UNIVERSITY OF CALCUTTA

Notification No. CSR/ 107 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 06.12.2018 (vide Item No.16) approved the revised syllabi of

a. M.Sc. in Computer and Information Science under Choice Based Credit System (CBCS), and,

b. B.Tech. in Computer Science and Engineering ,

under this University as laid down in the accompanying pamphlet.

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 13th December, 2018

(Dr. Soumitra Sarkar)
Registrar (Officiating)

Minutes of the Meeting held on 22/11/18

EMERGENCY BOS MEETING HELD ON 22.11.18 AT 2PM IN ROOM 209, UNIVERSITY OF CALCUTTA, TECHNOLOGY CAMPUS, JD BLOCK, KOLKATA-700106

In the meeting, the following decisions have been taken :

1. **The name of the course is to be modified as Master of Science (M.Sc.) in Computer Science instead of M. Sc. in Computer & Information Science.**
2. In CISM103 (Advances in Database Management) a module of 'Data Warehouse' is to be incorporated.
3. The Paper name of CISM304 should be 'Cryptography & Network Security ' instead of 'Network Security' and necessary modules are to be incorporated in the details.
4. There will be some changes in CISM103 (Advances in Data Structure).
5. ' Introduction to Soft Computing' will be introduced as a compulsory paper instead of 'Internet Technology' and 'Internet Technology' will be treated as an elective paper
6. 'Theory of Computations' and 'Compiler Design' are two separate papers with some necessary modifications.
7. The distribution of marks in Project(Minor) and Project(Major) are as follows:
   i. In the 3rd Semester **Project** (Minor) break up with marks allocation is as follows :
      a) Literature Review and Problem Formulation : 30 marks
      b) Report Writing: 10 marks
      c) Presentation & Viva-Voce: 10 marks
   ii. In the 4th Semester **Project** (Major) break up with marks allocation is as follows:
      a) Methodology: 80 marks
      b) Evaluation/Implementation: 40 marks
      c) Documentation/Report Writing with plagiarism checking: 30 marks
      d) Presentation & Viva-Voce: 50 marks
8. The paper codes will be prefixed by CSM instead of CISM.
9. Considering all the suggested changes and necessary modifications, the following detailed syllabus (attached herewith) for M.Sc. in Computer Science has been framed
10. The numeric grade point as specified in point 21 (e) of CSR/89/18 should be an integer number since letter grade specifies a band of marks not the individual.

Grading and marking system will be followed as :

% of Marks (M)*	Letter Grade	Grade Point (GP)
$M \geq 90$	O (Outstanding)	10
$80 \leq M < 90$	A+ (Excellent)	09
$70 \leq M < 80$	A (Very Good)	08
$60 \leq M < 70$	B+ (Good)	07
$50 \leq M < 60$	B (Above Average)	06
$41 \leq M < 50$	C+ (Average)	05
$M = 40$	P (Pass)	04
$M < 40$	F (Fail)	00
Absent	Ab	00

instead of

% of Marks (M)*	Letter Grade	Grade Point (GP)
$M \geq 90$	O (Outstanding)	$09 \leq GP \leq 10$
$80 \leq M < 90$	A+ (Excellent)	$08 \leq GP < 09$
$70 \leq M < 80$	A (Very Good)	$07 \leq GP < 08$
$60 \leq M < 70$	B+ (Good)	$06 \leq GP < 07$
$55 \leq M < 60$	B (Above Average)	$5.5 \leq GP < 06$
$50 \leq M < 55$	C+ (Average)	$05 \leq GP < 5.5$
$40 < M < 50$	C (Below Average)	$04 < GP < 05$
$M = 40$	P (Pass)	$GP = 04$
$M < 40$	F (Fail)	00
Absent	Ab	00

UNIVERSITY OF CALCUTTA
Faculty of Science
Syllabus for Master of Science (M.Sc.)
COMPUTER SCIENCE
Effective from 2018-2019
CSR No.: CSR/107/18.a. Dated 13.12.2018

FIRST SEMESTER				
THEORETICAL	**PAPER NAME**	**MID-SEMESTER / SESSIONAL**	**END-SEMESTER**	**CREDIT**
CSM101	ADVANCES IN COMPUTER ARCHITECTURE	30	70	4
CSM102	ADVANCES IN DATABASE MANAGEMENT SYSTEM	30	70	4
CSM103	ADVANCES IN DATA STRUCTURE	30	70	4
CSM104	DATA COMMUNICATION	30	70	4
PRACTICAL				4
CSM105(P)	MODULE 1: DATA STRUCTURE MODULE 2: DATABASE MANAGEMENT SYSTEM	60	40	4
SECOND SEMESTER				
THEORETICAL				
CSM201	COMPUTER NETWORKS	30	70	4
CSM202	DESIGN AND ANALYSIS OF ALGORITHMS	30	70	4
CSM203	OBJECT ORIENTED SYSTEMS	30	70	4
CSM204	SOFTWARE ENGINEERING	30	70	4
PRACTICAL				
CSM 205(P)	MODULE 1: OBJECT ORIENTED PROGRAMMING MODULE 2: SOFTWARE ENGINEERING	60	40	4
THIRD SEMESTER				
THEORETICAL				
CSM301	INTRODUCTION TO SOFT COMPUTING	30	70	4
CSM302	ADVANCES IN OPERATING SYSTEM	30	70	4
CSM303	CBCS A: THEORY OF COMPUTATION	30	70	4
CSM304	CBCS B: CRYPTOGRAPHY & NETWORK SECURITY	30	70	4
PRACTICAL				
CSM305(P)	MODULE 1: SOFT COMPUTING		25	4
	MODULE 2: OPERATING SYSTEM		25	
CSM306(P)	PROJECT WORK (MINOR)	40	10	
FOURTH SEMESTER				
THEORETICAL				
CSM401	ELECTIVE I	30	70	4
CSM402	ELECTIVE II	30	70	4
PRACTICAL				
CSM403(P)	SEMINAR		50	2
CSM404(P)	GRAND VIVA-VOCE		50	2
CSM405(P)	PROJECT WORK (MAJOR)	150	50	8

SET OF ELECTIVE PAPERS

Elective-I:

1. Cloud Computing
2. Wireless Sensor network
3. VLSI Design
4. Compiler Design
5. Embedded System

Elective-II:

1. Introduction to Data Science
2. Image Processing
3. Internet Technology
4. Introduction to Data Mining
5. Statistics for Computer Science

Paper Code – CSM101 **Paper Name – Advances in Computer Architecture**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Computer Architecture & Organization. Basic Parallel Processing Architecture, Taxonomy- SISD. MISD, SIMD, MIMD structures, Serial, Parallel & Concurrent Computation, CISC vs RISC, Structure of Instruction of instruction sets and Desirable Attributes.	6
Module-2: **Pipelining**	Basic Concepts of pipelining, Instruction Pipelining. Hazards, Reservation Tables, Collision, Latency, Dynamic pipeline, Vector processing & Vector processors.	6
Module-3: **Memory Systems**	Cache Memory & Virtual Memory: Structure, Analysis & Design.	4
Module-4: **I/O Systems**	Design Issues, Performances Measures.	2
Module-5: **Multiprocessor Architecture**	Loosely Coupled & Tightly Coupled Systems, Concurrency & Synchronization, Scalability, Models of Consistency, Application of SIMD Structure.	3
Module-6: **Interconnection Network**	Definition. Types of Interconnected Networks; Baselines, Shuffle- Exchange, Omega, Cuba, Comparison & Application.	5
Module-7: **Systolic Architecture**	Systolic processor, Mapping Algorithm to array structures, Mapping design & Optimization, Systolization Procedure	5
Module-8: **Data Flow Architecture**	Data Flow Architecture, Different forms of DFA, Data Flow Graphs, Petri nets	3
Module-9: **Programming Environment**	Different Models, Languages, Compilers, dependency Analysis. Message Passing, Program mapping to Multiprocessors, Synchronization	4
Module-10: **Case Study**	Basic Features of Current Architectural Trends. DSP Processor, Multicore Technology	2

Text book:

1. John L. Hennessey and David A. Patterson, “Computer Architecture A Quantitative Approach”, Morgan Kaufmann/ Elsevier, Fifth Edition, 2012.
2. Kai Hwang and Faye Briggs, “Computer Architecture and Parallel Processing”, Mc Graw-Hill International Edition, 2000.

Paper Code – CSM102 **Paper Name – Advances in Database Management System**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Overview of Relational Database Design**	Schema Refinement through normalization, Lossless Join decomposition, Dependency preserving decomposition**;** Data Storage & Indexing: Cost model of basic file Organizations like Heap file, Sorted file, Hashed file, Need of Indexing and Hashing, Tree Structured Indexing: ISAM, B+ Tree; Hash based Indexing: Static, Extendable, Linear Hashing schemes Physical Database design: Index selection guideline with small use cases, Database tuning through reframing schema, query, view. Brief overview on Object relational data model.	12
Module-2: **Query Processing and Optimization**	Query Evaluation: External Sorting, Evaluation of relational Operators (Select & Join) including Join algorithms, Query Optimization: Heuristic based & Cost based optimization, Structure of Query Optimizer with small use case.	10
Module-3: **Transaction Processing**	Transaction & Schedule, ACID property, Serializability, Anomalies with Interleaved execution, Conflict & View Serializability, Concurrency Control techniques: Locking and Timestamp based protocols, Multi-version and Validation based schemes, Multiple Granularity locking, Deadlock handling, Crash Recovery: ARIES, Recovery Data Structure Log, Write Ahead Logging, Check-pointing, Recovery from a system crash.	10
Module-4: **Data Warehousing**	Introduction, DW architecture, Dimensional Modelling, OLAP operations, ROLAP: Snowflake & Star Schema, Data Pre-processing like Aggregation, Sampling, Dimensionality Reduction etc.	8

Text Books:

1. Database Management Systems, Raghu Ramakrishnan, WCB/McGraw-Hill.
2. Database System Concepts, Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw-Hill.
3. Fundamentals of Database Systems, R. Elmasri and S. Navathe, Addison-Wesley.
4. Principles of Database Systems, J. D. Ullman, Galgotia.

Paper Code – CSM103 **Paper Name – Advances in Data Structure**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Fundamentals of Linear and Non-Linear Data Structures**	Review: Basic concepts about algorithms, asymptotic notations, Abstract Data Type (ADT), recursion, review of linear data structure , review of non-linear data structures- trees, binary search tree, AVL trees, sorting, searching	10
Module-2: **Advanced tree data structure**	Selection Trees, counting binary trees, Disjoint set maintenance techniques	6
Module-3: **Efficient binary search trees**	Red-Black tree, Splay trees	6
Module-4: **Advanced Data Structures**	Binomial heaps, Fibonacci heaps; Multi-way search trees: 2-3 trees, B-trees, B+-tree, Range Tree	10
Module-5: **Analysis and Applications**	Amortized analysis of algorithms. Different applications and case studies	8

Text book:

1. Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein.
2. Fundamentals of Data Structures by E. Horowitz and S. Sahni.
3. Data Structure and Algorithm Analysis in C++ by Mark Allen Weiss, Pearson
4. Data Structures and Program Design in C++ by R. L. Kruse and A. J. Ryba.
5. An Introduction to Data Structures with Applications by J.-P. Tremblay and P. G. Sorenson.
6. Algorithms + Data Structures = Programs by N. Wirth.
7. Fundamental Algorithms by D. E. Knuth.
8. Design and Analysis of Computer Algorithms by A. V. Aho, J. E. Hopcroft, and J. D. Ullmann.

Paper Code - CSM104 **Paper Name – Data Communication**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Goals of Computer Network, Networks: Classification, Components and Topology, Layered architecture of a Network software, TCP/IP model	02
Module-2: **Physical Layer**	Fourier Series, Nyquist's theorem, Data rate in Noisy channel (Shannon's theorem) Transmission media: Copper Wire, Optical fiber, Wireless (Radio, Microwave, Satellite) Base Band Transmission: Line Code, NRZ, NRZI, Manchester, AMI, 4B/5B, Balanced Code, 8B/10B Pass Band Transmission: Modulation: Amplitude, Frequency, PSK, , CDMA, Walsh code Local Loop, Modems, ADSL Circuit Switching, Packet Switching Multiplexing: Frequency division, Time division and Wave division multiplexing, Spread spectrum concepts Mobile Telephone Systems: Frequency Reuse, AMPS, GSM Byte Stuffing, Bit Stuffing Error Detection and Correction, Hamming Codes, RS code, Convolutional code, Viterbi Decoding	12
Module-3: **Data Link Layer**	ARQ, Sliding Window, Go-back-N, Selective Repeat PPP, Asymmetric Digital Subscriber Loop.	14
Module-4: **Information and Coding Theory**	Uniquely Decipherable codes, Prefix codes, Macmillan's theorem, Kraft's theorem, Hoffman Encoding, Entropy, Properties of entropy, relation between entropy and minimum average code length. d-error detecting code, d-error correcting codes, mixed error detection and correction.	12
Text book: 1. Computer Networks, Fifth Edition, A S Tanenbaum 2. Introduction to Coding and Information Theory: Steven Roman		

Paper Code – CSM105(P) **Paper Name – MODULE 1: Data Structure** **MODULE 2: Database Management System**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module 1: **Data Structure**	Implementations of different data structures: AVL Tree, 2-3 Trees, B-Trees, Hashing, Binomial, Fibonacci heap, Disjoint-set data structure. Real-life applications.	6 hours per week
Module 2: **Database Management System**	Solving Small real life problems, Database Design Using Extended E-R diagram, Front end design, PHP Database Programming, Two-tier client-server applications using JDBC or ODBC, Laboratory project. Sample problem(s): Consider a CONFERENCE_REVIEW database in which researchers submit their research papers for consideration. Reviews by reviewers are recorded for use in the paper selection process. The database system caters primarily to reviewers who record answers to evaluation questions for each paper they review and make recommendations regarding whether to accept or reject the paper. The data requirements are summarized as follows: ■ Authors of papers are uniquely identified by e-mail id. First and last names are also recorded. ■ Each paper is assigned a unique identifier by the system and is described by a title, abstract, and the name of the electronic file containing the paper. ■ A paper may have multiple authors, but one of the authors is designated as the contact author. ■ Reviewers of papers are uniquely identified by e-mail address. Each reviewer's first name, last name, phone number, affiliation, and topics of interest are also recorded. Each paper is assigned between two and four reviewers. A reviewer rates each paper assigned to him or her on a scale of 1 to 10 in four categories: technical merit, readability, originality, and relevance to the conference. Finally, each reviewer provides an overall recommendation regarding each paper. ■ Each review contains two types of written comments: one to be seen by the review committee only and the other as feedback to the author(s). Design Implement the problem for generating necessary reports. Design an ER schema for keeping track of information about votes taken in the U.S. House of Representatives during the current two-year congressional session. The database needs to keep track of each U.S. STATE's Name (e.g., 'Texas', 'New York', 'California') and include the Region of the state (whose domain is {'Northeast', 'Midwest', 'Southeast', 'Southwest', 'West'}). Each CONGRESS_PERSON in the House of Representatives is described by his or her Name, plus the District represented, the Start_date when the congressperson was first elected, and the political Party to which he or she belongs (whose domain is {'Republican', 'Democrat', 'Independent', 'Other'}). The database keeps track of each BILL (i.e., proposed law), including the Bill_name, the Date_of_vote on the bill, whether the bill Passed_or_failed (whose domain is {'Yes', 'No'}), and the Sponsor (the congressperson(s) who sponsored—that is, proposed—the bill). The database also keeps track of how each congressperson voted on each bill (domain of Vote attribute is {'Yes', 'No', 'Abstain', 'Absent'}). Implement the problem for generating necessary reports. State clearly any assumptions you make.	6 hours per week

Paper Code – CSM201 **Paper Name – Computer Networks**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Data Link Layer**	**Data Link Layer**: Overview on ARQ Protocols, MAC protocols: Dynamic Channel Allocation, Random Access Protocols like ALOHA, S-ALOHA, CSMA/CD; Controlled Access techniques like Polling, Token Passing methods, IEEE 802.X standard,	12
	Switching in Data link layer: Learning Bridge (Spanning Tree), Virtual LAN. Wireless LAN: Architecture, MAC sub-layers DCF & PCF, IEEE 802.11 Standard, Bluetooth.	
Module-2: **Network Layer**	Design issues, Routing Algorithms: Routing Table, Adaptive Routing, Unicast Routing: Distance Vector & Link State Routing, Utility of Hierarchical Routing, Broadcast Routing Techniques: Flooding, Spanning Tree, Reverse Path Forwarding; Multicast Routing: Approaches like Source Based Tree & Group Shared Tree	12
	Protocols: Network Layer Addressing (IPV4); Sub-net, Classless Addressing, Working principle of NAT; Interior Routing Protocols: RIP, OSPF; Exterior Routing: BGP (Path Vector Routing); Multicast Routing Protocols: DVMRP; Protocols: IP, ARP, DHCP, IGMP, ICMP	6
Module-3: **Higher Layer issues**	Socket Addressing: Socket, Flow Control & Error Control mechanism; Connection less & Connection Oriented protocols: UDP & TCP; Congestion Control: Causes of Congestion, Open loop & Closed loop policy, Congestion Control in TCP, Quality of Service: Characteristics & Traffic Shaping technique. Domain Name System, Application Layer Protocols for Remote Login, E-mail and File Transfer	10

Text book:

1. Computer Networks, A. S. Tenenbaum, D. J. Wetheral, Pearson India, 5th Edition, 2016.

2. Data Communications and Networking, B.A. Forouzan, Tata McGraw Hill Education Private Limited.

3. Data and Computer Communications, William Stallings, Pearson-Prentice Hall, 8th Edition.

Paper Code – CSM202 **Paper Name – Design and Analysis of Algorithms**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Graph**	Asymptotic notations, Recurrences, Graphs	2
	Breadth-first search, Depth-first search, Topological sorting, strongly connected components	2
Module-2: **Algorithm Design Techniques:**	**Divide and Conquer:** Merge sort and Quick sort Algorithm, Lower bounds for comparison based sorting, Sorting in linear time. Finding the kth smallest item (Selection algorithm, Integer multiplications.	4
	Greedy Algorithm: Dijkstra's shortest path algorithm, Minimum Spanning tree (Prim's, Kruskal's), Activity Scheduling, Huffman coding, Disjoint set data structure and amortized analysis.	8
	Dynamic Programming: Longest common subsequence problem, Matrix Chain multiplication, All pair shortest path, Knapsack problem, Optimal binary search tree	4
Module-3: **Hashing**	Hash table, hash function, open addressing, uniform hashing, universal hash functions, Perfect hashing.	4
Module-4: **NP Completeness** and related topics	**NP Completeness:** Informal concepts of deterministic and nondeterministic algorithms, P and NP, NP-completeness and reducibility, statement of Cook's theorem, some standard NP-complete problems- Clique, Travelling salesman problem, Vertex cover, Hamiltonian Cycle, 3-coloring problem.	6
	Backtracking, Branch and Bound: 3 colouring problem, 8-queens problem, knapsack problem.	4
Module-4: **Network flow and Matching Algorithms**	Maximum flow problem and the Ford Fulkerson Algorithm, Maximum flows and minimum cuts, Matching problem, Bipartite matching.	6

Text book:

1. T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi, 1998.
2. Algorithm Design, Jon Kleinberg and Eva Tardos, Pearson New International Edition.
3. Aho, J. Hopcroft and J. Ullman: The Design and Analysis of Computer Algorithms, A. W. L, International Student Edition, Singapore, 1998.
4. S. Baase: Computer Algorithms: Introduction to Design and Analysis, 2nd ed., Addison-Wesley, California, 1988.
5. E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub. /Pitman, New Delhi/London, 1987/1978.
6. K. Melhorn: Data Structures and Algorithms, Vol. 1 and Vol. 2, Springer-Verlag, Berlin, 1984.
7. D. E. Knuth: The Art of Computer Programming, Vol. 1, 2nd ed., Narosa/Addison-Wesley, New Delhi/London, 1973; Vol. 2: 2nd ed., Addison-Wesley, London, 1981; Vol. 3: Addison-Wesley, London, 1973.

Paper Code – CSM203 **Paper Name – Object Oriented Systems**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Functional programming using Java and C++: algorithms using conditions, loops and basic IO. Introduction to Object-Oriented Design and Analysis using UML and its implementation in Java and C++. In-memory architecture of JRE. Role of Garbage Collector.	6
Module-2: **OOP Basics**	Encapsulation, Inheritance, Polymorphism, Interfaces, Multiple Inheritance, Reflection and runtime type information, Exception Handling, Generic Programming and Collection Framework.	10
Module-3: **Design Pattern Basics**	Overview. Creational Design Pattern: Singleton, Abstract Factory, Builder, Factory, Lazy Initialization, Object Pool. Structural Design Pattern: Adaptor, Bridge, Composite, Flyweight. Behavioural Design Pattern: Chain of Responsibility, Command, Iterator, Observer, Strategy. Model-View-Controller Design Pattern.	16
Module-4: **Advanced Programming using OOP**	GUI programming, Concurrent programming, Network Programming, Unit Testing.	8

Textbook:

1. Object-Oriented Software Development Using Java. Xiaoping Jia. Addison Wesley, ISBN 0-201-73733-7.

References:

2. Head First Object-Oriented Analysis and Design. Brett D. McLaughlin, Gary Pollice, and Dave West. O'Reilly.
3. Head First Design Patterns. Eric Freeman and Elizabeth Freeman. O'Reilly.

Paper Code – CSM204 **Paper Name – Software Engineering**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Models & Design**	Review of SDLC models, Qualitative analysis of SDLC models, Structured Analysis and Design, Data Flow Diagrams.	3
	Model-Driven Software Engineering: Foundations of MDSE – models and transformations, driving principles, Goal models, Case studies with Use Case diagram, i-star.	4
	Requirements Engineering: RE framework, System Context, Requirement artefacts – Goals, Scenarios, Solution-oriented Requirements, Requirements elicitation, analysis, negotiation.	6
	Software Design: High-level and detailed design, issues on data design and interface design, structure chart.	4
Module-2: **Software Configuration Management**	Software Configuration Management: Software Configuration Item (SCI), Configuration Control Board (CCB), Configuration Manager (CM), Change Request (CR), SCM process, Version Management.	3
Module-3: **Software Testing**	Debugging versus Testing, White-box testing (Statement Coverage, Decision Coverage, Condition Coverage, multiple-condition coverage, Basis Path Testing, Cyclomatic Complexity, Flow Control Graph, Loop testing), Black-box testing (Cause-Effect Graph, Equivalence Class Partitioning, Boundary Value Analysis), Integration testing (Bottom-up versus Top-down testing, Stub and Driver), Regression testing, Acceptance Testing, Alpha and Beta testing.	6
Module-4: **Software Cost Estimation**	Early empirical models for software cost estimation, COCOMO and COCOMO-II cost estimation models for effort and schedule estimation, Project Planning and Scheduling, Cost estimation metrics: Size, Function Point, Object Point.	6
Module-5 **Software Quality**	Early Quality Management, Total Quality Management, Software Quality Assurance, Software Quality Control, Cost of Quality, Capability Maturity Model.	4
Module-6: **Other Project Management Issues**	Other Project Management Issues: Risk Management, Basics on Agile systems.	4

Text Books:

1. M. Davis: Software Requirements— Objects, Functions and States, Prentice Hall, Englewood Cliffs, 1993
2. G. Booch: Object-Oriented Analysis and Design, Benjamin I Cumming Publishing co., New York, 1994.
3. Budgen: Software Design, Addison-Wesley, Reading, Mass., 1994.
4. M. C. Paulk, C. V. Weber, B. Curtis and M. Beth Chrissis: The Capability Maturity Model for Improving the Software Process, Carnegie Mellon University, Addison-Wesley, Reading, Mass., 1999.
5. J. D. Musa, A. Iannino, K. Okumoto: Software Reliability -Measurement, Prediction and Application, McGraw Hill, New Delhi, 1987.
6. R. Fairly: Software Engineering Concepts, Tata McGraw Hill, New Delhi, 1999.
7. P. Jalote: An Integrated Approach to Software Engineering, 2nd ed. Narosa, New Delhi, 1997.
8. R. S. Pressman: Software Engineering: A Practitioner's Approach, 5th ed., McGraw Hill, College Div, Singapore, 2000.
9. P. Oman and S. L. Pfleeger: Applying Software Metrics, IEEE Computer Society Press, Los Alamos, California, 1996.
10. S. L. Pfleeger: Software Engineering -Theory and Practice, Prentice Hall, New York, 1998.
11. Larman: Applying UML and Patterns, Addison-Wesley, Reading, Mass., 1998.
12. Capability Maturity Model: The Guidelines for Improving the Software Process, CMU, Software Engg. Inst., 1995.

Paper Code – CSM205(P) **Paper Name – MODULE 1: Object Oriented Programming** **MODULE 2: Software Engineering**		**Full Marks: 100**
Module	**Topics**	**Laboratory Hours**
Module 1**:** **Object Oriented Program and System**	Programming with OOL: Pointers, Enumeration, References, Function Overloading, Classes and Objects, Constructors and Destructors, Self-reference-This, Operator Overloading, Derived classes and Inheritance, Virtual Function, Virtual Base Class, Strings, Template, Exception Handling, Files & Streams, Standard Library, Header Files. **Java:** Collection Framework and GUI programming using Java. Implementation of Design Patterns using java. Assignment to develop GUI based small software using collection framework and design pattern.	6 hours per week
Module 2: **Software Engineering**	Developing (Requirements Engineering, Design, Coding and Testing) a Software following the techniques covered in the theory classes. Assignments are to be prepared covering the following aspects: Identify, document, analyze and refine requirements in multiple iterations eventually to come up with a correct and good requirements specification document using IEEE/ANSI 830-1993 standard; Usage of open-source tools for data and control flow analysis (Data Flow Diagrams (DFD), Structure Chart, etc.), Behavioral model to identify scope of the software and role of users (Use Case Diagram), Preparation of Architectural and Detailed Design maintaining traceability of design artifacts, Coding using C/C++/Java/Python, Testing and Verification. The tentative use-cases may be, but not restricted to the following application domains: Hospital Management System, Passport Issue and Renewal System, Travel and Tourism Software, Online Food Delivery System, Financial Portfolio Management System, etc.	6 hours per week

Paper Code – CSM301 **Paper Name – Introduction to Soft Computing**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	What is Soft Computing? Difference between Hard and Soft computing, Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing.	4
Module-2: **Neural Networks**	What is Neural Network, Learning rules and various activation functions, Single layer Perceptrons , Back Propagation networks, Architecture of Backpropagation(BP) Networks, Backpropagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.	10
Module-3: **Fuzzy Systems**	Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification	7
Module-4: **Genetic Algorithm**	History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization.	7
Module-5: **GA based Backpropagation Networks**	GA based Weight Determination, K - factor determination in Columns	4
Module-6: **Hybrid Systems**	Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.	4
Module-7: **Fuzzy Backpropagation Networks**	LR type Fuzzy numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BP, Application of Fuzzy BP Networks.	4

Text Books:

1. S.Rajasekaran, G. A. Vijayalakshami, PHI.
2. Genetic Algorithms: Search and Optimization, E. Goldberg.
1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI.
2. Build_Neural_Network_With_MS_Excel_sample by Joe choong.

Paper Code – CSM302 **Paper Name – Advances in Operating System**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Message Passing**	Inter-process communication, group communication, broadcasting algorithms.	3
Module-2: **Distributed Shared Memory**	Architecture, consistency model, replacement strategy, thrashing, coherence.	3
Module-3: **Clock Synchronization**	Event ordering, event precedence, Logical Clock model, Vector Clock.	3
Module-4: **State Recording**	Naïve State Recording algorithm, Chandy-Lamport's state recording algorithm.	3
Module-5: **Mutual exclusion in distributed environment**	Ricart-Agrawala Algorithm, Token based ME algorithm for Ring topology, Raymond's Algorithm.	5
Module-6: **Deadlock detection for Distributed Systems**	Mitchell-Merritt Algorithm, Ho-Ramamurthy Algorithms, Termination Detection algorithm – weight-throwing algorithm, diffusion computation algorithm.	4
Module-7: **Process Management**	Process migration, Pre-emptive and non-preemptive process migration, Resource migration, Resource-Process binding, Resource-Machine binding, Challenges and limitations for creating global references for resources.	5
Module-8: **Remote Procedure Call**	RPC Model, stub generation, server management, parameter passing, call semantics, communication protocols, Client-Server binding, exception handling, security, optimization, Case study on SUN RPC.	10
Module-9: **Distributed File Systems**	System wide deployment of DFS, Client-Server model for DFS, Indexed Block model for DFS, Case study on Hadoop File System, Naming in distributed systems, directory services, DNS.	4

Text Books:

1. Mukesh Singhal, Niranjan Shivaratri: Advanced Concepts in Operating Systems, Tata McGraw-Hill Education, 2001.
2. A. S. Tanenbaum: Distributed Operating Systems, Prentice Hall of India, New Delhi, 1996.
3. G. F. Colouris, J. Dollimore and T. Kindberg: Distributed Systems: Concepts and Design, 2nd ed., Addison-Wesley, Reading, Mass., 1994.
4. S. J. Mullender (Ed.): Distributed Systems: An Advanced Course, 2nd ed., Addison-Wesley, Reading, Mass., 1993.
5. P. K. Sinha: Distributed Operating Systems, IEEE Press, Los Alamos, California, 1997.

Paper Code – CSM303 (CBCS A) **Paper Name – Theory of Computation**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Regular Languages**	Introduction: Scope of study as limits to computability and tractability. Why it suffices to consider only decision problems, equivalently, set membership problems. Notion of a formal language	1
	DFAs and notion for their acceptance, informal and then formal definitions. Class of regular languages. Closure of the class under complementation, union and intersection. Strategy for designing DFAs	3
	Pumping lemma for regular languages. Its use as an adversarial game. Generalized version. Converses of lemmas do not hold	2
	NFAs. Notion of computation trees. Definition of languages accepted. Construction of equivalent DFAs of NFAs. NFAs with epsilon transitions. Guess and check paradigm for design of NFAs	4
	Regular expressions. Proof that they capture precisely class of regular languages. Closure properties of and decision problems for regular languages; Myhill-Nerode theorem as characterization of regular languages. States minimization of DFAs	3
Module-2: **Notion of Programming Languages**	Context free languages Notion of grammars and languages generated by grammars. Equivalence of regular grammars and finite automata. Context free grammars and their parse trees. Context free languages. Ambiguity	2
	Pushdown automata (PDAs): deterministic and nondeterministic. Instantaneous descriptions of PDAs. Language acceptance by final states and by empty stack. Equivalence of these two	2
	PDAs and CFGs capture precisely the same language class	1
	Elimination of useless symbols, epsilon productions, unit productions from CFGs. Chomsky normal form	2
	Pumping lemma for CFLs and its use. Closure properties of CFLs. Decision problems for CFLs	3
Module-3: **Turing machines, R.E. languages, undecidability**	Turing machines, r.e. languages, undecidability Informal proofs that some computational problems cannot be solved	1
	Turing machines (TMs), their instantaneous descriptions. Language acceptance by TMs	5
	Hennie convention for TM transition diagrams. Robustness of the model- - equivalence of natural generalizations as well as restrictions equivalent to basic model. Church-Turing hypothesis and its foundational implications. Codes for TMs. Recursively enumerable (r.e.) and recursive languages. Existence of non-r.e. languages. Notion of undecidable problems. Universal language and universal TM. Separation of recursive and r.e. classes. Notion of reduction. Some undecidable problems of TMs. Rice's theorem.	5
	Undecidability of Post's correspondence problem (PCP), some simple applications of undecidability of PCP.	3
Modue-4: **Intractability**	Intractability Notion of tractability/feasibility. The classes NP and co-NP, their importance. Polynomial time many one reduction. Completeness under this reduction. Cook-Levin theorem: NP-completeness of propositional satisfiability, other variants of satisfiability. NP-complete problems from other domains: graphs (clique, vertex cover, independent sets, Hamiltonian cycle), number problem (partition), set cover.	4
Module-5: **Cellular Automata**	What is Cellular Automata?; Types of Cellular Automata, Rules, Applications Membrane Computing, DNA Computing	4

Books:

1. John E. Hopcroft, Rajeev Motwani and Jeffery D. Ullman, Automata Theory,
2. Languages, and Computation (3rd. Edition), Pearson Education, 2008.
3. Michael Sipser, Introduction to the Theory of Computation, Books/Cole Thomson Learning, 2001.
4. JE Hopcroft and JD Ullman, Introduction to Automata Theory, Languages, and Computation, Addison-Wesley, 1979.

Paper Code – CSM304 (CBCS B) **Paper Name – Cryptography & Network Security**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Cryptography Basics**	Possible attacks, Cipher text generation, Block & Stream Cipher, Stream Cipher generation, Algorithmic Mode, Secret Key & Public Key Encryption, Secret Key Encryption: Algorithms DES, AES with necessary Mathematical Basis, Public Key Encryption: RSA, El-gamal, Elliptic Curve algorithms with necessary mathematical analysis, Digital Signature creation techniques, Message Integrity through Hash function, Authentication techniques.	25
Module-2: **Network Security**	Security layers in Network Protocol Stack, IP Sec, Secure Socket Layer, Security protocols used in Application layer like PGP, SHTTP etc., Network Defence tools – Firewalls, Intrusion Detection, Filtering, Security in Mobile Platforms: Threats in mobile applications, analyser for mobile apps to discover security vulnerabilities.	15

Text Books:

1. Cryptography and Network Security, Sixth Edition, Wiliam Stallings, Pearson
2. Cryptography and Network Security, Special Indian Edition, B.A. Forouzan,TMH publishing Company Limited
3. Cryptography and Network Security, Atul Kahate, Tata McGraw Hill Publication
4. Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Edition, Bruce Schneier, Willy Publication

Paper Code – CSM305(P) **Paper Name – MODULE 1: Soft Computing** **MODULE-2: Operating System**		**Full Marks: 50**
Module	**Topics / Example Assignments**	**Laboratory Hours**
Module 1: **Soft Computing**	• Create a perceptron with appropriate no. of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weights. • Create a simple ADALINE network with appropriate no. of input and output nodes. Train it using delta learning rule until no change in weights is required. Output the final weights. • Train the autocorrelator by given patterns: A1=(-1,1,-1,1), A2=(1,1,1,-1), A3=(-1, -1, -1, 1). Test it using patterns: Ax=(-1,1,-1,1), Ay=(1,1,1,1), Az=(-1,-1,-1,-1). • Train the hetrocorrelator using multiple training encoding strategy for given patterns: o A1=(000111001) B1=(010000111), A2=(111001110) B2=(100000001), A3=(110110101) o B3(101001010). Test it using pattern A2. • Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations. • Solve Greg Viot's fuzzy cruise controller using open source toolbox. • Solve Air Conditioner Controller using open source • Implement TSP using GA.	6 per week
Module 2: **Advanced Operating System**	Programming involving RPC, Process management, Threads, etc.	6 per week

Paper Code – CSM306(P) **Paper Name – Project Work (Minor)**		**Full Marks: 50**
		10 hours per week

General Guidelines:

Students are to undertake topic in consultation with supervisor to explore the domain for new idea/current status/improvement

Marks Distribution:

d) Literature/System/Technology/application Domain Survey : 20

e) Problem Formulation / Deliverables : 10

f) Technical Report Writing: : 10

g) Presentation & Viva Voce : 10

Paper Code – CSM401(01) **Paper Name – Cloud Computing (Elective-I)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction to Cloud Computing**	Cloud computing at a glance – The vision of cloud computing, Definition of cloud computing, The cloud computing reference model, Characteristics and benefits of cloud computing. Evolution of cloud computing – parallel computing, distributed computing, cluster computing, grid computing, virtualization, Web 2.0, Client/Server computing, P2P computing, service-oriented computing and utility-oriented computing. Business driver for adopting cloud computing. Cloud Service Models – IaaS, PaaS, SaaS, XaaS. Cloud Deployment Models – Private, Public, Hybrid, Community, Cloud Federation.	5
Module-2: **Virtualization Technologies**	Introduction to virtualization. Characteristics of virtualized environment – Security, Managed execution, Portability. Types of Virtualization – Bare Metal and Hosted. Hardware level virtualization – Machine(x86) reference model, Hypervisor, Hardware assisted virtualization, Full virtualization, Paravirtualization. Operating system level virtualization. Other types of virtualization – storage virtualization, Network virtualization, Desktop virtualization. VM Migration techniques. Pros and cons of virtualization. Case studies – Xen, VMware and Microsoft Hyper-V.	10
Module-3: **Cloud Services and Platforms**	Compute service – Amazon EC2, Google Compute Engine, Windows Azure VM. Storage Services – Amazon S3, Google Cloud Storage, Windows Azure Storage. Database Services – Amazon RDS, Amazon SimpleDB and DynamoDB, Google Coud SQL, Google Cloud Datastore, Windows Azure SQL Database and Table Service. Application Services – Amazon SQS, Amazon SNS, Email service. Content Delivery Services – Amazon CludFrnt, Windows Azure Content Delivery Network. Analytics Services – Amazon EMR, Google BigQuery, Windows Azure HDInsight. Deployment and Management Services – Amazon Elastic Beanstalk, Amazon CloudFormation. Open Source Cloud Platform – CloudStack, Eucalyptus, OpenStack.	10
Module-4: **Management of Cloud Resources**	Lifecycle management of cloud applications. Monitoring cloud resources – Zabix, Amazon CloudWatch. Feedback control based on dynamic thresholds, Bag-of-Task (BoT) scheduling problems, VM Placement problems, Resource bundling, combinatorial auctions, fair queuing, borrowed virtual time, Cloud scheduling subject to deadlines, Cost and Energy Efficient Scheduling algorithms, Scheduling in Federated environment. Identity and Access management for Cloud Resources – Amazon Identity and Access Management Services, Windows Azure Active Directory.	15

Text Books:

1. Mastering Cloud Computing - Foundations and Applications Programming by Christian Vecchiola, Rajkumar Buyya, and S. Thamarai Selvi, Elsevier, 2013.
2. Cloud Computing – A Hands-on Approach by Arshdeep Bahga and Vijay Madasetti, Universities Press, 2014.

Reference Books:

1. Cloud Computing Bible by Barrie Sosinsky, Wiley-India, 2010.
2. Cloud Computing: Principles and Paradigms by Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2014.
3. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012.
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010.

Paper Code – CSM401(02) **Paper Name – Wireless Sensor Network (Elective-I)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Commercially available sensor nodes - Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot, node – architecture, sensing and communication range, design issues, energy consumption, clustering of sensors, applications, sensor deployment, scheduling and coverage issues.	8
Module-2: **Medium Access Control Protocols**	Fundamentals of MAC protocols – Low duty cycle protocols and wakeup concepts – Contention-based protocols – Schedule-based protocols – SMAC – BMAC – Traffic-adaptive medium access protocol (TRAMA) – The IEEE 802.15.4 MAC protocol.	10
Module-3: **Routing And Data Gathering Protocols**	Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing – Gradient-based routing – Rumour Routing – COUGAR – ACQUIRE – Hierarchical Routing – LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP – Data aggregation – data aggregation operations – Aggregate Queries in Sensor Networks – Aggregation Techniques – TAG, Tiny DB, Energy efficient routing.	15
Module-4: **Embedded Operating Systems**	Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM.	7

Text Books:

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, “Wireless Sensor Networks Technology, Protocols, and Applications”, John Wiley & Sons, 2007.
2. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, Ltd, 2005.
3. K. Akkaya and M. Younis, “A survey of routing protocols in wireless sensor networks”, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
4. Philip Levis, “TinyOS Programming”
5. Holger Karl & Andreas Willig, “ Protocols and Architectures for Wireless Sensor Networks” , John Wiley, 2005.
6. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach”, Elsevier, 2007.
7. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks - Technology, Protocols, And Applications”, John Wiley, 2007.
8. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

Paper Code – CSM401(03) **Paper Name - VLSI Design (Elective-I)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction to VLSI System Design**	MOS Devices, Circuits and Fabrication, Design Principles and Characteristics of MOS Devices in Logic Circuits, Logic Implementation with nMOS, pMOS, CMOS, and PLAs, Pass and Transmission Logic of Transistors, Size and Complexity of Integrated Circuits, Feature Size, Impact of Shrinking, Clocking, Scaling, PLA Minimization and Folding, Inverters and Logic Gates, Design Rules and Layouts, Stick Diagram, Transistor Sizing.	10
Module-2: **Logic Design**	Static nMOS and CMOS Circuits, Steering Logic, Dynamic CMOS Circuits, Static vs. Dynamic CMOS Designs, Domino and NORA Logic Circuits, Charge Sharing, Clock Generation and Distribution, Transmission Gates.	8
Module-3: **VLSI Design Process**	System Specification, Functional Design, Logic Design, Circuit Design, Physical Design, Verification, Fabrication and Packaging.	4
Module-4: **Design Styles**	Custom Design, Standard-Cell Design, Gate-Array Design, FPGA, and MCMs.	4
Module-5: **Physical Design Issues**	Partitioning, Floor-Planning and Placement, Routing, Compaction, Complexity Issues, Algorithms and Data Structures for Layout Designs.	14

Text Books:

1. Principles of CMOS VLSI Design. N. Weste and K. Eshraghian. Addison Wesley; 2nd edition (December 20, 2000).
2. Basic VLSI Design. D. A. Pucknell and K. Eshraghian. Pearson College Div., Subsequent edition (January 1, 1995).
3. An Introduction to VLSI Physical Design. M. Sarrafzadeh and C. K. Wong. McGraw-Hill College (February 21, 1996).
4. Algorithms for VLSI Physical Design Automation. N. A. Sherwani. Springer; 3rd edition (November 30, 1998).
5. Multi-Layer Channel Routing: Complexity and Algorithms. R. K. Pal. Narosa, 1st edition (September 28, 2000).

Paper Code – CSM401(04) **Paper Name – Compiler Design (Elective-I)**		**Full Marks 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction to Compiling**	Introduction, Analysis-synthesis model, Phases of the compiler.	2
	Lexical Analysis: Role of lexical analyser, Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of tokens, Finite automata, regular expression to an NFA conversion, From a regular expression to NFA, From a regular expression to DFA, Design of a lexical analyser generator (LEX).	5
Module-2: **Syntax Analysis**	The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, Non-recursive Predictive parsing (LL), Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR, LALR), Parser generators (YACC). Error Recovery strategies for different parsing techniques.	8
	Syntax directed translation: Syntax directed definitions, Construction of syntax trees, Bottom-up evaluation of S attributed definitions, L-attributed definitions, and Bottom-up evaluation of inherited attributes.	5
Module-3: **Type checking**	Type checking: Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions	3
	Run time environments: Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Storage organization (Subdivision of run-time memory, Activation records), Storage allocation strategies, Parameter passing (call by value, call by reference, copy restore, call by name), Symbol tables, dynamic storage allocation techniques.	4
Module-4: **Intermediate code generation**	Intermediate code generation: Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).	4
Module-5: **Run Time Environment and Code Generation**	Storage Organization, Stack allocation Space, Access to Non local Data on the Stack, Heap Management- Issues in the design of code generator, a simple code generator, Register allocation & assignment.	4
Module-6: **Code optimization**	Code optimization: Introduction, Basic blocks & flow graphs, Transformation of basic blocks, Dag representation of basic blocks, the principle sources of optimization, Loops in flow graph, Peephole optimization.	5
Text Books: Aho, Sethi, Ullman – "Compiler Principles, Techniques and Tools" - Pearson Publication.		

Paper Code – CSM401(05) **Paper Name – Embedded System (Elective-I)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction to Embedded Systems**	Range of embedded systems --- CPU size and complexity; memory size; I/O handling variations; use of OS-es with single or multitasking. Interfacing in embedded systems --- Parallel interfacing and parallel bus with study of the PCI bus; serial interfacing standards like I2C, SPI, etc.; serial communication using Rs232C/RS485; the USB concept. Embedded systems design cycle --- From idea conception to marketing; reference designs; detailed design; hardware bring-up; flashing code into CPU; debugging; in-circuit emulation; boundary scanning; introduction to JTAG.	14
Module-2: **Microcontrollers used in Embedded Systems**	Some 8-bit microcontrollers --- 8051 as a historical study; ATMEGA 328. Some 16/32-bit microcontrollers --- ARM cortex, DSP-s; combos (OMAP, Qualcomm multi-cores, etc.). Input and Output --- Interrupts and service routines; DMA; 'deferred' interrupts; case study with serial I/O.	12
Module-3: **Aspects of Real-Time Operating Systems (RTOS)**	Introduction to RTOS --- Soft versus hard real-time; concept of deadline; coding discipline under RTOS. Study of some RTOS-es --- Some suitable examples like eCos, RT-Linux, Windows CE, etc.	5
Module-4: **Software Development for Embedded Systems (under and OS)**	Device Driver Concepts --- Introduction to device drivers; module versus port drivers; handling interrupts and MA; virtual to physical address translation; case study with a serial driver. Introduction to firmware, middleware, code-libraries, etc.	9

Text Books:

1. Wayne Wolf, Computers as Components-principles of Embedded computer system design, Elsevier.
2. Kenneth J. Ayala, The 8051 Microcontroller, Third Edition, Thomson.
3. Labrosse, Embedding system building blocks, via CMP publishers.
4. Michael Barr and Anthony Massa, Programming Embedded Systems: With C and GNU Development Tools, O'Reilly Media.
5. Jonathan Corbet, Alessandro Rubini and Greg Kroah-Hartman, Linux Device Drivers, 3rd Edition, O'Reilly Media.
6. Jean J. Labrosse, MicroC OS II: The Real Time Kernel (With CD-ROM) by Micrium Press.

Paper Code – CSM402(01) **Paper Name – Introduction to Data Science (Elective-II)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	What is Data Science? ; Big Data and Data Science; Datafication; Current landscape of perspectives; - Skill sets needed	3
	Statistical Inference: Populations and samples; Statistical modelling, probability distributions; fitting a model; Introduction to R	3
	Exploratory Data Analysis and the Data Science Process; Basic tools (plots, graphs and summary statistics) of EDA; - Philosophy of EDA; The Data Science Process; Case Studies	2
Module-2: **Three Basic Machine Learning Algorithms**	Linear Regression; k-Nearest Neighbors (k-NN); k-means One More Machine Learning Algorithm and Usage in applications Motivating application: Filtering Spam Why Linear Regression and k-NN are poor choices for Filtering Spam Naive Bayes and why it works for Filtering Spam Data Wrangling: APIs and other tools for scrapping the Web	8
Module-4: **Recommendation Systems: Building a User-Facing Data Product**	Feature Generation and Feature Selection (Extracting Meaning from Data) Motivating application: user (customer) retention Feature Generation (brainstorming, role of domain expertise, and place for imagination) Feature Selection algorithms Filters; Wrappers; Decision Trees; Random Forests Algorithmic ingredients of a Recommendation Engine Dimensionality Reduction Singular Value Decomposition Principal Component Analysis Exercise: build your own recommendation system	8
Module-5: **Mining Social-Network Graphs**	Social networks as graphs Clustering of graphs Direct discovery of communities in graphs Partitioning of graphs Neighbourhood properties in graphs	6
Module-6: **Data Visualization**	Basic principles; ideas and tools for data visualization Examples of inspiring (industry) projects Exercise: create your own visualization of a complex dataset	6
Module-7: **Data Science and Ethical Issues**	Discussions on privacy, security, ethics A look back at Data Science Next-generation data scientists	4

Text Book:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from the Frontline. O'Reilly. 2014.

Additional references and books:

1. Jure Leskovek, Anand Rajaraman and Jefffey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.
3. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
4. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009. (free online)
5. Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science.
6. Mohammed J. Zaki andWagner Miera Jr. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press. 2014.
7. Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011

Paper Code – CSM402(02) **Paper Name – Image Processing (Elective-II)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display.	4
Module-2: **Digital Image Formation**	A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non uniform.	4
Module-3: **Mathematical Preliminaries**	Neighbour of pixels, Connectivity, Relations, Equivalence & Transitive Closure; Distance Measures, Arithmetic/Logic Operations, Fourier Transformation, Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform.	10
Module-4: **Image Enhancement**	Spatial Domain Method, Frequency Domain Method, Contrast Enhancement -Linear & Nonlinear Stretching, Histogram Processing; Smoothing - Image Averaging, Mean Filter, Low-pass Filtering; Image Sharpening. High-pass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering; Enhancement in the frequency domain - Low pass filtering, High pass filtering.	8
Module-5: **Image Restoration**	Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Restoration, Geometric Transformation - Spatial Transformation, Gray Level Interpolation.	7
Module-6: **Image Segmentation**	Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection - Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel Aggregation, Region Splitting & Merging.	7

Text Books:

3. Digital Image Processing; by Gonzalez, Woods, Eddins; Pearson Publication
4. Fundamentals of Digital Image Processing; by Anil K Jain; PHI Publication

Paper Code – CSM402(3) **Paper Name – Internet Technology (Elective-II)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction to Internet**	Introduction to Internet: Network layer for Internet,	2
	CIDR : Address assignment and Routing, NAT Client-Server and P2P architecture; N-tiered system, MVC architecture DNS	6
Module-2: **Internet applications**	Internet applications: FTP, Telnet, Email, Chat; World Wide Web: Web server (apache), browser: plug-ins, helper applications, HTTP protocol. Designing web pages: HTML, CSS, javascript, jquery.	10
	Server Side Programming: PHP, JSP, servlets, Web services: SOAP, UDDI, XML, XML schema, SOA Content Delivery: Proxy Server, Server Farm, CDN, bit-torrent systems. Distributed hashing	16
Module-3: **Search Mechanisms**	Search Mechanisms: Search Engine, Crawler Technology, Filtering Technology Content based Searching, Agent Technology, Internet Robot.	6

Text book:

1. A S Tanenbaum and D J Wetheral: Computer Networks , Pearson
2. C. S. Horstmann and G. Cornell: Core Java 2, Vol. 1: Fundamentals, Prentice Hall, Englewood Cliffs, 1998.
3. Jacob Sebastian, The Art of XSD: SQL Server XML Schema, Simple Talk Publishing, 2009

Paper Code – CSM402(04) **Paper Name – Introduction to Data Mining (Elective-II)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Motivation, Definition, Data Mining Functionalities: Association, Classification, Clustering, Outlier Analysis, Challenges in DM like Scalability, Missing data handling etc, DM in KDD process, Data Pre-processing: Summarization, Cleaning, Integration, Reduction Motivation, Definition, Data Mining Functionalities: Summarization, Association, Classification, Clustering, Outlier Analysis, Challenges in DM like Scalability, Missing data handling, etc., DM in KDD process.	4
Module-2: **Association Rules**	Concepts and Definitions like Support, Frequent Set etc, Association Rule, Support-Confidence Measure, Discovering Association rules, Apriori Algorithm, FP tree Growth Algorithm, Interestingness measure for evaluation of rules	6
Module-3: **Classification**	Concepts and Definitions like Support, Frequent Set etc., Association Rule, Support-Confidence Measure, Discovering Association rules, Apriori Algorithm, FP tree Growth Algorithm, Interestingness measure for evaluation of rules.	6
Module-4: **Classification**	Classification problem, Classification techniques through supervised learning, **Decision tree**: Concept, Tree Construction (Top-down approach), Best Split & Entropy, Decision Tree extension, Pruning, **Bayes Classifier:** Class conditional probability, Posterior Probability, Multivariate Bayes, Naïve Bayesian Classification, Conditional independence, **Support Vector Machine**: Linear Discriminant, Hyperplane, Support vector, **K nearest neighbour Classifier, Classification by back-propagation, Classifier accuracy measure**	14
Module-5: **Clustering**	Cluster Analysis Problem, Partitioning, Classical approach: K-means & K-medoids, Density based methods: DBSCAN, Hierarchical Clustering approach: Agglomerative clustering, Outlier analysis	6
Module-6: **Applications in Data Mining**	Discussion on use cases like Financial data Analysis, Biological data Analysis etc.	4

Text Books:

1. Han, J., Kamber, M., & Pei, J., Data mining: Concepts and techniques (3rd ed.). Morgan Kaufmann, 2011.
2. A. K. Pujari: Data Mining Techniques, Fourth Edition, Universities Press,
3. D. J. Hand, H. Mannila and P. Smyth: Principles of Data Mining, MIT Press
4. 4. M. Berry and G. Linoff: Mastering Data Mining, John Wiley & Sons

Paper Code – CSM402(05) **Paper Name – Statistics for Computer Science (Elective-II)**		**Full Marks: 100**
Module	**Topics**	**Lecture Hours**
Module-1: **Introduction**	Statistics and its founding laws, population, sample, parameter, statistic, measures of central tendency, measures of dispersion, moments, skewness, kurtosis	4
Module-2: **Probability**	Probability, Laws of probability, Independence, Bayes' theorem. Geometric probability	6
Module-3: **Random Variable**	Random variable, Mathematical expectation, Cauchy- Schwarz inequality, Chebyshev inequality, Law of Large Numbers.	4
Module-4: **Data Distribution-1**	Binomial, Poisson, Hypergeometric distributions, Uniform, Exponential and Normal distributions, Chi-square distribution, t-distribution, F-distribution, Central Limit Theorem	6
Module-5: **Data Distribution-2**	Bivariate distribution, conditional and marginal distributions, Independence, Correlation Analysis, Regression Analysis	10
Module-6: **Statistical Data Modeling**	Stochastic Process, Markov Chain, Queuing Theory	10

Text Books:

1. Probability Theory by Hoel, Port and Stone
2. Stochastic Process by Hoel, Port and Stone
3. Probability Theory by Feller
4. Probability by Loeve
5. Statistics by Mood,Graybill & Boes
6. Mathematical Statistics by Hogg and Craig
7. Computer Application in Statistical work by Liping.

Paper Code – CSM403(P) **Paper Name – Seminar**		**Full Marks: 50**

General Guidelines:

Individual Topic will be given to students. Students are to submit a copy of the report with all reference materials. Reports should be checked for plagiarism.

Paper Code – CSM404(P) **Paper Name – General Viva-Voce**		**Full Marks: 50**

General Guidelines:

Examination will be conducted by a board of external experts.

Paper Code – CSM405(P) **Paper Name – Project Work (Major)**		**Full Marks: 200**

General Guidelines:

In the 4th Semester **Major Project** break up with marks allocation is as follows:

e) Methodology: 80 marks

f) Evaluation/Implementation: 40 marks

g) Documentation/Report Writing with plagiarism checking: 30 marks

h) Presentation & Viva-voce 50 marks

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(Draft copy of Marksheet)

UNIVERSITY OF CALCUTTA

(Document no)

(College Name)

UNIVERSITY LOGO

Master of Science (M.Sc.) in Computer Science
First Semester Examination, …….. (year)

The following is the statement of marks obtained by ………………………………….. (Name)
Roll No. : …………………….. , Registration No.: ……………………… at the aforesaid Examination, ……..(Year)
(held in …………… (month and year of examination)) in **Computer Science**.

Paper Code	Paper Name	Full Marks	Marks Obtained	Paper Total		Credit	Grade Point	Grade
				Full Marks	Marks Obtained			
xxxxxx	**Theoretical** xxxxxxxxxxxxxxxxxxxxxxxxx Mid Semester End Semester	30 70	………… …………	100	……….		……..	……..
xxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxx Mid Semester End Semester	30 70	………… …………	100	……….		……..	……..
xxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxx Mid Semester End Semester	30 70	………… …………	100	……….		……..	……..
xxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxx Mid Semester End Semester	30 70	………… …………	100	……….		……..	……..
	Theoretical Total			……….	………			
xxxxxx	**Practical** xxxxxxxxxxxxxxxxxxxxxxxxx Internal Assessment End Semester	60 40	……….. ………..	100	…………. .		………..	……… .
	Practical Total			……..	…………			

Q -Qualified for Next Semester

XP1 -Qualified for next Semester with one Supplementary

XP2 - Qualified for next Semester with two Supplementary

F -Failed

% of Marks	Grade	Explanation	Grade Point (P)
90-100	O	Outstanding	10
80-89	A	Excellent	9
70 -79	B	Very Good	8
60-69	C	Good	7
50-59	D	Satisfactory	6
40-49	E	Fair	5
00-39	F	Fail	0
Absent		AB	0

SEMESTER SUMMARY SHEET

Total Credit	Full Marks	Grand Total	SGPA	Result

(**Controller of Examinations**)

Note:

1. All underlined texts are to be omitted and corresponding data will be placed
2. If theoretical paper is elective the name format will be xxxxxxxxxxx (Elective-I) or (Elective-II)

Course Code (CSM401)	Elective -I
01	Cloud Computing
02	Wireless Sensor network
03	VLSI Design
04	Compiler Design
05	Embedded System
Course Code (CSM402)	Elective-II
01	Introduction to Data Science
02	Image Processing
03	Internet Technology
04	Introduction Data Mining
05	Statistics for Computer Science