Department of Computer Science and Engineering
UNIVERSITY OF KALYANI, KALYANI 741235
WEST BENGAL

SYLLABUS

FOR

MASTER OF COMPUTER APPLICATIONS (MCA)

(Two-Year Programme)

As per
AICTE MODEL CURRICULUM
(Effective from the Session: 2022-23)

Paper Code Convention: MCA – XYZ
[X = 1/2/3/4 (semester), Y = 0/1/2/3/4 (theory/practical/project/viva/bridge course), Z (paper id)]

Paper Code	Paper Name	Type	Credit	Weekly hours (L+T+P)	Marks Theory - (Exam+Internal Assessment) Bridge (Theory Exam+IA+Lab exam)
Semester - I					
MCA–101	Mathematical Foundation	Theory	4	3+1+0	100 (70+30)
MCA–102	Data and File Structures	Theory	4	3+1+0	100 (70+30)
MCA–103	Computer Organization and Architecture	Theory	4	3+1+0	100 (70+30)
MCA–104	Microprocessor and its Applications	Theory	4	3+1+0	100 (70+30)
MCA–105	Introduction to Management Functions	Theory	4	3+1+0	100 (70+30)
MCA–111	Communicative English and Business Presentation	Practical	2	0+0+2	50
MCA–112	Data and File Structures Laboratory with C	Practical	3	0+0+3	100
MCA–113	Digital Circuits and Computer Organization Laboratory	Practical	3	0+0+3	100
MCA–114	Microprocessor and its Applications Laboratory	Practical	3	0+0+3	100
MCA–141*	Introduction to Computing and C Programming	Bridge Course	--	2+0+2	100 (40+10+50)
TOTAL			31	31	850
*The bridge course is a mandatory non-credit course for the students without having computer science/application background. The students opting for this course must qualify/pass in order to complete the MCA degree.					
Semester - II					
MCA–201	Design and Analysis of Algorithms	Theory	4	3+1+0	100 (70+30)
MCA–202	Object Oriented Programming	Theory	4	3+1+0	100 (70+30)
MCA–203	Database Management Systems	Theory	4	3+1+0	100 (70+30)
MCA–204	Operating Systems	Theory	4	3+1+0	100 (70+30)
MCA–205	Scientific Computing	Theory	4	3+1+0	100 (70+30)
MCA–211	Object Oriented Programming Laboratory	Practical	3	0+0+3	100
MCA–212	Database Management Systems Laboratory	Practical	3	0+0+3	100
MCA–213	Scientific Computing Laboratory	Practical	3	0+0+3	100
MCA–214	Advanced Programming Laboratory–I	Practical	3	0+0+3	100
TOTAL			32	32	900
Semester - III					
MCA–301	Artificial Intelligence	Theory	4	3+1+0	100 (70+30)
MCA–302	Computer Networks	Theory	4	3+1+0	100 (70+30)
MCA–303	Software Engineering	Theory	4	3+1+0	100 (70+30)
MCA–304	Elective – I	Theory	4	3+1+0	100 (70+30)
MCA–305	Elective – II	Theory	4	3+1+0	100 (70+30)
MCA-306	Elective – III	Theory	4	3+1+0	100 (70+30)
MCA–311	Artificial Intelligence Laboratory	Practical	3	0+0+3	100
MCA–312	Web-based Programming Laboratory	Practical	3	0+0+3	100
MCA–313	Advanced Programming Laboratory-II	Practical	3	0+0+3	100
MCA–321	Project–I	Project	3	0+0+3	100
TOTAL			36	36	1000
Semester - IV					
MCA – 421	Project–II	Project	16	0+0+24	400
MCA – 431	Grand Viva	Viva	8	-	200
TOTAL			24	24	600
Overall Total			125	125	3350

Electives Papers

1. Computer Graphics
2. Pattern Recognitions
3. Soft Computing
4. Advanced DBMS
5. Embedded System Design
6. Simulation & Modeling
7. Mobile Computing
8. Parallel Processing
9. IoT and Sensor Networks
10. Digital Image Processing
11. Managerial Economics
12. Computational Geometry
13. Data warehousing and Data Mining
14. Distributed Computing
15. Graph Theory and Algorithms
16. VLSI Design
17. Numerical & Statistical Computing
18. Advance Data Structure
19. Network Programming
20. Remote Sensing & GIS Applications
21. Network Security
22. Real Time Systems
23. Multicriteria Decision Making
24. Computer Communication Principles
25. Managerial Accounting
26. Formal Language & Automata Theory
27. Compiler Design
28. E-Commerce
29. Values & Professional Ethics
30. Cloud Computing
31. Computational Biology
32. Big Data Analytics
33. Blockchain Technology
34. Machine Learning

* New elective papers may included/offered as per the need of the industry and modern technologies as and when required with the approval of the PG-BoS of Dept. of Computer Science & Engineering.

Semester - I

MCA–101. Mathematical Foundation
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Functions and Relations: Definition and type of functions, mappings, injection, bijection and surjection, equivalence relations and partitions, partial ordering relation, Lattices and their applications, generating functions, recurrence relations, solution of linear homogeneous and non- homogeneous recurrence relations by the method of generating functions and particular solution method.
Algebraic Structures: Groups, Rings and Fields, Group Codes, Concepts of Vector Spaces.
Probability: Sample space, Events, Axioms, Conditional probability, Bayes' rule, Random variables: Discrete and continuous, Distribution and density functions, Marginal and conditional distributions, Binomial distribution, Poisson distribution, Normal distribution, Stochastic independence.
Statistical Methods: Sampling, Frequency Distribution. Measures of Central Tendency and Dispersion, Moments, Discrete Distribution Binomial and Poisson Distribution, Regression Analysis/Curve Fitting, Correlation Co-Efficient, Multiple, Partial and Rank Correlations, Tests of Significance- X Test, T-Test and F-Test.
Discrete Mathematics: Sets, subsets, power sets, set operations, Counting functions, combinatorics, countability, basic proof techniques: induction, proof by contradiction, Basics of inductive, deductive, and propositional logic, Graphs theory.

Reference Books:

1. Narsingh Deo, Graph Theory With Applications To Engineering And Computer Science, PHI Learning
2. C. L. Liu, Elements of Discrete Mathematics, TMH, 2000.
3. Kenneth H. Rosen; Discrete Mathematics and its applications; TMH.
4. K. H. Rosen, Discrete Mathematics and applications, fifth edition 2003, TMH.
5. Ross, S., A First Course in Probability, Collier Macmillan, New York, 1976
6. Liu, C.L., Introduction to Combinatorial Mathematics, McGraw Hill. 1996
7. R.P. Grimaldi, B. V. Ramana, Discrete and Combinatorial mathematics: An applied introduction, Pearson Education, 2007
8. Murray, R., J. Spiegel, and R. Schiller. Schaum's outline of probability and statistics. 2013.
9. Lipschutz, Seymour, and Marc Lars Lipson. Discrete mathematics. McGraw-Hili, 2007.

MCA–102. Data and File Structures
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Data Types and Algorithms: Time and Space Analysis Of Algorithms-Order Natations: Linear Data Structures: Sequential Storage Representation-Arrays, Strings, Stacks, Queues, Dequeues and other their Applications: Linear Data Structures: Linked Storage Lists, Circularly Linked Lists, Doubly Linked Lists, Applications: Recursion-Design of Recursive Algorithms, Tail Recursion, When Not to use Recursion, Removal of Recursion; Non-Linear Data Structures: Trees, Binary Trees, Binary Search Tree, Traversals and Threads, Insertion and Deletion Algorithms, Height-Balanced and Weight-Balanced Trees, B-Trees, B+ Trees, Applications of Trees: Graphs-Representation, Sorting and Searching-Review of Various Algorithms, Hashing.

Text Books:

1. Ellis Horowitz, S. Sahni, D. Mehta Fundamentals of Data Structures in C++, Galgotia Book Source, New Delhi.

2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms (2nd ed.), Prentice-Hall of India, 2006
3. Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education Asia, 2nd Edition, 2002.
4. Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., "Data Structures and Algorithms", Addison Wesley

Reference Books:

1. 1 Debasis Samanta, Classic Data Structures, PHI, 2nd Edition
2. S. Lipschutz, Data Structures Mc-Graw Hill International Editions, 1986.
3. Jean-Paul Tremblay, Paul. G. Soresan, An introduction to data structures with Applications, Tata Mc-Graw Hill International Editions, 2nd edition, 1984.
4. A. Michael Berman, Data structures via C++, Oxford University Press, 2002.
5. M. Weiss, Data Structures and Algorithm Analysis in C++, Pearson Education, 2002, 2nd edition.
6. M.T. Goodrich, R. Tamassia and D. Mount, Data Structures and Algorithms in C++, John Wiley & Sons, Inc., 2004.
7. M.J. Folk, B. Zoellick and G. Riccardi, File Structures: An Object Oriented Approach With C++ (3rd ed.), Addison- Wesley, 1997.
8. Robert L. Kruse and A.J. Ryba, Data structures and program design in C++, Prentice-Hall, Inc., NJ, 1998.
9. B. Stroupstrup, The C++ Programming Language, Addison Wesley, 2004.
10. D.E.Knuth, Fundamental Algorithms, Vol. I, Addison Wesley, 1997.

MCA–103. Computer Organization and Architecture
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Fixed point Arithmetic: Arithmetic and logical operations of signed numbers and their implementation, Concepts of floating point numbers and operations, Bit-slice processors and Emulation

Principles of Computer design: Basic concepts, Instruction Set Architecture, Hardware System Architecture, Classifications of Computer Architecture: von Neumann's classification, Flynn's classification, Machine language instructions, Instruction formats, Instruction cycle and execution cycle, sequencing, Addressing modes, instruction types, Instruction set selection, Stacks, Queues, Subroutines (Example instruction set may be used: INTEL/ARM/MOTOROLA/others),

Register Transfer and Micro Operation: Register Transfer Language, Bus and Memory Transfers, Bus Architecture, Arithmetic Logic, Shift Microoperation, Arithmetic Logic Shift Unit, Design of Fast adders, Arithmetic Algorithms (addition, subtraction, Booth Multiplication).

Hardwired Control: Concepts, Data path and control path design, Fetching and storing word from/in main memory, Register transfers, Operations, execution of a complete instruction Hardwired control

Micro-programmed control: outline of microprogrammed control organization, control word, microprogram, next address generator (sequencer), control address register, control memory and control data register, advantages over hardwired control, address sequencing, mapping and associated hardware.

RISC Vs CISC, Pipelining in CPU design, Superscalar processors, Concepts of pipelining

I/O organization: Input-output processing, bus interface, Programmed data transfer; I/O interrupts-advantage over programmed transfer, DMA transfer, Performance evaluation - SPEC marks, Transaction Processing benchmarks.

Memory: Basic concepts, memory system, storage technologies, memory array organization, RAM, ROM – different types, characteristics, cache memories, memory hierarchy, virtual memory, address translation, secondary memories, interleaving, cache and virtual memories and architectural aids to implement these, input-output devices and characteristics.

References:

1. Mano, M, Computer System and Architecture, (3rd Ed.), PHI, 1994
2. Pal Chauduri, P., Computer Organisation and Design, PHI, 1994
3. Pranab Chakraborthy, Computer Organization and Architecture, Universities Press.
4. Rajaraman,V., and Radhakrishnan, T., Introduction to Digital Computer Design" (4th Ed.), PHI, 1997
5. Stallings. W, Computer Organization and Architecture, 2nd Ed., PHI,
6. C. Hamacher, Z. Vranesik, S. Zaky , Computer Organization, McGraw Hill
7. John P. Hayes, Computer Architecture and Organization, McGraw Hill
8. Tannenbaum, Structured Computer Organization, PHI Vravice, Zaky & Hamacher, Computer Organization, TMH

MCA–104. Microprocessors and Its Applications
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction to microprocessors. Microprocessor architecture organization and programming of microprocessor inter-8085.

Data transfer techniques and their implementation: programmed data transfer, DMA transfer, interrupt driven data transfer, serial and parallel communication.

Some common peripherals & their interfacing: key board & display, programmable parallel interface, programmable timer, ADC & DAC etc. development aids and troubleshooting techniques: self-test concepts, memory testing techniques, single stepping technique etc. basic features of some advanced microprocessors: single chip microcomputer, 16-bit & 32-bit microprocessors, RISC & CISC concepts, idea of transputer.

Text Books:

1. Krishna Kant, “MICROPROCESSORS AND MICROCONTROLLERS Architecture,programming and system design using 8085, 8086, 8051 and 8096”. PHI 2007.
2. Douglas V Hall, “MICROPROCESSORS AND INTERFACING, PROGRAMMING AND HARDWARE” TMH, 2006.

Reference Books:

1. Muhammad Ali Mazidi, Janice GillispieMazidi, RolinD.MCKinlay The 8051 Microcontroller and Embedded Systems, Second Edition, Pearson Education 2008.
2. Kenneth J. Ayala, “The 8086 Microprocessor: Programming & Interfacing The PC”, Delmar Publishers, 2007.
3. A K Ray, K M Bhurchandi, Advanced Microprocessors and Peripherals, TMH, 2007.

MCA–105. Introduction to Management Functions
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Accountancy- Its origin and scope, fundamental principal of double entry system single entry system,

books of original entry and prime entry, cash book and its different uses, Trial Balance, Preparation of final account and Balance sheet , Accounting for noon-trading concerns.
Financial Management: Discipline and scope of Finance as distinct from accountancy, analysis of the Profit and Loss A/C and Balance Sheet, including Ratio Analysis and their implication. Fund Flow Statement. Business Budget & its control. Concept of cost and method costing their application, (IT Act)

Text Books:
1. Financial Management and Accounting - P. K. Jain, S. Chand & Co.
2. Management & Accounting: Principles and Practice - R. K. Sharma & Shashi Kumar Gupta, Kalyani Publishers.
3. Advanced Management Accounting - Kaplan & Atkinson, PHI.
4. Fundamentals of Financial Management - Van Home, PE.

Reference Books:
1. Financial Mgmt Accounting, Gupta,Pearson
2. Financial Mgmt, I.M. Pandey, Vikas
3. Financial Mgmt., Khan & Jain, TMH
4. Financial Mgmt ,Mcmenamin, OUP
5. Financial Mgmt& Policy, Van Horne, PHI
6. Financial Mgmt,Kulkarni&Satyaprasad, Himalaya

MCA–111. Communicative English and Business Presentation
Full Marks: 50, Weekly Hours: 0 + 0 + 2
Allotted Hrs: 20P
This should cover general and technical writing, oral communication and listening skills: letter writing, technical report writing, and business communication.
Expression: Practical communication skill development, business presentation with multimedia, speaking skill, prepared speech, extempore speech.

MCA–112. Data and File Structures Laboratory with C
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-102

MCA–113. Digital Circuits and Computer Organization Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-103

MCA–114. Microprocessor Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-104

MCA–141. Introduction to Computing and C Programming
Full Marks: 100, Weekly Hours: 2 + 0 + 2
Allotted Hrs: 20L, 20P

Introduction to computers and operating environment, Program development cycle.
Algorithm – Representations of Algorithm, Pseudocode, Flowcharts
Programming Languages, Introduction to C, Data representation and data types
Control Structures - Conditional execution and transfers, repetitions
Subprograms- Functions, procedures, parameter passing
String processing, Structures and enumerated data types - Arrays, lists, stacks.
Records and set, Files, Pointers
Recursion, Structured Programming

Text Books:

1. TennenceW.Pratt, "Programming languages design and implementation", Prentice Hall of India.
2. Allen B. Tucker, "Programming Languages", Tata McGraw Hill.
3. Gottfried BS – Programming with C, TMH pub.
4. Balagurusamy:ANSI C TMH
5. Kanetkar, Yashvant – Understanding Pointers in C- 2nd Edn. BPB
5. Kanetkar, Yashvant - Let us C. - 3rd revised Edn. BPB

Reference Books:

1. Roosta- Foundation of Programming Languages,Vikas
2. Jeyapoovan- A First Course in Prog with C, Vikas
3. Programming In C++, Y.I. Shah and M.H. Thaker, ISTE/EXCEL BOOKS
4. Fundamentals of Programming Languages, R. Bangia,Cyber Tech

Semester-II

MCA–201. Design and Analysis of Algorithms
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Basic concepts – complexity measures, worst and average case, upper and lower bounds. Algorithm design principles – divide and conquer, recursion, greedy method, dynamic programming.
Bounds for selecting and sorting – finding maximum, finding minimum and quick sort, radix sort.
Union – Find algorithms
Graph algorithms – Breadth first search, depth first search, topological sort, connected and biconnected components, Minimum spanning trees – Kruskal's and Prim's, shortest paths – Dijkstra's, Bellman-Ford's and Floyd-Warshall's.
Algebraic algorithms – evaluation of polynomials, Strassen's matrix multiplication.
Pattern matching algorithms.

Text Books:

1. U. Manber: Introduction to Algorithms
2. T. Cormen, C. Leiserson and R. Rivest: Introduction to Algorithms
3. Randomised algorithms by R. Motwani & P. Raghavan, Cambridge University Press, 1995, ISBN 0-521-47465-5.

Reference Books:

1. 1. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Indtroduction to Algoritms, PHI, 2006
2. E. Horowitz, S. Sahni and S. Rajasekaran, Computer Algorithms/C++, Universities Press.
3. J. Kleinberg and E.Tardos, Algorithms Design, Pearson Education, 2006

4. S.Baase, Computer algorithms: Introduction to Design and Analysis, Addison Wesley, 1999
5. A.V. Levitin, Introduction to the Design and Analysis of algorithms, Pearson Education, 2006
6. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995
7. Teofilo F.Gonzalez, Handbook of NP-Completeness: Theory and Applications, Chapman & Hall, 2009
8. Vijay V. Vazirani, Approximation Algorithms, Springer-Verlag, France, 2006
9. S. Rajasekharan and John Reif, Handbook of Parallel Computing: Models,algorithms and applications, Chapman and Hall/CRC, 2007
10. Gareth A. Jones and Josephine M. Jones, Elementary Number Theory, Springer, 1998

MCA–202. Object Oriented Programming
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

History of the development of object-oriented programming languages, object-attributes and methods, message passing, Classes: Notion of abstraction, encapsulation/information hiding and modularity, Instantiation and initialization of objects: Constructors and destructor, Class hierarchy: single, multilevel, multiple and repeated inheritance, polymorphism, Object hierarchy – Aggregation; Advantages and disadvantages of object-oriented programming language, Features of C++.

Text Books:

1. Jana, C++ & Object Oriented Programming, PHI
2. Folk M. J.,Zoellick B., Riccard G., File Structures: An Object-Oriented Approach with C++

Reference Books:

1. Herbert Schild: The Complete Reference to C++, Osborne McGrawHill. McGraw Hill Education (India) Private Limited; 4 edition
2. Bjarne Stroustrup: Programming: Principles and Practice Using C++, Addison Wesley; 2 edition
3. James R Rumbaugh, Michael R. Blaha, William Lorensen, Frederick Eddy, William Premerlani. : Object Oriented Modeling and Design, Prentice Hall; 1 edition

MCA–203. Database Management Systems
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction: Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.
Entity-Relationship Model: Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.
Relational Model: Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations,
Views, Modifications of the Database.
SQL and Integrity Constraints: Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.
Relational Database Design: Functional Dependency, Different anamolies in designing a Database., Normalization using funtional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Nomalization using multi-valued depedencies, 4NF, 5NF.
Internals of RDBMS: Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction

model properties, state serializability, lock base protocols, two phase locking.
File Organization & Index Structures: File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

Text Books:
1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System, McGraw-Hill
4. Gray Jim and Reuter Address, "Transaction Processing: Concepts and Techniques", Moragan Kauffman
Publishers.
5. Jain: Advanced Database Management System Cyber Tech
6. Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
7. Ullman JD., "Principles of Database Systems", Galgottia Publication.

Reference Books:
1. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
2. "Fundamentals of Database Systems", Ramez Elmasri, Shamkant B. Navathe, Addison Wesley Publishing
Edition
3. "Database Management Systems", Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

MCA–204. Operating Systems
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Introduction: Introduction to OS. Operating system functions, evaluation of O.S., Different types of O.S.: batch, multi-programmed, time-sharing, real-time, distributed, parallel.
System Structure: Computer system operation, I/O structure, storage structure, storage hierarchy, different types of protections, operating system structure (simple, layered, virtual machine), O/S services, system calls.
Process Management:
Processes: Concept of processes, process scheduling, operations on processes, co-operating processes, interprocess communication.
Threads: overview, benefits of threads, user and kernel threads.
CPU scheduling: scheduling criteria, preemptive & non-preemptive scheduling, scheduling algorithms (FCFS, SJF, RR, priority), algorithm evaluation, multi-processor scheduling.
Process Synchronization: background, critical section problem, critical region, synchronization hardware, classical problems of synchronization, semaphores.
Deadlocks: system model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock.
Storage Management:
Memory Management: background, logical vs. physical address space, swapping, contiguous memory allocation, paging, segmentation, segmentation with paging.
Virtual Memory: background, demand paging, performance, page replacement, page replacement algorithms (FCFS, LRU), allocation of frames, thrashing.
File Systems: file concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, and indexed), and free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance.

I/O Management: I/O hardware, polling, interrupts, DMA, application I/O interface (block and character devices, network devices, clocks and timers, blocking and nonblocking I/O), kernel I/O subsystem (scheduling, buffering, caching, spooling and device reservation, error handling), performance.
Disk Management: Disk structure, disk scheduling (FCFS, SSTF, SCAN,C-SCAN), disk reliability, disk formatting, boot block, bad blocks.
Protection & Security: Goals of protection, domain of protection, security problem, authentication, one time password, program threats, system threats, threat monitoring, encryption.

Text Books:
1. Milenkovie M., "Operating System: Concept & Design", McGraw Hill.
2. Tanenbaum A.S., "Operating System Design & Implementation", Practice Hall NJ.
3. Silbersehatz A. and Peterson J. L., "Operating System Concepts", Wiley.
4. Dhamdhere: Operating System TMH

Reference Books:
1. Stalling, William, "Operating Systems", Maxwell McMillan International Editions, 1992.
2. Dietel H. N., "An Introduction to Operating Systems", Addison Wesley.

MCA–205. Scientific Computing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Definition and sources of errors, solutions of nonlinear equations; Bisection method, Newton's method and its variants, fixed point iterations, convergence analysis; Newton's method for non-linear systems; Finite differences, polynomial interpolation; Numerical integration - Trapezoidal and Simpson's rules, Gaussian quadrature; Initial value problems - Taylor series method, Euler and modified Euler methods, Runge-Kutta methods.
Linear programming, simplex algorithm, Integer programming, Constraint programming, knapsack problem

Reference Books:
1. D. Kincaid and W. Cheney, Numerical Mathematics and Computing, 7th Ed., Cengage, 2013. K. E.
2. Atkinson, Introduction to Numerical Analysis, 2nd Ed., John Wiley, 1989.
3. Rajaraman, Vaidyeswaran. Computer oriented numerical methods. PHI Learning Pvt. Ltd., 2018.
4. F.S. Hillier and G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.
5. An introduction to Optimization by Edwin P K Chong, Stainslaw Zak

MCA–211. Object Oriented Programming Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-202

MCA–212. Database Management Systems Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-203 and MCA-205

MCA–213. Scientific Computing Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-205

MCA–214. Advanced Programming Laboratory-I
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P

Semester-III

MCA–301. Artificial Intelligence
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Introduction – What is AI – Importance of AI – objectives.
Intelligent agents, state space representation, uninformed searches – BFS, DFS, IDS, informed and heuristic searches – Branch & bound, Best first, A* search; Local searches
and optimization, local and global optima, hill climbing, gradient descent, simulated annealing, genetic algorithms, Adversarial Search: Min-Max game tree
Knowledge – Its representation, Organization – Manipulation and Acquisition.
Predicate calculus in AI – First order predicate logic & its use in knowledge representation-Resolution principle. Use of resolution in reasoning and question answering.
Uncertainly Management-Fuzzy logic, Bayesian inferencing, dempster-shafer theory of beliefs, structured representation of knowledge- - Semantic networks, frames, conceptual dependency & scripts. Expert systems-rule based system architecture non-production system architecture-knowledge acquisition methods-Explanation methods-Expert system shells, Application of AI in natural language processing, speech understanding. Computer Vision, planning, etc.

Text Books:
1. Artificial Intelligence, Ritch & Knight, TMH
2. Artificial Intelligence A Modern Approach, Stuart Russel Peter Norvig Pearson
3. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI
4. Poole, Computational Intelligence, OUP
5. Logic & Prolog Programming, Saroj Kaushik, New Age International

Reference Books:
1. Expert Systems, Giarranto, VIKAS
2. Artificial Intelligence, Russel, Pearson

MCA–302. Computer Networks
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Communications: Concepts of data transmission, signal encoding, modulation methods, synchronization, multiplexing and concentration, coding method, cryptography.
Networks: Communication system architecture OSI reference model, topology types, selections, design, local area networks(LAN), CSMA/CD, token bus token ring techniques, link level control(LLC)

protocols, HDLC, analysis of protocols and performance, concepts in network layer, switching techniques, routing methods.
TCP/IP, Session, Presentation and Application Layers function. Data communication fundamentals-signals and communication channels. Baseband communication, modulation and MODEMS. Channel sharing techniques -FDM, TDM, polling and concentration. Error Detection -CRC codes, framing techniques. Stop-and-wait (PAR) protocol with efficiency analysis.
Network structure and architecture-communication subnet and local access. Circuit, message and packet switching. Elementary queuing theory (results only) with network applications. OSI reference model. Local area networks-Ethernet and token ring LANS. Network layer services and functions. Routing techniques. Network access protocols-X.25 and IP.
Important functions of transport, session and presentation layers-TCP and ISO protocols. Network application-file transfer and file servers, electron mail, virtual terminals, and distributed systems.

Text Book:
1. Behrouz A Forouzan, DeAnzaCollegeFirouzMosharraf: Computer Networks: A Top-Down Approach, McGraw Hill Education (India) Private Limited (11 November 2011)
2. Comer D E., Internetworking With TCP/IP Principles, Protocols, And Architecture, PHI (2013)

References Books:
1. Tanenbaum A.S., David J. Wetherall : Computer Network, Pearson; Pearson; 5 edition
2. Stalling W.: Data and Computer Communication, Pearson; Nineth edition (2013)
3. Peterson L L, Davie B S, Computer Networks: A Systems Approach, Morgan Kaufmann Publishers In; 5th Revised edition edition
4. Stevens, UNIX Network Programming, Pearson Education; 1ST edition (2003)

MCA–303. Software Engineering
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Software Engineering – Objectives, Definitions, Software Process models - Waterfall Model, Prototyping, RAD, Evolutionary Models, Incremental, Spiral. Software Project Planning- Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model.
Structured Analysis, Context diagram and DFD, Physical and Logical DFDs, Data Modelling, ER diagrams, Software Requirements Specification
Design Aspects: Top-Down and Bottom-Up design; Decision tree, decision table and structured English, Structure chart, Transform analysis Functional vs. Object- Oriented approach.
UML: Class diagram, interaction diagram: collaboration diagram, sequence diagram, state chart diagram, activity diagram, implementation diagram.
Coding & Documentation – Structured Programming, Modular Programming, Module Relationship-Coupling, Cohesion, OO Programming, Information Hiding, Reuse, System Documentation.
Testing – Levels of Testing, Integration Testing, System Testing.
Software Quality, Quality Assurance, Software Maintenance, Software Configuration Management, Software Architecture.

Text Books:
1. Pressman, R.S., Software Engineering: A Practitioner's Approach, McGraw Hill.
2. Rajib Mall: Fundamentals of Software Engineering, Prentice Hall India Learning Private Limited; Fourth edition (2 April 2014)

Reference Books:
1. Ian Sommerville: Software Engineering, Pearson Education; Nineth edition (2013)
2. Fairley, R.E., Software Engineering Concepts, McGraw Hill Education (India) Private Limited (23 April 2001)

MCA–304. Elective - I
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

MCA–305. Elective - II
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

MCA–306. Elective - III
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

MCA–311. Artificial Intelligence Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P
Lab pertaining to MCA-301

MCA–312. Web-based Programming Laboratory
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P

MCA–313. Advanced Programming Laboratory - II
Full Marks: 100, Weekly Hours: 0 + 0 + 3
Allotted Hrs: 30P

MCA-321. Project-I
Project Work-I

Semester IV

MCA-421. Project-II
Project Work-II

MCA-431. Grand Viva

Elective Papers

Elective: Computer Graphics
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Display Devices : Line and point plotting systems; raster, vector, pixel and plotters, Continual refresh

and storage displays, Digital frame buffer, Plasma panel displays, Very high resolution devices, High-speed drawing, Display processors, Character generators, Colour-display techniques (Shadow-mask and penetration CRT, colour look-up tables. analog false colours, hard-copy colour printers.)
Display Description: Screen co-ordinates, user co-ordinates; Graphical data structures (compressed incremental list, vector list, use of homogeneous co-ordinates); Display code generation; Graphical functions; the view algorithms, two-dimensional transformation.
Interactive Graphics: Pointing and positioning devices (cursor, light pen, digitizing tablet, the mouse, track balls). Interactive graphical techniques; Positioning, Elastic Lines, Inking, Zooming, Panning, Clipping, Windowing, Scissoring.
Graphic Languages: Primitives (constants, actions, operators, variables), plotting and geometric transformations, display subroutines.
3-D Graphics: Wire-frame perspective display, Perspective depth, Projective transformations, Hidden line and surface elimination, transparent solids, Shading. GKS is to be used as the standard teaching tool.

Text Book:
1. Hearn D., Baker P.M. : Computer Graphics, Prentice-Hall, 1986.
2. James D. Foley, Andries van Dam, Steven K. Feiner and John HughesComputer Graphics: Principles and Practice, Addison-Wesley Professional; 3rd edition.

Reference Books:
1. Akenine-Moller, Tomas, Eric Haines and Naty Hoffman. Real-Time Rendering. 3rd ed. A K Peters/CRC Press, 2008

Elective: Pattern Recognitions
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Introduction - Definitions, data sets for Pattern Recognition
Different Paradigms of Pattern Recognition
Representations of Patterns and Classes
Metric and non-metric proximity measures
Feature extraction, Different approaches to Feature Selection
Nearest Neighbor Classifier and variants
Efficient algorithms for nearest neighbour classification
Different Approaches to Prototype Selection
Bayes Classifier, Decision Trees, Linear Discriminant Function
Different Approaches to Prototype Selection, Bayes Classifier
Decision Trees, Linear Discriminant Function
Support Vector Machines, Clustering, Clustering Large datasets, Combination of Classifiers, Applications - Document Recognition.

Text Books:
1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000.

Reference Books:
1. Pattern Recognition Paperback by Narasimha Murthy and Susheela Devi
2. Pattern Recognition and Machine Learning (Information Science and Statistics) by Christopher Bishop

Elective: Soft Computing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction: Introduction to soft computing; introduction to biological and artificial neural network; introduction to fuzzy sets and fuzzy logic systems.
Introduction to Genetic Algorithm, Genetic Operators and Parameters, Genetic Algorithms in Problem Solving, Theoretical Foundations of Genetic Algorithms, Implementation Issues.
Artificial neural networks and applications: Different artificial neural network models; learning in artificial neural networks; neural network applications in control systems. Neural Nets and applications of Neural Network.
Fuzzy systems and applications: fuzzy sets; fuzzy reasoning; fuzzy inference systems; fuzzy control; fuzzy clustering; applications of fuzzy systems.
Neuro-fuzzy systems: neuro-fuzzy modeling; neuro-fuzzy control.
Applications: Pattern Recognitions, Image Processing, Biological Sequence Alignment and Drug Design, Robotics and Sensors, Information Retrieval Systems, Share Market Analysis, Natural Language Processing.

Text Books:

1. M. Mitchell: An Introduction to Genetic Algorithms, Prentice-Hall.
2. J.S.R.Jang, C.T.Sun and E.Mizutani: Neuro-Fuzzy and Soft Computing, PHI, Pearson Education.
3. Timothy J.Ross: Fuzzy Logic with Engineering Applications, McGraw-Hill.
4. Davis E.Goldberg: Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley.

Reference Books:

1. S. Rajasekaran and G.A.V.Pai: Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI.
2. D. E. Goldberg: Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley.

Elective: Advanced DBMS
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Distributed DBMS features and needs. Reference architecture. Levels of distribution transparency, replication. Distributed database design –fragmentation, allocation criteria. Storage mechanisms. Translation of global queries. / Global query optimization. Query execution and access plan. Concurrency control – 2 phases locks. Distributed deadlocks. Time based and quorum based protocols. Comparison. Reliability- non-blocking commitment protocols. Partitioned networks. Checkpoints and cold starts.
Management of distributed transactions- 2 phase unit protocols. Architectural aspects. Node and link failure recoveries. Distributed data dictionary management. Distributed database administration. Heterogeneous databases-federated database, reference architecture, loosely and tightly coupled. Alternative architecture. Development tasks, Operation- global task management. Client server databases -SQL server, open database connectivity. Constructing an application.

Text Books:

1. Database System Concepts, SilberschatzKorth, Sudarshan, MH
2. Database Management Systems,Ramakrishnan, MH
3. Beginning SQL Server 2000 programming, Dewson,SPD/WROX

Reference Books:

1. Database Management Systems, Leon, VIKAS
2. My SQL: Enterprise Solutions, AlexenderPachev, Wiley Dreamtech

Elective: Embedded System Design
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction: Characteristics of embedded systems; Applications; Concept of real time systems; Challenges in embedded system design.

Embedded Processors: Review of structure of a basic computer system: CPU, memory, I/O devices on a bus; Memory System Mechanisms – Caches, Memory Management Units and Address Translation; I/O subsystem – input and output devices, busy-wait I/O, interrupt driven I/O; Interrupts – Basics, interrupt latency; Co-processors; Processor Performance Enhancement-Pipelining, Superscalar execution, caching.

The Embedded Computing Platform: Board Buses – Bus Arbitration and Timing; The CPU Bus; Memory Devices and their Characteristics – Random-Access memories, Read-Only memories; I/O devices – Timers and Counters, Watchdog timers, GPIO, A/D, D/A, Displays, Keyboards; Component Interfacing – Memory interfacing, device interfacing, interfacing protocols; Designing with processors – System architecture, Hardware design; Target Devices-FPGA, CPLD.

Embedded Software Architectures: Round-Robin; Round-Robin with Interrupts; FunctionQueue-Scheduling Architectures; Real-Time Operating System Architecture; Selecting an Architecture.

Real-time operating systems: Tasks and Task States; Tasks and Data; Context Switching-Cooperative multitasking, Preemptive multitasking; Scheduling Policies-Rate-Monotonic scheduling, Earliest-Deadline-First scheduling, RMS versus EDF; Semaphores and Shared Data; Message Queues; Timer Functions; Events; Memory Management; Priority Inversion; Interrupt Routines in an RTOS Environment.

Low-power computing: Sources of energy consumption: toggling, leakage – Instruction-level nstrategies for power-management: functional unit management - Memory system power consumption: caches, off-chip memory - Power consumption with multiple processes – Systemlevel power management: deterministic, probabilistic methods.

Hardware Accelerators: CPUs and Accelerators – Why Accelerators, Accelerator Design; Accelerated System Design – Performance Analysis, System Architecture Framework, Partitioning, Scheduling and Allocation, System Integration and Debugging. Networked embedded systems: Why networked embedded systems - Example networked embedded systems: automobiles, factory automation systems - Types of network fabrics - Network performance analysis - Internet-enabled embedded systems.

Design and Development of Embedded Systems: Creating an Embedded System Architecture; Implementing the Design - Embedded Software Development Tools, Host and Target Machines, Linker/Loader for Embedded Software, Getting Embedded Software into Target System, Debugging Techniques and Tools, Testing on the host machine, instruction set simulators, oscilloscopes, logic analyzers, in-circuit emulators, monitors, System Boot-Up; Quality
Assurance and Testing of the Design.

Text Books:

1.Frank Vahid, Tony Givargis: Embedded System Design: A Unified Hardware/Software Introduction, Wiley; Student edition (21 July 2006)
2. Mazidi M. Ali , Mazidi J. G., and Rolin McKinlay, The 8051 Microcontroller and Embedded Systems; Pearson; Second edition (2008)

Reference Books :

1. Wayne Wolf, Computers as Components: Principles of Embedded Computing System

Design, Morgan Kaufmann; 2 edition (June 16, 2008)
2. David E. Simon, Embedded Software Primer,, Addison-Wesley Professional; 1 edition (August 15, 1999)
3. Raj Kamal: Embedded Systems ; McGraw-Hill Education (India); 2nd Edition (March 9, 2009)

Elective: Simulation & Modeling
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Elective: Mobile Computing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction, enabling concepts for mobile and personal communications. Terminal mobility, personal mobility and service mobility. The Intelligent Networks (IN) concept: Mobile and personal communication: Past, Present & Future some related network aspects.
Mobile computing Architecture: History of computers, History of internet, Internet – The ubiquitous Network Architecture for mobile computing, Three tier Architecture, Design considerations for mobile computing, Mobile computing through Internet, Making existing applications mobile enabled.
The cellular concept and its initial implementations: The cellular concept, Multiple access technologies for cellular systems, Cellular system operation and planning (General principles, System Architecture, Location updating and call setup), Handoff and power control. Initial implementations of the cellular concept: The AMPS system, TACS system, NMT system, NTT system, concluding remarks.
Digital cellular mobile systems: Introduction, GSM : The European TDMA digital cellular standard, GSM standardization and service aspects GSM reference architecture and function partitioning, GSM radio aspects, Security aspects, GSM protocol model, Typical call
flow sequences in GSM, Evolutionary directions for GSM IS-136 : The North American TDMA digital cellular standard(D-AMPS), Background on North American digital cellular, Service aspects of D-AMPS(IS-136), Network reference, Radio aspects, Security aspects, Protocol model and typical flow sequences, Evolutionary directions

Text Book:

1. Mobile Communications by Jochen Schiller, 2nd Edition, Pearson Education Limited
2. Mobile and Personal Communication systems and services, Raj Pandya, Prentice Hall of India, 2001.

Reference Books: 1

1. T. S. Rappaport: Wireless Communications: Principles and Practice, 2nd Edition, PHI
2. Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic: Mobile Ad Hoc Networking: The Cutting Edge Directions, Wiley-IEEE Press; 2 edition (March 4, 2013)

Elective: Parallel Processing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction to Parallel Processing, Parallelism in sequential Mechanics, Abstract
Model, Multiprocessor architecture, Architecture classifications and Techniques. Pipelining, Arithmetic and Instruction Pipelines, Pipelining Hazard. Interconnection Networks, Hyper cubes, Shuffle Exchanges, Trees, Meshes and
Butterfly networks, parallel Algorithm for, linear Algebra, Matrix Multiplication,
Solving linear systems, probabilistic algorithm, and possibility of super linear speedup, Sorting, Vector and Array Processors. 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 Parallel Programming Languages – FORTRAN 90 (Introduction)
Characterization of Distributed Systems – Introduction, 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.

Text Books:
1. Scientific Computing, An introduction with parallel computing: Gene Golub/James M.Ortega
2. Introduction to parallel processing: M Sasi kumar, Dinesh S., P. Ravi Prakesh: PHI, 2002.

Reference Books:
1. Parallel Computing, Quinn,TMH
2. Introduction to Parallel Processing, Sashi Kumar,PHI
3. Parallel Programming, Wilkinson, Pearson
4. Elements of Parallel Computing, Rajaraman,PHI
5. Fundamentals of Parallel Processing, Jordan, PHI
6. Advanced Computer Architecture, Hwang, TMH

Elective: IoT and Sensor Networks
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Introduction to Sensor networks in smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security, IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, hardware, Data representation and visualization, Interaction and remote control.
Exemplary Device Board, Linux on Raspberry, Interface and Programming & IoT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases
Industrial Automation-Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation
Applications: Smart Grid &IoT, Healthcare, Industry automation, Commercial building automation using IoT, Smart cities, recent trends in sensor network and IoT architecture.

Books:
1. Mandler, B., Barja, J., MitreCampista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publication

2. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things by Pearson Paperback – 16 Aug 2017 ,by Hanes David (Author), Salgueiro Gonzalo (Author), Grossetete Patrick (Author), Barton Rob (Author

Elective: Digital Image Processing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction: Digital Image representation; Fundamental steps in Image processing, Elements of digital Image processing systems.
Digital Image Fundamentals: Sampling and quantization, imaging geometry.
Image Transforms: Fourier, Walsh, Hademord, discrete cosine and Hotelling transforms and their properties.
Image Enhancement: Enhancement by point processing, spatial filtering, Frequency domain enhancement, Color image processing.
Image Restoration: Unconstrained and constraint restoring, inverse filtering, Wiener Filter, Geometric transforms.
Image Compression: Image Compression models, Error-free compression, Lossy compression, Image compression standards.
Image Segmentation: Detection of discontinuities, edge linking, Thresholding.
Representations and Descriptions: Chain codes, shape numbers, moments and Fourier and other descriptors. Recognition & Interpretations.

Text Book:

1. Digital Image Processing, Gonzalves,Pearson
2. Digital Image Processing, Jahne, Springer India
3. Digital Image Processing &Analysis,Chanda&Majumder,PHI
4. Fundamentals of Digital Image Processing, Jain, PHI

References Books:

1. Image Processing, Analysis & Machine Vision, Sonka, VIKAS
2. Getting Started with GIS- Clarke Keith. C; PE.
3. Concepts & Techniques of GIS - Lo C.P, Albert, Yeung K.W- PHI.

Elective: Managerial Economics
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

The Fundamentals of Managerial Economics: Goals and Constraints The Nature and Importance of Profits Understanding Incentives Economic rationality,Scarcity and opportunity cost Marginal and IncrementalAnalysis Basic Calculus: The Calculus of Optimization.
Theory of Demand:
Demand and Supply Market Equilibrium Price Ceilings and Price Floors Comparative Statics: Changes in Demand and Supply. Price Elasticity of Demand Price Elasticity, Total Revenue, and Marginal Revenue Factors Affecting Price Elasticity Cross Price Elasticity. Income Elasticity of Demand Other Elasticities, Elasticities for Nonlinear Demand Functions. Elasticity of Supply Demand Forecasting Choice and Utility Theory Law of Diminishing marginal utility Consumer Equilibrium Indifference curve Analysis Consumer Surplus Price effect, Substitution Effect and Income Effect.
Theory of Production and Cost:
The Production Function Profit-Maximizing Input Usage. Isoquants and Isocosts Cost Minimization and Optimal Input Substitution. The Cost Function Breakeven analysis, Contribution analysis Long-run Costs and Economies of Scale Multiple Cost Functions and Economies of Scope. Learning curve.
Theory of Market and pricing:

The Nature of Industry Perfect Competition Monopoly Monopolistic Competition Oligopoly Game theory Product pricing.

Text Books:
1. YogeshMaheswari, Managerial Economics, Phi Learning, Newdelhi, 2005 Gupta G.S.
2. Managerial Economics, Tata Mcgraw-Hill, New Delhi Moyer &Harris.

Reference Books:
1. Anagerial Economics, Cengage Learning, Newdelhi, 2005 Geetika, Ghosh & Choudhury, ,
2. Managerial Economics, Tata Mcgrawhill, Newdelhi, 2011

Elective: Computational Geometry
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Preliminaries: Basic Euclidean geometry
Grids and Hulls: Fixed-radius near neighbors, convex hull algorithms, dominance and applications.
Linear Programming: Half-plane intersection and randomized LP, backwards analysis, applications of low-dimensional LP.
Intersections and Triangulation: Plane-sweep line segment intersection, triangulation of monotone subdivisions, plane-sweep triangulation of simple polygons.
Point Location: Kirkpatrick's method, trapezoidal decompositions and analysis, history DAGs.
Voronoi Diagrams: Basic definitions and properties, Fortune's algorithm.
Geometric Data Structures: kd-trees, range trees and range searching, segment trees.
Delaunay Triangulations: Point set triangulations, basic definition and properties, randomize incremental algorithm and analysis.
Arrangements and Duality: Point/line duality, incremental construction of arrangements and the zone-theorem, applications.
Geometric Approximation: Dudley's theorem and applications, well-separated pair decompositions and geometric spanners, VC dimension, epsilon-nets and epsilon-approximations,
Geometric Retrieval: kd-trees, range trees, hereditary segment trees, nearest neighbor searching.

Text Books:
1. M. de Berg, M. Van Kreveld, M. Overmars, and O. Schwarzkopf, Computational Geometry: Algorithms and Applications (3rd Edition), Springer, 2008.
2. F. Preparata and M. Shamos, Computational Geometry, Springer-Verlag, 1985.
3. K. Mulmuley, Computational Geometry: An Introduction Trough Randomized Algorithms, Prentice-Hall, 1994.
4. J. O'Rourke, Computational Geometry in C, 2nd ed., Cambridge Univ. Press, 1998.

Reference Books:
1. K. Mulmuley, Computational Geometry: An Introduction Through Randomized Algorithms, Prentice Hall, 1994.
2. T. Cormen, et.al., Introduction to Algorithms, 2nd ed., MIT Press, 2001.
3. J. O'Rourke, Art Gallery Theorems and Algorithms, Oxford Univ. Press, 1987.
4. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge Univ. Press, 1995.

Elective: Data Warehousing and Data Mining
Full Marks: 100, Weekly Hours: 3 + 1 + 0

Allotted Hrs: 40L

Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Classification and Prediction: - Issues Regarding Classification and Prediction – Nearest Neighbour Classification - Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification –Support Vector Machines – Associative Classification –Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Mining Object, Spatial, Multimedia, Text and Web Data:

Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Books:

1. Reema Thareja, “Data Warehousing”, Oxford University Press.
2. Jiawei Han and Micheline Kamber, “Data Mining Concepts & Techniques”, Elsevier Pub.
3. Margret H. Dunham “Data Mining: Introductory and Advanced topics” Pearson Education
4. Paulraj Ponniah, “Data Warehousing Fundamentals”, John Wiley & Sons, Inc.
5. Vikram Pudi, P. Radha Krishana “Data Mining”, Oxford University press.

Elective: Distributed Computing

Full Marks: 100, Weekly Hours: 3 + 1 + 0

Allotted Hrs: 40L

Fundamentals: Evolution of Distributed Computing Systems, System models, issues in design of Distributed Systems, Distributed computing environment, web based distributed model, computer networks related to distributed systems and web based protocols.

Message Passing: Inter process Communication, Desirable Features of Good Message-Passing Systems, Issues in IPC by Message, Synchronization, Buffering, Multidatagram Messages, Encoding and Decoding of Message Data, Process Addressing, Failure Handling, Group Communication.

Remote Procedure Calls: The RPC Model, Transparency of RPC, Implementing RPC Mechanism, Stub Generation, RPC Messages, Marshaling Arguments and Results, Server Management, Communication Protocols for RPCs, Complicated RPCs, Client-Server Binding, Exception Handling, Security, Some Special Types of RPCs, Lightweight RPC, Optimization for Better Performance.

Distributed Shared Memory: Design and Implementation issues of DSM, Granularity, Structure of Shared memory Space, Consistency Models, replacement Strategy, Thrashing, Other Approaches to DSM, Advantages of DSM.

Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Election Algorithms.

Resource and Process Management:

Desirable Features of a good global scheduling algorithm, Task assignment approach, Load Balancing approach, Load Sharing Approach, Process Migration, Threads, Processor allocation, Real time distributed Systems.
Distributed File Systems: Desirable Features of a good Distributed File Systems, File Models, File Accessing Models, File-shearing Semantics, Filecaching Schemes, File Replication, Fault Tolerance, Design Principles, Sun's network file system, Andrews file system, comparison of NFS and AFS.
Naming: Desirable Features of a Good Naming System, Fundamental Terminologies and Concepts, Systems-Oriented Names, Name caches, Naming & security, DCE directory services.
Case Studies Mach & Chorus (Keep case studies as tutorial)

Books:
1. Distributed OS by Pradeep K. Sinha (PHI)
2. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair: Distributed SystemsConcepts and Design, Addison Wesley; 5 edition

Reference Books:
1. Tanenbaum S.: Distributed Operating Systems, Pearson Education
2. Tanenbaum S. Maarten V.S.: Distributed Systems Principles and Paradigms, (Pearson Education)

Elective: Graph Algorithms
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
PageRank algorithm. DFS, BFS, Tarjan's algorithm for strongly connected components. Representation of graphs.
Maze and river network simulation via invasion percolation case study. Minimum spanning trees, Prim-Dijkstra-Jarnik algorithm, Boruvka's algorithm, Kruskal's algorithm.
DAGs and topological ordering.
Road map path planning case study. Shortest paths, relaxation algorithms, Dijkstra's algorithm, Bellman-Ford algorithm, Johnson's algorithm.
A* algorithm, Euclidean distance based distance estimation, landmark-based distance estimation.
Transportation scheduling case study. Euler tours. Travelling salesman problem.
Exponential-time dynamic programming for the TSP, approximation algorithms and the approximation ratio, MST-doubling heuristic, Christofides' heuristic.
Baseball elimination case study. Maximum flow problem, minimum cut problem, max-flow min-cut theorem, augmenting path (Ford-Fulkerson) algorithm.
Medical school residency assignment case study. Matchings, stable marriage, Gale-Shapley algorithm for stable marriage.
Bipartite graphs, formulating bipartite maximum matching as a flow problem, Hopcroft–Karp algorithm.
Using matchings to find vertex covers and independent sets, partition into a minimum number of rectangles.
Graph coloring, greedy coloring, interval graphs, and perfect graphs.
Chordal graphs and using Lexicographic breadth-first search to find an elimination ordering.
Cliques, Moon-Moser bound on maximal cliques, Bron-Kerbosch algorithm.
Planar graphs; review of planarity-related topics from earlier weeks (graph drawing, road maps, invasion percolation via minimum spanning trees of grid graphs, graph coloring and the four-color theorem).
Duality, duality of Euler tours and bipartiteness, Euler's formula, greedy 6-coloring, Boruvka in linear time. Planarity testing, and Fáry's theorem.

Text Books:
1. Introduction to Graph Theory (Dover Books on Mathematics) 2nd Edition by Richard J. Trudeau.

2. Graphs, Algorithms, and Optimization (Discrete Mathematics and Its Applications) by William Kocay and Donald L. Kreher.

Reference Books:
1. Algorithm Design 1st Edition, by Jon Kleinberg and ÉvaTardos
2. The textbook Algorithms, 4th Edition by Robert Sedgewick and Kevin Wayne

Elective: VLSI Designing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Review of Microelectronics and Introduction to MOS Technologies: MOS, CMOS, BiCMOS Technology. Basic Electrical Properties of MOS, CMOS &BiCMOS Circuits: Ids – Vds relationships, Threshold Voltage VT, Gm, Gds and ωo, Pass Transistor, MOS, CMOS & Bi CMOS Inverters, Zpu/Zpd, MOS Transistor circuit model, Latch-up in CMOS circuits.
Layout Design and Tools: Transistor structures, Wires and Vias, Scalable Design rules, Layout Design tools. Logic Gates & Layouts: Static Complementary Gates, Switch Logic, Alternative Gate circuits, Low power gates, Resistive and Inductive interconnect delays.
Combinational Logic Networks: Layouts, Simulation, Network delay, Interconnect design, Power optimization, Switch logic networks, Gate and Network testing.
Sequential Systems: Memory cells and Arrays, Clocking disciplines, Design, Power optimization, Design validation and testing.
Floor Planning: Floor planning methods, Global Interconnect, Floor Plan Design, Off-chip connections.

Text Book:
1. Essentials of VLSI Circuits and Systems, K. EshraghianEshraghian. D, A. Pucknell, 2005, PHI.
2. Modern VLSI Design – Wayne Wolf, 3rd Ed., 1997, Pearson Education.

Reference Books:
1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
2. Principals of CMOS VLSI Design – N.H.E Weste, K. Eshraghian, 2nd Ed., Addison Wesley.

Elective: Numerical & Statistical Computing
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Prerequisite: A Good Knowledge of Linear Algebra and Calculus.
Floating – Point Representation of Number with Finite Precision and Its Consequences. Concepts of Truncation and Round-Off Errors. Roots of Equation: Iterative Methods, Bisection Methods, False Position Method, Newton-Raphson Method, Solution of Polynomial Equation, Solution of Simultaneous Linear Equation. Gaussian Elimination, Pivoting, Ill Conditioning, Gauss-Siedel Iterative Methods, Comparison of Direct and Iterative Methods. Interpolation: Finite Differences, Polynomial Interpolation, Spline Interpolation. Differentiation & Integration: Differentiation by Polynomial Fit, Trapezoidal and Simpson Rules, Gaussian Quadrature. Numerical Solution Of Ordinary Differential Equations: Solution by Taylor Series, Euler's Method, Predictor Corrector Method, Rungi-Kutta Method. Statistical Methods: Sampling, Frequency Distribution. Measures of Central Tendency and Dispersion, Moments, Discrete.
Distribution Binomial and Poisson Distribution, Regression Analysis/Curve Fitting, Correlation Co-Efficient, Multiple, Partial and Rank Correlations, Tests of Significance- X Test, T-Test and F-Test.

Text Books:
1. R. L. Burden and J. D. Faires: Numerical Analysis, Cengage Learning India; 09 edition 2012

Reference Books:
1. David Kincaid & Ward Cheney : Numerical Analysis, American Mathematical Society; Third edition (2010)
2. J. Stoer and R. Bulirsch : Introduction To Numerical Analysis , Springer (sie) (2009)

Elective: Advanced Data Structures
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Complexity of algorithms: worst case, average case, and amortized complexity. Algorithm analysis techniques, Amortized Analysis, Garbage collection, Analysis of Quick sort, Fibonacci Heaps, van Emde Boas Trees, Multithreaded Algorithms, Number Theoretic Algorithms, Strings and String Matching Algorithms, Computational Geometry, Lower Bound Theory – NP Completeness, Approximation Algorithms. Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B+ -trees, Application of trees; Graphs - Representations, Breadth-first and Depth-first Search.

Text Books:
1. A.V. Aho, J.E. Hopcroft, and J.D. Ullman, Data Structures and Algorithms, Addison Wesley, Reading Massachusetts, USA, 1983.
2. Donald Knuth. The Art of Computer Programming: Fundamental Algorithms, Third Edition. Addison-Wesley, 1997. ISBN 0-201-89683-4
3. Donald Knuth. The Art of Computer Programming Volume 3: Sorting and Searching, Third Edition. Addison-Wesley, 1997. ISBN 0-201-89685-0.

Reference Books:
1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to Algorithms, Third Edition. MIT Press and PHI, 2010.
2. Samet, Hanan, Foundations of multidimensional and metric data structures. Morgan Kaufmann, 2006, ISBN 978-0-12-369446-1.
3. Dinesh Mehta and SartajSahni Handbook of Data Structures and Applications, Chapman and Hall/CRC Press, 2007.
4. M.A. Weiss, Data Structures and Algorithms Analysis in C++, Benjamin/Cummins, Redwood City, California, USA, 1994

Elective: Network Programming
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Introduction to networking and Internet protocols via programming and hands-on labs.
TCP/IP protocol architecture; user datagram protocol (UDP); multicasting; transmission control protocol (TCP); standard Internet services, and protocol usage by common Internet applications.
Sockets programming; client/server; peer-to-peer; Internet addressing; TCP sockets; UDP sockets; raw sockets. Multithreading and exception handling. Finger, DNS, HTTP, and ping clients and servers.
Routers and architectures, routing protocols.

Router and switch configurations, Internet operating systems. Internetwork setup, network topology, wireless internetworking.
Network protocol analyzers; traffic generation.

Text Books:
1. Stevens, UNIX Network Programming, Pearson Education; 1ST edition (2003)
2. Behrouz A Forouzan, De Anza College Firouz Mosharraf: Computer Networks: A Top-Down Approach, McGraw Hill Education (India) Private Limited (11 November 2011)

Reference Books:
1. Comer D E., Internetworking With TCP/IP Principles, Protocols, And Architecture, PHI (2013)
2. Stalling W.: Data and Computer Communication, Pearson; Nineth edition (2013)

Elective: Remote Sensing & GIS Applications
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Introduction: Sun and atmosphere, Remote Sensing a historical perspective.
Electromagnetic Radiations: EM radiators, polarization, attenuation.
Thermal radiations, EM for remote sensing.
Fundamental of Radiometry.
Physical Basics of Signatures: Signature OIR, TIR & Microware Region
Remote Sensor: Classifications of Sensors, Sensor parameters.
Resolution- Spatial & Spectral
Optical, Microwave Sensors
Platform: Principle of Sattelite Motion, Types of orbit, Orbit perturbations.
GPS – Data Products: Dataformats, data product generation output media
Date analysis: Visual analysis, Digital Classifications
Application of Remote Sensing: Agriculture, Forestry, Land Cover Studies
Water Resource, Earth System Science
Geographical Interaction System Application.

Text Books:
1. Peter Burrough, Rachael A. McDonnell, Principles of Geographical Information Systems, OUP Oxford; 3rd edition (2015)
2. Marble D F and Calcins, H. W. , Basic Readings in Geographic Information System. Spad Systems Ltd.

Refrence Books:
1. Burrough, P. A., Principles of GIS for land Resource Assesment, Oxford publications
2. Jeffery Star and John Estates, Geographic Information Systems, an Introductory, Prentice Hall Inc.

Elective: Network Security
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and

Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks.
Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC.
Public key cryptography principles, public key cryptography algorithms, digital signatures, digital Certificates, Certificate Authority and key management Kerberos, X.509 Directory Authentication Service.
Email privacy: Pretty Good Privacy (PGP) and S/MIME.
IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.
Web Security Requirements, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET).
Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3. Intruders, Viruses and related threats.
Firewall Design principles, Trusted Systems. Intrusion Detection Systems.

Text Books:
1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.
2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn IdoDubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech

Reference Books:
1. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning.
2. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
3. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
4. Principles of Information Security, Whitman, Cengage Learning.

Elective: Real Time Systems
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
REVIEW OF OPERATING SYSTEMS
Basic Principles – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Operating System structures.
DISTRIBUTED OPERATING SYSTEMS
Topology – Network types – Communication – RPC – Client server model – Distributed file system – Design strategies.
REAL TIME MODELS AND LANGUAGES
Event Based – Process Based and Graph based Models – Petrinet Models – Real Time Languages – RTOS Tasks –RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.
REAL TIME KERNEL
Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and study of RTOS VX works and COS – Case studies.
RTOS APPLICATION DOMAINS
RTOS for Image Processing – Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications

– RTOS for Control Systems.

TEXT BOOKS:
1. Tanenbaum, "Distributed Operating Systems", Pearson Education.
2. Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", PHI 1999.

REFERENCE BOOKS
1. Charles Crowley, "Operating Systems-A Design Oriented approach", McGraw Hill 1997.
2. C.M. Krishna, Kang, G.Shin, "Real Time Systems", McGraw Hill, 1997.

Elective: Multicriteria Decision Making
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Different Multicriteria Decision Making (MCDM) algorithms for Big Data Analysis, Importance, Features, Case-based Studies, TOPSIS, Cognitive Map, VIKOR, SEM, Entropy, Fuzzy cognitive map etc. Applications in Retail, Supply Chain, Logistic Sector using MCDM approaches. Optimization in Routing, Behavioral, Model formulation in Decision making problems based on Data Sciences.
Real-life Applications – Multi-Echelon Supply Chain, railway management, Environment Concerning consumer behavior.

Electives: Computer Communication Principles
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Amplitude and Frequency Modulation – their generation and detection Bandwidth requirements Low Power and High
Modulators and Modulated amplifiers. Superheterodyne detection. Signal to Noise ratio of A.M. and P.M. transmission.
A/D, D/A Converters. Shannon's sampling Theorem. PAM, PWM, PPM and PCM. Their generation and detection.
Digital Modulation: ASK, FSK, PSK performance evaluation. Time Division Multiplexing and Demultiplexing.
Modems, Error control and coding, Channel capacity.
Data Transmission Synchronization, Data protection, error detection and correlation.
Elements of Satellite Communication tracking and control.

Text Books:
1. Taub H. and Shilling D. L., "Principles of Communication Systems", 2/e,TMH
2. Carlson R. B., "Communication Systems, 4/e, Mc.Graw Hill
3. Lathi B. P., "Communication Systems", John Wiley.

Reference Books:
1. Kennedy—Electronic Communication Systems, 4/e , TMH
2. Haykin S. S., "An Introduction to Analog and Digital Communication Systems", Wiley Eastern.

Elective: Managerial Accounting
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Financial Accounting – An Introduction: Introduction , Meaning of Accountancy, book-keeping and

Accounting , Accounting Process, Objectives for accounting , Differences between book-keeping and accounting Users of accounting information , Limitations of Accounting , Basic terminologies

Accounting Concepts, Principles, Bases and Policies: Introduction , Accounting Concepts, Principles, Policies and Standards, Types of accounting concepts - Business Separate entity concept - Going concern concept - Money measurement concept - Periodicity concept - Accrual concept, Accounting Principles - Principle of Income recognition - Principle of expense - Principle of matching cost and revenue - Principle of Historical costs - Principle of full disclosure - Double aspect principle - Modifying Principle - Principle of materiality - Principle of consistency - Principle of conservatism or prudence, Accounting Policies - Changes in Accounting Policies - Disclosure in case of changes in Accounting Policies, Accounting Standards - Scope and functions of Accounting Standards Board - International Financial Reporting System

Double Entry Accounting: Introduction , Meaning of double entry accounting, Classification of accounts under Traditional approach, Classification of accounts under Accounting Equation approach, Comparison of traditional approach with Modern approach equal approach, Accounting Trail , Transactions and events , Meaning and roles of debit and credit , Accounting equation

Secondary Books: Introduction , Secondary books , Purchases Book/Purchases Day book - Cash discount, Trade discount - Difference between cash discount and trade discount, Sales Book or Sales Day book - Purchase Returns Book - Sales Returns Book, Bills receivable book - Bills payable book - Cash book , Posting to Ledger accounts Posting to Ledger

Trial Balance: Introduction , Meaning , Objectives of preparing a trial balance , Methods of preparing a trial balance, Preparation of Trial balance, Adjusting Entries , Errors and their rectification, Errors disclosed by Trial Balance , Errors not disclosed by Trial Balance , Steps to locate the errors

Final Accounts: Introduction , Adjustments before preparing final accounts , Depreciation , Bad Debts and accounting treatment of bad debts , Provision for doubtful debts , Reserves for Discount on Debtors , Reserve for Discount on Creditors , Closing Stock, Trading Account , Profit and Loss Account, Balance Sheet

Introduction to Management Accounting: Introduction, Meaning of Management accounting ,The Role of Management Accounting , Management Accounting Framework , Functions of Management Accounting ,Tools of Management Accounting ,The Balanced Scorecard , Cost Management System , Value Added Concept , Merits of Management Accounting , Demerits of Management Accounting , Distinction between Management Accounting and Financial Accounting

Financial Statement Analysis: Introduction , Meaning of Ratio , Steps in Ratio Analysis, Classification of Ratios , Du Pont Chart , Solved Problems , Advantages of Ratio Analysis, Limitation of Ratio analysis

Funds Flow Analysis: Introduction, Meaning of Funds Flow Statement, Ascertainment of flow of funds, Technique of preparing funds flow statement, Schedule of Changes in Working Capital, Adjusted Profit and Loss account, Funds Flow Statement
Cash Flow Analysis: Introduction, Meaning of Cash Flow Statement, Purpose of Cash Flow Statement , Preparation of Cash Flow Statement, Format of Cash Flow Statement (AS3: Revised Method) , Cash Flow from Operating Activities , Cash Flow Statement under Direct Method , Different between Cash Flow Analysis and Fund Flow Analysis, Uses of Cash Flow Statement

Understanding Cost: Introduction, Meaning of Cost, Objective of Costing, Methods of Costing,

Technique of Costing, Classification of Cost, Elements of Cost, Statement of Cost Sheet, Solved Problems

Marginal Costing and Break Even Analysis: Introduction , Concept of Marginal Costing , Characteristics of Marginal Costing , Difference between Absorption Costing and Marginal Costing , Marginal Cost, Contribution , Cost Volume Profit (CVP) Analysis , Break Even Chart , Break Even Point, Profit Volume ratio or MCSR , Target profit , Margin of Safety , Application of Marginal cost , Limitations of Marginal cost, Solved Problems

Decisions Involving Alternative Choices: Introduction, Decision Making, Types of Costs, Types of Choices Decisions, Make or Buy Decisions, Addition / Discontinuance of a Product line, Sell or Process Further, Operate or Shut down, Exploring New Markets, Maintaining a desired level of profit

Budgetary Control: Introduction , Meaning of a Budget , Budgetary control , Objectives of budgetary control, Merits of budgetary control, Essential features of Budgetary Control , Steps in budgetary Control , Types of Budgets , Cast Budget , Flexible Budget , Limitation of Budget Control

Standard Costing: Introduction , Definition of Standard Costing, Meaning, Difference between Standard cost and Budgetary Control, Establishment of standards, Variance analysis, Material cost variance, Material price variance, Material usage variance , Material Mix variance, Material Yield variance, Direct labor variance, Labor Efficiency Variance, Labor Rate variance, Labor mix variance, Labor Yield Variance

Text Books:
1. Managerial Accounting, ISV (WSE) Paperback – 2012 by James Jiambalvo
2. Managerial Accounting 5th Edition by John Wild and Ken Shaw

Reference Books:
1. Managerial Accounting, 14th Edition 14th Edition by Ray Garrison (Author), Eric Noreen (Author), Peter Brewer
2. Managerial Accounting, 2nd Edition, RamjiBalakrishnan

Elective: Formal Language and Automata Theory
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction: Symbols, Strings, Alphabets and Languages. Set Properties. Kleen's Star. Chomsky Hierarchy.

Regular Language and Finite Automata: Introduction to Finite Automata. DFA definition and construction. NFA definition and construction. DFA vs NFA. Conversion. Introduction to regular language and expression. Closure Properties. Pumping Lemma. Construction of automata from regular expression and vice versa. DFA reduction. Regular grammar.

Context Free Language and Push Down Automata: Definition and construction of PDA. DPDA vs NPDA. Context Free Language and Grammar. Closure properties. Parse trees and Ambiguity. Reduction. Normal Forms.

Context Sensitive Language and Linear Bounded Automata: Introduction and Definition.

Turing Machine: Unbounded Languages. Introduction to Turing Machine. Definition and construction of Turing Machine. Single and Multi-tape TM. Parameter theorem, Diagonalisation, Reducibility, Rice's Theorem and its applications. Church Turing Thesis. Universal Turing Machine. Halting

Problem.
Overview of Computational Complexity and Different Complexity Classes**.**

Text Books:
1. Peter Linz. "An Introduction to Formal Languages and Automata". Narosa.
2. Hoperoft, Aho, Ullman, "Introduction to Automata theory, Language & Computation" 3rd Edition.Pearson Education. 2006

Reference Books:
1.Daniel I.A.Cohen, "Introduction to computer theory". John Wiley,1996
2. Lewis & Papadimitriou, "Elements of the theory of Computation". PHI 1997.
3. N. J. Cutland: "Computability: An Introduction to Recursive Function Theory", Cambridge University Press, London, 1980.

Elective: Compiler Design
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
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
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.
Basic Parsing Techniques: Top-Down parsers with backtracking, Recursive Descent Parsers, Predictive Parsers, No recursive Predictive Parsers, Bottom–up Parsers, Shift-Reduce Parsing, Operator Precedence Parsers, LR parsers. YACC, Syntax Directed Definitions, Type checking.

Text Books:
1. Alfred V Aho , Jeffrey D. Ullman: "Principles of Compiler Design", Narosa Publ. House.
2. A.V. Aho, R. Sethi and J.D Ullman: "Compiler: principle, Techniques and Tools", Addison Wesley.

Reference Books:
1. *Compiler Construction: Principles and Practice*, Kenneth C. Louden, PWS Publishing, 1997, ISBN 0-534-93972-4.
2. Tremblay and Sorenson: "The theory and Practice of Compiler Writing" – McGraw Hill.

Elective: E-Commerce
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Computer Systems in Electronic Business
Business Process Re-Engineering
Electronic commerce Policy and Theory
Supply Chain Management
Customer Relationship Management

International trading network & communication protocols
Electronic payment standards
E-Commerce strategy, Marketing and Business Processes.

Text Books:
1. E-Commerce & managerial Perspective,Joseph,PHI
2. E Commerce, Rayport, TMH

Reference Books:
1. E Commerce, Diwan& Sharma, EXCEL
2. Creating & winning E-Business, Napier,VIKAS

Elective: Values & professional Ethics
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Science, Technology and Engineering as Knowledge and as Social and Professional Activities.
Effects of Technological Growth:
Rapid Technological growth and depletion of resources. Reports of the Club of Rome. Limits to growth; sustainable development. Energy Crisis; Renewable Energy Resources.
Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations. Environmental Ethics. Appropriate Technology Movement of Schumacher: later developments. Technology and developing nations.
Problems of Technology transfer. Technology assessment/ impact analysis; Industrial hazards and safety, safety regulations safety engineering. Politics and technology, authorization versus democratic control of technology; Human Operator in Engineering projects and industries. Problems of man machine interaction. Impact of assembly line and automation. Human centred Technology.
Ethics of Profession:Engineering profession: Ethical issues in engineering practice. Conflicts between business demands and professional ideals. Social and ethical Responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond.
Case studies: Profession and Human Values, Value Crisis in contemporary society. Nature of values: Value Spectrum of a 'good' life Psychological values: Integrated personality; mental health. Societal values: The modern search for a 'good' society, justice, democracy, secularism, rule of law; values in Indian Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgments; canons of ethics; Ethics of virtue; ethics of duty; ethics of responsibility. Work ethics, professional ethics.

Text Books:
1. Blending the best of the East & West, Dr. Subir Chowdhury, EXCEL
2. Ethics& Mgmt. & Indian Ethos, Ghosh, VIKAS
3. BusinessEthics,Pherwani,EPH

Reference Books:
1. Ethics,Indian Ethos & Mgmt., Balachandran,Raja,Nair, Shroff Publishers
2. Business Ethics: concept and cases, Velasquez, Pearson

Elective: Cloud Computing

Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction to cloud computing – Overview of Computing, Cloud Computing NIST Model, Properties, characteristics and disadvantages, role of open standards.
Cloud computing architecture – cloud computing stack, service Models (XaaS), IaaS, Paas, SaaS, Daas, Deployment Models, private, public, hybrid, commercial cloud models.
Service management in Cloud computing – service level agreement (SLA), SLA violation, cloud economics.
Resource management in cloud computing – resource sharing, scalability, elasticity, transparency.
Data management in cloud computing – looking at data scalability and cloud services, database and data stores in cloud, large scale data processing
Cloud security – infrastructure security, data security and storage, identity and access management, access control, trust, reputation risk
Cloud simulators – CloudSim, CloudAnalyst, MultiRecCloudSim, CloudSimPlus, GreenCloudSimulator
Research trend in Cloud compting, green cloud computing, fog computing

Text Books:

1. Cloud Computing Bible by Barrie Sosinsky, Wiley India Pvt. Ltd, 2013
2. Mastering Cloud Computing by RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, McGraw Hill
3. Education (India) Private Limited, 2013

Reference Books:

1. Cloud computing: A practical approach, Anthony T. Velte, Tata Mcgraw-Hill
2. Cloud Computing, Miller, Pearson
3. Building applications in cloud:Concept, Patterns and Projects, Moyer, Pearson

Elective: Computational Biology
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction to molecular biology, cell, chromosome, DNA, RNA, proteins, Central Dogma, protein structures, computational biology and bioinformatics tasks;
Sequence databases,sequence comparison, sequence alignment, local and global sequence alignment, multiple sequence alignment, web tools for sequence comparisons;
Sequencing, genome sequencing, fragment assembly, next-generation sequencing, handling errors in sequencing, gene finding, promoter identification, sequence-based protein classification;
Protein structures, structure prediction from sequence, motif finding, structure alignment, structure-based protein classification, molecular design and docking;
Phylogeny analysis, phylogenetic tree construction algorithms, parsimony and distance-based techniques;
Gene expression analysis, microarray, microarray analysis, differential expression, microarray clustering, biclustering, classification, gene marker prediction, gene selection, gene ordering, gene prioritization, gene significance analysis, gene co-expression, differential co-expression;
Biological networks, protein-protein interactions, gene regulatory networks, metabolic networks, network analysis and prediction, systems biology;
Biological databases, sequence databases, gene/protein databases, protein structure/domain databases, microarray gene expression databases, protein-protein interaction databases, gene regulatory network

databases, metabolic network databases.

Text Books:

1. Carlos Setubal and Joao Meidanis, “Introduction to Computational Molecular Biology”, Brooks/Cole.

Reference Books:

1. Molecular Cell Biology by Daid Baltimar
2. Aurther M. Lesk, Introduction to Bioinformatics, Oxford University Press, 4th edition (2014)
3. Dan E. Krane and Michael L. Raymer, Fundamental Concepts of Bioinformatics Krane and Raymer, DORLING KINDERSLEY (RS); First edition (2003)
4. David Mount : Bioinformatics: Sequence and Genome Analysis, CBS; 2 edition (2005)

Elective: Big Data Analytics
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction, Dawn of the Big Data Era, Definition and Features of Big Data, Big Data Value, The Development of Big Data, Challenges of Big Data, Big Data and its importance, Drivers, Big data analytics, Storage System for Massive Data, Distributed Storage System, Storage Mechanism for Big Data - Database Technology, Design Factors, Database Programming Model

Traditional Data Analysis, Big Data Analytic Methods, Architecture for Big Data Analysis - Real-Time vs. Offline Analysis, Analysis at Different Levels, Analysis with Different Complexity, Tools for Big Data Mining and Analysis.

Data Storage and Analysis, Comparison with Other Systems, A Brief History of Hadoop, Apache Hadoop and the Hadoop Ecosystem, Analyzing the Data with Unix Tools, Analyzing the Data with Hadoop(MapReduce, Java MapReduce), Scaling Out, Hadoop Streaming, Hadoop Pipes, Task trackers, Hadoop Configuration, NoSQL Data Management, Hadoop with R and Python, Introduction to Apache Spark, Hadoop vs Spark, Map-reduce using Spark, Big Data tools and techniques, Pig and Hive.

Applications of big data analytics in healthcare, transportation, finance and banking, IoT and sensor networks, social networks, NLP, smart cities etc.

Books:

1. Boris lublinsky, Kevin T. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, ISBN: 9788126551071, 2015.
2. Chris Eaton, Dirk Deroos et al. “Understanding Big data”, McGraw Hill, 2012.
3. Tom White, “HADOOP: The definitive Guide”, O Reilly 2012.
4. Karau, Holden, et al. *Learning spark: lightning-fast big data analysis*. " O'Reilly Media, Inc.", 2015.
5. Prajapati, Vignesh. *Big data analytics with R and Hadoop*. Packt Publishing Ltd, 2013.

Elective: Blockchain Technology
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L

Introduction of Cryptography and Blockchain: What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

BitCoin and Cryptocurrency: What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain And Digital Currency, Transactional Blocks, Impact

Of Blockchain Technology On Cryptocurrency.
Introduction to Ethereum: What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What's a Transaction?, Smart Contracts.
Introduction to Hyperledger: What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer.
Solidity Programming:
Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Enum, address)
Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

Reference Books:
1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2. Antonopoulos, Mastering Bitcoin.
3. Antonopoulos and G. Wood, Mastering Ethereum.
4. D. Drescher, Blockchain Basics. Apress, 2017.

Elective: Machine Learning
Full Marks: 100, Weekly Hours: 3 + 1 + 0
Allotted Hrs: 40L
Advanced clustering methods, variants of K-means, BIRCH, DBSCAN, Expectation-Maximization, Cluster Evaluation Techniques – Internal and External, clustering ensemble.
Linear Discriminant Analysis, Support Vector Machine, Naïve Bayes, Gradient Descent, Class Evaluation Measures, Overfitting, Bias Variance Trade-off Precision, Recall, F1 Score, ROC, AUC, Validation Strategies.
Neural Network, LTU, Perceptron, MLP, Activation Function, Loss Functions, Optimizers, Momentum Adadelta, RMSProp, Adam, Early Stopping, drop-out, Batch Normalization; Word Embedding, CboW, Skip-gram, Glove, ElMo, CNN, RNN, LSTM, GRU, Encoder-Decoder Network, Transfer, Auto Encoder, Generative Adversarial Network; Ensemble Methods - Bagging, Committee Machines and Stacking, Ensemble Methods – Boosting, Gradient Boosting; Undirected Graphical Models, Markov Chains, Random walk Monte Carlo, HMM, Variable elimination, belief propagation, Introduction to Reinforcement Learning, Sampling-based techniques, Q Learning, Introduction to XAI, Lime, SHAP etc. Learning from online streaming data, Machine Learning Applications.

Books:
1. Machine Learning, Tom Mitchell, McGraw Hill, 1997.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Second Edition. Feb 2009. Trevor Hastie, Robert Tibshirani, Jerome Friedman.
3. Introduction to Machine Learning, third edition. Ethem Alpaydin. The MIT Press. September 2014: ISBN: 978-0-262-028189