SCHEME OF SYLLABI "Masters in Computer Application" (Total Credits: 152)

MCA-SEMESTER-1

	Course No.	Title	Credits	Total Marks	Internal Max.Marks/ Min.Marks	External Max. Marks/Min.Marks
Core Courses	MCACC101	OBJECT ORIENTED PROGRAMMING USING C++	04	100	20/08	80/32
	MCACC102	DISCRETE MATHEMATICS	04	100	20/08	80/32
	MCACC103	OPERATING SYSTEM	04	100	20/08	80/32
	MCAPC150	LAB BASED ON C++ AND OS	08	200	100/40	100/40
Elective-I (any one)	MCAEC104	OPERATIONS RESEARCH	04	100	20/08	80/32
	MCAEC105	NUMERICAL COMPUTING				
	MCAEC106	E-COMMERCE				
Foundation Compulsory	MCAFC105	STATISTICAL FOUNDATION FOR COMPUTER SCIENCE	02	50	10/04	40/16
TOTAL			26	650		

MCA-SEMESTER-2

	Course No.	Title	Credits	Total Marks	Internal Max./Min.	External Max./Min.
Core Courses	MCACC201	DATA STRUCTURES	04	100	20/08	80/32
	MCACC202	COMPUTER SYSTEM ARCHITECTURE	04	100	20/08	80/32
	MCACC203	JAVA PROGRAMMING	04	100	20/08	80/32
	MCAPC250	LAB BASED ON DS AND JAVA	08	200	100/40	100/40
Inter-Disciplinary Elective-I	MCAEC204	ELECTIVES OFFERED BY OTHER DEPARTMENTS (COMMUNICATION SKILLS IN ENGLISH)	04	100	20/08	80/32
Foundation Elective	MCAFC205	R PROGRAMMING	02	50	10/04	40/16
	MCAFC206	COMPUTER HARDWARE AND TROUBLESHOOTING				
TOTAL			26	650		

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MCA-SEMESTER-3

	Course No.	Title	Credits	Total Marks	Internal Max./Min.	External Max./Min.
Core Courses	MCACC301	SOFTWARE ENGINEERING	04	100	20/08	80/32
	MCACC302	ADVANCED DATABASE MANAGEMENT SYSTEM	04	100	20/08	80/32
	MCACC303	DESIGN AND ANALYSIS OF ALGORITHMS	04	100	20/08	80/32
	MCAPC350	LAB BASED ON DBMS & DESIGN AND ANALYSIS OF ALGORITHMS	08	200	100/40	100/40
Disciplinary Elective-I	MCAEC304	PARALLEL COMPUTING	04	100	20/08	80/32
	MCAEC305	IMAGE PROCESSING				
	MCAEC306	DATA WAREHOUSE & DATA MINING				
Foundation Elective	MCAFC305	PYTHON PROGRAMINING	02	50	10/04	40/16
	MCAFC306	PHP /MY SQL				
TOTAL			26	650		

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MCA-SEMESTER-4

	Course No.	Title	Credits	Total Marks	Internal Max./Min.	External Max./Min.
Core Courses	MCACC401	COMPUTER NETWORKS	04	100	20/08	80/32
	MCACC402	ARTIFICIAL INTELLIGENCE	04	100	20/08	80/32
	MCACC403	THEORY OF COMPUTATION	04	100	20/08	80/32
	MCAPC450	MINOR PROJECT	08	200	100/40	100/40
Inter-Disciplinary Elective-I	MCAEC404	ELECTIVE OFFERED BY OTHER DEPARTMENTS	04	100	20/08	80/32
Foundation Elective	MCAFC405	CURRENT TENDS AND TECHNOLOGY	02	50	10/04	40/16
	MCAFC406	INTERNET OF THINGS				
TOTAL			26	650		

MCA-SEMESTER-5

	Course No.	Title	Credits	Total Marks	Internal Max./Min.	External Max./Min.
Core Courses	MCACC501	ANDROID PROGRAMMING	04	100	20/08	80/32
	MCACC502	FUNDAMENTALS OF MICROPROCESSORS	04	100	20/08	80/32
	MCACC503	COMPUTER GRAPHICS	04	100	20/08	80/32
	MCAPC550	LAB OF COMPUTER GRAPHICS & ANDROID	08	200	100/40	100/40
Disciplinary Elective-I	MCAEC504	COMPILER DESIGN	04	100	20/08	80/32
	MCAEC505	CLOUD COMPUTING				
	MCAEC506	SOFT COMPUTING				
TOTAL			24	600		

MCA-SEMESTER-6

	Course No.	Title	Credits	Total Marks	Internal Max./Min.	External Max./Min.
	MCACC601	Project Work	24	600	200/80	400/160

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Annexure – II (A)

P.G. Department of Computer Science, GCW Parade Ground, Jammu

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Department of Computer Science
MCA Third Semester

Course Id: MCACC301 | **Title: Software Engineering**
No of Credits -4 | **Duration of the Examination: 3 Hrs**
Int. Assessment =20 | **Semester Exam=80** | **Total marks=100**

UNIT-1

Software Engineering: Evolving Role of Software, Software Engineering, Changing nature of Software, Software Myths, and Terminologies, Role of management in software development Software Process and desired Characteristics.
Software Process and desired Characteristics.
Software Life Cycle Models: Build & Fix Model, Component-based development, Formal methods model, Unified Process, Selection of appropriate development process.

UNIT-II

Software Requirements Analysis & specification: Requirements Engineering tasks, Data Modeling Concepts, Flow Oriented Modeling.
Software Project Planning: Size estimation, Cost Estimation, COCOMO, COCOMO II, and Software risk Management.

UNIT-III

Software Design Engineering: Design concept and Design models, software architecture and data design, mapping data flow into s/w architecture, Designing class based components.
SQA Tasks, Goals and Metrics, Software Review techniques: Informal reviews –Formal Technical Reviews, Software Reliability, and Software risk management.

UNIT- IV

Software Testing: approach to Software Testing, Test strategies for conventional software, Validation Testing, System Testing Debugging
Software Testing Fundamentals, Black -Box and White Box testing Basis Path Testing, Object Oriented Testing Methods , Testing for Real Time System

UNIT-V

Introduction: Clean room Software Engineering, Formal Methods , Reengineering; Business proposes reengineering, software reengineering, reverse reengineering , restricting forward reengineering, computer-Aided Software Engineering: Building blocks for CASE, taxonomy of CASE tools.

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Suggested Readings:

1. Pankaj Jalote, "An Integrated Approach to Software Engineering "3rd Edition; Narosa Publishing House,2005
2. K.K. Aggarwal and Yogesh singh," Software Egineering" 3rd Eition , New Age International (P) Ltd,2008
3. Pressman R.S., "Software Engineering- A Practitioner", sixth Edition, McGraw Hills,2008
4. Mall Rajib, "Fundamentals of Software Engineering"PHI, New Delhi 2005
5. Richard Fairley,"Software Engineering Concepts" Tata McGraw Hills.

Department of Computer Science
MCA Third Semester

Course id:MCACC302 **Course Title: Advance Database Management System**
Duration of Exam: 3 HOURS **Lectures: 4 hours per week**
Int. Assessment = 20 **Semester Exam. = 80** **Total Marks = 100**

Unit I

The Relational model of Data: RDBMS theoretical techniques and theoretical concepts, advanced sql programming. Relation, Attributes, entity, tuples, Domain, Degree, Cardinality, Keys (Candidate, Primary, Super, Foreign),referential integrity, Normalization, distributed relational systems, Security considerations.

Unit II

The extended Entity relationship Model and Object Model: The ER model revisited, complex data types, user defined abstract data types, subclass, super class, inheritance, specialization and generalization, constraints, types of relationship higher than degree two.

Unit III

Form of SQL Query: Examples of SQL queries, Nested queries, correlated query set, comparison Operators, Aggregative Operators, NULL values, Logical connectivity, AND,OR,NOT impact on SQL constructs, Outer Joins, Disallowing NULL values.

Unit IV

Schema Refinement: Problems caused by Redundancy, Decompositions, Problems caused by BCNF, Lossless join decomposition, dependency preserving decomposition, schema refinement in data base design, multivalued dependencies, Normalization up to 5th Normal form.

Unit V

Transaction Concepts: Transaction site, Atomicity and durability, concurrent execution, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, Lock based Protocol, Timestamp based Protocol, Recovery and Atomicity ,Log based Recovery, Recovery with concurrent transactions.

Suggested Readings:

1. Elmarsi,navathe,Gupta,"Fundamentals of Database System,Pearson Education.
2. Silberschatz,korth,Sudarshan,"Database system concept,Tata McGrawhill.
3. Singh S.K,"Database system concepts,design and application",Pearson Education,2006.

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Department of Computer Science
MCA Third Semester
Course Title: Design and Analysis of Algorithm

Course id:MCACC303 | **Credit-4**
Duration of Exam: 3 Hours | **Lectures: 2 hours per week** | **Total Marks = 100**
Int. Assessment = 20 | **Semester Exam. = 80**

UNIT I
Introduction to Algorithms, Analysing the Performance of an Algorithm, Space /Time complexity, Asymptotic Notation, Recurrence Relations, Master Theorem.

UNIT II
Divide and Conquer: - General methods, Binary Search, Finding the Maximum & Minimum, Merge sort, Quick Sort, Selection Problem, Stassen's Matrix, Multiplication.
Greedy Method: - General Methods, Optimal Storage on Tapes, Job Sequencing with Deadlines, Optimal Merge Patterns, Huffman Coding, Single Source shortest path, Fractional Knapsack Problem

UNIT III
Dynamic Programming: - General Methods, Multistage Graphs, 1/0Knapsack, Traveling Salesperson problem.
Back Tracking: - General Method, N- Queens Problem, Hamiltonian Cycles, Sum of Subsets
Branch & Bound: - Traveling Salesperson Problem, Assignment Problem

UNIT IV
Graph Algorithms: Review of graph algorithm topological sort, Minimum spanning trees- Kruskal's and Prims, Single source shortest paths, Dijkstra's algorithm, Bellman- Ford algorithm, All pairs shortest paths- Floyd-Warshall algorithm, Johnson's algorithm.

UNIT V
NP-Hard and NP- Complete Problems: -Basic concepts, Non-Deterministic Algorithms, Polynomial Time Algorithms, and NP-hard & NP –complete classes, Reduction, Cook's Theorem, Introduction to Approximation Algorithms.

REFERENCES:

1. Ellis Horowitz, Sartaj Sahni., "Fundamentals of Computer Algorithms".
2. J.M. Hopcraft, Ullman , "Data Structure & Algorithm"
3. Thomas H Cormen, Charles E Leiserson And Ronald L Rivest, "Introduction To Algorithms".
4. S.Sridhar "Design and Analysis of Algorithms", Oxford Publications.

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Department of Computer Science
MCA Third Semester

Course id: MCAEC304 | **Course Title: Parallel Computing**
Duration of Exam: 3 Hours | **Lectures: 4 hours per week**
Int. Assessment = 20 | **Semester Exam. = 80** | **Total Marks = 100**

Unit-I
Introduction to Parallel Processing, Parallelism in sequential Mechanics, Abstract model, Multiprocessor architecture, Architecture classifications and Techniques, pipelining, arithmetic and Instruction Pipelines, Pipelining Hazard.

Unit-II
Interconnection Networks, Hyper cubes, Shuffle Exchanges, Trees, Meshes and Butterfly networks, parallel Algorithms: linear Algebra, Matrix Multiplication, solving linear systems, probabilistic algorithm, possibility of super linear speedup, speed up law: amdhal's law, Sorting, vector and Array Processors, RISC, CISC scalar processors.

Unit-III
Shared Memory Programming, general model of shared Memory Programming, Thread management, attributed, Thread implementation Java Threads, Parallel Processing – Operating Systems for parallel Processors, types, tools and languages.

Unit-IV
Characterization of Distributed Systems – Introductions, Examples of Distributed Systems, Resource sharing and the Web, Challenges, Message passing Model, programming model, PVM, Remote procedure Call – parameter passing, Java Remote Method Invocation Other parallelism paradigms – Data Flow Computing, Systolic Architecture.

Unit-V
Distributed Data Base – objectives, issues, systems, database integrity, concurrency model, DDBMS structure Distributed Operating System – need, types, goals, design issues Inter process Communication.

Suggested Readings:

1. Vipin Kumar, Ananth Grama, Anshul gupta and George Karypis Introduction to Parallel Computing, Addison Wesley (2003) 2nd ed.
2. S G Akl, The Decision and Analysis of Parallel Algorithms, Prentice Hall (1989)
3. Hwang, Kai, Advanced Computer Architecture: Parallelism, Sealability, Programmability, McGraw Hill (1992).
4. J Jaja, An Introduction to parallel Algorithms, Addison Wesley (1992).

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5. T G Lewis and H El Rewini; Introduction to Parallel Computing, Prentice-Hall (1992).
6. M J Quinn, Parallel Computing: Theory and Practice, McGraw Hill (1994) 2nd ed.
7. Scientific computing, An introduction with Parallel computing: Gene Golub/ James M.Ortega.
8. Introduction to parallel processing: M Sasikumar, Dinesh S., P. Ravi Prakesh: PHI, 2002.

Department of Computer Science
MCA Third Semester

Course id:MCAEC305 **Course Title: Image Processing**
Duration of Exam: 3 Hours **Lectures: 2 hours per week** **Credit-4**
Int. Assessment = 20 **Semester Exam. = 80** **Total Marks = 100**

Unit-I

Image Processing Fourier Transform and Z-Transform, Causality and Stability, Toeplit and Circulate Matrics, orthogonal and unitary Matrices and Kroenker product, Markov Processes KI Transform Mean Square Estimates and Orthogonal Principles.

Unit-II

Image Sampling quantization, Band Limited Image Sampling Versus Replication, Reconstruction of image from samples Sampling Theorem, Sampling Theorem for Random Fields, Sampling Optimal Sampling, Nonrectangular Grid Sampling, Sampling Aperture, Display Aperture/Interpolation Functions, Lang range Interpolation, Moire Effect, Image Quantization Uniform Optimal Quantizer, Properties of Mean Square Quantizer, Commands Design Visual Quantization.

Unit-III

Image Transforms: Two Dimensional Orthogonal and Unitary Transforms and their properties. One Dimensional and Two Dimensional DFT Cosine and Sine Transforms Iiadmard, slant, IIARR and KI, Transforms and their properties, Approximation to KI Transforms. Image representation by stochastic model, One Dimensional Causal Models, AR and ARMA models, Non Causal Representation Spectral factorization, Image Decomposition

Unit-IV

Image Enhancement and Restoration: Point Operation, Histogram Modeling, Spatial Operations, Transform Operations. MultiSpeciral Image Enhancement. Image Observation Models, Inverse and Wiener Filtering FIR wiener Filters, Filtering using Image Transform Casual Models and recursive filtering Maximum entropy restoration. Extrapolation of band limited signal.

Unit-V

Image Analysis and Image Compression: Spatial feature extraction, Edge detection and boundary extraction boundary, region and moment representations structures, Texture, Image Segmentation, Reconstruction from Projections, Pixel Coding, Productive Techniques, Transform Coding Theory, Coding of Image, Coding of two-tone image.

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REFERENCE BOOKS

1. Anil Jain: Digital Image Processing, Pearson Publication, New Delhi
2. W.K.Pratt.-Digital Image Processing ,3/e Edn., John Wiley & sons, Inc. 2006
3. 2. M. Sonka et.al Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007.
4. Gonzalez Woods: Image Processing, Pearson Publication, New Delhi

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P.G. Department of Computer Science, GCW Parade Ground, Jammu

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Department of Computer Science
MCA Third Semester
Course Title: Data warehousing and Mining

Course id:MCAEC305 | **Lectures: 4 hours per week** | **Credit-4**
Duration of Exam: 3 Hours | **Semester Exam. = 80** | **Total Marks = 100**
Int. Assessment = 20

UNIT I- Data Warehousing
Data warehousing Components –Building a Data warehouse — Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata.

UNIT II- Business Analysis
Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – Need – Multidimensional Data Model – OLAP Guidelines – Multidimensional versus Multi relational OLAP – Categories of Tools – OLAP Tools and the Internet.

UNIT III- Data Mining
Introduction – Data – Types of Data – Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems – Data Mining Task Primitives – Integration of a Data Mining System with a Data Warehouse – Issues –Data Preprocessing.

UNIT IV- Association Rule Mining and Classification
Mining Frequent Patterns, Associations and Correlations – Mining Methods – Mining various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining – Classification and Prediction – Basic Concepts – Decision Tree Induction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction.

UNIT V- Clustering and Trends in Data Mining
Cluster Analysis – Types of Data – Categorization of Major Clustering Methods – K-means– Partitioning Methods – Hierarchical Methods – Density-Based Methods –Grid Based Methods – Model-Based Clustering Methods – Clustering High Dimensional Data – Constraint – Based Cluster Analysis – Outlier Analysis – Data Mining Applications.

REFERENCES:

1. Alex Berson and Stephen J.Smith, —Data Warehousing, Data Mining & OLAPl, Tata McGraw – Hill Edition, 35th Reprint 2016.
2. K.P. Soman, Shyam Diwakar and V. Ajay, —Insight into Data Mining Theory and Practice, Eastern Economy Edition, Prentice Hall of India, 2006.
3. Ian H.Witten and Eibe Frank, —Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, Second Edition.

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P.G. Department of Computer Science, GCW Parade Ground, Jammu

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Department of Computer Science
MCA Third Semester

Course id: MCAFC306 **COURSE TITLE: PHP/MYSQL**
DURATION OF EXAM: 2 HOURS **Lectures: 2 hours per week** **Credit-2**
Int. Assessment = 10 **Semester Exam. = 40** **Total Marks = 50**

Unit-I

Introduction to PHP:

Evaluation of Php, Basic Syntax, Defining variable and constant, Php Data type, Operator and Expression, Embedding PHP script. If, Else if, switch statement, looping foreach() with Html.

Creating function, recursive function, returning values, scope and global variables, and accessing. String Searching and Replacing string, Formatting String. Creating and Anatomy of an Array, Creating index based and Associative array.

Unit-II

Capturing Form, Data with Multi-value filed, and Generating File uploaded form, redirecting a form after submission, Handling submission, Validating form data, Custom validation function.

Session and Cookie: Introduction to Session Control, Session Functionality, Setting Cookies with PHP, Using cookies with Sessions, Deleting Cookies, Destroying the variables and Session.

Unit-III

Database Connectivity with MySQL:

Introduction to RDBMS, connection with MySQL Database, Setting queries parameter.

Database APIs in PHP, Retrieving data from MySQL, Working with retrieved data, Creating records with PHP, Updating and deleting records with PHP, Validating Results.

Suggested Readings:

1. Learning PHP, MySQL, books yb 'O' riley Press.
2. PHP and MySql book by Mice Magrah, Tata McGrahils.
3. Learn PHP and MySQL – Zero to Hero Programming Crash Course – by Paul Madoff.
4. PHP and MySQL Web Development by Luke Welling and Laura Thomson.
5. The Joy of PHP Programming: A Beginner's Guide – by Alan Forbes.
6. PHP & MySQL. Novice to Ninja – by Kevin Yank.
7. PHP & MySQL Web Development – by Luke Welling & Laura Thompson.

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P.G. Department of Computer Science, GCW Parade Ground, Jammu

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Department of Computer Science
MCA Third Semester

Course id:MCAFC305 **Course Title: Python Programming**
Duration of Exam: 2 Hours **Lectures: 2 hours per week** **Credit-2**
Int. Assessment = 10 **Semester Exam. = 40** **Total Marks = 50**

Unit 1 - (Introduction to Python, Data Types and Operations)
Introduction to Python, Features of Python, How to Run Python, Identifiers, Reserved Keywords, Variables, Input, Output and Import Functions, Operators- Arithmetic, Relational, Assignment, Logical, Bitwise, Membership and Identity Operators. Data Types – Numbers: Mathematical Functions, Trigonometric Functions, Random Number Functions, String: Escape Characters, String Formatting Operator, String Formatting Functions, Lists: Built-in List Functions, Built-in List Methods, Tuple: Built-in Tuple Functions, Dictionary: Built-in Dictionary Functions, Built-in Dictionary Methods, Data Type Conversions, Example programs

Unit 2 - (Flow Control and Functions)
Decision Making: *if* statement, *if....else* statement, *if...elif...else* statement, Nested *if* statement, Loops: *for* loop, *for* loop with *else,* while loop, *while* loop with *else* statement, Nested Loops, Control Statements: *break* statement, *continue* statement, *pass* statement, Types of Loops - Infinite Loop, Loops with condition at the top, Loops with condition in the middle, Loops with condition at the bottom, Example programs. Functions- Definition, Function calling, Function arguments- Required arguments, Keyword arguments, Default arguments, Variable-length arguments, Anonymous(Lambda) Functions, Recursive Functions, Functions returning more than one value, Example programs

Unit 3 – (Modules & Packages, File Handling)
Modules & Packages - Creating Modules, import Statement: import with renaming, from..import statement, import all names, Locating Modules-PYTHONPATH variable, Namespaces and Scope, dir() function, reload() function, Packages. File Handling - Opening a File, Closing a File, Writing to a File, Reading from a File, File Methods, Renaming a File, Deleting a File, Directories in Python, Example Programs (Chapter 6 of Book 1)

Reference Books:

1. Jeeva Jose, "Taming Python by Programming", Khanna Publishers, New Delhi.
2. Downey, A. et al., "How to think like a Computer Scientist: Learning with Python", John Wiley, 2015
3. Core Python Programming by Wesley J. Chun, 2nd Edition , Pearson Education
4. Programming in Python 3 by Mark Summerfield, Pearson Education

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Department of Computer Science
MCA Fourth Semester
COURSE TITLE: COMPUTER NETWORKS

Course id: MCACC401 **Lectures: 4 hours per week**
DURATION OF EXAM: 3 HOURS **Total Marks = 100**
Int. Assessment = 20 **Semester Exam. = 80**

Unit I
Introduction to Data communication, Advantages of Networks, Structure of communication networks, Point to Point and Multi-drop Circuits, Data flow and Physical Circuits, Network Topologies, Topologies and design goals, Hierarchical Topology, Horizontal Topology, Star Topology, Ring Topology, Mesh Topology, Network models Channel Spped, bit rate, Baud, Band Width and frequency spectrum, Modem.

Unit II
Connection oriented and connection less Networks, Classification Of Communication protocols, Polling and selection systems, Selective and Group Polling, stop and wait Polling, Multiplexing; Definition, TDM, FDM, Phase Multiplexing, Carrier Sense System. Transmission Media: Guided Media, Unguided Media: wireless, switching, circuit switched networks, datagram networks. Reference Models: OSI Reference Models and TCP/IP Reference Models.

Unit III
Analog & Digital System: advantages, Signal Conversion, Analog to Digital techniques, Asynchronous and Synchronous transmission, Data Link layer, Design issues, Frame, Error detection and correction, Flow Control, Elementary Data link protocols, Character-Oriented and bit-oriented Protocols, Sliding window protocols. Channel allocation methods, TDM, FDM, ALOHA, Carrier sense Multiple access protocols, Collision free protocols, Ethernet, Token bus, Token ring.

Unit IV
Network Layer, Store and Forward Packet Switching, connectionless and Connection-oriented services, Virtual circuit, Routing Algorithms, Shortest path, Flooding, Link State, Distant vector, Hierarchical, Broadcast and Multicast Routing. Congestion, Congestion control algorithms.

Unit V
TCP/IP Protocol, IP Addresses, Classes of IP Addresses, Subnets, IPv6, Network layer in the Internet and ATM, Internet Control Protocols, ARP, RARP, BOOTP, DHCP, OSPF, BGP. Transport Layer: Protocol Stack-UDP, TCP, SCTP, Transport Services Primitives, Sockets, Socket Programming with TCP and UDP. Applications layer, Name service (DNS) Domain Hierarchy, Name services, Name resolutions, Traditional APPLICATIONs, SMTP, MIME World wide web-HTTP, FTP.

Suggested Readings:

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P.G. Department of Computer Science, GCW Parade Ground, Jammu

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Department of Computer Science
MCA Fourth Semester

Course id: MCACC402 **TITLE: Artificial Intelligence**
No. of Credits = 4 **Duration of the Examination: 3 Hrs**
Int. Assessment = 20 **Semester Exam. = 80** **Total Marks = 100**

Unit-I

Introduction to AI: AI Domains: games, theorem proving, Natural Language Processing, vision and speech processing, robotics, expert systems, AI techniques- search knowledge, abstraction. Problem solving: State space search; Production system, search space control: depth-first, breadth-first search, heuristic search – Hill climbing, best-first search, A* search, AO search, branch and bound.

Unit-II

Knowledge Representation: Predicate Logic: Unification, modus pones, resolution, dependency directed backtracking. Rule based Systems: Forward reasoning: conflict resolution, backward reasoning: use of no backtracks. Structured Knowledge Representation: Sematic Nets: slots, exceptions and default frames, conceptual dependency, scripts.

Unit-III

Unicertainity: Non-monotonic reasoning, Logics Implementation, Probability and Bayes theorem- Certainty factors, Bayesian networks, Dempster- Shafer theory

Unit-IV

Natural Language Processing: Definition, Phases Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing. APPLICATIONs of Natural Language Processing

Unit-V

Expert Systems: Features, Characteristics-Architecture-Basic Activities-Stages in development, Structure of a knowledge base, Probability based Expert Systems – Tools, Need and justification for expert systems, knowledge acquisition, Case studies: MYCIN,DENDRAL
Introduction to PROLOG

Suggested Readings:

1. E.Rich and K. Knight, "Artificial intelligence", TMH, 2nd Ed., 1992
2. N.J. Nilsson, "Principles of AI", Narosa Publ. House. 1990.
3. D.W. Patterson, "Introduction to AI and Expert Systems", PHI, 1992.
4. Peter Jackson, "Introduction to Expert Systems", AWP, M.A., 1992.
5. R.J. Schalkoff, "Artificial Intelligence – an Engineering Aproach", McGraw Hill Int. Ed., Singapore, 1992.
6. M. Sasikumar, S. Ramani, "Rule Based Expert Systems", Narosa publishing House, 1994.

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4. Data communication & Networking, Fourth Edition by Behrouza A. Forouzan, TMH.
5. Computer networks, A.S Tanenbaum, 4th edition, Pearson Education.
6. Introduction to Data communications and Networking, W. Tomasi, Pearson education.
7. Data and computer communications, G.S. Hura and M.Singhal, CRC Press, Taylor and Francis Group.
8. An Engineering Approach to Computer networks-S. Keshav, 2nd Edition, Pearson Education.
9. Understanding communications and Networks, 3rd Edition, W.A. Shay, Cengage Learn.
10. Computer Network, S.S.Shinde, New Age International Publisher.
11. Data & Computer communication, William Stallings, pearson.

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Department of Computer Science
MCA Fourth Semester

TITLE: Theory of Computation

Course id: MCACC403
No. of Credits = 4
Int. Assessment = 20
Semester Exam. = 80
Duration of the Examination: 3 Hrs
Total Marks = 100

Unit-I

Introduction: Basic concepts of strings, Symbols, string Concatenation, alphabet, Language, Tree, States, Transition tables, Sets, Relations, Finite Automata, Regular Expressions, Compilers and translators, structure of a compiler,. APPLICATIONs of automata theory.

Unit II

Finite State Systems: Deterministic Finite Automata (DFA) and Non-deterministic finite Automata (NFA), Equivalence of the DFA and NFA, Converting NDFA to equivalent DFA, Minimization of DFA, Finite Automata with Output (Moore and mealy machines), Transformation of a Mealy machine into a Moore Machine, FSM properties and limitations.

Unit III

Regular Expressions: Regular expression designing, Equivalence of finite Automata and Regular Expressions, Algebraic method using Arden's theorem conversion of NFA with ε moves into an equivalent NFA without ε-moves, construction of FA equivalent to a regular expression, Pumping lemma of regular sets, Closure properties of regular sets, Comparison of automata models, APPLICATIONS of regular expressions and Finite automata.

Unit IV

Context free grammars, Derivation Tree (Left and right Derivation), Ambiguous Grammar (Removal of Ambiguity in the CFGs), Grammar simplifications: Reduced Grammar, Removal of ε productions from a Grammar, Nullable Symbols, Removing Unit Productions, APPLICATIONSs of context- free Grammar

Normal Forms: Chomsky Normal Form, Greibach Normal Form, Chomsky Hierarchy, Regular Grammars and FA.

Unit V

Pushdown Automata (PDA), Non-Deterministic PDA, Context-Free Grammars and Push-down Automata, construction of a PDA from the Context-Free Grammar, Properties of Context-Free Languages, PDA with two Stacks. Turing Machines: Turing Machine Model, Representation, Non-deterministic turing Machines, Recursive and Recursively Enumerable languages. Turing Machine Limitations (Unsolvability), Church's Hypothesis, Universal Turing machines, decidability, Halting problem.

Suggest References:

1. H.R. Lewis and C. H. Papadimitriou – Elements of the Theory of computation, Prentice Hall.

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2. J.E. Hopcroft, R. Motwani and J.D. Ullman –Introduction to Automata Theory, Languages and computation, Pearson Education Asia.
3. J. E. Hopcroft, and J. D. Ullman – Introduction to Automata Theory, Languages and computation, Addison Wesley.
4. J.C. Martin – Introduction to Languages and Theory of Computation, Tata Mcgraw Hill.
5. E. V. Krishna Moorthy, "Introductory theory of Computer Science". East West Press Pvt. Ltd., New Delhi.
6. K.L.P. Mishra and N. Chandrasekaran – "Theory of Computations (Automata, languages and Computation)", Prentice Hall.
7. Rogers H., Theory of Recursive Functions and effective computing, Mcgraw- Hill.

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Department of Computer Science
MCA Fourth Semester
Course Title: Current Trends and Technologies
Course id: MCAFC405 **Lectures: 2 Hours per week** **Credits-2**
Duration of Exam: 2 Hrs. **Total Marks = 50**
Int. Assessment = 10 **Semester Exam. = 40**

Unit-I

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

Cloud Service: Cloud Service Models: Infrastructure as a Service (Iaas), Platform as a Service (PaaS), and Software as a Service (SaaS)

Unit II

INTRODUCTION TO BIG DATA: Introduction; distributed file system; Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data Applications. Introduction to Data Science,

Unit III

introduction to HADOOP.

Suggested Readings:

1. Kai Hawang, "Distributed and Cloud Computing", Elesevier, 2012.
2. Barrie Sosinsky, "Cloud computing: Bible," Wiley Publishing, 2011.
3. Kris Jamsa," Cloud Computing: Saas, Paas, Iaas, Virtulization:, Jones and Bartlett learning, 2013.
4. Chris Eaton, Dirk deroos et al., "Understanding Big data", McGraw Hill, 2012.
5. Tom White, "HADOOP: the definitive Guide", O Reilly 2012.
6. Vijay Madisetti, Arshdeep Bahga, "Internet of Thigns: A Hands-On Approach".
7. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: theory and Practice.

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Department of Computer Science
MCA Fourth Semester

Course Title: Internet of Things

Course id: MCAFC406 **Credits-2**
Duration of Exam: 2 Hrs. **Lectures: 2 Hours per week**
Int. Assessment = 10 **Semester Exam. = 40** **Total Marks = 50**

Department of Computer Science
MCA Fourth semester

Title: Internet of Things

Course id: **Duration of the Examination: 3 Hrs**
No. of Credits = 2
Int. Assessment = 10 **Semester Exam. = 40** **Total Marks = 50**

Unit-I

Introduction and Concepts of IOT Introduction to IOT, definition and characteristics of IOT, Architecture of Internet of Things, Physical and logical design of IOT, IOT enabling technologies, IOT levels and deployment templates, Domain specific IOTs, home automation, cities, environment, Domain specific IOTs, Energy, retail, agriculture, industry, health and lifestyle.

Unit II

IOT and M2M Communication M2M, difference between IOT and M2M, ETSI M2M Architecture, system architecture, ETSI M2M SCL resource structure, Security in ETSI M2M framework, SDN and NFV for IOT, IOT system management, need for IOT system management, SNMP, Network operator requirements, NETCONF-YANG, IOT system management with NETCONF-YANG, IoT Design methodology-case study on IOT system for Weather Monitoring.

Unit III

Introduction to Microcontrollers, Microprocessors, IOT Technical Standards and Protocols RF Protocols: RFID, NFC; IEEE 802. 15. 4: ZigBee, Z-WAVE, THREAD; Bluetooth Low Energy (BLE), IPv6 for Low Power and Lossy Networks (6LoWPAN) and Routing Protocol for Low power and lossy networks (RPL), CoAP, XMPP, Web Socket, AMQP, MQTT, WebRTC, PuSH, Architectural Considerations in Smart Object Networking.

SUGGESTED READINGS:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-on Approach", University Press, First Edition 2015.
2. Oliver Hersent, David Boswarthick, Omar Elloumy, "The Internet of Things", First Edition, 2015.
3. Michael Miller, "The Internet of Things, How Smart TVs, Smart Cars, Smart Homes, and Smart Cities are changing the World", Pearson, First edition, 2015.
4. https://thingsee.com/blog/quality-hardware-list-for-your-iot-projects.

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Department of Computer Science
MCA Fifth Semester

Course Id:MCACC501 **Title: ANDROID PROGRAMMING**
Duration of Exam: 3 Hrs **Lectures: 4 Hrs per week**
Internal Assessment : 20 **Semester Exam. = 80** **Total Marks: 100**

Unit-I (Fundamentals of Java for Android APPLICATIONS Development)
Introduction to Java, Java Dalvik Virtual Machine, Java Tokens, Primitive Data Type and Variables, Java Operators, Expressions, Selection Statements, Iteration Statements.
Declaring Classes, Creating Objects, Methods, Interfaces, Inheritance.
10 HOURS

Unit-II (Getting an overview of Android)
Introducing Android: Version history of Android platform, Android APLs, Android Architecture and APPLICATIONS Framework. The Manifest file.
Downloading and installing Android SDK, Exploring the Development Environment.
Developing and Executing Android APPLICATIONS using Eclipse IDE.
10 HOURS

Unit-III (Using Activities, Fragments and Indents in Android)
Activities: Creating and Starting an Activity, Managing the life cycle of an Activity, Displaying Applying Styles and Themes to an Activity, Hiding the Activity Title, Displaying a Dialog Window.
Indents: Understanding the Intent Object, Linking Activities Using Intents, Resolving Intent Filter Collision, Returning Results from Intent, Passing Data Using and Intent Object.
Fragments: Fragment implementation, Finding Fragments, Adding, Removing and Replacing Fragments, Calling Built-In APPLICATIONSs Using Intents.

Unit-IV (Working with the User Interface Using Views and ViewGroups)
Understanding the Components of a Screen: Views and ViewGroups, LinearLayout, TableLayout, RelativeLayout, FrameLayout, ScrollView Layout.
Using Basic Views TextView, Button, ImageButton, EditText, CheckBox, ToggleButtons, RadioButton, and RadioGroup, ProgressBar AutoComplete TextView.
Adapting to Display Orientation: Anchoring Views, Resizing and Repositioning
Creating Menus: Options Menu, Context Menu, Sub Menu. 10 HOURS

Unit-V (Handling Pictures and Hardware Sensors)
Working with Image Views: Displaying Images in the Gallery View, Displaying Images in Grid View, Using the Image Switcher View. Using AnalogClock and DigitalClock Views.
Hardware Sensors: Introducing Sensors, Exploring the Sensor Framework, Understanding Sensor Coordinate System, Using Sensors.

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Suggested Readings:

1. Pradeep Kothari – "Android APPLICATIONS Development: Black Book", Dreamtech Press.

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Department of Computer Science
MCA Fifth Semester

Course Id:MCACC502 **Title Fundamentals of Microprocessor**
No. of Credits = 4 **Duration of the Examination: 3 Hrs**
Internal Assessment : 20 **Semester Exam. = 80** **Total Marks: 100**

Unit-I

Introduction to microprocessors, overview of Microcomputer Structure and operation. Memory: Basic memory cell, 2D/3D Static RAM, Static and Dynamic memory, Types of ROM, associative memory and interleaved memory, Random access, Sequential access, Direct access virtual memory, Introduction to hardware, software and firmware.

Unit-II

Microprocessor Architecture and its operations (8085), introduction to: address bus, data bus, control bus, memory map and Addresses, Input and Output devices: Peripheral-Mapped I/O and memory-Mapped I/O, Pin Description of 8085, APPLICATIONSs of microprocessors.

Unit-III

Introduction to 8085 Instructions: instruction Set and Instruction Format. Data Transfer Instructions, Arithmetic Operations, Logic and Branch Operations, programming Techniques with Additional Instructions, Looping, Counting and Indexing, Logic Operations, Rotate Compare.

Unit-IV

Counters and Time Delay Pro
grams, Stack and Subroutines, Conditional Call and Return Instructions & Code Conversions, BCD to Binary, Binary to BCD, BCD to Seven Segment L.E.D, ASCII to Binary, BCD Additon, BCD Subtraction, Introduction to Advanced Instructions and APPLICATIONSs, Multiplication, Subtraction with carry.

Unit-V

Parallel Input/Output and Interfacing:- Basic Interfacing Concepts, Interfacing Output Displays, Interfacing Input Keyboards, Memory Mapped I/O, Interfacing Memory, Programmable Interface Device:- Basics of Programmable I/O, General Purpose Programmable Peripheral Divces – 825A, 8259A, Direct memory Access Controller – 8237, 8279, 8253, 8155.

Suggested Readings:

1. Microprocessor Architectu4re, Programming and APPLICATIONSs with 8085/8080 – Ramesh S. Gaonkar.
2. Introduction to microprocessors – Aditya Mathur
3. Programming & Design - LIU & Gibson
4. Micorprocessor & Interfacing - Douglas V. Hall

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Department of Computer Science
MCA Fifth Semester

Course Id:MCACC503 **Title COMPUTER GRAPHICS**
No. of Credits = 4 **Duration of the Examination: 3 Hrs**
Internal Assessment : 20 **Semester Exam. = 80** **Total Marks: 100**

Unit-I

Introduction to Computer Graphics: Concept of Computer Graphics and its APPLICATIONSs. Graphics input and output devices. Graphic display devices (refreshing display devices. Random scan display device, Raster scan devices. 10 HOURS.

Unit-II

Graphic Primitives Concept of Graphic Primitives, points, lines etc., line generation algorithms (DDA and Bresemhams) Circle and its properties, generation of circle (mid point algorithms). Polygon filling, using scan line filing algorithm. Point and Line clipping. Cohen Sutherland and Cyrus – Beck Line Clipping algorithms. 10 HOURS

Unit-III

Transformations: Concept of 2D transformations. Basic Transformations (translation, rotation, scaling, shearing) composite transformations, transformations using homogeneous coordinate systems. 3D transformations (Translation, rotation, scaling, shearing, reflection) 10 HOURS

Unit-IV

Viewing Transformations: Introduction, objectives of viewing transformation. Concept of projections: parallel projection, orthographic and oblique projections, isometric projections, perspective projections (concept of vanishing points, single point, perspective transformation with COP in the origin. 10 HOURS

Unit-V

Curves and Surfaces: Polygon representation methods (polygon surfaces, polygon tables, plain equation, polygon meshes) Hermite and Bezier curves and their properties. Surface of revolution. Concept of visible surface detection. Methods of visible surface detection (depth buffer, scan line, area sub division) 10 HOURS

Suggested Readings:

1. Giloi, Wk.: Interactive Computer Graphics, Prentice-Hall, 1978.
2. Newman, W., Sproul, R.F.: Principles of Interactive Computer Graphics, McGraw-Hill, 1980.
3. Rogers, D.F.: Procedural Elements for Computer Graphics, McGraw-Hill, 1985.
4. Harrington, S.: Computer Graphics: A Programming Approach, TataMcGraw-Hill, 1983.
5. Foley, J.D., Van Dam, A.: Fundamentals of Interactive Computer Graphics, Addison Wesley, 1982.
6. Hearn, D., Baker, and P.M.: Computer Graphics, Prentice-Hall, 1986.
7. Tosijasu, L.K.: computer Graphics, Springer Verlog, 1983.
8. Rogers, D.F. McGraw Hill: Mathematical Elements of Computer Graphics.

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Department of Computer Science
MCA Fifth Semester

Course Id: MCAEC504 **Title: Compiler Design**
No. of Credits = 4 **Duration of the Examination: 3 Hrs**
Internal Assessment : 20 **Semester Exam. = 80** **Total Marks: 100**

Unit I:Compiler Structure & Lexical Analysis
Compiler Structure: Compilers and Translators, Analysis- Synthesis Model of Compilation, Various Phases of Compiler, Pass Structure, Bootstrapping & Compiler Construction Tools.Lexical Analysis: Interface with input, parser and symbol table, token, lexeme and patterns, difficulties in lexical analysis, Error Reporting, Regular definition, Transition diagrams, LEX.Capabilities of Lexical Analyzer.
10 HRS

Unit II:Finite Automata
Nondeterministic Finite Automata, Deterministic Finite Automata, Subset Construction, Thompson's construction, DFA State Minimization.The Syntactic Specification of Programming Languages: CFG, Derivation and Parse tree, Ambiguity, Capabilities of CFG.
10 HRS

Unit III:Parsing
Basic Parsing Techniques: Top-Down parsers with backtracking, Recursive Descent Parsers, Predictive Parsers, Non-recursive Predictive Parsers, Bottom–up Parsers, Shift-Reduce Parsing, Operator Precedence Parsers, LR parsers.YACC, Syntax Directed Definitions, Type checking.
10 HRS

Unit IV: Memory Management & Intermediate Code Generation
Run Time Memory Management: Static and Dynamic storage allocation, stack based memory allocation schemes, Symbol Table management. Error Detection and Recovery: Lexical phase errors, Syntactic phase errors, Semantic errors. Intermediate Code Generation: Different Intermediate forms: three address code, Quadruples & Triples.
10 HOURS

Unit V: Code Optimization & Generation
Sources of optimization, Local optimization, Loop optimization, Peephole optimization
Issues in the design of Code Generator, Basic Blocks and Flow Graphs, Transformations on Basic Blocks, DAG, Code Generation Algorithm, Register Allocation and Assignment.
10 HRS

References:

1. Alfred V Aho, Jeffrey D. Ullman, "Principles of Compiler Design", Narosa Publ. House.

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2. A. V. Aho, R. Sethi and J. D Ullman, "Compiler: principle, Techniques and Tools", Addison Wesley.
3. Tremblay and Sorenson: "The theory and Practice of Compiler Writing", McGraw Hill, 1985.
4. Londan: "Compiler Construction", Thomson Learning.
5. H. I. Holub, "Compiler Design in C", Prentice Hall.
6. Appel, Andrew W., "Modern compiler implementation in C", Cambridge university press, 2004.
7. Louden, Kenneth C, "Compiler construction", Cengage Learning, 1997.

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Department of Computer Science
MCA Fifth Semester

Course Id: MCAEC505 | **Title: Cloud Computing**
No. of Credits = 4 | **Duration of the Examination: 3 Hrs**
Internal Assessment : 20 | **Semester Exam. = 80** | **Total Marks: 100**

Unit-I

Distributed Computing and Enabling Technologies. Vision of Cloud Computing, Defining a Cloud. Desired features and benefits, issues and challenges of cloud computing. Exploring the Cloud Computing Stack, Architecture, Applications, deployment models, and service models.

Unit-II

Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Need for Virtualization, Pros and Cons of Virtualization Types of Virtualization: Hardware, Storage and Network virtualization, Concept of Hypervisors, Virtual machines provisioning and manageability: VM provisioning process

Unit-III

Distributed Management of Virtual Infrastructures, Server consolidation, Dynamic provisioning and resource management, Resource Optimization and Load Balancing, various load balancing techniques
Broad Aspects of Migration into Cloud, Migration of virtual Machines and techniques. Fault Tolerance Mechanisms.

Unit-IV

Cloud Storage definition, Provisioning cloud storage: unmanaged cloud storage, managed cloud storage. Introduction, Apache Hadoop: Framework to process big data, Master/ Slave architecture, Core components, Map-Reduce Programming Model: Map reduce working, working of mapper, working of reducer, Running Hadoop on cloud, Design of data applications based on Map Reduce in Apache Hadoop.

Unit-V

Cloud Infrastructure security: network, host and application level – aspects of data security, provider data and its security, Identity and access management architecture, IAM practices in the

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cloud, SaaS, PaaS, IaaS availability in the cloud - Key privacy issues in the cloud – Cloud Computing Risk Issues- Security Challenges- Cloud Security and Trust Management Grid of Clouds, Green Cloud, Mobile Cloud Computing

Text/Reference Books

1. Cloud Computing Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, Wiley Publishers 2011.
2. Cloud Computing Bible, Barrie Sosinsky, Wiley Publishers 2010.
3. Cloud Computing: Web-based Applications that change the way you work and collaborate online, Michael Miller, Pearson Education 2008.
4. Mastering Cloud computing, Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, McGraw Hill 2013.
5. Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide, David S. Linthicum 2010.
6. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly 2010.
7. Cloud Computing : A Practical Approach, Toby Velte, Antohy T Velte, Robert Elsenpeter, McGraw Hill 2009.

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Department of Computer Science
MCA Fifth Semester

Course Id: MCAEC506 | **Title: Soft Computing**
No. of Credits = 4 | **Duration of the Examination: 3 Hrs**
Internal Assessment : 20 | **Semester Exam. = 80** | **Total Marks: 100**

Unit-I

Soft Computing: Introduction, soft computing vs. hard computing, various types of soft computing techniques, Applications of soft computing techniques, 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.

Unit-II

Learning rules, Thresholds and activation functions, Single layer network, Perceptron and its training algorithm, Linear Separability, XOR problem, ADALINE, MADALINE. Introduction to multilayer layer Perceptron, Back propagation neural(BPN) networks

Unit-III

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, Selection, crossover, mutation, schema analysis, analysis of selection algorithms; convergence; Reproduction, Crossover, and mutation, Mapping objective functions to fitness form, Fitness scaling. Meta-heuristic search: Overview of ACO, PCO

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Text/Reference Books

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.
7. Genetic Algorithm, Goldberg

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