Sidho-Kanho-Birsha University, Purulia

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Department of Computer Science

Syllabus for M.Sc. in Computer Science

with effect from the academic session 2020-21

Semester I

I. Principle of Programming Languages (Procedural, Functional, Logic, Object oriented)

II. Advanced Operating System (network, distributed, real-time, cloud)

III. Design and Analysis of Algorithms

IV. Mathematical Foundations (Statistical techniques, statistical inferences, linear algebra, tensor, optimization techniques)

V. Operating system Lab (Network OS, multi thread prog, Open source cloud)

VI. Programming & Algorithm Analysis Lab (java, python, functional programming)

Semester II

I. Formal Languages & Automata Theory

II. ADBMS (distributed, data warehouse, data----as per NET)

III. Advanced Computer Networks (fog, cloud, edge, sensor, wireless)

IV. Information Security (coding theory, cryptography, crypto analysis)

V. Network Lab

VI. Database Lab

Semester III

I. Compiler Design

II. Artificial Intelligence

III. Open Elective---- fixed

IV. Major Elective-I

V. AI Lab

VI. Compiler Design Lab

Semester IV

I. Data Analytics (statistical analysis, optimization, neural network, regression, mining, machine learning,)

II. Advanced Software Design (object oriented, uml, testing, verification, quality analysis)

III. Major Elective – II

IV. Major Elective – III

V. Add on Course--- Data Analytics/Advanced Software Design

VI. Major Project

VII. Seminar and Grand Viva

ELECTIVES:

Group-I: Data Science

Machine Learning, Deep Learning, Computer Vision & Pattern Recognition, Business Intelligence, Soft Computing

Group-II: Cyber Security

Network Security, Digital Forensic, Post Quantum Cryptography, Hardware Security, Cyber Law

Group-III: Distributed System & Resources

Cloud Computing, IOT, Service Oriented Computing, Semantic Web, Multimedia Systems & Database

	Paper Code	Paper Title	Credits	Marks
SEM- I	MCSTCC101	Programming Languages	4	40+10
	MCSTCC102	Advance Operating systems	4	40+10
	MCSTCC103	Design and analysis of Algorithms	4	40+10
	MCSTCC104	Mathematical foundations	4	40+10
	MCSTCS105	Programming & algorithm analysis Lab	4	50
	MCSTCS106	Operating system Lab	4	50

(10 Marks: Internal Assessment**, 40 Marks:** Term Examination**)**

Curriculum Semester I

Paper Code – **MCSTCC101** Paper Name – **Programming Languages**		Credit: **4** Full Marks: **40+10**
Module	**Topics**	**Lecture Hours**
Language Design and Translation Issues	Programming Language Concepts, Paradigms and Models	
Programming Environments	Binding and scope, Programming, Language Syntax and semantics, Stages in Translation, Formal Transition Models. Compilers, Interpreters, Interactive development tools, Debugging tools, variables, data abstraction,	
Memory management	Static & dynamic allocation, control structures, selective structures. Modular programming, function, parameter passing methods, lifetime of variables, recursion, error handling.	
Elementary Data Types	Properties of Types and Objects; Scalar and Composite Data Types.	

Programming Languages	Object oriented-programming, Event driven programming, Exception handling, Concurrent programming, Foundations of functional programming: λ-calculus, type checking, Logic programming, Scripting languages	
Object Oriented Programming using python	Characteristics of object oriented programming, Classes and Objects, Methods. Operator Overloading, super () and Method Overriding, abstraction, inheritance, polymorphism, Design Principles for object oriented programming,	

Textbook: 1. R. Sebesta, Concepts of Programming Languages, Addison Wesley

References:

2. John C Mitchell, Concepts in Programming Languages, Cambridge University Press, 2003.

3. Ravi Sethi, Programming Languages, Addison Wesley, 1996.

4. Van Roy, Haridi, Concepts, Techniques and Models of Computer Programming, MIT Press, 2004

5. Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India

6.Bruce Eckel-Thinking in Java, 4th Edn.

7.

Paper Code – **MCSCCT102** Paper Name – **Advance Operating systems**		Credit: **4** Full Marks: **40+10**
Module	Topics	**Lecture Hours**

Distributed Systems	Characteristics of distributed System: Examples of distributed systems –issues in the design of distributed system. System models: Architectural models and fundamental models. Distributed objects and remote invocation: communication between distributed objects – remote procedure call – Events and notification. Operating system support: Operating system layer – protection – processes and threads communication and invocation – Operating system architecture security: Overview of security techniques	20
Distributed file system	File service architecture - network file system- Andrew file system-recent advances Transactions and concurrency control: nested transactions-locks-optimistic concurrency controlcomparison of methods for concurrency control-flat and nested distributed transactions-distributed deadlockstransactions recovery. Replication System model and group communication- fault tolerant services-transactions with replicated data	16
Real-Time	Real-time process concepts, categories of real-time task, real-time scheduling,	10
Networks		8
Cloud Computing	Overview, Introduction to service and service oriented architecture, Layers and types of cloud service model, Uses of Cloud; Components of Cloud Computing - Software as a Service, Platform as a Service, Infrastructure as a Service, Identity as a Service; Data storage and virtualization in the cloud	6

Textbook: 1. George Coulouris, Jean Dollimore and Tim Kindberg, Distributed Systems: Concepts and Design - Pearson Education

References: 2. Andrew S Tanenbaum and Marten Van Steen, Distributed Systems: Principles and paradigms – Pearson Education

3. Venkatakrishnaŋl, Principles of Grid Computing – Concepts And Applications, Ane Books

4. Kris Jamsa, Cloud Computing, Jones &Bartlett Learning.

5. Rahul Deva &GarimaKulshreshtha, Soft Computing, Shrof Publishers & Distributors Pvt.Ltd.

6. Rajkumar Buya and etal, Cloud Computing – Principles And Paradigms, Wiley Publishers.

Paper Code – **MCSCCT103** Paper Name – **Design and Analysis of Algorithms**		Credit: **4** Full Marks: **40+10**
Module	**Topics**	**Lecture Hours**
Algorithms	Properties of good algorithms, Efficiency of algorithms, Time and Space complexity. Non-linear data structures: trees, Binary search tree- algorithms on BST, balanced trees- AVL rotations, multi-way search trees- B Tree, B+ tree. Basic concepts of Red-Black tree, splay tree, tries	15
String Processing	KMP, Boyre-Moore, Rabin Karp algorithms.	4
Introduction to randomized algorithms	Random numbers, randomized quick sort, randomly built binary search tree.	3
Number Theoretic Algorithms	GCD, addition and multiplication of two large numbers, polynomial arithmetic, Fast-Fourier transforms.	3
Advanced Techniques to analyze algorithms	Use and study advanced data structures unionfind (Disjoint Set Structure), Fibonacci heaps.	3
Graph algorithms	Matching and Flows, Graph capture	5
Parallel algorithms	Basic techniques for sorting, searching and merging in parallel.	15
Geometric algorithms	Point location, Convex hulls and Voronoi diagrams.	8
Complexity Theory	P and NP Class Problems; NP-completeness and Reducibility.	4

Textbook: 1.T.H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein Introduction to Algorithms,

PHI, 3rd Edition 2009

References: 2. Sarabasse& A.V. Gelder, Computer Algorithm – Introduction to Design and Analysis, Publisher,Pearson 3rd Edition 199

3. Jon Kleinberg and Eva Tardos, Algorithm Design, Pearson New International Edition.

4. Aho, J. Hopcroft and J. Ullman: The Design and Analysis of Computer Algorithms, A. W. L,

International Student Edition, Singapore, 1998.

5. S. Baase: Computer Algorithms: Introduction to Design and Analysis, 2nd ed., Addison-Wesley, California, 1988.

6. E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub. /Pitman, New Delhi/London, 1987/1978

Paper Code – **MCSCCT104** Paper Name – **Mathematical Foundations**		Credit: **4** Full Marks: **40+10**
Module	**Topics**	**Lecture Hours**
Mathematical Logic	Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers. Concepts of descriptive logic. Rules of Inference.	7
Probability and Statistics	Discrete probability, simple random variables, the law of large numbers, Binomial, Poisson and normal distributions, central limit theorem, Non-uniform probability distributions, Bayes' Theorem on conditional probability. Importance of random sampling, sampling distributions (Normal, t-distribution, chi-square distribution, F-distribution, ANOVA); statistical inferencing. Rejection method, Metropolis algorithm, random variables, expectations and moments, Stochastic process, Markov model	25
Sets and Relations	Permutation Functions, Growth of Functions. Partially ordered sets, Lattices, Finite Boolean algebra.	5
Counting Mathematical Induction	Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion-Exclusion principle, Pigeonhole Principle, Mathematical Induction.	3
Algebraic structures	Semigroups, Monoids, Groups, Subgroups, Symmetric groups, Groups homomorphism and isomorphism, Cosets	6

	and Lagrange's Theorem, Normal subgroups, Permutation of groups and Burnsides theorem. Boolean Functions and its Representation, Simplifications of Boolean Functions.	
Graph Theory	Basic Concept of Graph Theory, Euler Paths and Circuits, Hamiltonian Paths and Circuits, Spanning tree.	5
Optimization Technics	Linear Programming Problems - Mathematical Model, Graphical Solution, Simplex and Dual Simplex Method, Sensitivity Analysis. Integer Programming, Transportation and Assignment Models. PERT-CPM: Diagram Representation, Critical Path Calculations, Resource Levelling, Cost Consideration in Project Scheduling. Introduction to nonlinear programming problems	10

References:

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Application to computer science [Tata McGraw –Hill]

2. Bernard Kolman c,Busby & Sharon Ross, Discrete Mathematical Structures

3. N. L. Biggs: Discrete Mathematics, Oxford Science Publications.

4. 4.W. Feller, W: An Introduction to Probability Theory and its Applications, Vol.1, John Wiley.

5. G. R. Grimmett and D. R. Stirzaker: Probability and Random Processes, Oxford Science Publications.

6. J. Nesetril, J. Matousek: Invitation to Discrete Mathematics, Clarendon Press.

7. Grassmann, Logic and Discrete Mathematics: A Computer Science Perspective, Pearson Education, 2007.

Paper Code – **MCSCCS105** Paper Name – **Programming & Algorithm Analysis Lab**		Credit: **4** Full Marks: **50**
Module	**Topics**	**Lab Hours**
Python Programming	Running Python Programs and User Interaction, Variables and Expressions, Data Types in Python, Advanced Data Types (List, Set, Tuples, related operations, Dictionary)	
Conditional expressions and Loops	Conditional Expressions, Loops, Nested Loops, Exception Handling	
Functions, Recursions	Syntax and Basics of a Function, Use of a function, Parameters and Arguments, Return statement, Local and Global Scope Scope of a Variable, Recursive functions	
File Handling	Need of File Handling, Reading/Writing Text and Numbers to/from a File, Directories on a disk.	
Modules and packages	Understanding and Creating Python modules and packages for modular programming, NumPy, Pandas, MatPlotLib, and NLTK	
Object Oriented Programing	Classes and Objects, Methods. Operator Overloading, Inheritance, super () and Method Overriding.	
Programming using Python	• Function definitions: pattern matching, induction • Basic data types, tuples, lists • Higher order functions • Polymorphism • Reduction as computation, lazy evaluation • Measuring computational complexity • Basic algorithms: sorting, backtracking, dynamic programming • User-defined datatypes: enumerated, recursive and	

	polymorphic types • Input/output	
Design and Analysis of Algorithms Lab	1) i. Implement Insertion Sort (The program should report the number of comparisons) ii. Implement Merge Sort(The program should report the number of comparisons) 2. Implement Heap Sort(The program should report the number of comparisons) 3. Implement Randomized Quick sort (The program should report the number of comparisons) 4. Implement Radix Sort 5. Create a Red-Black Tree and perform following operations on it: i. Insert a node ii. Delete a node iii. Search for a number & also report the color of the node containing this number. 6. Write a program to determine the LCS of two given sequences 7. Implement Breadth-First Search in a graph 8. Implement Depth-First Search in a graph 9. Write a program to determine the minimum spanning tree of a graph	
Textbook: 1. Jupyter Notes Manual.... **References: 2.**		

3.

Paper Code – **MCSCCS106** Paper Name – **Operating System Lab**		Credit: **4** Full Marks: **50**
Module	**Topics**	**Lab Hours**
Distributed System		
Open source cloud		
Multi-threaded programming		
Network operating system		
Textbook: 1. **References: 2.** **3.**		

Semester 2

Paper 201: Formal Languages and Automata Theory

Mathematical Preliminaries for Finite Automata and Formal Languages:
Sets, Relations and Functions, Graphs and Trees, Mathematical Induction, Mathematical Logic, Formal Language, Chomsky Hierarchy Languages (CHL), Automata Theory

Regular Expressions and Regular Languages:
Regular Expressions, Regular Languages and Regular Grammar

Finite State Automata:
Deterministic Finite Automata, Non-Deterministic Finite Automata, NFA and Regular Expressions, Conversion of Finite Automata to Regular Expression, Conversion of NFA to DFA, NFA with e-Transitions (e-NFA), Conversion from e-NFA to NFA, Conversion from e-NFA to DFA, Output Associated with Finite Automata, Moore and Mealy Machines, Minimization of Automata

Properties of Regular Languages:
Regular sets, regular expressions, identity rules, Constructing finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Pumping lemma of regular sets, closure properties of regular sets (proofs not required).

Grammar Formalism: Regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and FA, inter conversion, Context free grammar, derivation trees, sentential forms. Right most and leftmost derivation of strings.

Context Free Grammars: Ambiguity in context free grammars. Minimisation of Context Free Grammars. Chomsky normal form, Greiback normal form, Pumping Lemma for Context Free Languages. Enumeration of properties of CFL (proofs omitted).

Push Down Automata: Push down automata, definition, model, acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence. Equivalence of CFL and PDA, interconversion. (Proofs not required). Introduction to DCFL and DPDA.

Turing Machines:
Turing Machine, definition, model, design of TM, Computable functions, recursively enumerable languages. Church's hypothesis, counter machine, types of Turing machines (proofs not required).

Computability Theory: Chomsky hierarchy of languages, linear bounded automata and context sensitive language, LR(0) grammar, decidability of, problems, Universal Turing Machine, undecidability of posts. Correspondence problem, Turing reducibility, Definition of P and NP problems, NP complete and NP hard problems.

References

- "Introduction to Automata Theory Languages and Computation". Hopcroft H.E. and Ullman J. D.Pearson Education
- Introduction to Theory of Computation –Sipser 2nd edition Thomson
- Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
- Introduction to languages and the Theory of Computation ,John C Martin, TMH
- "Elements of Theory of Computation", Lewis H.P. &Papadimition C.H. Pearson/PHI.
- Theory of Computer Science – Automata languages and computation -Mishra andChandrashekaran, 2nd edition, PHI

Paper 202: Advanced DBMS (distributed dbms, recovery management, data warehouse, data mining, no-SQL, follow NET syllabus)

Database System Concepts and Architecture: Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; Centralized and Client/Server Architectures for DBMS. (4)

Data Modeling: Relational Schemas, Update Operations and Dealing with Constraint Violations; Relational Algebra and Relational Calculus; Codd Rules. (8)

SQL: Views, Stored Procedures and Functions; Database Triggers, SQL Injection. (8)

Normalization and Transactional Management: Functional Dependencies and Normalization; Algorithms for Query Processing and Optimization; Transaction Processing, Concurrency Control Techniques, Database Recovery Techniques, Object and Object-Relational Databases; Concepts of ACID and CAP theory, Database Security and Authorization. Transactions, Recovery, System Recovery, Media Recovery, Two-phase Commit. (14)

Enhanced Data Models: Temporal Database Concepts, No SQL databases- document oriented models, key-value models, columnar data models, graph data model, Multimedia Databases, Deductive Databases, link data managenent. (10)

Distributed Database: Distributed Database System, Distributed Database Design, Data Fragmentation, Data Replication, Data Allocation, Query Processing in Distributed Databases. (8)

Data Warehousing: Data Modeling for Data Warehouses, Concept Hierarchy, OLAP and OLTP. (4)

Big Data Systems: Big Data Characteristics, Types of Big Data, Big Data Architecture, Introduction to Map-Reduce and Hadoop; Distributed File System, HDFS. (4)

References

- Ceri S. Pelagatti. G, ***Distributed Database systems Principles and Systems***, McGraw Hill.
- Silberschatz, Korth, ***Database System Concepts***, TMH
- Elmasri & Navathe, ***Fundamental of Data Base System***, The Benjamin Cummins Publishing Inc.
- Silberschatz, Korth and Sudarshan, ***Database System Concepts – 6th Edition***
- C.J. Date, ***Database Design and Relational Theory: Normal Forms and All That Jazz***
-

Paper 3: Advanced Computer Networks
(Distributed networks, IOT, fog, cloud, wireless sensor networks, internet working, ssl)

Data Communication: Components of a Data Communication System, Digital and Analog Transmission; Data Encoding and Modulation Techniques; Broadband and Baseband Transmission; Multiplexing, Transmission Media, Transmission Errors, Error Handling Mechanisms. (8)

Network Models: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Physical, Logical, Port and Specific Addresses; Switching Techniques. (6)

Functions of OSI and TCP/IP Layers: Framing, Error Detection and Correction; Flow and Error Control; Sliding Window Protocol, HDLC, Multiple Access – CSMA/CD, CSMA/CA, Reservation, Polling, Token Passing, FDMA, CDMA, TDMA, Network Devices, Backbone Networks, Virtual LANs.

IPv4 Structure and Address Space; Classful and Classless Addressing; Datagram, Fragmentation and Checksum; IPv6 Packet Format, Mapping Logical to Physical Address (ARP), Direct and Indirect Network Layer Delivery; Routing Algorithms, TCP, UDP and SCTP Protocols; Flow Control, Error Control and Congestion Control in TCP and SCTP. (20)

Internetworking: Switch/Hub, Bridge, Router, Gateways, Concatenated virtual circuits, Tunnelling, Fragmentation. **(8)**

Network Security: Malwares, Cryptography and Steganography; Secret-Key Algorithms, Public-Key Algorithms, Digital Signature, Virtual Private Networks, Firewalls, Mechanisms of TLS, SSL, IPSec. (16)

Adhoc Networks: Mobile Adhoc Networks, P2P network, Wireless Transmission and Wireless LANs, semantic sensor networks. (8)

Cloud Computing and IoT: SaaS, PaaS, IaaS, Public and Private Cloud; Virtualization, Virtual Server, Cloud Storage, Database Storage, Resource Management, Service Level Agreement, Basics of IoT.

References

- Data and Computer Communication, William Stallings. Prentice Hall of India.
- Computer Networks — Andrew S Tanenbaum, 4th Edition. Pearson Education/PHI
- Data Communications and Networking – Behrouz A. Forouzan, Third Edition TMH.
- An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education
- Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson COMPUTE

Paper 4: Information and Coding Theory

Models for Information Channel: Discrete Memoryless Channel, Binary Symmetric Channel (BSC), Burst Channel. Bit-error rates. Probability, Entropy and Shannon's measure of information. Mutual information. Channel capacity theorem. Rate and optimality of Information transmission. (10)

Variable Length Codes: Prefix Codes, Huffmann Codes, Lempel-Ziev (LZ) Codes. Optimality of these codes. Information content of these codes, Vcoder. (8)

Error Correcting and Detecting Codes: Finite fields, Hamming distance, Bounds of codes, Linear (Parity Check) codes, Parity check matrix, Generator matrix, Decoding of linear codes, Hamming codes, decoder, BCH. (12)

Cryptography: Concepts and Techniques, symmetric and asymmetric key cryptography, steganography, Symmetric key Ciphers: DES structure, DES Analysis,

Security of DES, variants of DES, Block cipher modes of operation, AES structure, Analysis of AES, Key distribution Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Analysis of RSA, Diffie-Hellman Key exchange. (10)

Message Authentication and Hash Functions: Authentication requirements and functions, MAC and Hash Funtions, MAC Algorithms, MD5: Secure Hash Algorithm, Whirlpool, HMAC, Digital signatures, X.509, Kerberos, IPSec, Secure Socket Layer(SSL), Transport Layer Security(TLS) (10)

Introduction to Cryptoanalysis: Linear Cryptanalysis, Differential Cryptanalysis, Cryptanalysis of DLP (5)

Recent trends in security: IOT, Biometric, Visual Cryptography. (5)

Text Books:

- Principles of Information Security : Michael E. Whitman, Herbert J. Mattord, CENGAGE Learning, 4th Edition.
- Cryptography and Network Security : William Stallings, Pearson Education,4th Edition
- Cryptography and Network Security : Forouzan Mukhopadhyay, Mc Graw Hill, 2nd Edition
- Atul Kahate, Cryptography and Network Security, McGraw Hill
- Kaufman, c., Perlman, R., and Speciner, M., Network Security, Private Communication in a public world, 2nd ed., Prentice Hall PTR., 2002
- Stallings, W.,.Cryptography and Network Security: Principles and Practice, 3rd ed., Prentice Hall PTR., 2003
- Stallings, W. Network security Essentials: Applications and standards, Prentice Hall, 2000
- Cryptography and Network Security; McGraw Hill; Behrouz A Forouzan
- Information Security Intelligence Cryptographic Principles andApp. Calabrese Thomson
- D. P. Nagpal, Information Security, S. Chand Complany Limited

Paper 5: Network Lab

Problems and assignments related to Paper 3.

Paper 6: Database Lab

Problems and assignments related to Paper 2.