2017-2018

of Tech (Computer Science & Technology)

Central University of Jammu

Scheme of Syllabus for M.Tech (Computer Science & Technology)

First Semester (For examinations to be held in Dec 2017, 2018, 2019)

Type	Course Code	Course Name	Credits	Marks
Core Courses	MTC101	Design and Analysis of Advanced Algorithm	4	100
	MTC102	Network Security & Cryptography	4	100
	MTC103	Computer Based Optimization Techniques	4	100
	MTC104	Computing Lab-1 (Based on core courses)	6	150
Elective-I	MTE101	Wireless and mobile networks	4	100
	MTE102	Big Data Analytics		
	MTE103	Open Source Technologies		
	MTE104	Advanced Operating System		
Foundation Compulsory	MTF101	Statistical Methods for Computer Science	2	50
		Total	24	600

Second Semester (For examinations to be held in May 2018, 2019, 2020)

Type	Course Code	Course Name	Credits	Marks
Core Courses	MTC201	Research Methodology	4	100
	MTC202	Digital Image Processing	4	100
	MTC203	Grid & Cloud Computing	4	100
	MTC204	Computing Lab-2 (Based on core courses)	6	150
Elective-II	MTE201	Advanced Computer Architecture	4	100
	MTE202	Simulation & Modelling		
	MTE203	Soft Computing Techniques		
	MTE204	Machine Learning		
	MTE205	SMAC & Internet of Things		
Foundation Elective-I (Skill Based)	MTF201	Software Testing Techniques	2	50
	MTF202	Database Application Development		
	MTF203	Scientific Computing		
		Total	24	600

Deepti Malhotra 13.07.17 13.7.17

Third Semester (For examinations to be held in Dec 2018, 2019, 2020)

Type	Course Code	Course Name	Credits	Marks
Core Courses	MTC301	Cyber Security	4	100
	MTC302	Biometrics & Pattern Recognition	4	100
	MTC303	Dissertation Part-A	10	250
Interdisciplinary Elective		Elective offered by other departments	4	100
Foundation Elective-II (Skill Based)	MTE301	Smartphone Computing and Applications	2	50
	MTE302	Digital Forensics		
	MTE303	Data Mining Techniques		
	MTE304	Advanced Web Technologies		
		Total	24	600

Fourth Semester (For examinations to be held in May 2019, 2020, 2021)

Type	Course Name	Credits	Marks
Core Course	Dissertation Part-B	20	500
Interdisciplinary Elective	Elective offered by other departments	4	100
Total		24	600

Dissertation

The supervisor for dissertation shall be allocated to the student in the beginning of third semester facilitating identification of dissertation topic, review of literature, etc. Evaluate of dissertation and viva-voce will be conducted by external examiner as well as internal examiner (i.e. supervisor of the student). The External examiner will evaluate for 300 marks and internal examiner for 200 marks. The student is required to pass internal and external examination separately.

In addition, for facilitating the students to select their topic of dissertation, student may choose an advisor from any University/Department or IT industry. The advisor shall help the student choosing an appropriate topic of dissertation with social or industry relevance.

The student will be required to publish atleast one paper in SCI (Thomson Reuters) Or UGC approved list of journals.

Dept 13.7.17

Department of Computer Science and Information Technology

Programme Educational Objectives (PEOs)

We focus on the following objectives to realize our vision.

PEO-1: To gain in-depth knowledge of Computer Science and Technology and acquire capabilities to compete at the global level with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge to conduct research in theoretical, practical, and policy contexts.

PEO-2: Have in-depth knowledge and research skills to professionally practice in a variety of fields including Security, Machine Learning, Internet of Things (IoT), Natural Language Processing, and Ubiquitous Computing.

PEO-3: Acquire professional and intellectual integrity and ethics, learn independently and continuously to upgrade the knowledge and competence with enthusiasm.

Programme Outcomes (POs)

A postgraduate of the Computer Science and Technology Program will demonstrate

PO-1: An ability to independently carry out research and development work to solve practical problems.

PO-2: Ability to write and present a substantial technical report/document.

PO-3: A degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO-4: An ability to use modern computational tools in modeling, simulation, and analysis with effective participation in multi-disciplinary teams and contribute towards achieving the common goals of the team.

PO-5: An ability to work with integrity and ethics in their professional practice having an understanding of responsibility towards society with sustainable development for a lifetime.

(Computer Science & Technology)

COURSE TITLE: Design and Analysis of Advanced Algorithm COURSE No :MTC105

Internal Assessment=25 Mid-term Examination=25 End –Term Examination = 50

Total Marks= 100

DURATION OF EXAM: 3 HOURS Lectures: 4 hours per week

UNIT – I

Fundamentals of Algorithmic Problem Solving : Understanding the Problem ,Ascertaining the Capabilities of the Computational Device ,Choosing between Exact and Approximate Problem Solving, Algorithm Design Techniques, Designing an Algorithm and Data Structures ,Methods of Specifying an Algorithm, Proving an Algorithm's Correctness, Analyzing an Algorithm

UNIT – II

Fundamental of Data Structures: Linear Data Structures, Graphs, Trees, Fundamentals of the Analysis of Algorithm Efficiency- The Analysis Framework, Units for Measuring Running Time, Worst-Case, Best-Case, and Average-Case Efficiencies

Asymptotic Notations and basic efficiency classes.

UNIT – III

Brute Force and Exhaustive Search: Introduction, Advantages and Disadvantages, suitcase password checking problem, applications of Brute Force Method: Sorting Problem: Properties Bubble Sort, Sequential Search.

Computational Geometry Problems: Closest-Pair and Convex-Hull

Exhaustive Searching: Knapsack Problem, Traveling Salesman Problem

UNIT – IV

Divide- and Conquer Approach: Introduction, Advantages and Disadvantages, Merge Sort, Quick Sort, Finding Maximum and Minimum Elements.

Balanced Search Trees: AVL Trees and its Rotations

Space and Time Trade-Offs: Introduction, sorting by counting, Hashing and Hash tables Collision

Input Enhancement in String Matching: Horspool's Algorithm ,TheBoyer-Moore algorithm

UNIT – V

Greedy Algorithms: Introduction, Suitability of Greedy approach, knapsack problem

Dynamic Programming: components, characteristics, Warshall's Algorithms, Floyd's Algorithm for the All-Pairs Shortest-Paths Problem

Backtracking: Introduction, generation of State- space trees, Searching state –space trees, Hamiltonian Circuit Problem, P and NP Problems

REFERENCE BOOKS

1. Fundamentals of Computer Algorithms. by Ellis Horowitz, Sartaj Sahni.
2. Data Structure & Algorithm by J.M. Hopcraft , Ullman.
3. Introduction To Algorithms, Thomas H Cormen, Charles E Leiserson And Ronald L Rivest
4. Design and Analysis of Algorithms by S.Sridhar, Oxford Publications
5. Foundations of Algorithms by Neapolitan, Jones & Barlett Learning
6. Introduction to the Design and Analysis of Algorithms by Anany Levitin, third Edition , Pearson

COURSE OBJECTIVES

 To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

 To develop the understanding of the mathematical and logical basis to many modern

 techniques in information technology like machine learning, programming language

 design, and concurrency.

 To study various sampling and classification problems

COURSE OUTCOMES

After completion of course, students would be able to:

 To understand the basic notions of discrete and continuous probability.

 To understand the methods of statistical inference, and the role that sampling distributions play in those methods.

 To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.

COURSE TITLE: NETWORK SECURITY & CRYPTOGRAPHY COURSE No: MTC102.
Continuous Assessment=25 Mid-term Exam.=25 End - Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS Lectures: 4 hours per week

UNIT-1

Fundamentals of Network Security: Need & Importance of Security in Networks, OSI security architecture, Security Attacks, Security services & Mechanisms, Security Model.
Threats & Vulnerabilities : Types of threats, Unauthorized Access, Impersonation, Denial of Service, Client side and server side vulnerabilities, Malicious Softwares,Viruses & Antiviruses.
Strategies & Processes, Importance of Security Policies and Audits.

UNIT-2

Cryptography: Introduction, Cryptanalysis, Classical encryption techniques, cipher types, substitution ciphers, Transposition ciphers, one time pads. Traditional ciphers, simple modern ciphers, Modern round ciphers. Key Distribution Centres.
Conventional Encryption Techniques: Symmetric encryption principles, Data Encryption Standard, TDES, AES, Cipher modes.
Public key Cryptography: Public Key cryptography Principles, RSA, Diffie-Hallman algorithm.

UNIT-3

Authentication: Introduction, Need, Types of authentication-Basic, Multifactor & cryptographic, Message authentication, MAC, Digital Signatures, MAC.
Entity Authentication-Passwords, challenge response, password and address based, authentication using Kerberos.
Hash functions: Hash function criteria, Security of hash functions, Hash functions based on block ciphers, Hash algorithm-SHA-1,MD5
Public Key Infrastructure, Digital Certificates, Certificate Authorities.

UNIT-4

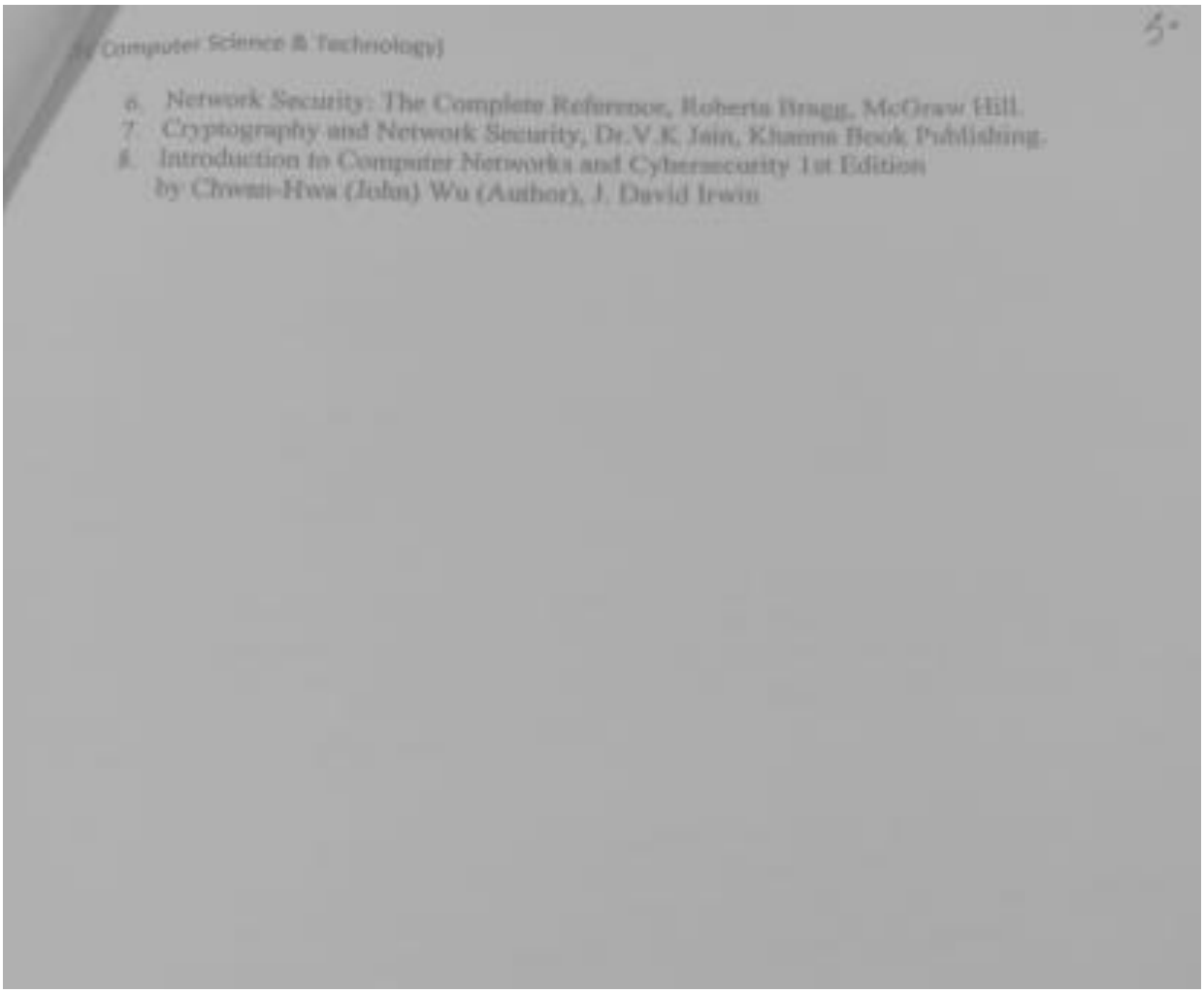
System Security : Intruder Behaviour Patterns, Intrusion Techniques, Intrusion detection System-Host Based or network based IDS, Approaches used for IDS-Anamaloy based, signature based, adaptive profiles; Network based IDS, Host based IDS; Honeypots, ID exchange format.
Firewalls: Characteristics and Types of Firewalls-Packet Filtering Firewall, Stateful Inspection Firewalls, Application-Level Gateway, Circuit-Level Gateway. Firewall Basing- Bastion Host, Host-Based Firewalls, Personal Firewall. Firewall Location and Configurations- DMZ Networks, Virtual Private Networks, Distributed Firewalls

UNIT-5

Internet Security: Introduction, Web Security and Threats, Approaches to web security, IPSecurity (IPSec) , Two Modes, Two Security Protocols, Security Association, Internet Key Exchange (IKE),Virtual Private Network.SSL/TLS- Services, Security Parameters, Sessions, and Connections, Four Protocols, Transport Layer Security, PGP-Security Parameters, Service, Key Rings. Security protocols- HTTPS,SSH, PEM, S/MIME.

REFERENCES

1. Network Security Essentials, William Stallings,Applications and Standards, Pearson.
2. Computer Networks, Andrew S.Tanenbaum, Pearson Publishing.
3. Data Communications and Networking, Behrouz A Forouzan, McGrawHill
4. Network security & Cryptography ,R.Rajaram ,SCITECH.
5. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education.



Course Objectives

- To understand the need of network and cyber security
- To understand the need and working of cryptography.
- To understand how network threats materialize into attacks.
- To understand the tools for threats, attacks, exploits.

Course Outcomes

After completion of course, students would be able to:

- Analyze the vulnerabilities in the network.
- Identify the security issues in networks
- Working of various tools for attacks and defence

COURSE TITLE: Computer Based Optimization Techniques COURSE No. MTC103.
Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS Lectures: 4 hours per week

Unit-I

An introduction to Linear Programming (LP), general model of linear programming, application areas of linear programming, formulating a problem as an LP Model, Graphical method for solution, special cases in linear programming as identified and treated in Graphical method

Unit -II

Solution of LP problem through Simplex method, principle of Simplex method, computational aspect of Simplex method, special cases in Simplex method, two phase and big M-method, sensitivity analysis in Simplex method, dual problem of primal problem, characteristics of dual problem, advantages of duality

Unit -III

Transportation Problem : Introduction, the general structure of transportation problem, solution procedure of transportation problem, methods for finding the initial feasible solution : north west corner method, least cost method, and Voggel's approximation method; test of optimality : stepping stone method, modified distribution (MODI) method, unbalanced transportation problems, degeneracy, multiple solution problems

Unit IV

Integer Programming : Introduction, some applications of integer programming, methods of integer programming, Cutting Plane method, Branch and Bound method.

Dynamic Programming : An introduction to Dynamic programming (D.P.) methodology, principle of optimality, definitions and notations, example of DP models and computation.

Unit -V

An introduction to PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) for scheduling of projects, network diagram representation, critical path calculations, finding the project completion time, determining the slack times of different activities Assingment Problem, solution Methods of Assignment Problem, Maximization in Transportation Problem, Unbounded Transportation Problem, Multiple Solution Problems.

REFERENCE

1. TAHA, H. A. : Operation Research, Macmillan, New York.
2. Gillet, B. E. : Introduction to Operation Reseach – A Computer Oriented Algorithmic Approach, McGraw Hill (1976).
3. Churchman, C. W. A. Arnchoff E. L. : Introduction to Operation Research – John Wiley and Sons.
4. Srinath, L. S. : Linear Programming, East-West, New Delhi.
5. Kapoor, V.K :. Operation Research Techniques for Management – Sultan Chand & Sons. New Delhi.

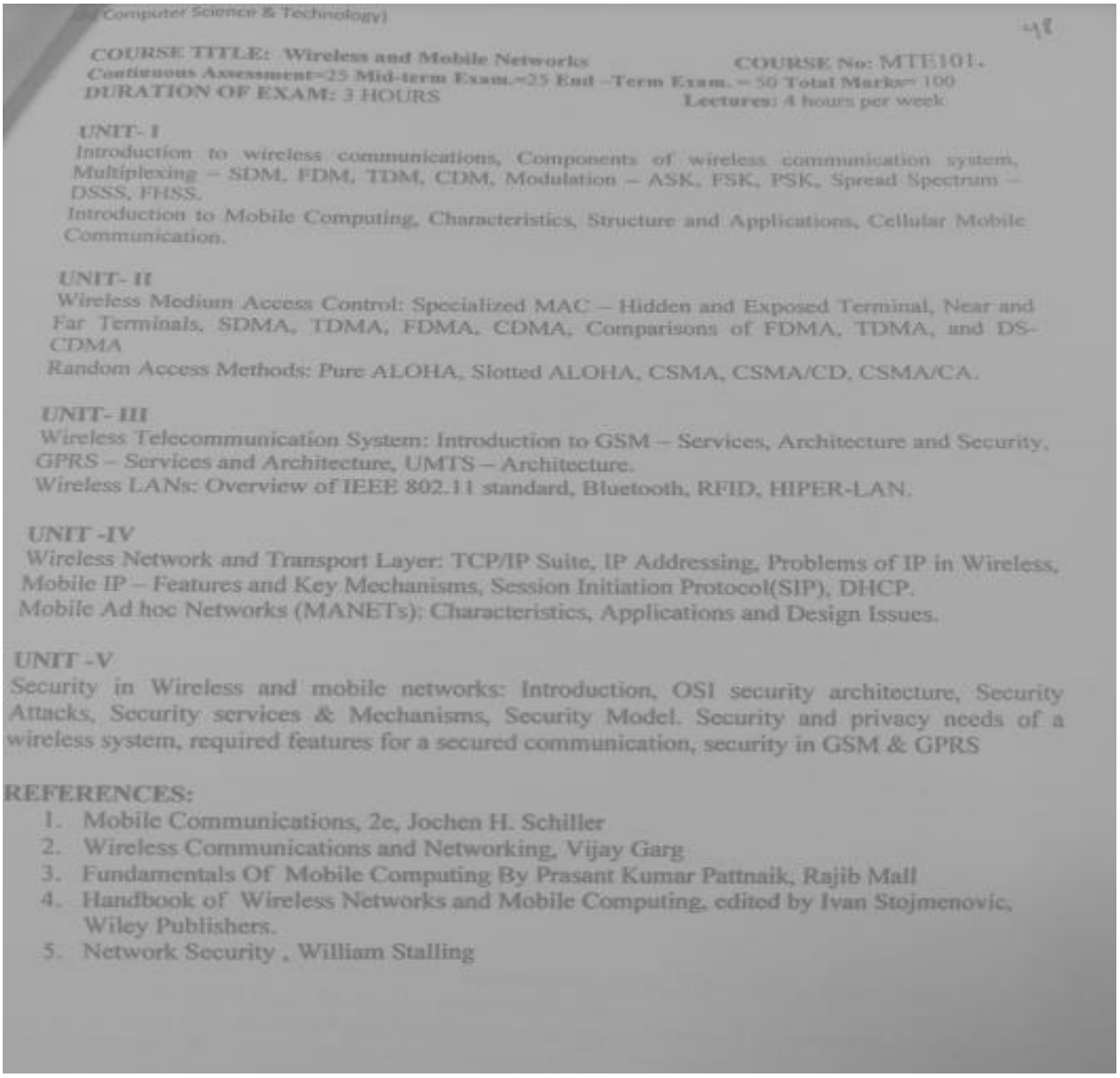
Course Objectives

- Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focuses what is needed to build simulation software environments, and not just building simulations using pre-existing packages.
- Introduce concepts of modelling layers of society's critical infrastructure networks.
- Build tools to view and control simulations and their results.

Course Outcomes

After completion of course, students would be able to:

- Understand the meaning of modeling and simulation.
- Know what is GPSS model and understand different statistical tests for measuring quality of generators
- Understand the concept of random numbers and the method to generate random numbers
- Understand random processes and different queuing models
- Network simulation tools.



Computer Science & Technology)

COURSE TITLE: Wireless and Mobile Networks **COURSE No: MTE101.**
Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS **Lectures: 4 hours per week**

UNIT- I

Introduction to wireless communications, Components of wireless communication system, Multiplexing – SDM, FDM, TDM, CDM, Modulation – ASK, FSK, PSK, Spread Spectrum – DSSS, FHSS.

Introduction to Mobile Computing, Characteristics, Structure and Applications, Cellular Mobile Communication.

UNIT- II

Wireless Medium Access Control: Specialized MAC – Hidden and Exposed Terminal, Near and Far Terminals, SDMA, TDMA, FDMA, CDMA, Comparisons of FDMA, TDMA, and DS-CDMA

Random Access Methods: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA.

UNIT- III

Wireless Telecommunication System: Introduction to GSM – Services, Architecture and Security, GPRS – Services and Architecture, UMTS – Architecture.

Wireless LANs: Overview of IEEE 802.11 standard, Bluetooth, RFID, HIPER-LAN.

UNIT -IV

Wireless Network and Transport Layer: TCP/IP Suite, IP Addressing, Problems of IP in Wireless, Mobile IP – Features and Key Mechanisms, Session Initiation Protocol(SIP), DHCP.

Mobile Ad hoc Networks (MANETs): Characteristics, Applications and Design Issues.

UNIT -V

Security in Wireless and mobile networks: Introduction, OSI security architecture, Security Attacks, Security services & Mechanisms, Security Model. Security and privacy needs of a wireless system, required features for a secured communication, security in GSM & GPRS

REFERENCES:

1. Mobile Communications, 2e, Jochen H. Schiller
2. Wireless Communications and Networking, Vijay Garg
3. Fundamentals Of Mobile Computing By Prasant Kumar Pattnaik, Rajib Mall
4. Handbook of Wireless Networks and Mobile Computing, edited by Ivan Stojmenovic, Wiley Publishers.
5. Network Security , William Stalling

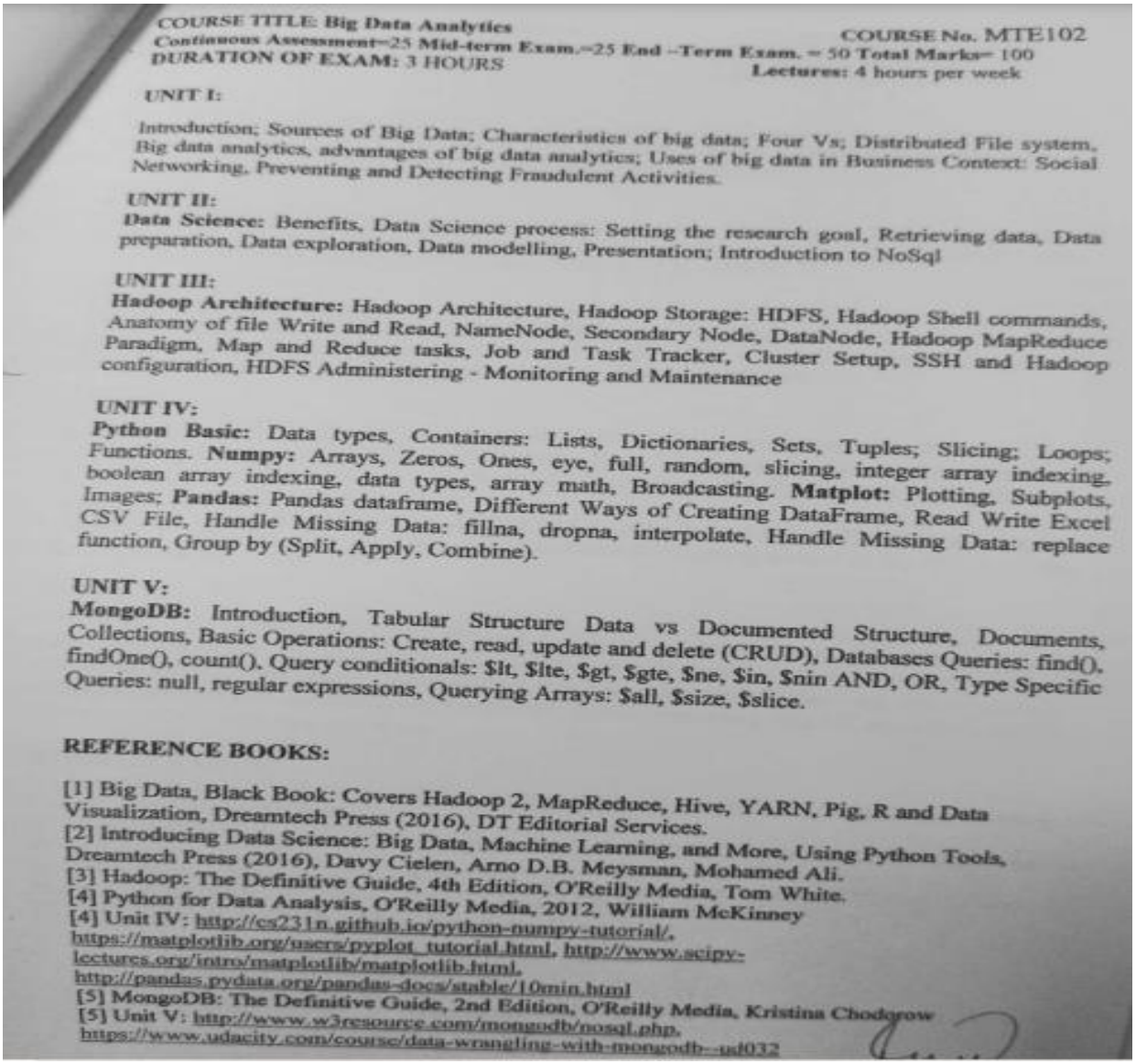
Course Objectives

- Architect sensor networks for various application setups.
- Devise appropriate data dissemination protocols and model links cost.
- Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers.
- Evaluate the performance of sensor networks and identify bottlenecks

Course Outcomes

After completion of course, students would be able to:

- Describe and explain radio standards and communication protocols for wireless sensor networks.
- Explain the function of the node architecture and use of sensors for various applications.
- Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.



COURSE TITLE: Big Data Analytics
COURSE No. MTE102
Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS
Lectures: 4 hours per week

UNIT I:

Introduction; Sources of Big Data; Characteristics of big data; Four Vs; Distributed File system, Big data analytics, advantages of big data analytics; Uses of big data in Business Context: Social Networking, Preventing and Detecting Fraudulent Activities.

UNIT II:

Data Science: Benefits, Data Science process: Setting the research goal, Retrieving data, Data preparation, Data exploration, Data modelling, Presentation; Introduction to NoSql

UNIT III:

Hadoop Architecture: Hadoop Architecture, Hadoop Storage: HDFS, Hadoop Shell commands, Anatomy of file Write and Read, NameNode, Secondary Node, DataNode, Hadoop MapReduce Paradigm, Map and Reduce tasks, Job and Task Tracker, Cluster Setup, SSH and Hadoop configuration, HDFS Administering - Monitoring and Maintenance

UNIT IV:

Python Basic: Data types, Containers: Lists, Dictionaries, Sets, Tuples; Slicing; Loops; Functions. **Numpy:** Arrays, Zeros, Ones, eye, full, random, slicing, integer array indexing, boolean array indexing, data types, array math, Broadcasting. **Matplot:** Plotting, Subplots, Images; **Pandas:** Pandas dataframe, Different Ways of Creating DataFrame, Read Write Excel CSV File, Handle Missing Data: fillna, dropna, interpolate, Handle Missing Data: replace function, Group by (Split, Apply, Combine).

UNIT V:

MongoDB: Introduction, Tabular Structure Data vs Documented Structure, Documents, Collections, Basic Operations: Create, read, update and delete (CRUD), Databases Queries: find(), findOne(), count(), Query conditionals: $lt, $lte, $gt, $gte, $ne, $in, $nin AND, OR, Type Specific Queries: null, regular expressions, Querying Arrays: $all, $size, $slice.

REFERENCE BOOKS:

[1] Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, Dreamtech Press (2016), DT Editorial Services.
[2] Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press (2016), Davy Cielen, Arno D.B. Meysman, Mohamed Ali.
[3] Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media, Tom White.
[4] Python for Data Analysis, O'Reilly Media, 2012, William McKinney
[4] Unit IV: http://cs231n.github.io/python-numpy-tutorial/, https://matplotlib.org/users/pyplot_tutorial.html, http://www.scipy-lectures.org/intro/matplotlib/matplotlib.html, http://pandas.pydata.org/pandas-docs/stable/10min.html
[5] MongoDB: The Definitive Guide, 2nd Edition, O'Reilly Media, Kristina Chodorow
[5] Unit V: http://www.w3resource.com/mongodb/nosql.php, https://www.udacity.com/course/data-wrangling-with-mongodb--ud032

Course Objectives

- Understand the Big Data Platform and its Use cases
- Provide an overview of Apache Hadoop
- Provide HDFS Concepts and Interfacing with HDFS
- Understand Map Reduce Jobs
- Apply analytics on Structured, Unstructured Data.
- Exposure to Data Analytics with R.

Course Outcomes

After completion of course, students would be able to:

- Understand what Big Data is and why classical data analysis techniques are no longer adequate
- Understand the benefits that Big Data can offer to businesses and organizations
- Understand conceptually how Big Data is stored
- Understand how Big Data can be analyzed to extract knowledge

COURSE TITLE: Open Source Technologies **COURSE No:** MTE103
Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS **Lectures:** 4 hours per week

UNIT I:

Free Software Foundation, GNU Project, Introduction to Open Source Software, Need for Open Source Applications, The philosophy of OSS, The Cathedral and Bazaar, Application of Open Source, Open source development model, Commercial software vs OSS.

UNIT II:

Basic Principles of Copyright Law, Contract and Copyright, Open Source Software Licensing, Open source software license: MIT License, BSD License, Apache License, GNU General Public License. GNU Lesser General Public License, Mozilla Public License.

UNIT III:

Popular Open Source Software: Apache HTTP Server and its flavours, WAMP Server(Windows, Apache, MySQL, Php), Open Source RDBMS: MySQL; Overview of Open Source Languages: Python; Open Source Content management systems: Drupal, Wordpress.

UNIT IV:

Linux and its distributions, Moving Around the File system: Linux file system structure, Linux File systems versus Windows-Based File systems, Basic File system Commands, Metacharacters and Operators, Listing Files and Directories, Understanding File Permissions and Ownership, Moving, Copying, and Removing Files;

Working with Text Files: VIM editor: Adding text, Moving around in text, Deleting, copying and changing text, Pasting, Repeating and exiting commands, Skipping around in the file, Searching for text, ex mode;

UNIT V:

Finding Files: locate command, find command: find files by name, size, user, permission, data and time, using not and or, find with exec; Searching in files with grep.

Managing Running processes: Understanding Processes, Listing process - ps, top commands, Managing Background and Foreground Processes, Killing processes with kill and killall, Setting processor priority with nice and renice.

REFERENCE BOOKS:

[1] Fundamentals of Open Source Software: A Developer's Perspective, Prentice-Hall of India Pvt.Ltd; First Edition, M. N. Rao

[2] Understanding Open Source and Free Software Licensing, O'Reilly Media, 2008, Andrew M. St. Laurent

[3] Open Source: Technology and Policy, Cambridge University Press, 2007, Fadi P. Deek, James A. M. McHugh

[4] Linux Bible, Wiley, Ninth edition, Christopher Negus

COURSE TITLE: Advanced Operating Systems **COURSE No:** MTE104
Continuous Assessment=25 **Mid-term Exam.**=25 **End –Term Exam.** = 50 **Total Marks**= 100
DURATION OF EXAM: 3 HOURS **Lectures:** 4 hours per week

UNIT – I

Operating Systems basic concepts: Definition and functions of OS, Types of operating systems, Computer System Structure- operation, I/O structure, storage structure, hardware protection, Operating System Services, system calls.
Process Management: Process Concept, Process Scheduling, Operation on processes, Cooperating Processes, Concepts of threads, Inter-Process communication.

UNIT – II

Operating System revisited: Overview of processor scheduling, Memory management techniques: Memory allocation methods, Paging and Segmentation, Demand paging, page replacement algorithms, Deadlock management techniques, File management: Access methods, directory structure, allocation methods, free space management

UNIT – III

Network Operating System (NOS): Definition, Distributed Operating System (DOS): Definition, Design Issues, **Multicomputer Operating Systems**: definition, Multicomputer Architecture, Different Models, desired features, operating system consideration, Middleware: different middleware models, Distributed Shared Memory (DSM): Definition, Design Issues, Implementation Issues

UNIT – IV

Real-Time Operating System (RTOS): Real-time task, different issues, evolution, Design philosophies, characteristics and requirements, features
Memory Management in RTOS: Memory allocation, Memory Locking, Memory Protection.

UNIT – V

Case Studies: Linux System: Architecture, Linux file structure, Design principles, Kernel modules, Process management scheduling, Memory management, Input-Output Management, System Inter-process communication, Overview of Shell Scripts and programming
Introduction to Android operating system: Architecture and SDK Framework overview.

REFERENCES

1. Mukesh Singhal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems – Distributed, Database, and Multiprocessor Operating Systems", Tata McGraw-Hill.
2. Silberschatz, Galvin, "Operating System Concepts", Wiley, 2015, ninth edition.
3. William Stallings, "Operating Systems, Internals and Design Principles", Pearson Education, Inc,2014.
4. Deitel H.M., "Operating System", Pearson Education, Inc, third edition.
5. P.Chakraborty , " Operating System",Jaico Publishing house,2011.
6. Tanenbaum, A.S., "Modern Operating System", Pearson Education, 2008, third edition.
7. Milenkovic M, "Operating system-concepts and design", McGraw Hill, International editions.
8. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006

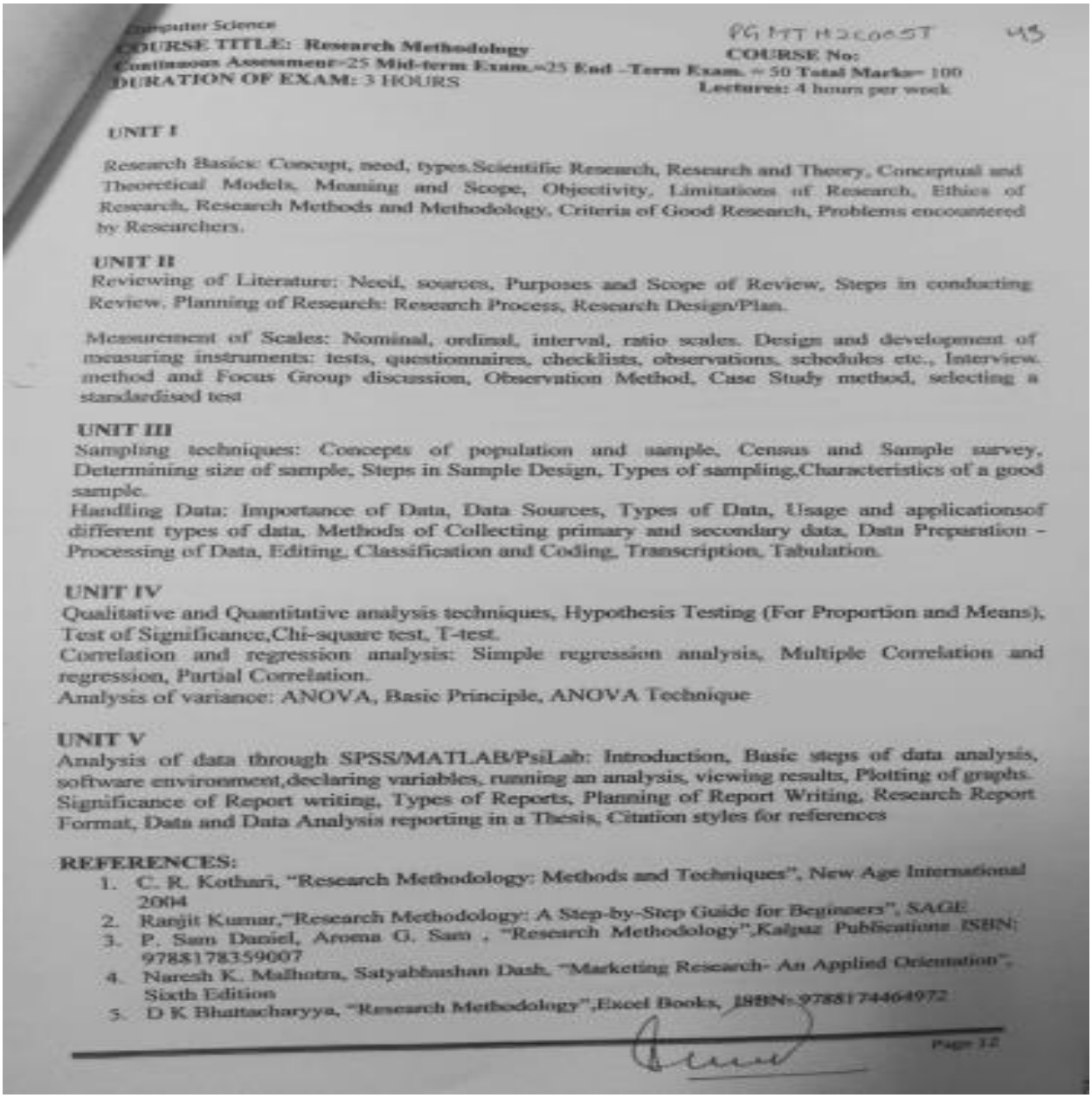
Course Objectives

- To introduce the students with the basic features in distributed operating systems.
- To make the students understand the necessary message and Stream-Oriented communication.
- To familiarize students with advanced paradigms associated with code migration and scheduling in various operating systems.
- To provide a platform for students to understand and develop hands-on knowledge of advanced operating systems.

Course Outcomes

After completion of course, students would be able to:

- Have strong hands-on grasp of operating systems at the level of distributed operating system
- Analyze the security parameters in case of distributed systems.
- Implement a real/simulated operating system



Computer Science

COURSE TITLE: Research Methodology

PG MTH20005T 45

COURSE No:

Continuous Assessment=25 Mid-term Exam.=25 End -Term Exam. = 50 Total Marks= 100

DURATION OF EXAM: 3 HOURS

Lectures: 4 hours per week

UNIT I

Research Basics: Concept, need, types.Scientific Research, Research and Theory, Conceptual and Theoretical Models, Meaning and Scope, Objectivity, Limitations of Research, Ethics of Research, Research Methods and Methodology, Criteria of Good Research, Problems encountered by Researchers.

UNIT II

Reviewing of Literature: Need, sources, Purposes and Scope of Review, Steps in conducting Review. Planning of Research: Research Process, Research Design/Plan.

Measurement of Scales: Nominal, ordinal, interval, ratio scales. Design and development of measuring instruments: tests, questionnaires, checklists, observations, schedules etc., Interview method and Focus Group discussion, Observation Method, Case Study method, selecting a standardised test

UNIT III

Sampling techniques: Concepts of population and sample, Census and Sample survey, Determining size of sample, Steps in Sample Design, Types of sampling,Characteristics of a good sample.

Handling Data: Importance of Data, Data Sources, Types of Data, Usage and applicationsof different types of data, Methods of Collecting primary and secondary data, Data Preparation – Processing of Data, Editing, Classification and Coding, Transcription, Tabulation.

UNIT IV

Qualitative and Quantitative analysis techniques, Hypothesis Testing (For Proportion and Means), Test of Significance,Chi-square test, T-test.

Correlation and regression analysis: Simple regression analysis, Multiple Correlation and regression, Partial Correlation.

Analysis of variance: ANOVA, Basic Principle, ANOVA Technique

UNIT V

Analysis of data through SPSS/MATLAB/PsiLab: Introduction, Basic steps of data analysis, software environment,declaring variables, running an analysis, viewing results, Plotting of graphs. Significance of Report writing, Types of Reports, Planning of Report Writing, Research Report Format, Data and Data Analysis reporting in a Thesis, Citation styles for references

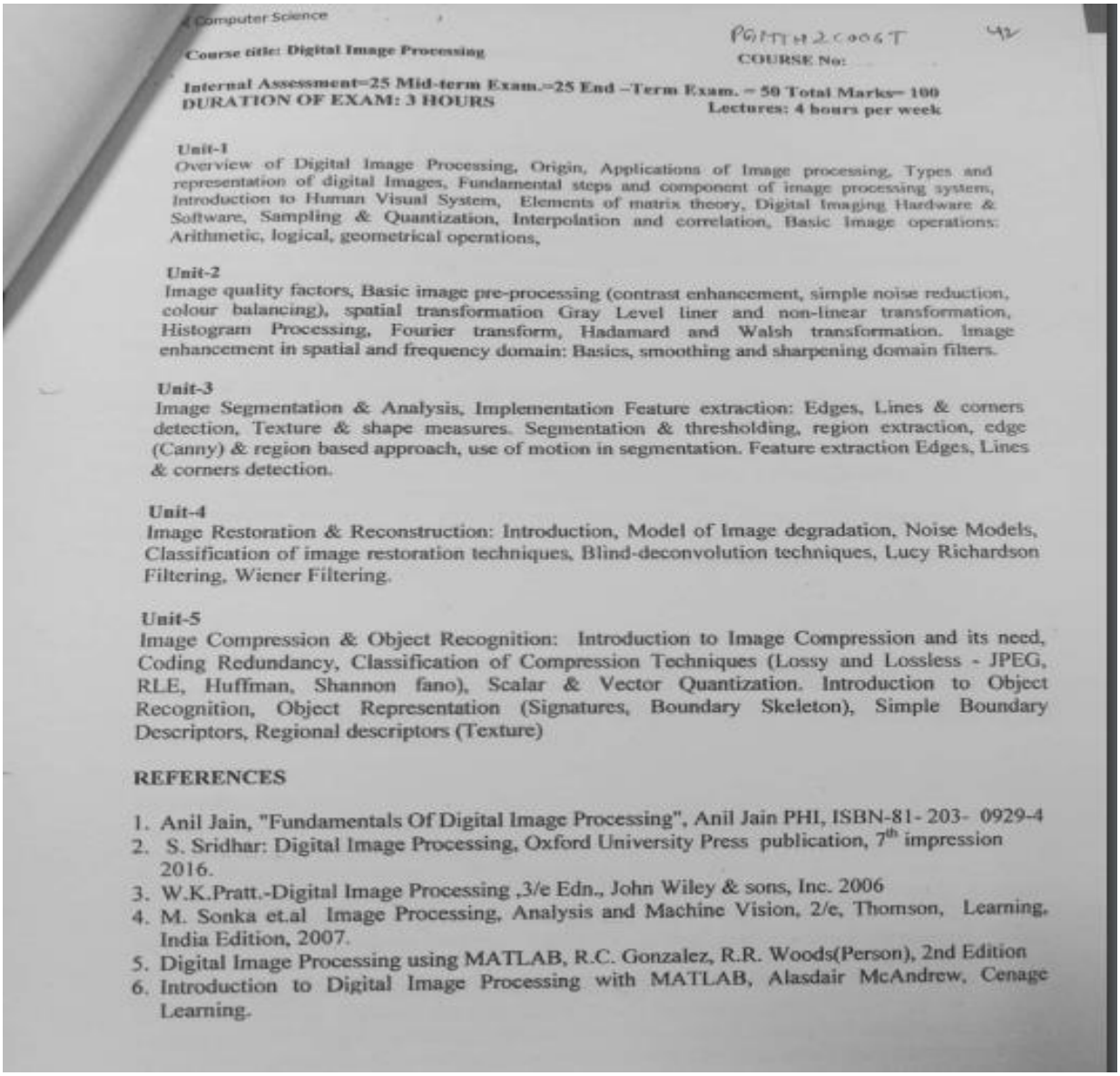
REFERENCES:

1. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International 2004
2. Ranjit Kumar,"Research Methodology: A Step-by-Step Guide for Beginners", SAGE
3. P. Sam Daniel, Aroena G. Sam , "Research Methodology",Kalpaz Publications ISBN: 9788178359007
4. Naresh K. Malhotra, Satyabhushan Dash, "Marketing Research- An Applied Orientation", Sixth Edition
5. D K Bhattacharyya, "Research Methodology",Excel Books, ISBN: 9788174464972

Page 12

COURSE OBJECTIVES

- Understand research problem formulation.
- Analyze research related information.
- Follow research ethics.
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.



Computer Science

Course title: Digital Image Processing

COURSE No:

Internal Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS
Lectures: 4 hours per week

Unit-1
Overview of Digital Image Processing, Origin, Applications of Image processing, Types and representation of digital Images, Fundamental steps and component of image processing system, Introduction to Human Visual System, Elements of matrix theory, Digital Imaging Hardware & Software, Sampling & Quantization, Interpolation and correlation, Basic Image operations: Arithmetic, logical, geometrical operations,

Unit-2
Image quality factors, Basic image pre-processing (contrast enhancement, simple noise reduction, colour balancing), spatial transformation Gray Level liner and non-linear transformation, Histogram Processing, Fourier transform, Hadamard and Walsh transformation. Image enhancement in spatial and frequency domain: Basics, smoothing and sharpening domain filters.

Unit-3
Image Segmentation & Analysis, Implementation Feature extraction: Edges, Lines & corners detection, Texture & shape measures. Segmentation & thresholding, region extraction, edge (Canny) & region based approach, use of motion in segmentation. Feature extraction Edges, Lines & corners detection.

Unit-4
Image Restoration & Reconstruction: Introduction, Model of Image degradation, Noise Models, Classification of image restoration techniques, Blind-deconvolution techniques, Lucy Richardson Filtering, Wiener Filtering.

Unit-5
Image Compression & Object Recognition: Introduction to Image Compression and its need, Coding Redundancy, Classification of Compression Techniques (Lossy and Lossless - JPEG, RLE, Huffman, Shannon fano), Scalar & Vector Quantization. Introduction to Object Recognition, Object Representation (Signatures, Boundary Skeleton), Simple Boundary Descriptors, Regional descriptors (Texture)

REFERENCES

1. Anil Jain, "Fundamentals Of Digital Image Processing", Anil Jain PHI, ISBN-81- 203- 0929-4
2. S. Sridhar: Digital Image Processing, Oxford University Press publication, 7th impression 2016.
3. W.K.Pratt.-Digital Image Processing ,3/e Edn., John Wiley & sons, Inc. 2006
4. M. Sonka et.al Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007.
5. Digital Image Processing using MATLAB, R.C. Gonzalez, R.R. Woods(Person), 2nd Edition
6. Introduction to Digital Image Processing with MATLAB, Alasdair McAndrew, Cenage Learning.

Course Objective

The significance of digital image processing is threefold; to enhance the appearance of a digital image to a human observer by applying specific operations, to extract from image quantitative and summarized information that is not readily apparent to the human eyes, and to standardize an image in photometric or geometric terms.

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Analyze general terminology of digital image processing.
- Examine various types of images, intensity transformations and spatial filtering.
- Develop Fourier transform for image processing in frequency domain.
- Evaluate the methodologies for image segmentation, restoration etc.
- Implement image process and analysis algorithms.

PGMTH12C003T

COURSE TITLE: Grid and Cloud Computing **COURSE No:**

Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS **Lectures:** 4 hours per week

UNIT I: Introduction to Grid Computing: Definition, history of Grid, need for Grid technology, types of Grid, Grid Requirements, Grid Architecture Models, Grid Components Grid: User's perspective, an administrator's perspective and an application developer's perspective, benefits of Grid.

UNIT II: Resource and Service Management: Resource Management on the Grid, Requirements, Resource Management framework, Resource Discovery and Selection. Challenges in Resource Management, Grid Resource Scheduling.

UNIT III: Introduction to Cloud Computing: Cloud Computing definition, Central ideas behind cloud computing, Cloud types: Deployment Models (Public, private, hybrid), desired features of a cloud, Benefits of Cloud computing, Benefits and challenges of cloud computing.

Differences and Similarities among different types of computing: Grid computing, Cloud Computing, Cluster Computing, Utility Computing, Parallel Computing.

UNIT IV: Cloud Architecture: Exploring cloud computing stack
Cloud Service: Cloud Service Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS).Application as a Service
Virtualization Techniques: Need for Virtualization, Pros and Cons of Virtualization, Types of Virtualization.
Different Providers and comparison of Services: Amazon Web services,, Microsoft Azure Services.,GoGrid.

UNIT V:
Security in Grid and Cloud:
Grid Security Fundamentals: authentication, access control, data integrity, trust and reputation, Security Threats.
Cloud Security Fundamentals, Cloud computing and Data Security Risks, Cloud computing and identity,Vulnerability assessment tool for cloud.

REFERENCES

1) Ian Foster and Carl Kesselman, "THE GRID2", Elesevier, 2004, second edition.
2) Lizhe Wang ," Grid Computing,Infrastructure, Service and Application",CRC Press,2009
3) Luis Ferreira, Viktors Berstis, "Fundamentals of Grid Computing ", ibm.com/redbooks, 2002.
4) Luis Ferreira, Viktors Berstis, "Introduction to Grid Computing with Globus", ibm.com/redbooks, 2002.
5) Rajkumar Buyya, James Broberg," Cloud Computing: Principles and Paradigms", Wiley, 2011.
6) Kai Hawang, "Distributed and Cloud Computing", Elesevier, 2012.
7) Barrie Sosinsky, "Cloud Computing: Bible,"Wiley Publishing, 2011.
8) Kris Jamsa," Cloud Computing: Saas,Paas,Iaas,Virtualization",Jones & Bartlett learning,2013.
9) John Rittinghouse and James Ransome," Cloud Computing, Implementation, Management and Strategy", CRC Press, 2009.

Course Objective

Cloud Computing is a large-scale distributed computing paradigm that has become a driving force for information technology over the past several years. The exponential growth of data size in scientific instrumentation/simulation and social media has triggered the wider use of cloud computing services. This course covers topics and technologies related to Cloud Computing, different architectural models of cloud computing, the concepts of virtualization and cloud orchestration. Advanced cloud programming paradigms such as Hadoop's Map Reduce are also included in the course.

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand cloud computing models, namely, infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).
- Understand security implications in cloud computing.
- Analyse the operation, implementation and performance of cloud computing systems, and the relative merits and suitability of each for complex data-intensive applications.
- Understand the underlying principle of cloud virtualization and cloud storage.

COURSE TITLE: Advanced Computer Architecture PGMTH2E0027 **COURSE No:**

Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS Lectures: 4 hours per week

Unit-I

Introduction to Parallel Processing: Parallelism in uniprocessor system; Classification of Instruction Set Architectures, Review of performance measurements Basic parallel processing techniques: instruction level, thread level and process level parallel computer structure, architectural classification Schemes: Flynn's & Feng's Classification.

Unit-II

Instruction level parallelism: Basic concepts of pipelining, Arithmetic pipelines, Instruction pipelines, Hazards in a pipeline: structural, data, and control hazards, Overview of hazard resolution techniques, Vector Pipelining, Dynamic instruction scheduling, Branch prediction techniques, Instruction-level parallelism using software approaches, Superscalar techniques, Speculative execution.

UNIT-III

Memory management and organization: Memory hierarchy, Virtual memory system, memory allocation and management, cache memory management: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses mapping and management techniques, memory replacement policies.

Unit-IV

Thread and process level parallel architecture: Centralized vs. distributed shared memory, Interconnection topologies, Multiprocessor architecture (loosely coupled, tightly coupled), interconnection networks.

MIMD Architecture, Multithreaded Architectures, Distributed Memory MIMD Architectures, Shared Memory MIMD Architecture, Symmetric multiprocessors, Cache coherence problem, Synchronization, Memory consistency, Multicore architecture.

Unit-Modern Processors: Pentium Processor: IA 32 and P6 micro architectures, Embedded CPU architecture: ARM Processor, Workstation /Server CPU architectures: MIPS Architecture, Mixed Core CPU Architectures.

REFERERCES

1. K Hwang, Advanced Computer Architecture, Tata McGraw-Hill Education, 2003
2. David E. Culler, Jaswinder Pal Singh, Anoop Gupta, Morgan Kaufman, Parallel Compute Architecture, A Hardware / Software Approach –, 1999.
3. Dezso Sima, Terence Fountain, Peter Kacsuk,, Advanced Computer Architectures- A Design space approach Pearson Education 1997.
4. H.S. Stone, High-performance Computer Architecture, 3rd edition, Addison-Wesley, 1993.
5. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Third Edition, Morgan Kaufmann, May 2002.

Course Objectives

- A broad and deep knowledge of contemporary computer architecture issues and techniques.
- Knowledge of advanced hardware-based techniques for exploiting instruction level parallelism.
- Knowledge of various architectures and techniques used for building high performance scalable multithreaded and multiprocessor systems.

Course Outcomes

After completion of course, students would be able to:

- Describe the principles of computer design.
- Classify instruction set architectures.
- Describe the operation of performance enhancements such as pipelines, dynamic scheduling, branch prediction, caches, and vector processors.
- Account and argue for the design and programming of multiprocessor systems and shared memory, especially taking coherence and memory modules into account.
- Describe the operation of virtual memory.
- Describe modern architectures such as RISC, Super Scalar, VLIW (very large instruction word), multi-core and multi-CPU systems.
- Compare the performance of different architectures

Computer Science
COURSE TITLE: Simulation And Modelling **COURSE No:**
Continuous Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS **Lectures: 4 hours per week**

Unit I

System Concepts : definition of system, inputs, entities, attributes and activities, state of system, outputs, functions/relationships, feedback, subsystem

Introduction to Simulation, need for simulation, model of system, types of models, major steps of simulation model, types of simulation, advantages of simulation, areas of simulation

Simulation of discrete system, fixed time step vs. next event models, Monte Carlo simulation, determination of value of π

Simulation of continuous system, description of continuous model using differential equations, chemical reactor system, selection of integration formula, other examples of continuous system simulation, water reservoir system.

Unit II

Random Numbers : Desirable attributes of random numbers, methods of random number generation, testing of randomness and random numbers : *chi-square method, Poker's Test*

Non uniform random numbers, methods of generation of non-uniform random numbers, inverse transformation, rejection method, Box and Mueller technique, Random numbers of : *uniform distribution, exponential distribution, Poisson distribution, normal distribution, gamma distribution, Erlang distribution*

Unit III

Queuing Theory : introduction, terminologies of queuing system, empirical queuing models, classification of empirical queueing models

Simulation of queueing system using high level languages : introduction, single-server queueing system with single queue, Two Server queueing with common queue, single-server queueing system with Balking and Reneging, single-server model with single queue and with bulk arrivals

Unit IV

Simulation of *PERT*, network model of project, critical path computation, uncertainties in the activity durations, normal PERT calculations, simulation of activity network, comparison of normal PERT calculation and PERT calculation through simulations.

Simulation of inventory system, elements of inventory theory, more complex inventory models, examples of simulation of inventory system : with respect to *service level* considerations and *minimum cost* considerations

Unit V

General Purpose Simulation System (GPSS): introduction, GPSS blocks, Matrix SAVEVALUES, Simula language, SIMSCRIPT III language, SIMAN language, SLAM II, Arena simulation software, ProModel simulation software

REFERERCES

1. Gorden, G. : System Simulation, Parentice Hall, 1978
2. R. Panneerselvam, P. Senthilkumar : System Simulation, Modelling and Languages
3. Payer T. A. : Introduction to Simulation, McGraw-Hill, 1982
4. Reitman, J. : Computer Simulation Application, Wiley, 1971
5. Spriet, W.A. : Computer-aided Modeling and Simulation, Academic Press, 1982
6. Barnes, B. : Modelling and Performance measurement of Computer Systems, 1982
7. Deo, N. : Systems Simulation with Digital Computer, Prentice Hall, New Delhi, 1979
8. Banks J., Carson II J.S., Nelson B.L. : Discrete-Event system Simulation, Prentice Hall, New Delhi, 1996

Course Objectives

- Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focuses what is needed to build simulation software environments, and not just building simulations using pre-existing packages.
- Introduce concepts of modelling layers of society's critical infrastructure networks.
- Build tools to view and control simulations and their results.

Course Outcomes

After completion of course, students would be able to:

- Understand the meaning of modeling and simulation.
- Know what is GPSS model and understand different statistical tests for measuring quality of generators
- Understand the concept of random numbers and the method to generate random numbers
- Understand random processes and different queuing models
- Network simulation tools.

PCMTH2E00TT 38

COURSE TITLE: Soft Computing Techniques **COURSE No.**

Internal Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100

DURATION OF EXAM: 3 HOURS **Lectures: 4 hours per week**

Unit – I

Soft Computing: Introduction, soft computing vs. hard computing, various types of soft computing techniques, Applications of soft computing techniques, Artificial Intelligence: Introduction, Types of production systems, characteristics of production systems, Search techniques: breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies.

Unit – II

Neural Networks : Introduction, Structure and function of a neuron, Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural networks, Difference between ANN and human brain, Characteristics and applications of ANN, Learning rules, Thresholds and activation functions, Single layer network, Perceptron and its training algorithm, Linear Separability, XOR problem, ADALINE, MADALINE, ,

Unit – III

Introduction to multilayer layer Perceptron, Back propagation neural(BPN) networks, Counter propagation network, Hopfield/ Recurrent network, Associative memory, Hopfield v/s Boltzman machine, competitive learning, Kohonen's self organizing networks, Adaptive Resonance Theory(ART).

Unit – IV

Introduction to Fuzzy Logic: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations, Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: FIS, Fuzzification and de-Fuzzification.

Unit – V

Genetic algorithms(GA): Basic concepts, Conventional Vs. GA, Simple, GA working, encoding, fitness function, reproduction, Genetic Programming(GP), Selection, crossover, mutation, schema analysis, analysis of selection algorithms; convergence; Reproduction, Crossover, and mutation, Mapping objective functions to fitness form, Fitness scaling.

REFERENCES

1. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication.
2. S.N. Sivanandam & S.N. Deepa, Principles of SoftComputing, Wiley Publications
3. Rich E and Knight K, Artificial Intelligence, TMH, New Delhi.
4. Bose, Neural Network fundamental with Graph , Algo.& Appl, TMH
5. Kosko: Neural Network & Fuzzy System, PHI Publication
6. Klir & Yuan ,Fuzzy sets & Fuzzy Logic: Theory & Appli.,PHI Pub.

Course Objectives

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- The student should be able to choose appropriate soft computing technique and use it to solve a specific problem.
- Students should be able to understand the necessary mathematical abstraction to solve problems.
- Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms
- Student should be able to come up with analysis of efficiency.

Course Outcomes

After completion of course, students would be able to learn:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply genetic algorithms to combinatorial optimization problems.
- Evaluate and compare solutions by various soft computing approaches for a given problem.
- Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.

M.Tech. (Computer Science ...) PGITH2E008T 37

COURSE TITLE: Machine Learning **COURSE No.**

Internal Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100
DURATION OF EXAM: 3 HOURS **Lectures: 4 hours per week**

UNIT I:
Introduction to Machine Learning, Supervised Machine Learning, Unsupervised Machine Learning, Reinforcement Learning, Recommender Systems, Content Based recommendation, Collaborative filtering, Application of Machine Learning.

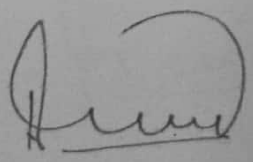
UNIT II:
Supervised Learning: Linear Regression, Linear Regression Cost function, Gradient Descent algorithm, minimize Linear Regression with Gradient Descent, Feature Scaling, Learning Rate α, Normal Equation for Linear Regression.
Classification: Logistic Regression, Hypothesis Representation, Decision Boundary: Linear and Non-Linear, Cost function for Logistic Regression, minimize Logistic Regression with Gradient Descent (SGD), Multiclass Classification Problems, Overfitting and Underfitting, Regularization.

UNIT III:
Neural Networks overview, Model Representation: Artificial neural network - representation of a neurone, notation, Forward Propagation, NN Cost function, Back Propagation, Multiclass classification.
Advice for applying machine learning techniques: Debugging a learning algorithm, evaluation hypothesis using test set error, model selection, bias vs variance, learning curves.

UNIT IV:
Support Vector Machine: Introduction, SVM cost function, Large margin intuition, Vector inner product, SVM Decision boundary, Kernels: SVM Non-Linear Classifier - Gaussian Kernel.
Spam Classification Example, Precision and Recall.

UNIT V:
Unsupervised Learning: Introduction, k-means algorithm, k-means objective function, how to choose the number of clusters.
Dimensionality Reduction: Motivation behind dimensionality reduction, Principal Component Analysis, PCA Algorithm, Application of PCA.

REFERENCES:
[1] Pattern Recognition and Machine Learning by Christopher Bishop
[2] Machine Learning by Tom M. Mitchell
[3] Pattern Classification by David G. Stork, Peter E. Hart, and Richard O. Duda
[4] Introduction to Machine Learning by Ethem Alpaydin
[5] http://www.holehouse.org/mlclass/
[6] http://cs229.stanford.edu/materials.html
[7] MOOC - https://www.coursera.org/learn/machine-learning



Course Objectives

- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning technique and various feature extraction strategies.

Course Outcomes

After completion of course, students would be able to:

- Extract features that can be used for a particular machine learning approach in various IOT applications.
- To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
- To mathematically analyse various machine learning approaches and paradigms.

PGMTH2E006T 3L

COURSE TITLE: SMAC and Internet of Things **COURSE No. .**

Internal Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100

DURATION OF EXAM: 3 HOURS **Lectures: 4 hours per week**

Unit-1

Introduction to SMAC, Convergence of 4 Disruptive Technologies, ADAPT: Adapting to Change, Digitisation, Crowd Sourcing, Crowd Storming, Collaboration, Co-Creation.
Social Media- Overview of social networking, Online Networking-Media sharing, Marketing, Impact of social media on business, Users Challenges, Future of Social Media, Blogging and Micro blogging; Strategy ,Tactics and Practice

Unit-2

Mobile – Introduction, Mobile Technology-Growth and reach, Mobile applications, Impact of Mobile-Mobility, Mobile Commerce, Mobile Payments, Mobile Wallets.
Analytics – Introduction, Big Data, Characteristics of Big Data, Digital Footprints and its Categories, Big Data Analytics Life Cycle, Data Acquisition and Transformation, Predictive analysis, Emerging trends and Challenges.

Unit-3

Cloud Computing – Overview, Deployment Models and Service Models, Cloud Architecture and Resource Management, Mobile Clouds, Impact of cloud computing on Business, Emerging Trends and challenges, Issues and Challenges in cloud computing. Security issues in Cloud Computing

Unit-4

Internet of Things – Introduction, IoT Emergence and Evolution,IoT Data Management and Analytics, IoT Applications, Security and Privacy, Identity Management and Authentication

Unit-5

IoT Architectures- SOA-Based and API-Oriented, Open IoT Architecture for IoT/Cloud Convergence, IoT Communication Protocols,Device/Cloud Collaboration Framework, FOG Computing – Principles, Architecture and Applications.

REFERENCES:

1. Big-Data Analytics Made easy- Y.Lakshmi Prasad.
2. Bussiness models for the social mobile cloud-Ted Shelton.
3. Cloud Computing,aself teaching introduction -Rajiv Chopra.
4. Internet of Things: Principles and Paradigms, edited by RajkumarBuyya, Amir Vahid Dastjerdi
5. Internet of Things and Data Analytics Handbook, edited by Hwaiyu Geng
6. Social Media Marketing Book,-O'reilly ,Dan Zarrella

Course Objectives:

- Able to understand the application areas of IOT.
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
- Able to understand building blocks of Internet of Things and characteristics.

Course Outcomes:

On completion of the course the student should be able to

- Understand the vision of IoT from a global context.
- Analyze various protocols for IoT.
- Determine the Market perspective of IoT
- Use of Devices, Gateways and Data Management in IoT.
- Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

M.Tech. (Computer Science ...

Course title: Software Testing Techniques

PGMTH2F003T
COURSE No:

Continuous Assessment=12.5 **Mid-term Exam.** =12.5 **End Term Exam.** = 25
Total **Marks**= 50
DURATION OF EXAM: 2 HOURS

Lectures: 2hours per week

UNIT I

Introduction to software testing: basics, importance, types of software testing: Functional, Performance, Maintenance, Automation versus Manual Testing, Why Do We Test Software? Seven fundamental principles of Software testing (learn with a case study).

UNIT II

Types of Testing: white box, black box Unit testing, integration, system, alpha testing, beta testing,

Testing Techniques: Structural Versus Functional Techniques, Verification Versus Validation, Static Versus Dynamic, Examples of specific testing techniques.

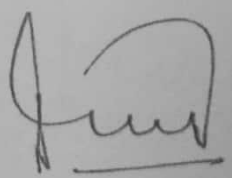
Software Testing Life Cycle: Test planning, test case development SDLC vs. STLC.

UNIT III

Test Case Development: Test Scenarios, Test cases, Test plan: Create Write and importance, Test logistic, **Software** Testing TOOLS & their Types: test management tools, test execution tools, performance measurement tools.
Case study: Telecom Domain Application with Sample Test cases, HealthCare Domain Testing with Sample Test Cases

REFERENCES:

- John Watkins, Simon Mills, Testing IT: An Off-the-Shelf Software Testing Process, 2nd edition, 2011, Cambridge University Press, ISBN 978-0521148016
- James Whittaker, Jason Arbon, Jeff Carollo, How Google Tests Software, 2012, Addison-Wesley, ISBN 978-0321803023
- Jez Humble, David Farley, Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, 2010, Addison-Wesley, 978-0321601919
- https://www.guru99.com/software-testing.html



Course Objectives

- To study fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- To learn the process of improve the quality of software work products.
- To gain the techniques and skills on how to use modern software testing tools to support software testing projects.
- To expose Software Process Improvement and Reengineering

Course Outcomes

After completion of course, students would be able to:

- Be able to design analyze, implement, test and deliver real-world software systems
- Be able to design software engineering processes appropriate to a specific problem or set of non-functional requirements
- Be able to research, understand and apply cutting edge computing technology to the solution of complex problems in software engineering
- Be able to work with external stakeholders to develop quality requirements specifications
- Be able to effectively manage large teams utilizing a variety of software engineering processes

M.Tech. (Computer Science [illegible]

Course title: DATABASE APPLICATION DEVELOPMENT COURSE No: PGMTH2F004T

Continuous Assessment=12.5 Mid-term Exam.=12.5 End Term Exam. = 25 Total Marks= 50
DURATION OF EXAM: 2 HOURS Lectures: Two hours per week

Unit-I

Overview of Relational Database systems: Relational database model, properties of relations, Logical database modelling: ER modelling, EER model, Database system architecture. Installing Database package and Creating a Database, Database design using oracle 10/11g, Database interface, Planning Database Applications—Approaches, Risks, and Standards.

Unit-II

Oracle SQL and SQL* plus: Data types in SQL ,Concept of Keys, Structured query language (SQL) , SQL components, Data types in SQL, DDL Command, DML commands, SQL operators, DISTINCT, BETWEEN/IN, ORDER BY clause, GROUP / HAVING clause, SQL Functions, Concept of Sub query, JOIN operations. Integrity Constraints: NULL, PRIMARY KEY , UNIQUE KEY , FOREIGN KEY , CHECK value constraint, Default value, DCL commands; Granting/ Revoking privileges to users .

Unit-III

Other database objects: Practical implementation of Index, Sequence, Views, and Synonyms, cursors, PL/SQL: Creating procedures, Triggers, Database export & import in oracle, Performance monitoring. Overview of Object Relational Database, user interface design.

REFERENCES

1. Kevin Loney, Oracle Database 11g : The Complete Reference, Mc Graw Hill
2. Johan Scott, Expert Oracle Application Express Apress 1St Edition , Prism Books Pvt Ltd.
3. Shah Nilesh, Database Systems Using Oracle : A Simplified Guide, Publisher : Phi Learning Pvt. Ltd-New Delhi
4. Ivan Bayross, Oracle Application Developer, BPB Publication Delhi.

Course Objectives

- To understand the basic concepts and terminology related to DBMS and Relational Database Design
- To the design and implement Distributed Databases.
- To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

Course Outcomes

Upon successful completion of this course, candidates will be able to demonstrate their competence in, and their ability to:

- Exposure for students to write complex queries including full outer joins, self-join, sub queries, and set theoretic queries.
- Knowhow of the file organization, Query Optimization, Transaction management, and database administration techniques

M.Tech. (Computer Science & Technology)

COURSE TITLE: Scientific Computing
Continuous Assessment=12.5 Mid-term Exam.=12.5 End Term Exam. = 25 COURSE No:
DURATION OF EXAM: 2 HOURS Total Marks= 50
Lectures: 2hours per week

UNIT I:

MATLAB/Octave: Overview, MATLAB/Octave expression syntax, Creating Arrays, Mathematical operators with arrays, Using Script and Managing Data: input to a script file, disp, fprintf command, save, load commands, importing and exporting data.
Two-Dimensional Plots: plot, fplot command, plotting multiple graphs in the same plot, formatting a plot, histograms, subplots, multiple figure windows.

UNIT II:

Programming in MATLAB/Octave: Relational and Logical Operators, conditions statement, switch-case statements, loops, user defined functions and function files: Structure of a function file, anonymous and inline functions, function functions, subfunctions, nested functions.

UNIT III:

Polynomials, Curve fitting, Interpolation, Three-Dimensional Plots: Line Plots, Mesh and Surface Plots, Image Handling, Symbolic Math: Symbolic Objects and symbolic expressions, changing the form of an existing symbolic expression.
GUI with MATLAB/Octave: figure, push buttons, static text, pop-up menu, axes components to the UI, Adding Behaviour: Pop-up Menu, Push Button, Callbacks.

REFERENCE BOOKS:

[1] MATLAB: An Introduction with Applications, Wiley; Fourth edition (2012), Amos Gilat
[2] MATLAB: A Practical Introduction to Programming and Problem Solving, Stormy Attaway
[3] GNU Octave Beginner's Guide, Packt Publishing Limited, Jesper Schmidt Hansen
[4] Graphics and GUIs with MATLAB, Chapman and Hall/CRC, O. Thomas Holland, Patrick Marchand
[5] https://in.mathworks.com/help/matlab/creating_guis/about-the-simple-programmatic-gui-example.html
[6] http://www.wi.tu-darmstadt.de/media/vwl1/downloads/team_2/eschenhof/LinearAlgebranew.pdf
[7] https://in.mathworks.com/help/matlab/creating_guis/about-the-simple-programmatic-gui-example.html

Course Objective

Computation becomes crucially important in situations like the problem at hand cannot be solved by customary experimental or theoretical means e.g. attempt to predict climate change. The traditional programming languages are not able to deal with complex problems that involve specialised computations on specific formats of data. The modern programming languages such as Python or matrix laboratory are significant to code a complicated algorithm in an efficient manner.

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Write scientific programs to implement advanced algorithms.
- Build the GUI applications using MATLAB.
- write a scientific paper in well-structured formats of standard Journals.
- Students will be able to use scientific tools to simulate their algorithms/ techniques.
- Plot scientific graphs and draw effective diagrams using typical tools.

COURSE TITLE: Cyber Security
COURSE No.: MTC301
Credits: 4
Semester: III

Course Objectives

- To understand the need of network and cyber security
- To understand the need and working of cryptography.
- To understand how network threats materialize into attacks.
- To understand the tools for threats, attacks, exploits.

Course Outcomes

After completion of course, students would be able to:

- Analyze the vulnerabilities in the network.
- Identify the security issues in networks
- Working of various tools for attacks and defence

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction: Information Security, OSI security architecture, Threats, Vulnerabilities, Attacks-active and passive attacks, malware and its types, obfuscation and mutations in malware, rootkits, zero day vulnerabilities, Hacking and its types, ethical hacking process.	**10**
Unit-II Cryptography: Cryptographic principles, Classical encryption techniques, cipher types, Symmetric Key Cryptography: DES, AES, Cipher modes. Asymmetric key Cryptography: RSA, Diffie-Hallman Introduction to Hash Functions.	**10**
Unit-III Cybercrimes: Introduction, classification of cybercrimes, types of cybercriminals,3P's in cybercrime-phishing, pharming and phoraging, cyberstalking; internet bots, botnet attacks and defence, network reconnaissance, attack vectors ,advanced persistent threat(APT)	**10**
Unit-IV	**10**

Tools and Techniques: Introduction, Proxy servers, Anonymizers, Keyloggers, Steganography, DoS, DDoS, SQL Injections, Buffer overflow, Attacks on wireless Networks, Web based attacks-web service protection, HTTP response splitting attacks, database defensive measures	
Unit-V Cyber Threats and defense: Firewalls and its types, Intrusion Detection System (IDS) Intrusion Prevention System (IPS), Virtual Private Networks (VPN) and Access Control, Domain Name system protection-Cache poisoning attack, Honeypots and its working, analysing honeypot data.	**10**

Course Outcomes

After completion of course, students would be able to:

- Analyze the vulnerabilities in the network.
- Identify the security issues in networks
- Working of various tools for attacks and defence

Text/Reference Books

1. Behrouz A. Forouzan, "Cryptography and Network Security", Tata McGraw-Hill
2. William Stalling, "Network Security Essentials",Pearsons
3. Tannenbaum, " Computer Networks",Pearsons
4. Cyber Security, Nina Godbole ,SunitBelapure ,Wiley India.
5. Introduction to Computer Networks And Cyber Security, Ist Edition ,Chwan-Hwa(John) Wu (Author),J.David Irwin.

COURSE TITLE: Biometrics and Pattern Recognition **COURSE No:**

Internal Assessment=25 Mid-term Exam.=25 End –Term Exam. = 50 Total Marks= 100

DURATION OF EXAM: 3 HOURS **Lectures: 4 hours per week**

UNIT-I

Biometric fundamentals: Biometrics as a pattern recognition tool, Evolution, Biometric traits, Biometrics Vs traditional recognition techniques, Characteristics of a good biometrics, Benefits of biometrics, Key biometric processes: verification, identification and biometric matching, Performance measures in biometric systems: FAR, FRR, FTE, FTA rate, EER, ROC, DTE etc., Biometrics applications, Challenges to biometrics systems.

UNIT-II

Fingerprint Patterns, fingerprint features, fingerprint sensing technologies, fingerprint feature extraction: Minutiae Determination, Fingerprint Matching: Fingerprint Classification, Overview and working of Iris, Hand geometry, Face, Ear, Signature biometrics systems, comparison of various biometrics, Limitations of Uni-biometrics.

UNIT-III

Introduction to multibiometrics, Taxonomy of multibiometrics, Issues in Designing a Multibiometric System, Normalization strategy, Fusion techniques, Overview of Multimodal biometrics, Multi factor biometrics : two-factor authentication with passwords, tickets and tokens, Case Study: ADHAR for unique identification system.

UNIT-IV

Biometrics vulnerabilities, Attacks, Ratha's framework, synthetic fingerprints: SFING, feature template security, classification of template security techniques, Liveness detection in biometrics, Spoof detection schemes, Biometrics databases, Biometrics standards, soft biometrics.

UNIT-V

Basics of pattern recognition: Features, Feature Vectors and Classifiers, Supervised versus Unsupervised Pattern Recognition, Feature Vectors and Classifiers. Parameter estimation methods, Non-parametric techniques for density estimation, Sequential Pattern classification, Context-dependent classification, discrete hidden Markov models, Continuous density hidden Markov models, Dimension reduction methods: Fisher Discriminant analysis, Principal component analysis (FDA, PCA).

REFERENCES

1. Anil K Jain, Patrick Flynn, Arun A Ross, "Handbook of Biometrics", Springer, 2008.
2. Arun A. Ross , Karthik Nandakumar, A.K.Jain, "Handbook of Multibiometrics", Springer, New Delhi, 2006.
3. Samir Nanavathi, Michel Thieme, and Raj Nanavathi, "Biometrics -Identity verification in a network", Wiley Eastern, 2002.
4. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005
5. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
6. Handbook of Fingerprint Recognition, D. Maltoni, D. Maio, A.K. Jain, and S. Prabhakar, Springer 2003.

Course Objective

- To discuss and compare different methods for pattern recognition along with their strengths and weaknesses
- To expose parametric and linear models for classification
- To make the students understand pattern recognition theories such as Bayes classifier, HMM, etc.
- To learn the various Statistical, Syntactical and Neural Pattern recognition techniques.
- To learn how to use pattern recognition for biometrics system.

Course Outcomes

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

- Identify and describe existing pattern recognition approaches for different human interaction modalities (voice, gesture, etc.)
- Evaluate and select the best approach for the recognition and identification of various patterns.
- Compare and identify the best technological solution for designing and implementing a complete recognition system based on pattern matching approach
- Identify a set of business use--cases using pattern based technology and discuss related advantage and drawbacks

M.Tech. (Computer Science & Technology)

COURSE TITLE: Smartphone Computing And Applications **COURSE No:**
Continuous Assessment=12.5 Mid-term Exam.=12.5 End Term Exam. = 25 Total Marks= 50
DURATION OF EXAM: 2 HOURS Lectures: 2hours per week

UNIT I

Introduction: Challenges in mobile computing, convergence of sensing, computing, and communications, Introduction to smartphones, tablet, PDA, or other digital mobile devices, Introduction to smartphone system architecture. Difference with the classical programming practices, Introduction to mobile operating systems, iOS, Android, Windows, Learning the Development workflow and Mobile application development.

UNIT II

Android Basics & its Components: Introduction to Android-The Open Handset Alliance, Android SDK installation, Android SDK & their codenames, Advantages of Android, The Android OS architecture, Overview of IDE for Android application, AVD, launching and starting AVD (android virtual device), Android Application Components: application context, activities and its life cycle, Services and its life cycle, Content provider, intents, shutting down components, Android manifest file, use of intent filter. Managing application resources-what are resources, resource value types, storing different resource value types (string, string arrays, Boolean, colors, integer, animation & menus)

UNIT III

Exploring building blocks: Android views and Layouts, UI Controls, Application navigation, Event Handling (Event Listeners & Event Handlers, Event Listeners Registration). Accessing files and directories, Custom Components, Drag & Drop, Notifications (Create And Send Notifications, The Notificationcompat.Builder Class, Big View Notification) Alert Dialog, Animations.

REFERENCES:

1. PeiZheng, Lionel Ni ,"Smart Phone and Next Generation Mobile Computing (Morgan Kaufmann Series in Networking)"
2. Hansmann, LotharMerk, Martin Niclous, Stober, "Principles Of Mobile Computing"
3. Tomasz Imielinski," Mobile Computing", Springer
4. Joseph Annuzzi, Jr. Lauren Darcey, Shane Conder, "Introduction to Android Application Development", Addison Welsey, Pearson, 5th edition
5. Shane Condor, Lauren Darcey, "Android Wireless Applications development", Addison Welsey, , 2nd edition
6. Rick Rogers, John Lombardo, "Android Application Development" O'Reilly

COURSE TITLE: Digital Forensics
COURSE No.: MTE302
Credits: 2
Semester: III

Course Objective

- Provides an in-depth study of the rapidly changing and fascinating field of computer forensics.
- Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
- Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools
- E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics

Course Outcomes

After completion of course, students would be able to:

- Utilize a systematic approach to computer investigations.
- Utilize various forensic tools to collect digital evidence.
- Understand the core concepts related to malware, hardware and software vulnerabilities and their causes
- Understand ethics behind hacking and vulnerability disclosure
- Appreciate the Cyber Laws and impact of hacking
- perform digital forensics analysis upon Windows, MAC and LINUX operating systems

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to Digital Forensics, Forensic Software and Hardware, Analysis and Advanced Tools, Forensic Technology and Practices, Forensic Ballistics and Photography, Face, Iris and Fingerprint Recognition, Audio Video Analysis, Windows System Forensics, Linux System Forensics, Network Forensics.	**10**
Unit-II Overview of Cyber Crime, Nature and Scope of Cyber Crime, Types of Cyber Crime: Social Engineering, Categories of Cyber Crime, Property Cyber Crime.	**10**

Unauthorized Access to Computers, Computer Intrusions, Digital laws and legislation, Law Enforcement Roles and Responses.	
Unit-III Introduction to Cyber Crime Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Hands on Case Studies. Encryption and Decryption Methods, Search and Seizure of Computers, Recovering Deleted Evidences, Password Cracking. Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case	**10**
Unit-IV Forensics analysis- validating forensics data, data hiding techniques. Forensics auditing – step-by-step, how-to process for securing, investigating, and auditing or assessing various IT environments.	**10**
Unit-V Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data. Mobile Forensics: mobile forensics techniques, mobile forensics tools.	**10**

Text/Reference Books

1. Shon Harris, Allen Harper, Chris Eagle and Jonathan Ness, Gray Hat Hacking: The Ethical Hackers' Handbook, TMH Edition
2. Jon Erickson, Hacking: The Art of Exploitation, SPD
3. Nelson Phillips and Enfinger Steuart, “Computer Forensics and Investigations”, Cengage Learning, New Delhi, 2009.
4. Kevin Mandia, Chris Prosise, Matt Pepe, “Incident Response and Computer Forensics”, Tata McGraw -Hill, New Delhi, 2006.
5. Robert M Slade, “Software Forensics”, Tata McGraw - Hill, New Delhi, 2005.
6. Bernadette H Schell, Clemens Martin, “Cybercrime”, ABC – CLIO Inc, California, 2004.
7. 5. Nelson, B, Phillips, A, Enfinger, F, Stuart, C, “Guide to Computer Forensics and Investigations”, 2nd Ed, Thomson Course Technology, 2006.

COURSE TITLE: Data Mining Techniques
COURSE No.: MTE303
Credits: 2
Semester: III

Course Objective

- To introduce Data Warehousing and Mining techniques.
- To give detailed application of data mining in web mining, pattern matching and cluster analysis.

Course Outcomes

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

- Study different sequential pattern algorithms
- Study the techniques to extract the patterns from the time series data and its application in real world.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction to Data Warehousing :Data mining, data mining versus knowledge discovery in databases, basic data mining tasks, process of data mining (CRISP-DM), data mining issues, data mining techniques for analysis	**10**
Unit-II Statistical based: Logistic Regression, Bayes classification,Distance based, Simple approach, K Nearest Neighbour, Decision tree Induction, Rule based Classification, Support Vector Machine. Case Study: Prediction of Diabetes using Classification Algorithm.	**10**
Unit-III Clustering: K means Clustering, Agglomerative Hierarchial Clustering, Partitional Algorithms, Squared- Error Clustering, K means Clustering, Anomaly or Outlier Detection, Association Rules, Apriori Algorithm	**10**
Unit-IV Introduction, Working of Predictive analytics, Models: Predictive and Descriptive, Stages of Predictive Analysis, Data Collection, Data Analysis, Statistics, Modelling, Deployment and Monitoring, Graph Mining.	**10**
Unit-V	**10**

Recent trends in Data Mining: Web Mining, Temporal Mining/Spatial Mining, Distributed Data mining, Oracle Data mining, Data mining in Bio Informatics, Data mining as a service (DMaaS)	

Text/Reference Books

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. Parteek Bhatia, Data Mining and Data Warehousing: Principles and Practical Techniques., Cambridge , 2019.

COURSE TITLE: Advanced Web Technologies
COURSE No.: MTE304
Credits: 2
Semester: III

Course Objectives

- To provide an insight to WWW, Servlets.
- Understand how to apply a framework to help identify strategic uses of Internet.
- Compare the fundamental types of web technologies and how they can be used to provide real business benefit.
- Upon successful completion of the course, students will have an understanding of the web services, java server pages, .NET framework.

Course Outcomes

After completion of course, students would be able to:

- Define the fundamental ideas and standards underlying Web Service Technology.
- Work with .NET framework ASP.NET.
- Understand and use the basics of the XML based technologies.
- Understand and define and utilize the Web Services.

Course Outlines

Contents	**No of Lectures**
Unit-I Introduction: The World Wide Web, WWW Architecture, Web Search Engine, Web Crawling, Web Indexing, Web Searching, Search Engine Optimization and Limitations, Introduction to the Semantic Web	**10**
Unit-II Introduction to Servlets, Servlet Life Cycle, Servlet Classes, Servlet, Servlet Request, Servlet Response, Servlet Context, Threading Models, Http Sessions	**10**
Unit-III Java server pages : JSP Development Model ,Components of JSP page , Request Dispatching , Session and Thread Management	**10**
Unit-IV	**10**

Introduction to Web Services: Software as a Service, Web Service Architectures, SOA(Service Oriented Architecture), XML Syntax, DTDs and XML Schema, XPath, XSLT, Sax and DOM	
Unit-V Introduction to .NET Framework : Evolution of .NET, Comparison of Java and .NET, Architecture of .NET Framework, Common Language Runtime, Common Type System, Meta Data, Assemblies, Application Domains, CFL, Features of .NET, Advantages and Applications. Web applications in ASP.NET: ASP.NET Coding Modules, ASP.NET Page directives, Page Events and Page Life Cycle, Post Back and Cross Page Posting, ASP.NET Application Compilation Models, ASP.Net, Server Controls, HTML Controls, Validation Controls, Building Databases.	**10**

Text/Reference Books

1. ASP.NET: The Complete Reference Book, Matthew Macdonald, McGraw Hill education.
2. Web Technology & Design, C.Xavier, New Age International Publication, Delhi.
3. Web Technology: A Developer's Perspective, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013.
4. Papazoglou, Web Services: Principles and Technology (2nd edition); ISBN: 978-0-273-73216-7, Prentice Hall, 2012.