would be able to:

1. Impart state-of-the-art technologies and protocols of wireless network security
2. Identify and investigate in-depth both early and contemporary threats to mobile and wireless networks security
3. To apply proactive and defensive measures to deter and repel potential threats, attacks and intrusions
4. Comprehend the fundamental concepts of mobile and wireless network security
5. Identify security threats in wireless networks and design strategies to manage network security
6. Design secured network application considering all possible threats

UNIT -I

Wired/wireless networks; Effect of mobility on networks and systems; impact on IP stack from MAC layer and up

UNIT – II

Ad-hoc and sensor networks; wireless broadcast, IP broadcast, Satellite broadcast; issues of information capacity

UNIT-III

Distinction between wired and wireless networks from information theory Issues of security in wireless; issues of 802.11 protocols; routing in wireless networks, design of secure protocols

UNIT-IV

Key distribution for access control, source authentication of transmissions, and non-repudiation; Power management and selfishness issues

UNIT-V

Attacks in wireless networks; DoS and DDoS attacks, reaction to attacks, information processing for sensor networks.

Suggested Readings:

1. Lei Chen, Jiahuang Ji, Zihong Zhang, "*Wireless Network Security*", Springer Science & Business Media, 2013.
2. Noureddine Boudriga, "*Security of Mobile Communications*", Taylor and Francis Group 2010.
3. Levente Buttyan and Jean-Pierre Hubaux, "*Security and Cooperation in Wireless Networks*", 2008.
4. James Kempf, "*Wireless Internet Security: Architectures and Protocols*", Cambride University Press 2008.
5. Patrick Traynor, Patrick McDaniel and Thomas LaPorta, "*Security for Telecommunications Networks*", 2008.
6. Frank Adelstein, Sandeep K.S.Gupta, Golden G.Richard III,and Loren Schweibert, "*Fundamentals of Mobile and Pervasive Computing*", 2005.

OE701BM

MICRO ELECTRO-MECHANICAL SYSTEMS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce to basics of Micro-electro-mechanical systems
- To understand properties of materials involved in MEMS
- To pertain fabrication methods involved in MEMS manufacturing
- To apply the concepts for various applications

Course Outcomes:

Upon completion of the course, the student will be able to

1. Elucidate basic concepts involved in MEMS technologies
2. Realize the properties of various materials involved in MEMS technologies
3. Apply the concepts and technologies involved in designing of MEMS
4. Relate different manufacturing processes involved in fabrication of MEMS
5. Recognize micro sensors, micro actuators and their applications in various fields.

UNIT- I

Introduction to MEMS: What is MEMS, Historical Background, classification, Micro-engineering, importance of micro-engineering. Technological advancements in MEMS, advantages and disadvantages of MEMS.

UNIT -II

MEMS Materials: Materials used in MEMS. Material properties: electrical, mechanical, thermal, chemical, biological, optical and processing. Reliability issues of materials

UNIT -III

Designing of MEMS: Design and analysis process for MEMS. Initial design process, structured design process. Commonly used design flow, structured design flow. Design flow for MEMS cad design. Design and verification flow for integrated MEMS.

UNIT- IV

MEMS Fabrication Techniques: Photolithography, materials for micromachining, bulk micromachining Surface micromachining, High aspect-ration-micromachining, assembly and system integration.

UNIT- V

MEMS structures and devices: Mechanical sensors, mechanical actuators, micro-fluidic devices, optical/photonic micro-systems, biological transducers.

Suggested Readings:

1. Adams TM, Layton RA. "*Introductory MEMS: Fabrication and applications*", 2010.
2. Tobergte DR, Curtis S. "*An Introduction to Micro-electro-mechanical Systems Engineering*" Second Edition. vol. 53. 2013.
3. Kreith F, Kreider JF. "*The MEMS Handbook*" CRC Press 2002.
4. Reza Ghodssi · Pinyen Lin. "MEMS Materials and Processes Handbook" Springer 2013
5. Gad-el-Hak M. "*MEMS applications*" 2nd edition, CRC press 2006.

OE 702CE

GREEN BUILDING TECHNOLOGY

Instruction: 3 Periods per week | Duration of SEE: 3 hours
CIE: 30 Marks | SEE: 70 Marks
Credits: 3

Course Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes:

Student will be

1. Understand the fundamentals of energy use and energy processes in building.
2. Identify the energy requirement and its management.
3. Know the Sun-earth relationship vis-a-vis its effect on climate.
4. Be acquainted with the end-use energy requirements.
5. Be familiar with the audit procedures of energy.

UNIT- I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT- II

Indoor environmental requirement and management: Thermal comfort - Ventilation and airquality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditoryrequirement.

UNIT- III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance onthe earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT- IV

End-use, energy utilization and requirements: Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building - Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

UNIT- V

Energy management options: Energy audit and energy targeting - Technological options for energy management.

Suggested Readings:

1. Michael Bauer, Peter Mösle and Michael Schwarz, *"Green Building – Guidebook for Sustainable Architecture"*, Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, *"Heating, Cooling, Lighting - Sustainable Design Methods for Architects",* Wiley, New York, 2015.
3. Mike Montoya, *"Green Building Fundamentals*", Pearson, USA, 2010.
4. Charles J. Kibert, *"Sustainable Construction - Green Building Design and Delivery*", John Wiley & Sons, New York, 2008.
5. Regina Leffers, *"Sustainable Construction and Design*", Pearson / Prentice Hall, USA, 2009.
6. James Kachadorian, *"The Passive Solar House: Using Solar Design to Heat and Cool Your Home",* Chelsea Green Publishing Co., USA, 1997.

OE 703CS

INFROMATION SECURITY

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To learn legal and technical issues in building secure information systems
- To provide an understanding of network security
- To expose the students to security standards and practices

Course Outcomes:

Student will be able to:

1. Understand the common threats and attack to information systems
2. Understand the legal and ethical issues of information technology
3. Identify security needs using risk management and choose the appropriate risk control strategy based on business needs
4. Use ethical hacking tools to study attack patterns and cryptography and secure communication protocols
5. Understand the technical and non-technical aspects of security project implementation and accreditation

UNIT I

Introduction: History, Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access,the SDLC, the Security SDLC.

Need for Security: Business Needs, Threats, Attacks, and Secure Software Development

UNIT II

Legal, Ethical and Professional Issues: Law and ethics in Information Security, Relevant U.S. Laws, International Laws and Legal Bodies, Ethics and Information Security.

Risk Management: Overview, Risk Identification, Risk Assessment, and Risk Control Strategies, Selecting a Risk Control Strategy, Quantitative versus Qualitative Risk Control Practices, Risk Management discussion Points, and Recommended Risk Control Practices.

UNIT III

Planning for Security: Security policy, Standards and Practices, Security Blue Print, Security Education, Continuity strategies.

Security Technology: Firewalls and VPNs: Physical Design, Firewalls, and Protecting Remote connections.

UNIT IV

Security Technology: Intrusion Detection, Access Control, and other Security Tools: Intrusion Detection and Prevention Systems-Scanning, and Analysis Tools- Access Control Devices.

Cryptography: Foundations of Cryptology, Cipher methods, Cryptographic Algorithms, Cryptographic Tools, Protocols for Secure Communications, Attacks on Cryptosystems

UNIT – V

Implementing Information Security: Information security project management, Technical topics of implementation, Non-Technical aspects of implementation, Security Certification and Accreditation.

Security and Personnel: Positioning and staffing security function, Employment Policies and Practices, and Internal control Strategies.

Information Security Maintenance: Security management models, Maintenance model, and DigitalForensics.

Suggested Readings:

1. Michael E Whitman and Herbert J Mattord, "*Principles of Information Security*", Cengage Learning, 2011.
2. Thomas R Peltier, Justin Peltier, John Blackley, "*Information Security Fundamentals*", Auerbach Publications, 2010.
3. Detmar W Straub, Seymour Goodman, Richard L Baskerville, "*Information Security, Policy, Processes, and Practices*", PHI, 2008.
4. Mark Merkow and Jim Breithaupt "*Information Security Principle and Practices*", Pearson Education, 2007.

OE704CS

DATA BASE MANAGEMENT SYSTEMS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce three schema architecture and DBMS functional components.
- To learn formal and commercial query languages of RDBMS.
- To understand the principles of ER modeling and theory of normalization.
- To study different file organization and indexing techniques.
- To familiarize theory of serializablity and implementation of concurrency control, and recovery.

Course Outcomes:

Student will be able to:

1. Understand the mathematical foundations on which RDBMS are built.
2. Model a set of requirements using the Extended Entity Relationship Model (EER), transform an EER model into a relational model, and refine the relational model using theory of Normalization.
3. Develop Database application using SQL and Embedded SQL.
4. Use the knowledge of file organization and indexing to improve database application performance.
5. Understand the working of concurrency control and recovery mechanisms in RDBMS.

UNIT – I

Introduction: Database System Applications, Purpose of Database Systems, View of Values, Nested Sub-queries, Complex Queries, Views, Modification of the Database, Joined Relations Data, Database Languages, Relational Databases, Database Design, Object–based and Semi-structured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators.

Database Design and the E-R Model: Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity-Relationship Diagrams, Entity – Relationship Design Issues, Weak Entity Sets, Extended E-R Features, Database Design for Banking Enterprise, Reduction to Relational Schemas, Other Aspects of Database Design

UNIT – II

Relational Model: Structure of Relational Databases, Fundamental Relational-Algebra Operations, Additional Relational – Algebra Operations, Extended Relational - Algebra Operations, Null Values, Modification of the Databases.

Structured Query Language: Data Definition, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Null.

UNIT – III

Advanced SQL: SQL Data Types and Schemas, Integrity Constraints, Authorization, Embedded SQL, Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced SQL Features. Relational Database Design: Features of Good Relational Design,

Atomic Domains and First Normal Form, Functional-Dependency Theory, Decomposition using Functional Dependencies.

UNIT – IV

Indexing and Hashing: Basic Concepts, Ordered Indices, B^+-tree Index Files, B-tree Index Files, Multiple-Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.

Index Definition in SQL Transactions: Transaction Concepts, Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability

UNIT – V

Concurrency Control: Lock-based Protocols, Timestamp-based Protocols, Validation-based Protocols, Multiple Granularity, Multi-version Schemes, Deadlock Handling, Insert and Delete Operations, Weak Levels of Consistency, Concurrency of Index Structures.

Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems.

Suggested Readings:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "*Database System Concepts"*, McGraw-Hill International Edition, 6th Edition, 2010.

2. Ramakrishnan, Gehrke, "*Database Management Systems"*, McGraw-Hill International Edition, 3rd Edition, 2003.

3. Elmasri, Navathe, Somayajulu, "*Fundamentals of Database Systems"*, Pearson Education, 4th Edition, 2004.

OE 705EC

EMBEDDED SYSTEMS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To gain knowledge to design embedded systems.
- To understand the processor selection criteria for Embedded System Design.
- To gain the knowledge of ARM Cortex on Zynq for embedded systems.
- To gain the knowledge of tool chain for embedded systems.
- To understand the importance of RTOS in building real time systems

Course Outcomes:

Student will be able to:

1. Design an embedded system.
2. Distinguish between RISC and CISC
3. Use the ARM Cortex for design of embedded system
4. Use Embedded Software Development Tools for Designing Embedded System applications
5. Apply their understanding in building real time systems

UNIT-I

Introduction To Embedded Systems: The Embedded Design Life Cycle - Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware (selection fo processor) and Software Design, Hardware/Software Integration, Product Testing And Release, Maintenance and Upgradation.

UNIT-II

ARM Embedded Systems: The RISC design philosophy, The ARM design philosophy, ARM processor fundamentals, registers, current program status register, pipeline, exceptions, interrupts,and vector table, core extensions, architecture revisions, ARM processor families.

UNIT-III

Embedded processing with ARM CORTEX on Zynq: Fundamentals of FPGA, types of FPGA, case study of Xilinx FPGA, Processing System, programmable logic, programmable logic interfaces, security, Zynq 7000 family members, Zynq versus standard FPGA, Zynq versus standard processor.

UNIT-IV

Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution, and Locator Maps. Getting Embedded Software into Target System: PROM programmer, ROM emulator, In Circuit- Emulators, Monitors, Testing on Your Host Machine - Instruction Set Simulators, Logic Analyzers.

UNIT-V

Introduction to Real Time Operating Systems: Tasks and task states, tasks and Data, Semaphores and shared data. Operating system services: Message queues, mailboxes and pipes, timer functions,events, memory management, Interrupt routines in an RTOS environment.

Suggested Readings:

1. Arnold S Berger, "*Embedded Systems Design*", South Asian edition, CMP Books, 2005.

2. Andrew Sloss, Dominic Symes, Chris Wright, ARM "*System Developer's Guide: Designing and Optimizing System Software*", Elsevier, 2004.

3. Louise H Crockett, Ross. A. Elliot et al "*The Zynq Book*", Edition 1, Strathclyde academic media, July 2014.

4. David E Simon, "*An Embedded software primer*", Pearson, 2012.

OE 706EC

VERILOG HDL

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL.
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL
- To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU)
- To learn Synthesis and FPGA design flow.
- To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU, FIR filter.

Course Outcomes:

Student will be

1. Implement and distinguish different Verilog HDL modeling styles
2. Construct and analyze Verilog HDL models of combinational and sequential circuits
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications
4. Outline FPGA design flow and timing analysis

UNIT - I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT - II

Structural and Dataflow modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples

UNIT - III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT - IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT - V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Readings:

1. Samir Palnitkar, "*Verilog HDL A Guide to Digital Design and Synthesis*", 2nd Edition, Pearson Education, 2006.

2. Ming-Bo Lin, "Digital *System Designs and Practices: Using Verilog HDL and FPGA*", Wiley India Edition, 2008.

3. J. Bhasker, "*A Verilog HDL Primer*", 2nd Edition, BS Publications, 2001.

OE 707EC

SATELLITE COMMUNICATION AND APPLICATIONS

Instruction: 3 Periods per week | Duration of SEE: 3 hours
CIE: 30 Marks | SEE: 70 Marks
Credits: 3

Course Objectives:

- To familiarize with basic concepts related to satellite Communication.
- To understand Sub-Systems of Satellites and Launches.
- To design the Earth Station antennas.
- To know about the parameters affecting the Satellite System Performance.
- To understand the applications of satellites.

Course Outcomes:

Student will be

1. Able to have knowledge about the Satellite communications Principles and Properties.
2. Able to know about the Space craft subsystems and Launch vehicles.
3. Able to design the Satellite Earth station antennas
4. Able to analyze the effects of various parameters on Satellite System performance.
5. Able to understand the applications of Satellite Communication.

UNIT–I

Origin of Satellite communications, A Brief History of Satellite Communication, Basic principlesand properties of satellite communication. Earth segment, Space segment, Interpretation of Kepler's Laws. Orbital Mechanics: The Equation of the Orbit, Describing the Orbit, Locating the Satellite inthe Orbit, Orbital effects in communication system Performance: Doppler shift, Range variation, Eclipse and Sun-Transit Outage.

UNIT– II

Space craft sub systems, Equipment Reliability and Space Qualification: Space Qualification, Reliability, and Redundancy, Satellite launch and launch vehicles and Mechanics of Launching a Synchronous Satellite.

UNIT– III

Earth Stations: Earth Station Design for Low System Noise Temperature, Design of large antennasand small earth station antennas. Low noise amplifiers and High power Amplifiers for Satellite communication.

UNIT– IV

Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T ratio: Noise Temperature, calculation of System Noise Temperature, Noise Figure and Noise Temperature, Propagation on Satellite-Earth paths: Attenuation, depolarization, atmospheric absorption, Tropospheric Multipath effects and Land and Sea Multipath, Multipath Effects in System Design,Faraday rotation in the Ionosphere, Ionospheric scintillations, Rain and ice effects.

UNIT– V

Satellite Navigation Applications: Global and Regional Satellite Navigation Systems- Operating Principles, Advantages, Limitations, Current Status and Applications, Remote Sensing Satellites.

Suggested Readings:

1. Wilbur L. Pitchand and Henri G. Suyderhoud, Robert A. Nelson, "*Satellite Communication Systems Engineering*", 2nd edn.3rd Impression, Pearson Education.2008.

2. Timothy Pratt and Charles Nestian. W, "*Satellite Communication*", John Wiley and Sons, 1988.

3. Tri T. Ha, "*Digital Satellite Communication*", Tata McGraw- Hill, Special Indian Edition 2009.

OE708EE

OPTIMIZATION TECHNIQUES

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To understand the need and basic concepts of operations research and classify the optimization problems.
- To study about the linear programming and non-linear programming concepts and their applications
- To understand various constrained and un-constrained optimization techniques and their applications.
- To understand the concepts and implementation of Genetic Algorithms to get the optimum solutions
- To study the concepts of Meta heuristics Optimization techniques

Course Outcomes: After completion of this course, the students shall be able to:

1. Analyze any problem of optimization in an engineering system and able to formulate a mathematical model to the problem and solving it by the techniques that are presented.
2. Solve problems of L.P. by graphical and Simplex methods
3. Apply various constrained and un-constrained optimization techniques for the specific problems.
4. Could able to implement the Genetic Algorithms to solve the for optimum solution
5. Understands the concepts to use the Meta heuristics Optimization techniques

UNIT-I

Introduction: Definitions, Characteristics, Objective function, Classification of optimization problems, Engineering applications and limitations. Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints and Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Condition

UNIT-II

Linear Programming: Definitions and Formulation of the LPP, Construction of L.P. Models, Slack and surplus variables, Standard form, Canonical form and matrix form of LP Problems. Artificial Variables, solution by the Big-M method, Duality principle, Dual problems and numerical problems.

UNIT-III

Random Search Methods concepts: Direct Search Methods - Univariate Method, Gradient of a Function, Indirect Search Methods - Gradient of a Function, Steepest Descent (Cauchy) Method, Newton's Method.

UNIT-IV

Binary Genetic Algorithm: Genetic Algorithms Natural Selection on a Computer, Components of a Binary Genetic Algorithm. Selecting the Variables and the Cost Function. Variable Encoding and Decoding, The Population, Natural Selection, Selection, Mating. Mutations, the Next Generation and Convergence, Components of a Continuous Genetic Algorithm.

UNIT-V

Metaheuristics Optimization: Concepts of Simulated Annealing, Theoretical approaches, Advantages and disadvantages, applications, Ant Colony Algorithms - Introduction, Collective behavior of social insects, Formalization and properties of ant colony optimization.

Suggested Readings:

1. Rao, S.S. (2009), "*Engineering Optimization: Theory and Practice*", John Wiley & Sons, Inc.

2. Taha, H.A. (2008), "Operations Research, Pearson Education India", New Delhi, India.

3. Randy L. Haupt and Sue Ellen Haupt, "*Practical genetic algorithms*", second edition, a John Wiley & sons, inc., publication -2004.

4. Sharma J.K. (2013), "*Operation Research: Theory and Applications*", Fifth Edition, Macmillan Publishers, New Delhi, India.

5. J. Dreo A. Petrowski, P. Siarry E. Taillard, "*Metaheuristics for Hard Optimization*", Springer.

OE709EE

NON-CONVENTIONAL ENERGY SOURCES

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To understand the different types of energy sources
- To Understand the need of non-conventional energy sources and their principles
- To understand the limitations of non-conventional energy sources
- To outline division aspects and utilization of renewable energy sources for diriment application.
- To analyze the environmental aspects of renewable energy resources

Course Outcomes:

After completion of this course, the students shall be able to:

1. Know the different energy resources and need of renewable energy resources.
2. Understand the concepts of working of fuel cell systems along with their applications.
3. Describe the use of solar energy and the various components and measuring devices used in the energy production and their applications.
4. Appreciate the need of Wind Energy and their classification and various components used in energy generation and working of different electrical wind energy system.
5. Understand the concept of OTEC technology, Biomass energy resources and different types of biogas Plants used in India.

UNIT-I

Review of Conventional and Non-Conventional energy sources, Need for non-conventional energy sources Types of Non-conventional energy sources, Fuel Cells, Principle of operation with special reference to H2O2 Cell, Classification and Block diagram of fuel cell systems, Ion exchange membrane cell, Molten carbonate cells, Solid oxide electrolyte cells, Regenerative system, Regenerative Fuel Cell, Advantages and disadvantages of Fuel Cells, Polarization, Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy, Solar radiation and its measurements, Solar Energy collectors, Solar Energy storage systems, Solar Pond, Application of Solar Pond, Applications of solar energy.

UNIT-III

Wind energy, Principles of wind energy conversion systems, Nature of wind, Power in the Wind, Basic components of WECS, Classification of WECS, Site selection considerations, Advantages and disadvantages of WECS, Wind energy collectors, Wind electric generating and control systems, Applications of Wind energy, Environmental aspects.

UNIT-IV

Energy from the Oceans, Ocean Thermal Electric Conversion (OTEC) methods, Principles of tidal power generation, Advantages and limitations of tidal power generation, Ocean waves, Wave energy

conversion devices, Advantages and disadvantages of wave energy, Geo-thermal Energy, Types of Geo-thermal Energy Systems, Applications of Geo-thermal Energy.

UNIT-V

Energy from Biomass, Biomass conversion technologies / processes, Photosynthesis, Photosynthetic efficiency, Biogas generation, Selection of site for Biogas plant, Classification of Biogas plants, Details of commonly used Biogas plants in India, Advantages and disadvantages of Biogas generation, Thermal gasification of biomass, Biomass gasifies.

Suggested Readings:

1. Rai G.D, "*Non-Conventional Sources of Energy*", Khandala Publishers, New Delhi, 1999.

2. M. M. El-Wakil, "*Power Plant Technology*", McGraw Hill, 1984.

OE 710ME

STARTUP ENTREPRENEURSHIP

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise by creative thinking and shape ideas into reality.
- To understand action driven business plan and learn to prepare project budget.

Course Outcomes:

Student will be able to

1. Think creatively and transform ideas into reality.
2. Differentiate market transforming strategy.
3. Create a complete business plan and workout the budget plan.

UNIT – I

Creativity & Discovery: Definition of Creativity, self-test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas, Innovative to borrow or adopt, choosing the best of many ideas, management of tradeoff between discovery and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories.

UNIT – II

From Idea to Startup: Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map.

UNIT – III

Innovation career lessons: Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming Strategy; Dare to Take Action; Fighting Resistance; All About the startup Ecosystem; Building a Team; Keeping it Simple and Working Hard.

UNIT – IV

Action driven business plan: Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is 'most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map.

UNIT – V

Startup financing cycle: Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self-financing). Prepare a risk map. Prepare a business plan comprising five sections: The

Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan detailed activities and starting and ending dates); and a project budget.

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management"*, Himalaya Publishing House, 1997.
2. Prasanna Chandra, *"Project – Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, "*Entrepreneurship for Engineers*", Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, "*First Things First",* Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, *"Entrepreneurship*", Tata McGraw Hill Edition, 2002.

OE711ME

NANO TECHNOLOGY

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To familiarize Nano materials and technology.
- To understand Nano structures, fabrication and special Nano materials.

COURSE OUTCOMES: Upon successful completion of this course, the student will be able to:

1. Apply the nano materials to different industrial applications
2. Explore the nano materials various human applications
3. Design and manufacture nanomaterial processes

UNIT-I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology, Bottom-up and Top-down approaches, challenges in NanoTechnology.

UNIT-II

Materials of Nano Technology: Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM.

UNIT-III

Nano Structures: Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles
One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes.

UNIT-IV

Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

UNIT-V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications. Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications.

Suggested Readings:

1. A.K.Bandyopadyay, "*Nano Materials*", New Age Publications, 2007.
2. T. Pradeep, "*Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy*", Tata McGraw-Hill, 2008.
3. Carl. C. Koch, "*Nano Materials Synthesis, Properties and Applications*", Jaico Publishing House, 2008.
4. Willia Illsey Atkinson, "*NanoTechnology*", Jaico Publishing House, 2009.

PW 751 CS

MAJOR PROJECT PHASE -I

Instruction: 2 Periods per week CIE: 50 Marks
Credits: 2

Course Objectives:

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic Literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:

Student will be able to:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one page synopsis before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

*Problem definition and specification

*Literature survey

*Broad knowledge of available techniques to solve a particular problem.

*Planning of the work, preparation of bar (activity) charts

*Presentation- oral and written.

PW 961 CS

SUMMER INTERNSHIP

University Examination	:	50 Marks
Credits		--

Course Objectives:

- To train and provide hands-on experience in analysis, design, and programming of information systems by means of case studies and projects.
- To expose the students to industry practices and team work.
- To provide training in soft skills and also train them in presenting seminars and technical report writing.

Course Outcomes:

Student will be able to :

1. Get Practical experience of software design and development, and coding practices within Industrial/R&D Environments.
2. Gain working practices within Industrial/R&D Environments.
3. Prepare reports and other relevant documentation.

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Computer Industry/Software Companies/R&D Organization for a period of 8 weeks. This will be during the summer vacation following the completion of the III year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co-ordinate (person from industry).

After the completion of the project, student will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the Department. Award of sessionalsare to be based on the performance of the students, to be judged by a committee constituted by the department. One faculty member will co-ordinate the overall activity of Industry Attachment Program.

SCHEME OF NSTRUCTION
BE (COMPUTER SCIENCE & ENGINEERING)
VIII SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P/D	Contact Hours/ Week	CIE	SEE	
Theory Courses									
1	**Professional Elective-VII**		3	0	0	3	30	70	3
	PE801CS	Architecting Applications for Cloud							
	PE802CS	Large Scale Data Processing and Optimization							
	PE803CS	Machine Vision							
	PE804CS	Digital Forensics							
2	**Professional Elective-VIII**		3	0	0	3	30	70	3
	PE821CS	Computational Intelligence							
	PE822CS	Information Retrieval Systems							
	PE823CS	Multi Core & GPU Programming							
	PE824CS	Human Computer Interaction							
3	**Open Elective-III**		3	0	0	3	30	70	3
	OE801BM	Basic Medical Equipment							
	OE802CS	Data Science Using R							
	OE803EC	Mobile Communication							
	OE804EC	Internet of Things and Applications							
	OE805EC	Global and Regional Satellite Navigation System							
	OE806EE	Applications of Electrical Energy							
	OE807ME	Composite Material Applications							
	OE808ME	Industrial Administration and Financial Management							
	OE809CS	Software Engineering							
	OE810CS	Python Programming							
	OE811CS	Cyber Security							
Practicals									
4	PW851CS	Major Project Phase-II	0	0	6	12	50	100	6
Total			**9**	**0**	**6**	**21**	**140**	**310**	**15**

L : Lectures T : Tutorials P : Practicals

CIE : Continuous Internal Evaluation SEE : Semester End Examination

PE801CS

ARCHITECTING APPLICATIONS FOR THE CLOUD

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

Students will learn

- To identify the cloud software considerations and logging services in cloud.
- How to integrate Kafka with Spark Streaming API in distributed computing applications.
- To impart the knowledge on cloud applications, services and security principles.
- To know the fine-grained functions and deployment of a scalable web applications with Docker.
- To gain knowledge on DevOps for the cloud, CI/CD pipeline and IaC.

Course Outcomes:

Students will be able to:

1. Explain the Software Architecture principles and patterns for a cloud application monitoring, messaging and logging services in cloud.
2. Apply knowledge on distributed computing to integrate Kafka with Spark Streaming API in distributed computing applications.
3. Discuss different applications, principles and services for the cloud.
4. Illustrate the containers & micro services to get the fine-grained functions and deployment of scalable web applications with Docker.
5. Analyze DevOps tools for the Cloud and Infrastructure as a code (IaC)

UNIT-I

Software Architecture –Principles & Patterns, Architecture Principles for Cloud applications Monitoring, Messaging and Logging Services on Cloud

UNIT-II

Distributed Computing, Applications with Apache Spark , Real time Processing tools- Spark streaming , Kafka

UNIT-III

Applications for the Cloud - Serverless Computing, Cloud APIs and Managed Services , Cloud Security Principles and Services

UNIT-IV

Containers & Microservices Introduction to Containers Docker + Deploying a Web App using Docker Deploying a Container Cluster, Distributed Microservice Architectures & Design Patterns

UNIT-V

DevOps for the Cloud - CI/CD Principles and Application Deployment Pipeline, Infrastructure as Code (IaC)

Suggested Readings:

1. Kamal Arora, Erik Farr, John Gilbert, Piyum Zonooz, "*Architecting Cloud Native Applications: Design high-performing and cost-effective applications for the cloud*", Packt Publishing: 1st edition, 2019.

2. Ashutosh Shashi, " *Re-Architecting Application for Cloud: An Architect's reference guide*" , 2020.

PE802CS

LARGE SCALE DATA PROCESSING AND OPTIMIZATION

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:
Students will learn:

- To understand key concepts of scalable data processing approaches in future computer systems.
- To obtain a clear understanding of building distributed systems using data centric programming and large-scale data processing.
- To gain knowledge on Deploying Tensor-Flow models on Amazon EC2
- To represent Stream data processing and data/query model.
- To formulate Optimized computer systems using machine learning.

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

1. Describe Large scale data processing and optimization and Data flow programming
2. Analyze Large scale graph data processing in terms of storage , processing model and parallel processing
3. Apply Map-Reduce algorithm with Deep Neural Network using Tensor Flow with Amazon EC2.
4. Evaluate Stream data processing and data/query model.
5. Build optimized computer systems using machine learning and optimize task scheduling.

UNIT- I
Introduction to large-scale data processing and optimization – Overview of technologies for Big Data Processing, The Big Data Problem
Data flow programming: Map/Reduce to Tensor Flow

UNIT- II
Large-scale Graph Data Processing: storage, processing model and parallel processing, How Programming for Data Flow Differs, Basic Spark, Working with Vectors and Matrices in Spark, Brief tour of Spark ML, Beyond parallelization, Practical Big Data

UNIT- III
Stream data processing and data/query model, Anatomy of Fast Data Applications, SMACK Stack – Functional Decomposition, Message Backbone- Understanding messaging requirements.

UNIT- IV
Data ingestion, Fast data& low latency, Message Delivery Semantics, Distributing Messages.

UNIT - V
Machine learning for optimization of computer systems , Task scheduling optimization and Auto-tuning, Compute Engines- Micro Batch Processing, One-at-a time Processing, Choice of processing engine, Storage as the Fast Data Borders, The message backbone as Transition Point.

Suggested Readings:

1. Bahaaldine Azarmi, "*Scalable Big Data Architecture: A Practitioner's Guide to Choosing Relevant Big Data Architecture*", APRESS 2016.

2. Sherif Sakr, Mohamed Gaber, "*Large Scale and Big Data Processing and Management*", Auerbach Publications 2016.

3. Claus O.Wilke, "*Fundamentals of Data Visualization A Primer on Making Informative and Compelling Figures*", O'Reilly Media, Inc 2019.

4. Stavros Kontopoulos, Sean Glover, "*Designing Fast Data Application Architectures by Gerard Maas*", O'Reilly Media, Inc., *June 2018.*

5. Bill Chambers & Matei Zaharia, "*Spark- The definitive Guide*" O'Reilly Media, Inc., *2019.*

PE803CS

MACHINE VISION

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- Be familiar with both the theoretical and practical aspects of computing with images.
- Have described the foundation of image formation, measurement, and analysis.
- Grasp the principles of state-of-the-art deep neural networks

Course Outcomes: On completion of this course, student will be able to

1. Design ML architecture for computer vision tasks
2. Select a model (such as ResNet, SqueezeNet, or EfficientNet) appropriate to your task
3. Create an end-to-end ML pipeline to train, evaluate, deploy, and explain your model
4. Preprocess images for data augmentation and to support learnability
5. Deploy image models as web services or on edge devices
6. Monitor and manage ML models

UNIT- I

Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis Edge detection, Edge detection performance, Hough transform, corner detection Segmentation, Morphological filtering, Fourier transform Feature extraction, shape, histogram, color, spectral, texture, using CV/ IP tools, Feature analysis, feature vectors, distance /similarity measures, data preprocessing

UNIT- II

ML Models for Vision- Machine Perception, Linear model using Keras, Neural Network using Keras,

UNIT- III

Image Vision - Pretrained Embeddings, Convolution Networks, The quest for Depth, Modular Architectures, Neural architecture search designs, choosing a model.

UNIT-IV

Creating Vision Datasets – Collecting Images, Data types, Manual Labeling, Labeling at scale, Automated Labeling, Bias, creating a dataset.

UNIT- V

Recent trends in Activity Recognition, computational photography, Biometrics, Object Recognition.Scene Matching and Analysis, Robotic Vision.

Suggested Readings:

1. Richard Szeliski, "*Computer Vision: Algorithms and Applications*", Springer 2011.
2. Valliappa Lakshmanan, Martin Görner, and Ryan Gillard, "*Practical Machine Learning for Computer vision*", O'Reilly Media 2021.
3. Ion Goodfellow, Bengio, and Courville, "*Deep Learning*", 2016.
4. Fisher R. B, "*Dictionary of Computer Vision and Image Processing"*, 2014.

PE804CS

DIGITAL FORENSICS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
- To understand how to examine digital evidences such as the data acquisition, identification Analysis.

Course Outcomes:

After completion of course Student will be able:

1. To apply forensic analysis tools
2. To identify the evidence for identifying computer crime.
3. To learn the network analysis tools

UNIT - I

File Systems: FAT/NTFS file Systems, Parsing FAT/NTFS file systems, Prefetch and Superfetch, Shortcuts and Jumplists.
Adversary and Malware hunting: Malware detection, Malware analysis
Memory Forensics: Memory acquisition, Memory analysis, memory analysis tools, Advanced Recycle bin, Server Logs, Google forensics.
Anti-Forensics Detection: detection methodologies, Volume shadow copy, ESE databases, Advanced Registry, Thumbnail cache.

UNIT- II

Computer crime and legal issues: Privacy issues, Intellectual property.
Incident Response: Threat and Adversary Intelligence, Financial crime analysis
Live/Online Forenics: Live Digital Forensics Investigation.
Tools: BitTorrent, Sleuthkit toolset, Windows Forensics. Toolchest Moot court: Moot court case.

UNIT-III

Networking overview: Windows Networks, Users and Groups, Introduction to Network investigations
Windows and Linux servers: Server roles, Server analysis, Windows Registry, Event logs
Linux Forensics: Linux File systems, Linux server configurations, Linux artifacts, Apache server forensics, LAMP forensics, SMB and Linux file shares.

UNIT- IV

IIS and Microsoft Exchange server: IIS server, Mailserver, Windows rootkits, Compromised server analysis
SQL server and Data bases: Microsoft SQL server, SQL server permission and encryption,
SQL server Forensics Acquisition and analysis: SQL server forensics and traditional windows forensics, SQL server artifacts, Resident and non-resident artifact's Collecting SQL data bases, Creating an analysis database, Importing evidence, Activity Reconstruction, Data recovery, SQL server rootkits

UNIT- V

Network Traffic Analysis: Network addressing, DNS poisoning, ARP table analysis, DHCP analysis, Wire shark analysis.

Network Device Forensics: management of switches and routers, diagramming physical networks, Securing and isolating physical devices, Collecting Volatile/Non-volatile evidences from the routers, Volatile/Non-volatile.

Suggested Readings:

1. H. Carvey, "Windows Forensics Analysis DVD Toolkit", Syngress publishers 2009.
2. S. Anson, S. Bunting, R. Johnson, S. Perason, "Mastering Windows Network Forensics and Investigations", Sybex publishers K. Fowler, SQL Server Forensic Analysis, Addison Wesley 2012.
3. K. Mandia, M. Pepe , J. Luttgens, "*Incident Response & Computer Forensics*", Third Edition 2014.
4. M.H. Ligh, A. Case, J. Levy, A. waters, "*The art of memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory*", Wiley 2014.
5. S. Davidoff, J. Ham, "*Network Forensics: Tracking Hackers through Cyberspace*", Prentice Hall 2012.

PE821CS

COMPUTATIONAL INTELLIGENCE

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce the concepts of Biological and Artificial neural networks.
- To understand different neural architectures with supervised learning and their learning mechanisms.
- To study different neural architectures with unsupervised learning such as PCA Networks ,
- Kohenen‘s Self-Organizing Maps.
- To introduce Markov decision processes, Q-Learning and TD-Learning.
- To study different models of evolution and learning, neuro-fuzzy techniques, rough set theory and their applications.

Course Outcomes:

Student will be able to :

1. Design single and multi-layer feed-forward neural networks
2. Implement various unsupervised learning networks
3. Design new evolutionary operators, representations and fitness functions for specific practical problems
4. Apply fuzzy logic and rough sets to handle uncertainty and vagueness in practical problems

UNIT -I

Introduction to Computational Intelligence / Soft computing: Soft versus Hard Computing, Various paradigms of computing.

Foundations of Biological Neural Networks: Introduction to Neural Networks, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN (Learning, Generalization, Memory, Abstraction, Applications), McCulloch-Pitts Model, Historical Developments

Essentials of Artificial Neural Networks: Introduction, Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity (Feed forward, feedback, Single and Multi-layer), Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules (Error Correction, Hebbian, Competitive, Stochastic), Types of Application (Pattern Classification, Pattern Clustering, Pattern Association / Memory, Function Approximation, Prediction, Optimization)

UNIT –II

Neural Architectures with Supervised Learning: Single Layer Feed Forward Neural Networks (Perception), Multilayer Feed forward Neural Networks (Back propagation learning), Radial Basis Function Networks, Support Vector Machines, Simulated Annealing, Boltzmann Machine, Feedback (Recurrent) Networks and Dynamical Systems

Associative Memories: Matrix memories, Bidirectional Associative Memory, Hopfield Neural Network,

UNIT –III

Neural Architectures with Unsupervised Learning: Competitive learning, Principal Component Analysis Networks (PCA), Kohonen's Self-Organizing Maps, Linear Vector Quantization, Adaptive Resonance Theory (ART) Networks, Independent Component Analysis Networks (ICA)

UNIT -IV

Reinforcement Learning: Markov Decision Processes, Value Functions, Bellman Optimality Criterion, Policy and Value Iterations, Q-Learning, TD Learning

UNIT -V

Fuzzy Logic: Basic concepts, fuzzy set theory, basic operations, fuzzification, defuzzification, neurofuzzy approach, applications.

Evolutionary and Genetic Algorithms: Basic concepts of evolutionary computing, genetic operators, fitness function and selection, genetic programming, other models of evolution and learning, ant colony systems, swarm intelligence, applications

Rough Set Theory: Basic concepts, in-discernability relation, lower and upper approximation, decision systems based on rough approximation, applications.

Suggested Readings:

1. Jacek M. Zurada, "*Introduction to Artificial Neural Systems*", Jaico Publishers, 1992.
2. S. Haykin, "*Neural Networks: A Comprehensive Foundation*", Prentice Hall, 1999
3. P. S. Churchland and T. J. Sejnowski, "*The Computational Brain*", MIT Press, 1992.
4. A. M. Ibrahim, "*Introduction to Applied Fuzzy Electronics*", PHI, 2004
5. Z. Pawlak, "*Rough Sets*", Kluwer Academic Publishers, 1991.

PE822CS

INFORMATION RETRIEVAL SYSTEMS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To understand indexing and querying in information retrieval systems
- To learn the different models for information retrieval
- To expose the students to text classification and clustering
- To learn about web searching

COURSE OUTCOMES:

Students will be able to

1. Understand the algorithms and techniques for information retrieval (document indexing and retrieval, query processing)
2. Quantitatively evaluate information retrieval systems
3. Classify and cluster documents
4. Understand the practical aspects of information retrieval such as those in web search engines.

UNIT-I

Boolean Retrieval: An example information, Building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval.

The term vocabulary and postings lists: Document delineation and character sequence decoding, determining the vocabulary of terms, faster postings list intersection via skip pointers, Positional postings, and Phrase queries.

Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction.

Index construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, dynamic indexing, Other types of indexes.

UNIT-II

Index compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression.

Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, and Variant tf-idf functions.

Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.

Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

UNIT-III

Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

XML retrieval: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval.

Probabilistic information retrieval: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model.

Language models for information retrieval: Language models, The query likelihood model.

UNIT-IV

Text classification and Naive Bayes: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, and Feature selection.

Vector space classification: Document representations and measures of relatedness in vector spaces, Rocchio classification, k- nearest neighbor, Linear versus nonlinear classifiers.

Flat clustering: Clustering in information retrieval, Problem statement, Evaluation of clustering, k-means.

Hierarchical clustering: Hierarchical agglomerative clustering, Single-link and complete-link clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering.

UNIT-V

Matrix decompositions and Latent semantic indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing.

Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.

Web crawling and Indexes: Overview, Crawling, Distributing indexes, Connectivity servers.

Link analysis: The Web as a graph, Page Rank, Hubs and Authorities.

Suggested Readings:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, "*An Introduction to Information Retrieval"*, Cambridge University Press, Cambridge, England, 2008.
2. David A. Grossman, Ophir Frieder, "*Information Retrieval – Algorithms and Heuristics"*, Springer, 2nd Edition (Distributed by Universities Press), 2004.
3. Gerald J Kowalski, Mark T Maybury. "*Information Storage and Retrieval Systems"*, Springer, 2000.
4. Soumen Chakrabarti, "*Mining the Web: Discovering Knowledge from Hypertext Data"*, Morgan-Kaufmann Publishers, 2002.

PE823CS

MULTI CORE & GPU PROGRAMMING

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To learn the paradigms of parallel computing, PRAM and BSP model.
- To study the heterogeneous processor architectures
- To understand the multicore programming using OpenCL
- To provide basics of OpenCL computing models

Course Outcomes: Student will be able to

1. Apply the knowledge of parallel computing models to solve real time applications.
2. Gain the knowledge of heterogeneous processor architectures
3. Apply the multi core programming knowledge to solve the sequential tasks

UNIT-I

Introduction to Parallel Computing: Scope of Parallel Computing, Sieve of Eratosthenes, Control and Data Approach, PRAM model of parallel computation, Design paradigms of Parallel Computing, examples, Bulk Synchronous Parallel (BSP) model, algorithms on PRAM and BSP model.

UNIT-II

Introduction to Heterogeneous Multi-Core Processors, Many cores Programming, Cell Processor Multinode Computing.

Introduction to Graphics Processors, Graphics Processing Units, GPGPUs and GPU Hardware. Programming using CUDA/ OpenCL, Direct Compute CPU alternatives, Directives and libraries, Understanding Parallelism with GPUs.

UNIT-III

Heterogeneous Multi-Core Programming with OpenCL: OpenCL Programming Model, OpenCL Device Architectures, Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories

UNIT-IV

Introduction to OpenCL: Understanding OpenCL's Concurrency and Execution Model, Dissecting a CPU/GPU, OpenCL Implementation. Programs for concurrent Data Structures such as Work lists, Linked-lists. Synchronization across CPU and GPU.

Functions: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.

UNIT-V

Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning, Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing

Suggested Readings:

1. David Kaeli, Perhaad Mistry, Dana Schaa and Dong Ping Zhang **,** *Heterogeneous Computing with OpenCL 2.0***,** 1st Edition, Mourgan Kaufmann, 2015.

2. Vipin Kumar, George Karypis, Anshul Gupta, Ananth Grama, "*Introduction to Parallel Computing*" , Addison Wesley, 2003.

3. Gregory V. Wilson, *Practical Parallel Programming*, PHI, 1998.

PE824CS

HUMAN COMPUTER INTERACTION

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce interaction frameworks and styles
- To learn about interaction design process , design standards and principles
- To introduce the concept of usability and usability testing
- To familiarize interface components and technical issues of concern

Course Outcomes :

Student will be able to :

1. Describe different types of interactive environments and interaction styles
2. Understand the user interface design process and the need for user-centered design
3. Describe techniques for developing prototypes of user interfaces and evaluation of user interfaces Create an appropriate usability test plan
4. Understand the human and technical issues involved in the usage of text, icons and colors in user interfaces

UNIT- I

Interaction Paradigms: Computing Environments, Analyzing Interaction Paradigms, Interaction Paradigms.

Interaction Frameworks and Styles: Frameworks for Understanding Interaction, Coping with Complexity, Interaction Styles.

UNIT- II

Interaction Design Process: Iterative Design, User-Centered Design, Interaction Design Models, Overview of Interaction Design Models

Discovery: Discovery Phase Framework, Collection, Interpretation , Documentation

Design: Conceptual Design, Physical Design, Evaluation, Interface Design Standards, Designing the Facets of the Interface.

UNIT- III

Design Principles: Principles of Interaction Design, Comprehensibility, Learnability, Effectiveness/Usefulness, Efficiency/Usability, Grouping, Stimulus Intensity, Proportion, Screen Complexity, Resolution/Closure, Usability Goals.

Interaction Design Models: Model Human Processor, Keyboard Level Model, GOMS, Modeling Structure, Modeling Dynamics, Physical Models.

Usability Testing: Usability, Usability Test, Design the Test, Prepare for the Test, Perform the Test, Process the Data.

UNIT- IV

Interface Components: The WIMP Interface, Other Components

Icons: Human Issues Concerning Icons, Using Icons in Interaction Design, Technical Issues Concerning Icons

Color: The Human Perceptual System, Using Color in Interaction Design, Color Concerns for Interaction Design, Technical Issues Concerning Color

UNIT- V

Text: Human Issues Concerning Text, Using Text in Interaction Design, Technical Issues Concerning Text.

Speech and Hearing: The Human Perceptual System, Using Sound in Interaction Design, Technical Issues Concerning Sound.

Touch and Movement: The Human Perceptual System, Using Haptics in Interaction Design, Technical Issues Concerning Haptics.

Suggested Readings:

1. Steven Heim, "*The Resonant Interface: HCI Foundations for Interaction Design"*, Addison-Wesley, 2007.

2. J. Preece, Y. Rogers, and H. Sharp, "*Interaction Design: Beyond Human-Computer Interaction"*, Wiley & Sons, 2nd Edition, 2007.

3. Ben Shneiderman , Catherine Plaisant, "*Designing the User Interface: Strategies for Effective Human-Computer Interaction",* Addison-Wesley, 5th Edition, 2009.

OE801 BM

BASIC MEDICAL EQUIPMENT

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To make the students understand the need for several Biomedical Equipments.
- To make the students understand the operating principles of a wide range of Biomedical Equipment.

Course Outcomes:

Upon completion of the course, the students will be able to:

1. Learn about various physiological parameters, monitoring and recording.
2. Assess the need and operating principle of equipment used in physiotherapy
3. Interpret the working principle and operating procedure and applications of Medical Imaging equipments.
4. Perceive the governing principles and functions of critical care equipments.
5. Learn about the various Therapeutic Equipment used for different applications

UNIT-I

Medical Monitoring and recording: Patient monitoring: System concepts, bedside monitoring systems, central monitors, heart rate and pulse rate measurement. **Temperature measurement Blood pressure measurement:** Direct and indirect methods. **Respiration rate measurement:** Impedance pneumograph, Apnoea detectors. Ambulatory monitoring: Arrhythmia monitor,

UNIT-II

Physiotherapy and Electrotherapy Equipment: Diathermy machines: Short wave diathermy, Microwave diathermy and ultrasonic diathermy. **Electro diagnostic/Therapeutic apparatus:** Nerve muscle stimulator, Functional electrical stimulator etc.

UNIT-III

Medical Imaging Equipment:

X-Ray machines: Properties and production of X-Rays, X-ray machine, Image Intensifier. **X-ray computed tomography:** basic principle and construction of the components. **Ultrasonic Imaging:** Physics of ultrasonic waves, medical ultrasound, basic pulse echo apparatus. **Magnetic Resonance Imaging:** Principle, Image reconstruction techniques, Basic NMR components, Biological effects, Merits.

UNIT-IV

Critical care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. **Drug delivery system:** Infusion pumps, basic components, implantable infusion system, closed loop control in infusion pump. **Cardiac Defibrillators:** Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer.

UNIT-V

Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types.

Dialysis Machine: Function of kidney, artificial kidney, Dialyzers, Membranes, Hemodialysis machine. Lithotripters: The stone diseases problem, Modern Lithotripter systems, extra corporeal shockwave therapy.

Suggested Readings:

1. R.S.Khandpur, "*Hand Book of Biomedical Instrumentation*", Tata McGrawHill, Second Edition, 2014.

2. John G.Webster, "*Medical Instrumentation Application and design*", Wiley India Edition, 2009.

OE 802CS

DATA SCIENCE USING R

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To learn basics of R Programming environment: R language, R- studio and R packages
- To learn various statistical concepts like linear and logistic regression, cluster analysis,time series forecasting
- To learn Decision tree induction, association rule mining and text mining

Course Outcomes:

Student will be able to

1. Use various data structures and packages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

UNIT- I

Introduction to R: Introduction, Downloading and Installing R, IDE and Text Editors, Handling Packages in R.

Getting Started with R: Introduction, Working with Directory, Data Types in R, Few Commands for Data Exploration.

Loading and Handling Data In R: Introduction, Challenges of Analytical Data Processing, Expression, Variables, Functions, Missing Values Treatment In R, Using 'As' Operator To Change The Structure Of The Data, Victors, Matrices, Factors, List, Few Common Analytical Tasks, Aggregation And Group Processing Of A Variable, Simple Analysis Using R, Methods For Reading Data, Comparison Of R GUI's For Data Input, Using R With Databases And Business Intelligence Systems.

UNIT- II

Exploring Data In R: Introduction, Data Frames, R Functions for Understanding Data in Data Frames, Load Data Frames, Exploring Data, Data Summary, Finding the Missing Values, Invalid Values and Outliers, Descriptive Statistics, Spotting Problems In Data with Visualization.

UNIT- III

Linear Regression Using R: Introduction, Model Fitting, Linear Regression, Assumptions of Linear Regression, Validating Linear Assumption.

Logistic Regression: Introduction, What Is Regression? Introduction to Generalized Linear Model, Logistic Regression, Binary Logistic Regression, Diagnosing Logistic Regression, Multinomial Logistic Regression Model.

UNIT- IV

Decision Tree: Introduction, What Is a Decision Tree? Decision Tree Representation In R, Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning, Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

Time Series in R: Introduction, What Is Time Series Data, Reading Time Series Data, Decomposing Time Series Data, Forecasts Using Exponential Smoothing, ARIMA Models.

UNIT- V

Clustering: Introduction, What Is Clustering, Basic Concepts in Clustering, Hierarchical Clustering, K-Means Algorithm, CURE Algorithm, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Association Rules: Introduction, Frequent Item set, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

Text Mining: Introduction, Definition of Text Mining, A Few Challenges in Text Mining, Text Mining Verses Data Mining, Text Mining In R, General Architectures of Text Mining Systems, Pre-Processing of Documents In R, Core Text Mining Operations, Using Background Knowledge for Text Mining, Text Mining Query Languages.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods.Frequent Item set, Closed Item set And Association Rules.

Frequent Item set: Mining Methods, Pattern Evaluation Methods, and Sentiment Analysis

Suggested Readings:

1. Seema Acharya, "*Data Analytics using R*", McGraw Hill education.
2. Nina Zumel and John Mount, "*Practical Data Science with R*", Manning Shelter Island.
3. Crawley, Michael J., " *The R book*", John Wiley & Sons, Ltd

OE 803EC

MOBILE COMMUNICATION

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- Understand basics of Cellular systems, their generations and Characteristics of Mobile Communications.
- Understand the Frequency reuse mechanism for Mobile operations and Co-Channel interference concepts
- Understand the Mobile signal Coverage in different terrains and Lee models
- Understand the working of Antennas at Cell-site and at Mobile units.
- Understand the various Handoff mechanisms and Concept of Dropped calls

Course Outcomes:

Student will be

1. Able to analyze the various operational features of Mobile Communication Systems
2. Able to deal with the Mobile communication system designs of Frequency re-use and Interference Factors
3. Able to carry out the Design aspects of Mobile signal coverage over different terrains
4. Able to analyze the different Cell-site and Mobile antennas for different applications
5. Able to characterize the Handoffs mechanisms.

UNIT – I

Introduction to Cellular Mobile Communications:

History of Mobile cellular: AMPS system (First-generation systems), Second-generation System, 3G Systems, 4G Systems, 5G Systems, Other Cellular-like Systems, Spectrum allocation, Spectrum Efficiency Considerations.

Basic Cellular systems, Circuit-Switched and Packet-Switched Systems, Performance criteria, Voice quality, Data quality, Picture quality, Service quality and special features.

Uniqueness of Mobile Radio Environment, Description of Mobile Radio Transmission Medium, Model of Transmission Medium, Mobile Fading characteristics, The Radius of Active Scatter region, Delay spread and Coherence Bandwidth, Noise level in Cellular Frequency band

UNIT – II

Frequency Reuse Concept and Cellular system Components:

Concept of Frequency reuse channels, Frequency reuse schemes, Frequency reuse distance, Number of Customers in the System, Co-Channel Interference Reduction Factor, Desired C/I from a Normal case in an Omni-directional antenna System, Handoff mechanism, Cell splitting, Consideration of the Components of Cellular Systems, Antennas, Switching equipment and Data Links.

UNIT – III

Cell Coverage:

General Introduction, Ground Incident angle and Ground Elevation angle, Ground Reflection angle and Reflection point, Obtaining the Mobile Point-to-Point Model (Lee Model), A standard condition, Obtain Area-to-Area Prediction model, The Phase difference between a direct path and ground-reflected path, A general formula for Mobile Radio Propagation Propagation over water or Flat open

area, Between Fixed stations, Land-to-Mobile transmission over water, Foliage Loss, Propagation in Near-In distance, Long distance propagation, Obtain Path loss from a Point-to-Point Prediction Model in Non-obstuctive condition and obstructive condition, Form of a Point-to-Point Model, General Formula and its Merit

UNIT – IV

Cell-Site and Mobile Antennas:

Antennas at Cell-site, Omnidirectional antennas, Directional antennas, Location antennas, Set-up Channel antennas, Space Diversity Antennas at cell site, Umbrella-Pattern Antennas, Interference reduction antennas, Unique Situations of Cell-Site antennas, Smart antennas, types and applications
Mobile Antennas, Roof-mounted antenna, Glass-Mounted antenna, High-gain antenna, horizontally and vertically oriented Space-Diversity Antennas.

UNIT – V

Handoff and Dropped Calls:

Value of Implementing Handoffs, Types of Handoff, Initiation of Hard Handoff, Delaying a Handoff, Forced Handoffs. Queuing of handoffs, Power difference Handoffs, MAHO and Soft Handoff, Cell-site Handoff only, Intersystem Handoff
Introduction to Dropped Call Rate and Formula of Dropped Call Rate

Suggested Readings:

1. William C.Y.Lee*, "Wireless and Cellular Telecommunications*", 3rd International edition, McGraw Hill, 2006.

2. Theodere S. Rappaport, *"Wireless Communications, Principles and Practice*", 2nd edition, Prentice Hall, 2003.

3. Gordon L. Stuber. "*Principles of Mobile Communications",* 3rd edition, Springer Publications, 2011.

OE 804EC

INTERNET OF THINGS AND APPLICATIONS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce the concepts of automation in daily life.
- To familiarize the concepts of all IoT based communication systems.
- To understand the importance of cloud technologies in the field of IoT.
- To get familiar with standard embedded boards like Raspberry Pi.
- To study a real time system with a view of an application program interface (API).

Course Outcomes: Student will be

1. Able to design IoT based solutions for given problem statements.
2. Able to develop programs for Raspberry Pi.
3. Able to demonstrate the functionality of cloud communication.
4. Able to analyze the technologies used in IoT.
5. Able to incorporate multiple sensors to develop an IoT based system.

UNIT- I

Introduction to Internet of Things

Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT,IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling TEchnologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

UNIT- II

Internet Principles and communication technology

Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling.

UNIT- III

API Development and Embedded Programming

Getting started with API, Writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather Monitoring.

UNIT -IV

IoT Systems - Logical Design using Python

Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations, Classes, and Python packages for IoT, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT- V

Cloud computing and Data analytics and IoT Product Manufacturing

Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Sky net IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation.(Ref 1) Business model for IoT product manufacturing, IoT Startups, Mass manufacturing, Ethical issues in IoT.

Suggested Readings:

1. Vijay Madisetti, ArshdeepBahga, "*Internet of Things (A Hands-on-Approach)",* VPT Publisher, 1st Edition, 2014.

2. Adrian McEwen (Author), Hakim Cassimally, *"Designing the Internet of Things",* Wiley India Publishers.

3. Kenneth A Lambert and B.L. Juneja*, "Fundamentals of Python*", Cenage Learning.

OE 805EC

GLOBAL AND REGIONAL SATELLITE NAVIGATION SYSTEM

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To explain the basic principle of GPS and its operation.
- To make the students to understand signal structure.
- To make the students understand the GPS errors.
- Highlight the importance of integrating GPS with other systems.
- To make the students understand about various GRNSS.

Course Outcomes:

Student will be able to:

1. Understand the principle and operation of GPS.
2. Understand the GPS Signal structure and services.
3. Analyze GPS in various fields such as navigation, GIS etc.
4. Apply principle of Operation of various GRNSS.

UNIT- I

Introduction to Satellites, their properties, Orbits and Launch vehicles, Kepler's Laws, GPS fundamentals: Principle of Trilaiteration, Transit, GPS Operating Principle, And Architecture: Space, Control and User Segments and its Frequencies.

UNIT- II

GPS Signal structure: C/A and P-Codes, SPS and PPS services, GPS Coordinate Systems: Significance, Types of GPS receivers, Selective Availability, Spoofing and Anti-spoofing.

UNIT- III

GPS Errors: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath; Dilution of Precision (DOP).

UNIT- IV

GPS Modernization: Future GPS satellites, New signals and their benefits, New Control Segment, Principle of operation of DGPS, architecture and limitations, GPS Applications: Surveying Mapping Marine, air and land Navigation, Military and Space Application. GPS Integration with Geographic Information System (GIS), Inertial Navigation System (INS), Pseudolite and Cellular.

UNIT- V

Other GRNSS: GLONASS, GALILEO, QZNSS, CNSS and IRNSS System: Principle ofOperation, Features and their Current Status.

Suggested Readings:

1. Ahmed El-Rabbany, "*Introduction to GPS*", Artech House Publishers, 2/e, Boston 2006.
2. Elliot D Kaplan and Christopher J Hegarty," *Understanding GPS principles and applications*", Artech House Publishers, 2/e Boston & London 2005.
3. B.Hofmann-Wellenhof, H.Lichtenegger, and J.Collins, "*GPS Theory and Practice*," Springer Verlog, 5/e, 2008.

OE806EE

APPLICATIONS OF ELECTRICAL ENERGY

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
- To understand various techniques of electric welding and types of batteries.
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electric traction including speed – time curves of different traction services.
- To understand systems of train lighting.

Course Outcomes:

After completion of this course, the students shall be able to:

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
4. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.
5. Select proper train lighting scheme.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT- II

Electric Welding: Classification of Electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT- III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects, Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT- IV

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion.

UNIT – V

Train Lighting: Systems of train lighting, special requirements of train lighting, Methods of obtaining unidirectional polarity, Methods of obtaining constant output, Single battery system, Double battery parallel block system, Principal equipment of double battery system, Coach wiring, Dynamo.

Suggested Readings:

1. Partab H, "*Art and Science of Utilization of Electric Power*", Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, "*Electrical Design*", Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, "*Modern Electric Traction*", Dhanpat Rai & Sons, 2000.
4. B.L.Theraja," *A Text Book of Electrical Technology",* S.Chand& Company Ltd, Vol-I.

OE 807ME

COMPOSITE MATERIAL APPLICATIONS

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To know the properties of fiber and matrix materials used in composites, as well as some common manufacturing techniques.
- To know the various moulding process and architecture of composite laminates
- To know how to estimate the laminate properties from lamina properties.
- To understand the strength of an orthotropic lamina and measurement of basic composite properties.

Course Outcomes:

Student will be able to

1. Understand the distinction of composites, its advantages, classification and applications
2. Predict the properties of composite lamina and laminate
3. Understand the testing of composites and design the structure using the appropriate design criteria.

UNIT- I

Introduction to composite materials, general characteristics, Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fibre composites.

UNIT- II

Molding Processes: hand layup, vacuum molding, compression molding, pultrusion molding, centrifugal molding, filament winding, prepegs and molding compounds and architecture of composite materials: laminates, sandwich composites and other architectures.

UNIT- III

Micromechanics of Composites: Mechanical properties: Production of Elastic constant, micromechanical approach, Halpin-Tsal equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT- IV

Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation.

UNIT- V

Strength of an orthotropic lamina: Maximum stress theory, maximum strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials. **Measurement of constituent material properties:** Fibre tests, Matrix tests. Measurement of basic composite properties: Tensile test, compressive test, a plane shear test, interlaminar shear test, flexure test.

Suggested Readings:

1. Jones, R.M., *"Mechanics of Composite Materials",* McGraw Hill Co., 1967.
2. Ronald F. Gibson, "*Principles of Composite Materials Mechanics*", McGraw-Hill, Inc.,1994.
3. Krishan, K. Chewla, "*Composite Material*", Springer - verlag, 1987.
4. Carl. T. Herakovich, *"Mechanics of Fibrous Composites*", John Wiley Sons Inc., 1998.

OE808ME

INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT

Instruction: 3 Periods per week | Duration of SEE: 3 hours
CIE: 30 Marks | SEE: 70 Marks
Credits: 3

Course Objectives:

- To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources
- To understand the importance of quality, inventory control and concepts like MRP I and MRP II
- To understand the nature of financial management and concepts like breakeven analysis, depreciation and replacement analysis

Course Outcomes: At the end of this course student is expected reach the following outcomes.

1. Understand the different phases of product life cycle, types of manufacturing systems, plant layout optimization problems
2. Role of scheduling function in better utilization of resources
3. Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP –II.
4. Know the different terminology used in financial management and apply different techniques of capital budgeting
5. Analyse and various types of costs involved in running an industrial organization

UNIT-I

Types of organizations, organizational structures. Designing Products, Services and Processes:
New product design and development. Product life cycle: phasing multiple products.
Manufacturing process Technology: Product, job shop, batch, assembly line and continuous process technology; flexible manufacturing systems. Design of Services, service process technology operations capacity; capacity planning decisions, measuring capacity; estimating future capacity needs.

UNIT-II

Locating production and services facilities, effects of location and costs and revenues, factor rating, simple median model (linear programming) Layout planning; process layout; product layout - Assembly lines; line balancing manufacturing cellular layout. Scheduling systems and aggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria.

UNIT-III

Quality planning and Control: basic concepts, definitions and history of quality control. Quality function and concept of quality cycle. Quality policy and objectives. Economics of quality and measurement of the cost of quality. Quality considerations in design. Process control: machine and process capability analysis. Use of control charts and process engineering techniques for implementing the quality plan. Acceptance sampling: single, double and multiple sampling, operating characteristic Curve - calculation of producers risk and consumers risk.

UNIT-IV

Inventory control: deterministic and stochastic inventory models; variable demand; lead time, specific service level, perishable products and service. Inventory control in application; concepts for the practioners; saving money in inventory systems; ABC classifications. Inventory control procedures; Quantity - reorders versus periodic inventory systems; material requirement planning (MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure; Detailed capacity planning; MRP - limitation and advantages; Manufacturing Resources Planning (MRP-II).

UNIT-V

Elements of cost, overheads, breakeven analysis, depreciation, replacement analysis. Nature of financial management-time value of money, techniques of capital budgeting and method, cost of capital, financial leverage.

Suggested Reading:

1. Buifa and Sarin, "*Production and operations management*" - Wiley Publications.
2. I.M. Pandey, "*Elements of Financial Management*" Vikas Publications, New Delhi, 1994.
3. James C. Van Home & John, M. Wachowicz, Jr., "*Fundamentals of Financial Management*", Pearson Education Asia, 11 Th ed. 2001.

OE809CS **SOFTWARE ENGINEERING**

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- To impart knowledge on various phases, methodologies and practices of software development
- To understand the importance of testing in software development and study various testing strategies and software quality metrics

Course Outcomes: Student will be able to

1. Acquire working knowledge of alternative approaches and techniques for each phase of software development
2. Acquire skills necessary for independently developing a complete software project
3. Understand the practical challenges associated with the development of a significant software system

UNIT-I

Introduction to Software Engineering:
A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns, Process Assessment.

Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.
An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models.

UNIT-II
Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment.
System Engineering: Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling.
Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT-III
Building the Analysis Model: Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model.
Design Engineering: Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design.

UNIT-IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design, Assessing Alternative Architectural Designs, Mapping Data Flow into a Software Architecture.

Modeling Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components.

Performing User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT-V

Software Quality Assurance: Basic Elements, Tasks, Goals and Metrics, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO 9000 Quality Standards, SQA Plan.

Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Test Strategies for O-O Software, Validation Testing, System Testing, The Art of Debugging.

Testing Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods, Testing Methods applicable on the Class Level, Inter Class Test Case Design, Testing for Specialized Environments, Architectures and Applications, Testing Patterns.

Product Metrics: Software Quality, A Framework for Product Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance.

Suggested Readings:

1. Roger S.Pressman," *Software Enigneering: A Practitioner's Approach*", 7th Edition, McGraw Hill, 2009.
2. Ali Behforooz and Frederick J.Hudson, "*Software Engineering Fundamentals*", Oxford University Press, 1996.
3. Pankaj Jalote, "*An Integrated Approach to Software Engineering*", 3rd Edition, Narosa Publishing House, 2008.

OE810CS

PYTHON PROGRAMMING

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:
The main objective is to teach Computational thinking using Python.

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes: On completion of the course, students will be able to:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT-III

Files and Exception: Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, "*Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R, "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "*Think Python: How to Think Like a Computer Scientist*'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

OE811CS

CYBER SECURITY

Instruction: 3 Periods per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies.

Course Outcomes:

After Completion of the course, Student will be able to:

1. Understand the various network threats
2. Analyse the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual

Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

PW851CS **MAJOR PROJECT PHASE – II**

Instruction: 3L hrs per week *Duration of SEE :* Viva Voce
CIE : 50 Marks *SEE : 100 Marks*
Credits: 6

Course Objectives:

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic Literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:

Student will able to :

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of project work–II is to implement and evaluate the proposal made as part of project - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

Re-grouping of students - deletion of internship candidates from groups made as part of project work-I. Re-Allotment of internship students to project guides Project monitoring at regular intervals.
All re-grouping/re-allotment has to be completed by the 1nd week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

Note: Three periods of contact load will be assigned to each project guide.